University of Nova Gorica
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DETERMINATION OF SPRAY DEPOSIT ON DIFFERENT COLLECTORS

Master Thesis

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In serious trouble, clench your teeth, look at the sun and smile.

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V hudih težavah v sonček poglej, stisni zobe in se nasmej.

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ABSTRACT

Four preventive fungicides against downy mildew (*Plasmopara viticola* (Berk & Curt.) Berl. & de Toni), all containing copper in the form of copper hydroxide as active ingredient, were used in seven treatments (plots) of vineyard at different application rates of plant protection products and different water volumes per hectare. The test was performed using a standard axial vineyard sprayer.

We assessed the effect of treatments on the downy mildew infection of vine grapes and vine leaves, as well as the effect of treatments on the deposit of the active substance (determined as copper ion deposit), spray coverage and impact density for different collectors. Copper ion deposit, spray coverage and impact density were determined using standard analytical procedures: atomic absorption spectroscopy (AAS), and routine computer assisted image analysis (Optomax V image analyser).

The field trial was carried out during the 2002 growing season. One of the major emphases of the study was the dynamics of the copper ion deposit on vine leaves for the seven treatments in relation to the application date – four applications in ten-day-intervals from 20 July to 19 August. Samples were taken before and after each application, the sampling height ranging from 1.0 m to 1.6 m (1.0 m being the height of the second and 1.6 m that of the fourth wire in the vineyard). Copper ion deposit was studied also on filter papers, while spray coverage and impact density were assessed using water-sensitive papers (WSP). Artificial collectors (filter papers as well as water-sensitive papers) were placed on two sampling heights (1.0 m and 1.6 m) on upper as well as on the lower side of the leaves.

In our case, the biological efficacy of the four plant protection products (Cuprablau Z, Cuprablau Z Ultra, Champion 50 WP, Kocide DF) used against downy mildew was excellent (98 % for grapes and 97 % for leaves). There was no statistically significant difference between treatments for the amount of copper ions in vine grapes.

The amount of copper ions on green leaves increased from the first to the fourth application. There is some indication that, on the average, Champion 50 WP and possibly Kocide DF suffered more wash-off of copper ion deposit (53 % and 49 % respectively) compared to Cuprablau Z (43 %) and Cuprablau Z Ultra (42 %).

The copper ion deposit on filter papers was always considerably higher on the upper leaf-side compared to the lower leaf-side, the deposit showed no statistically significant differences as to the height in the canopy. The spray coverage of WSP-s was better for high water volume (1000 L ha^{-1}) compared to low water volume (400 L ha^{-1}) and impact density on WSP-s was lower for the high water volume compared to the low water volume.

All these measurements taken together indicate that when using a preventive fungicide in a vineyard one should take into account optimal plant protection effect (i. e. minimum wash out, optimal distribution) as well as environmental considerations (i. e. minimum application rates of copper ions). No single set of deposit measurements, especially not that on artificial collectors can be considered decisive for meaningful interpretation, it can only solve a single, well-defined technical question.

Key words: spray deposit, natural collectors, artificial collectors, spray coverage, impact density, downy mildew, preventive fungicides

IZVLEČEK

Testirali smo štiri bakrove fugicide, ki se splošno uporabljajo za preventivna škropljenja proti peronospori vinske trte (*Plasmopara viticola* (Berk & Curt.) Berl. & de Toni). V vseh primerih je bila aktivna snov bakrov hidroksid. Poskus je zajel sedem različnih obravnavanj, pri čemer smo spreminjali odmerek fitofarmacevtskega sredstva in količino vode na hektar. Pršenje vinske trte smo izvedli s standardnim aksialnim vinogradniškim pršilnikom.

Ocenjevali smo vpliv obravnavanj na okužbo grozdov in listov s peronosporo vinske trte, predvsem pa vpliv obravnavanj na depozit fitofarmacevtskega sredstva (ki smo ga določali kot depozit bakrovih ionov), na pokrovnost in na gostoto zadetkov (angl. impact density) za različne kolektorje. Določanja depozita, pokrovnosti in gostote zadetkov smo izvajali z že uveljavljenimi tehnikami (metodami): z atomsko absorpcijsko spektroskopijo (AAS) in z računalniški programi za slikovno analizo (Optomax V image analyser).

Študijo smo izvajali v rastni sezoni 2002. Z določevanjem depozita bakrovih ionov na zelenih listih za sedem obravnavanj smo ocenjevali tudi spiranje fitofarmacevstega sredstva v času štirih škropljenj v desetdnevnih intervalih v času od 20. julija do 19. avgusta. Naravne kolektorje (zelene liste) smo vzorčili pred škropljenjem in po njem, na višini od 1,0 m do 1,6 m (med drugo in četrto žico v vinogradu). Depozit bakrovih ionov smo določali tudi na umetnih kolektorjih (lističi filtrirnega papirja), za določanje pokrovnosti in gostote zadetkov pa smo uporabili indikatorske lističe (na vodo občutljivi lističi, WSP). Umetne kolektorje (lističe filtrirnega papirja in indikatorske lističe) smo namestili v dveh višinah (1,0 m in 1,6 m) na zgornji in na spodnji strani zelenih listov.

Pri vseh obravnavanjih (Cuprablau Z, Cuprablau Z Ultra, Champion 50 WP, Kocide DF) je bila zaščita pred peronosporo vinske trte skoraj popolna (98 % za grozde in 97 % za liste). Vsebnost bakrovih ionov v grozdih se ni v nobenem primeru statistično signifikantno razlikovala od povprečne vsebnosti vseh obravnavanj.

Vsebnost bakrovih ionov na zelenih listih je bila od prvega do četrtega škropljenja vse večja. Vrednosti kažejo, da je spiranje za Champion 50 WP in morda za Kocide DF (53 % oz. 49 %) nekoliko večje kot za Cuprablau Z (43 %) in Cuprablau Z Ultra (42 %).

Depozit bakrovih ionov je bil vedno precej večji na zgornji strani listov v primerjavi s spodnjo stranjo, ni pa bil odvisen od višine na rastlini. Pokrovnost je bila večja pri večji porabi vode (1000 L ha^{-1}) v primerjavi z zmanjšano količino vode (400 L ha^{-1}), gostota zadetkov na indikatorskih lističih pa je bila pri večji porabi vode manjša.

Zbrani podatki kot celota kažejo, da moramo pri izbiri preventivnega fungicida za škropljenje vinograda upoštevati tako vidik varstva rastlin (tj. minimalno spiranje in optimalno razporeditev) kot tudi vpliv na okolje (tj. kar najmanjši vnos bakrovih ionov v okolje). Posamezne skupine meritev, posebno tiste na umetnih kolektorjih, niso dovolj povedne za celovito interpretacijo, lahko pa dajo odgovor na posamezna tehnična vprašanja.

Ključne besede: depozit, naravni kolektorji, umetni kolektorji, pokrovnost, gostota zadetkov, peronospora vinske trte, preventivni fungicidi

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CODES AND ABBREVIATIONS

Code:	Explanation:
0con	Control or untreated plot
1CuZ	Cuprablau Z, 3.0 kg ha^{-1} and spray volume 400 L ha^{-1}
2CuZU	Cuprablau Z Ultra, 2.5 kg ha^{-1} and spray volume 400 L ha^{-1}
3CuZU	Cuprablau Z Ultra, 2.5 kg ha^{-1} and spray volume 1000 L ha^{-1}
4Cha	Champion 50 WP, 2.5 kg ha^{-1} and spray volume 400 L ha^{-1}
5Koc	Kocide DF, 2.0 kg ha^{-1} and spray volume 400 L ha^{-1}
6Cha	Champion 50 WP, 2.0 kg ha^{-1} and spray volume 400 L ha^{-1}
7Koc	Kocide DF, 2.5 kg ha^{-1} and spray volume 400 L ha^{-1}

Abbreviation:	Explanation:
AAS	Atomic absorbtion spectroscopy
AD	Application date
AR	Application rate
AS	Active substance
BBCH	Biologische Bundesanatalt, Bundessortenamt and Chemical industry
CV	Coefficient of variation
EC	Emulsifiable concentrate
EPPO	European and Mediterranean Plant Protection Organization
F	Formulation
GLM	General Linear Models
ICP	Inductively coupled plasma
IHPS	Slovenian Institute of Hop Research and Brewing
IPM	Integrated pest (and disease) management
LS	Leaf-side
MB	Maribor
OSP	Oil-sensitive paper
PLASVI	*Plasmopara viticola*
PPP	Plant protection product
R	Replication
SAS	SAS Institute Inc.
SC	Suspension concentrate
SD	Standard deviation
SH	Sampling height
ST	Sampling time
T	Treatment
TCode	Treatment code
VMD	Volume median diameter
WG	Water dispersible granules
WP	Wettable powder
WSP	Water-sensitive paper

Trade and company names used in this thesis are solely for providing specific information. Their mention does not constitute an endorsement over other products not mentioned.

1 INTRODUCTION

Plant protection is one of the fundamental measures in modern agriculture production and it is especially important for quality and sufficient yields of the cultivated plants. Since modern consumers demand a good supply and a wide choice of quality food throughout the year, it would not be possible to maintain the expected supply and quality without using plant protection products. Plant protection products are active substances and preparations containing one or more active substances, put up in the form in which they are supplied to the user, intended to: protect plants or plant products against all harmful organisms or prevent the action of such organisms; influence the life processes of plants, other than as a nutrient, (e.g. growth regulators); preserve plant products; destroy undesired plants or destroy parts of plants, check or prevent undesired growth of plants. The main purpose of the use of plant protection products in agriculture production is to control the pests which are harmful to the cultivated plants. However, the incorrect and uncontrolled use of plant protection products can cause damage to people because of unadequate yields and quality, to wild life with undesired effects on non-target species, and to environment because of direct pollution.

The Plant Protection Products Directive (91/414/EEC) adopted by the Council of Ministers on 15 July 1991, concerning the placing of plant protection products on the market, regulates the field of their use and in connection with this all the necessary documentation, which is required for their authorisation. The aim of mentioned Directive is to protect human health, biotic and abiotic compartments of the environment in context to the use of plant protection products.

The modern studies on the area of plant protection products are directed to the development of the methods used to determine the deposit of plant protection products in order to reduce their direct environmental impact.

1.1 General remarks on the deposit of plant protection products and its determination

Protection of foliage and developing bunches of grapevine from attack of various pests and especially fungal pathogens, is essential for the production of adequate yields of good-quality grapes, and especially for adequate vinification. Correct application of any plant protection product, usually as spray, is a fundamental necessity for the crop, and is often specified in detail by advisory services concerned with the maintenance of the highest quality of the product. For protection against some of the most important diseases, a programme of fungicide sprays serves as a rule in most circumstances (European and Mediterranean Plant Protection Organizaton (EPPO), 2002). Use of biological control agents has little place in the protection of grapevine, mainly because the most important pests are fungi. Use of resistant grapevine cultivars has a limited potential as well, because the production of high-quality wines depends in many cases on the use of certain traditional cultivars. These cultivars may be very susceptible to the main diseases, and have to be protected by chemical treatment. In general, *vinifera* (*Vitis vinifera* L. subsp. *sativa*) – i.e. European varieties are much more susceptible than American types, and the French hybrids are of somewhat intermediate susceptibility (Ellis, 1994). Riesling (Rheinriesling) which was the cultivar in our field trial (in the case where the infections of grapes and leaves were evaluated and also in the case where the spray deposit on different collectors was determined), is one of the intermediate susceptible cultivars to downy mildew.

Biological efficacy, in spite of being very important for the grower, is by itself a method which is not informative enough for the evaluation of spray technique from the cognitive point of view. It is so because it does not tell about effective use of chemicals and especially not about the uniformity of the spray distribution and the possible overdosing of spray neither about the off-target loss. Besides, efficacy experiments are very costly, time consuming and requiring a lot of space in the field (Holownicki *et al*., 2002). Many fruit growers are trying to apply chemicals in the most efficient and cost effective manner and wherever possible they are moving to integrated pest (and disease) management (IPM) strategies, where the use of pesticide is generally minimised and monitored by a board of experts. Many are also changing the wasteful high-volume spraying, either to or past the point of run-off, for more efficient and cheaper low-volume spraying. Efficient concentrate spraying also reduces off-target environmental contamination (Furness *et al*., 1998). Because of high costs and time consuming work the biological experiments are often applied only for the final verification of technical assessments of spraying techniques. The measurements of the spray deposit and those of the coverage give either absolute or relative data about the spray distribution within the crop canopy (Holownicki *et al*., 2002). A high correlation between the deposit and the sprayer characteristics has been verified (De Moor *et al*., 2000a; De Moor *et al*., 2000b; Salyani and Fox, 1994). The data about the deposit of pesticides on treated plants, (their dependence on the way of application, on spray volume, on timing of the application, on choice of spray formulation, on type of equipment, on calibration of equipment, on weather and on other conditions) are of great importance (Kač, 1993; Pergher, 1997; Praat *et al*., 1996; Hoffmann and Salyani, 1994). For this reason, the spray deposit is often measured by the means of several quantitative methods and expressed as amount of spray per area unit (Cross *et al*., 1997b; Salyani and Fox, 1994). These methods usually use tracers which can be easily analysed (Holownicki *et al*., 2002).

The use of a copper as spray tracer was first reported by Large in 1940 (Large, 1940 *op cit* Cooke and Hislop, 1993. Meanwhile, the use of a fluorescent tracer was first reported by Sharp in 1955 (Sharp, 1955) and the method has been very much appreciated for its accuracy, additionally the analysis was simple and fast (Salyani and Withney, 1988; Holownicki *et al*., 1996; Huijsmans *et al*., 1993). Visible or fluorescence dyes are widely used in spray deposit experiments. Even three different tracers with different spectra can be sprayed on trees during consecutive passes. Using three water-soluble tracers allows a direct comparison of three different treatments on the same samples (Cross *et al*., 1997b). Spray deposit alone however does not tell much about the quality of application, especially about the uniformity of the distribution of the spraying broth on the leaves and/or about the possible local overdosing of the spray and does not give premises for determining the biological efficacy of the treatment. Spray coverage expressed as a percentage of the target area covered by the spraying broth gives additional useful information indicating what portion of the protected area is in direct contact with the chemical (Cross *et al*., 1997b; Jiang and Derksen, 1995). Spray coverage depends on many factors including basic sprayer performance, climatic i. e. weather conditions, canopy geometry and density, droplet size and driving speed (Praat *et al*., 1996). Image analysis is a relatively simple and straightforward evaluation of spray coverage on leaves (Cross *et al*., 1997b; Jiang and Derksen, 1995) and on artificial collectors (Holownicki *et al*., 1996; Val *et al*., 1996).

1.2 Objectives

The main objectives of the study were not only to provide guidelines to improve the spray efficiency, but also to reduce environmental pollution and (economical) loss of pesticide to the environment. To achieve this, amount of spray broth deposited on the plants (target areas) should be as high as possible and its distribution as even as possible. Consequently, the loss to the environment (non-target areas) will be at its minimum. Adequate evaluations of the spray deposit as well as that of the spray coverage are of vital importance in this context.

Our contribution to this general goal was to evaluate and compare the spray deposit and the spray coverage due to different spraying applications, different plant protection products (with the same active substance) as well as the influence of different analytical techniques in their determination (measurement).

In this study four preventive fungicides with copper hydroxide as active substance were used in all together seven different treatments (different application rates and different broth volumes) in order to compare their spray deposit and spray coverage. The data on the spray deposit determined on vine leaves were compared to those obtained on filter papers.

Part I

Background

2 COPPER

2.1 General properties of copper

Origin of name copper comes from the Latin word '*cuprum*', meaning the island of '*Cyprus*'. (http://www.webelements.com/webelements/elements/text/Cu/hist.html, 31.01.2007). Copper is one of the most important metals to man. It is of reddish colour, takes on a bright metallic lustre and it is malleable, ductile and a good conductor of heat and electricity. Copper (atomic no. 29) is transition metal and belongs to group I-B of the periodic table (Adriano, 1986; Joseph, 1999).

2.2 Production and uses of copper

To trace the history of copper use it would be necessary to go back more than 5000 years ago when people used copper for tools, pots, coins, etc. The electrical industry is one of the major users of copper in the production of electrical wires and other electrical apparatus. Because of its high thermal conductance and relative inertness, copper is extensively used in containers such as boilers, steam pipes, automobile radiators and cooking utensils. It is widely used in water delivery systems, marine paints and textile industry. Copper is also extensively used in agriculture, approximately 6 % of dissipation of in-use copper to the environment (Lander and Lindeström, 1999, *op cit* Graedel *et al.*, 2002), in a form of fertilizers, bactericides, fungicides, and algicides in water purification. It is used as a feed additive (such as antibiotics, drugs and selected chemical compounds), as a growth promoter and as an agent for disease control in livestock and poultry production (Adriano, 1986). Lander and Lindeström (1999) *op cit* Graedel *et al.* (2002) estimated the loss rates of copper from different sources of dissipation of in-use copper to the environment as shown in table 2.1.

Table 2.1: *Sources of dissipation of in-use copper to the environment.*

Source	Percentage
Road traffic (brake linings, tires, road surfaces)	~56
Paints, impregnating agents	~20
Waste dumps, landfills	~14
Agricultural systems	**~6**
Building corrosion	~4

2.3 Natural occurrence of copper

In nature, copper is found in sand stones and in minerals, it forms sulfides, sulfates, sulfosalts, carbonates, and other compounds and also occurs as the native metal. Cooper associated with the soil organic matter represents about 36 % of the copper burden in soil. The primary import pathways of copper to soil are waste disposal, fertilizer application and atmospheric deposition. The major export pathway is via river run-off and erosion. The levels of copper in soil derive from the soil parent material and from the redistribution of copper in the profile due to pedogenesis (Adriano, 1986).

2.4 Copper in plants

Copper occurs naturally in most plants, it is an essential element for animals and humans. Copper is one of the seven essential micronutrients (zinc (Zn), copper (Cu), manganese (Mn), iron (Fe), boron (B), molybdenum (Mo) and chlorine (Cl)) for normal plant nutrition. In the 1930s primary through the work of Sommer (1931), *op cit* Adriano (1986); Lipman and MacKinney (1931), *op cit* Adriano (1986) with nutrient cultures, the essentiality of copper was firmly established. Copper is required in very small amounts: 5-20 ppm in plant tissue is adequate for normal growth, while less than 4 ppm is considered deficient and more than 20 ppm is considered toxic (Jones, 1972, *op cit* Adriano, 1986).

In most plant species, copper deficiency is characterized by chlorosis, necrosis, leaf distortion, and terminal dieback, with symptoms occurring first in young shoot tissues (Robson and Reuter, 1981, *op cit* Adriano, 1986). Once absorbed, copper is poorly translocated. Hence, the terminal growth of most plants is first to be affected. Specific symptoms often depend on plant genotypes and the stage of deficiency. In general, deficiencies in crops produce abnormal colouring and development, lowered quality in fruit and grain, and lower grain yields (Murphy and Walsh, 1972, *op cit* Adriano, 1986).

One of the limiting factors in the use of copper compounds is their serious potential for phytotoxicity, or toxic activity in plants. Phytotoxicity of copper could be predicted by copper concentrations in soil, either on total or extractable basis. Copper can accumulate in soil from continued applications of copper in excess of the need for normal plant growth. The most common copper toxicity symptoms include reduced growth vigor, poorly developed and discoloured root system and leaf chlorosis (Robson and Reuter, 1981, *op cit* Adriano, 1986). In addition, copper toxicity causes stunting, reduced branching, thickening and unusually dark coloration in the rootlets of many plants (Reuter and Labanauskas, 1965, *op cit* Adriano, 1986). The chlorotic symptoms in shoots often resemble those of iron deficiency.

2.5 Copper in environment and agriculture

Only a small percent of world copper production is used in agriculture (app. 6 % reported by Lander and Lindeström, 1999), which effect directly the environment and it represents one of the important sources of dissipation of in-use copper to the soil and the whole environment (Graedel *et al.*, 2002).

2.5.1 Copper fungicides

Joseph (1999) quote that copper and its compounds have an extensive employment in agriculture where the first recorded use was in 1761, when it was discovered that seed grains soaked in a weak solution of copper sulphate solution inhibited seed borne fungi. The greatest breakthrough for copper salts undoubtedly came in the 1880s when the French scientist Millardet, while looking for a cure for downy mildew disease (*Plasmopara viticola*) of vines noticed that those vines which have been daubed with a paste of copper sulphate and lime in water in order to make the grapes unattractive to passers-by, appeared freer of downy mildew. This chance observation led to experiments and in 1885 Millardet announced that he found a cure for dreaded mildew. The mixture becomes known as Bordeaux mixture and since then it has been intensive used not only against downy mildew disease, but also against the whole host of fungus diseases of plants. Copper sulphate is not the only copper fungicide. Other copper fungicides which are important against over 300 diseases on almost 50 food crops are copper hydroxide (copper(II) hydroxide ($Cu(OH)_2$)), copper oxide (copper(I) oxide (Cu_2O)) copper sulphate (copper(II) sulphate(VI) ($CuSO_4$)), copper oxychloride (dicopper chloride trihydroxide ($Cu_2Cl(OH)_3$)), and others (Richardson, 1997). Copper has also the inhibitory effects on mites, bacterium, nematodes, etc. (Rusjan, 2004).

In spite of good efficacy against pests the copper is still heavy metal which is accumulated on grapes and in soil. The repeated use of copper fungicides since the end of the 19th century to control vine downy mildew, caused by the plant pathogenic fungus *Plasmopara viticola*, has been responsible for the heavy increase of total copper content in the upper layers of vineyard soils (Brun *et al.*, 2003). Repeated spraying with copper fungicides in vineyards lead to serious copper enrichment in soils, but copper toxicity is very rare. High concentrations of copper ions can disrupt the uptake and translocation of iron and copper toxicity induces symptoms resembling those of iron deficiency (Bergman, 1992). Because of the frequent and wide use of copper it becomes serious pollutant.

2.5.2 Copper accumulation in soil

Copper is naturally present in soil in content from 2 to 60 mg kg^{-1}, while arable land usually presents amounts of copper between 5 and 30 mg kg^{-1}. In many vine and hop growing areas copper concentrations between 200 and 500 mg kg^{-1} have been found (Drouineaou and Mazoyer, 1962 *op cit* Brun, 2003; Geofrion, 1975 *op cit* Brun, 2003; Deluisa *et al.* , 1996 *op cit* Brun, 2003; Brun *et al.*, 1998 *op cit* Brun, 2003; Maček *et al.*, 1976a; Maček *et al.*, 1976b), sometimes even up to 1500 mg kg^{-1} in the topsoil (Flores-Velez *et al.*, 1996, *op cit* Chaignon *et al.*, 2003; Brun *et al.*, 1998, 2001 *op cit* Chaignon *et al.*, 2003). The world soil has an average concentration of 30 mg kg^{-1} (Adriano, 1986).

In Slovenia the situation is similar: the amount of copper in soil changes a lot because of the geographical structure. The major amounts of copper are especially in agricultural and industrial regions where the amount of copper in soil exceeds 50 mg kg^{-1} (Figure 2.1a (Podatki tal …, 2003 *op cit* Rusjan, 2004)). For illustration the analysis of the amount of copper in soil made in the period from 1989 to 2005 is given in figure 2.1b (Center …, 2005). (Full size of figures see in appendices, as figure App1 and figure App2 where the legend of figure App2 is explained).

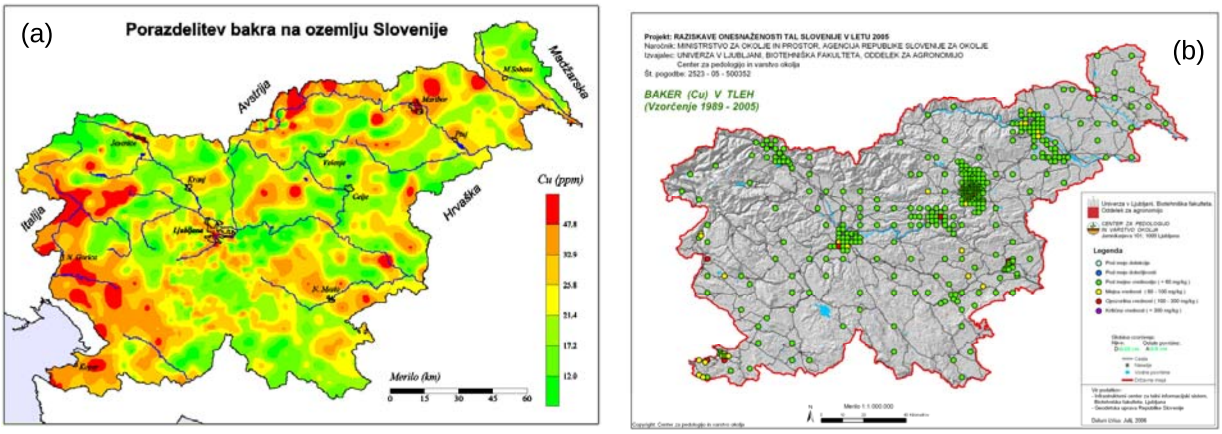


Figure 2.1: *The copper amount in soil over Slovenia in 2003 (a) and 2005 (b).*

Maček *et al.* (1976a) found that Slovenian vineyard soils contained in average 71.82 mg kg^{-1} of copper (between 23 and 265 mg kg^{-1}). The monitoring was made in all three Slovenian vineyard regions (Podravje, Posavje and Primorje region). Big differences in contents of copper in vineyard soil between all three regions were found:

- Podravje region - contained 82.36 mg kg^{-1} of copper, from 34 to 142 mg kg^{-1}.
- Posavje region - contained 99.9 mg kg^{-1} of copper, from 35 to 265 mg kg^{-1}.
- Primorje region - contained 52.06 mg kg^{-1} of copper, from 23 to 147 mg kg^{-1}.

Pavlovič (1988) and Stritar and Pavlovič (1988) found the following amounts of copper in vineyard soil in Posavje region (Krško-Brežice region):

Table 2.2: *Average value of copper (mg kg^{-1}) in vineyard soil in Krško-Brežice region.*

Soil depth / Age	up to 20 cm	20 to 40 cm	40 to 60 cm
vineyard (> 20 years old)	72.0	46.6	14.5
vineyard (20 years old)	17.5	12.3	8.4
forest	0.8	0.9	1.0

The latest research (Rusjan *et al.*, 2006) showed that the content of copper in vineyard soil is the following:

- Primorje region (Goriška brda) - contained 75.83 mg kg^{-1} of copper, from 57 to 99 mg kg^{-1}, where the content of copper significantly increases with the age of the vineyard (table 2.3).

Table 2.3: *Average value of copper (mg kg^{-1}) in vineyard soil in Primorje region.*

Age \ Soil depth	up to 20 cm	20 to 40 cm	40 to 60 cm
vineyard (> 20 years old)	99	88	86
vineyard (<20 years old)	73	67	72
forests	51	51	52

The comparison of analyses of Maček *et al.* (1976a) and those of Rusjan *et al.* (2006) of copper in vineyard soil shows that the pollution with copper in vineyard soil increased for 23.77 mg kg^{-1} during thirty years.

Besides, the contamination of soil in vineyard regions, the contamination of soil in hop growing regions where copper fungicides were widely in use, was studied; Especially in Savinja valley and in other hop growing areas in Podravje, Posavje and Koroška region. The results of monitoring (Maček *et al.*, 1976b) in Savinja valley on hop fields where the copper fungicides were used for 50 years showed the following copper concentrations:

- hop soil - 30.3 mg kg^{-1}, from 5.6 to 80 mg kg^{-1},
- grasslands sampled near the hop fields - 14.7 mg kg^{-1}, from 4.5 to 44.8 mg kg^{-1}.

The results of monitoring (Maček *et al.*, 1976b) in other hop growing areas (Podravje, Posavje and Koroška region) where the copper fungicides were used for 20 years showed the following copper concentrations:

- hop soil - 21.4 mg kg^{-1}, from 4.5 to 108 mg kg^{-1},
- grasslands near sampled hop fields - 9.5 mg kg^{-1}, from 3.5 to 62.6 mg kg^{-1}.

The average copper concentrations in vineyards are above the limit value (the limit value for Slovenia is 60 mg of copper per kg of dry matter (Directive, 1996)) in all vineyard regions, also in Primorje region. So, it can be concluded that soil pollution with copper is generally present in areas where vine production exists for many years. The main source of this pollutant in all vineyard regions is intensive viticulture practice, especially the use of copper fungicides.

The main problem is that copper is one of the least mobile of the trace elements. Applied or deposited copper persists in soil because it is strongly fixed by organic matter, oxides of iron, aluminium and manganese, and clay minerals (Baker, 1974, *op cit* Adriano, 1986; Gilbert, 1952, *op cit* Adriano, 1986; Schnitzer, 1969, *op cit* Adriano, 1986).

2.5.3 Copper bioavailability to different plants

The solubility, mobility and availability of copper to plants depend largely on the pH of the soil. Copper availability is drastically reduced at a soil pH above 7, it is most readily available below pH 6 and especially at pH below 5 (Lucas and Knezek, 1972, *op cit* Adriano, 1986).

From an environmental point of view, one of the major issues is to quantify the bioavailability and toxicity of copper accumulated in vineyards to a range of living organisms including cultivated plants. Copper accumulated in soils can be responsible for phytotoxicity above the threshold, which depends on both: plant species and soil properties. The phytotoxicity of copper is mainly observed in acidic soils, and is most likely to occur at pH <6 in soils exhibiting low cation exchange capacity (Drouineau and Mazoyer, 1962 *op cit* Brun *et al.*, 2003; Gupta and Aten, 1993 *op cit* Brun *et al.*, 2003, Brun, 1998 *op cit* Brun *et al.*, 2003).

As copper remains concentrated mostly in the upper layers of the soil (0 to 15 cm), plants with the bulk of their roots in the top soil are affected directly by high soil copper concentrations (Brun *et al.,* 1998 *op cit* Brun *et al.*, 2003). Most of these plants are ruderals (Maillet, 1992 *op cit* Brun *et al.*, 2003). Weedy or ruderal species are adopted to survive in disturbed environments and are characterized by short life cycles, high rates of dry matter production, and early reproduction (Grime, 1977 *op cit* Brun *et al.*, 2003).

2.5.4 Copper distribution in vineyard soil

It is known that copper tends to accumulate in surface layers of the soil and consequently the topsoil of most vineyards contain large amounts of copper. Furthermore, the major parts of vineyards are located on steep slopes and this leads to extensive soil-erosion processes. All these can wash the copper to downstream crops or ecosystems and copper is disseminated in the environment by run-off.
It was estimated (Besnard *et al*., 2001) that 1.7 mg soil/ha/year were removed by erosion in Champagne vineyards between 1985 and 1994, corresponding to the removal of an 8 mm thick soil layer during this period. Organic amendments are efficient to limit soil erosion and to increase soil fertility.

2.5.5 Copper consumption in Slovenian agriculture and limit values

Slovenia is defined as a wine growing country and copper fungicides are widely applied in our vineyards during the last 200 years and also in hop fields during the last 100 years. The wholesale of copper used as fungicides (with copper hydroxide, copper oxychloride, copper oxysulphat and copper sulphate as active substances) in agriculture on Slovene market is shown in table 2.4 (Phytosanitary administration of the Republic of Slovenia, 2007). The consumption of copper fungicides in the past few years has been pretty much constant, however, with smaller oscillations, which are mainly the result of weather conditions.

Table 2.4: *Copper fungicides – wholesale on Slovene market, tons of active substances.*

Year	2000	2001	2002	2003	2004	2005
Copper wholesale (in tons of AS)	148	124	137	113	106	112

Because of the intensive use of copper fungicides and consequent accumulation of copper in soil and environmental pollution with copper in the last century, the government of Slovenia published limiting values of pollutants in soil. This is a directive of limit, warning and critical values of dangerous heavy metals in the soil of Slovenia (Directive, 1996). The values for total copper concentrations are as follows:

- limit value (60 mg of copper per kg of dry matter)
- warning value (100 mg of copper per kg of dry matter)
- critical value (300 mg of copper per kg of dry matter)

The comparison of Slovenian limit values (Directive, 1996) with the limit values in European Union, Switzerland and United Kingdom is given in table 2.5 (Rusjan, 2004).

Table 2.5: *Slovenian limit value (mg kg^{-1}) mentioned in Directive and comparison with the limit values in other EU countries.*

Metal	Slovenia	EU	Switzerland	United Kingdom
copper	60	50-140	50	135

Also the vine growers included in integrated pest management (IPM) where a rational application of a combination of biological, biotechnological, chemical, cultural or plant-breeding measures is applied whereby the use of chemical plant protection products is limited to the strict minimum necessary to maintain the pest population at levels below those causing economically unacceptable damage or loss, have to take into consideration the limit for yearly deposit of copper, which should not exceed 5 kg per year (Tehnološka …, 2004-2007).

The integrated production of grapes and vine in Slovenia is monitored by a board of experts. Also all users and sellers of plant protection products have to be included in intensive education and training.

3 DOWNY MILDEW (*Plasmopara viticola* (Berk & Curt.) Berl. & de Toni)

Chapter 3 gives a short introduction of epidemiology and basic characteristics of this disease (Vršič and Lešnik, 2001; Ellis, 1994) and in the end about the protection against it.

Because the spores of downy mildew are ubiquitous, consequently, their infection is always threatening. Therefore, preventive fungicides, preferably those which are very persistent, have to be used regularly.

The aim of plant protection measures is to keep the infection of grapevines on the level which does not cause any downy mildew damage on grapevines. If we do not spray as it is recommended for integrated pest (and disease) management (IPM) or in the worst case, if we do not spray at all, the damage on the grapevines will be total and will cost us a lot also during the next few years not just during the year when the treatment was not applied. This is the reason, why it is so difficult to choose an untreated plot of the right size in the middle of vineyard. EPPO guidelines recommended to choose untreated plot outside of vineyard where we evaluate plant protection products (EPPO, 2001). We followed the EPPO guidelines and chose the untreated plot in Maribor, where the growing and climatic conditions are very similar to Slovenske Konjice (see chapter 7.9.1).

Downy mildew is one of the most damaging diseases of grapevines. It is caused by the fungus *Plasmopara viticola* (Berk & Curt.) Berl. & de Toni. The Slovenian weather conditions are very often favourable for development of this disease. The fungus causes direct yield losses by rotting inflorescences, clusters (vine grapes) and shoots.

Epidemiology of downy mildew in year 2002 was as follows: conditions for primary infection in Maribor region and in most vineyards in NE Slovenia were between 12 and 14 May 2002. The first incubation period was over on 20 May 2002. The first leaf spots were noted on 28 May 2002. The grapes on untreated plot in Maribor were affected by downy mildew on 13 August 2002 by 56.5 %, and the leaves on untreated plot in Maribor were effected by downy mildew on 13 August 2002 by 79.2 % (Matis, 2002). Generally, the weather conditions for infections and disease development in 2002 were very favourable.

Plasmopara viticola can damage grapevine at every stage of development, and the fungus is able to attack every green part of the plant (EPPO, 2002). On leaves, first symptoms are observed as very small, greenish-yellow, translucent spots that are difficult to see. With time the lesions enlarge, appearing on the upper leaf surface as irregular pale yellow to greenish yellow spots up to 5 mm or more in diameter (Figure 3.1). On the underside of the leaf, the mycelium (the ‘downy mildew’) can be seen within the border of the lesion as a delicate, dense, and white to greyish, cotton-like growth (Figure 3.2). The infected tissue gradually becomes dark brown, irregular, and brittle. Severely infected leaves eventually turn brown; they wither, curl and finally drop. The disease attacks older leaves in late summer and autumn, producing a mosaic of small, angular, yellow to red-brown spots on the upper surface. Lesions commonly form along veins and the fungus sporulates in these areas on the lower leaf surface during periods of wet weather and high humidity.

Figure 3.1: *Pale yellow leaf spots caused by downy mildew on the upper surface of a grape leaf (Vršič and Lešnik, 2001).*

Figure 3.2: *Downy mildew on the underside of infected leaves (Photo: Simona Luskar).*

The really dangerous, crop threatening, infection occurs at the beginning of flowering (Figure 3.3). The most of it taking place during two distinct periods in the growing season. The first one is the period when berries are about the size of small peas. When infected at this stage, young berries turn light brown and soft, shatter easily, and under humid conditions are often covered with the downy-like growth of the fungus (Figure 3.4). Generally, little infection occurs during hot summer months. As nights become cooler in late summer or early fall, the second infection period may develop. Berries infected at this time generally do not turn soft or become covered with the downy growth. Instead, they turn dull green, then dark brown to brownish-purple (Figure 3.5). They may wrinkle and shatter easily and, in severe cases, the entire fruit cluster may rot. These infected grapes will never mature normally. On shoots and tendrils, early symptoms appear as water-soaked, shiny depressions on which dense downy mildew growth appears. Usually young shoots are stunted and become thickened and distorted. Severely infected shoots and tendrils usually die.

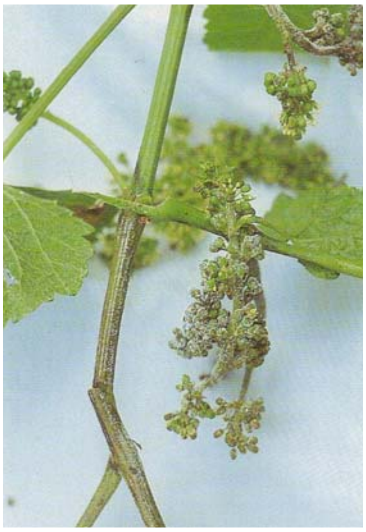


Figure 3.3: *Grape at the beginning of flowering and shoot infected with downy mildew (Vršič and Lešnik, 2001).*

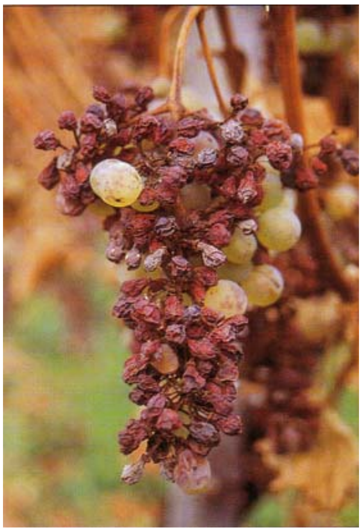


Figure 3.4: *Grape berries infected with downy mildew (Vršič and Lešnik, 2001).*

Figure 3.5: *'Late' downy mildew on the grape (Vršič and Lešnik, 2001).*

As mentioned before, downy mildew is caused by the fungus *Plasmopara viticola*. The fungus overwinters in infected leaves on the ground and possibly in diseased shoots (Figure 3.6). The overwintering spores (oospores) germinate in spring (usually in the middle of May) and produce a different type of spores (sporangia). These sporangia are spread by wind and splashing rain. When plant parts are covered with a film of moisture, the sporangia release small swimming spores, called zoospores. Zoospores, which are also spread by splashing rain, germinate by producing a germ tube that enters the leaf through stomata (tiny pores) on the lower leaf surface. The optimum temperature for disease development is 18 to 25 °C. The disease can tolerate a minimum temperature of 11 to 13 °C, and a maximum temperature of about 30 °C. Once inside the plant, the fungus grows and spreads through tissues. Infections are usually visible as lesions in about 10 to 12 days. At night, during periods of high humidity and temperatures above 13 °C, the fungus grows out through the stomata of the infected tissue and produces microscopic, branched, tree-like structures (sporangiophores) on the lower leaf side. More spores (in sporangia) are produced on the tips of these tree-like structures. The small sporangiophores and sporangia make up the cottony, downy mildew growth. Sporangia cause secondary infections and are spread by rain and wind.

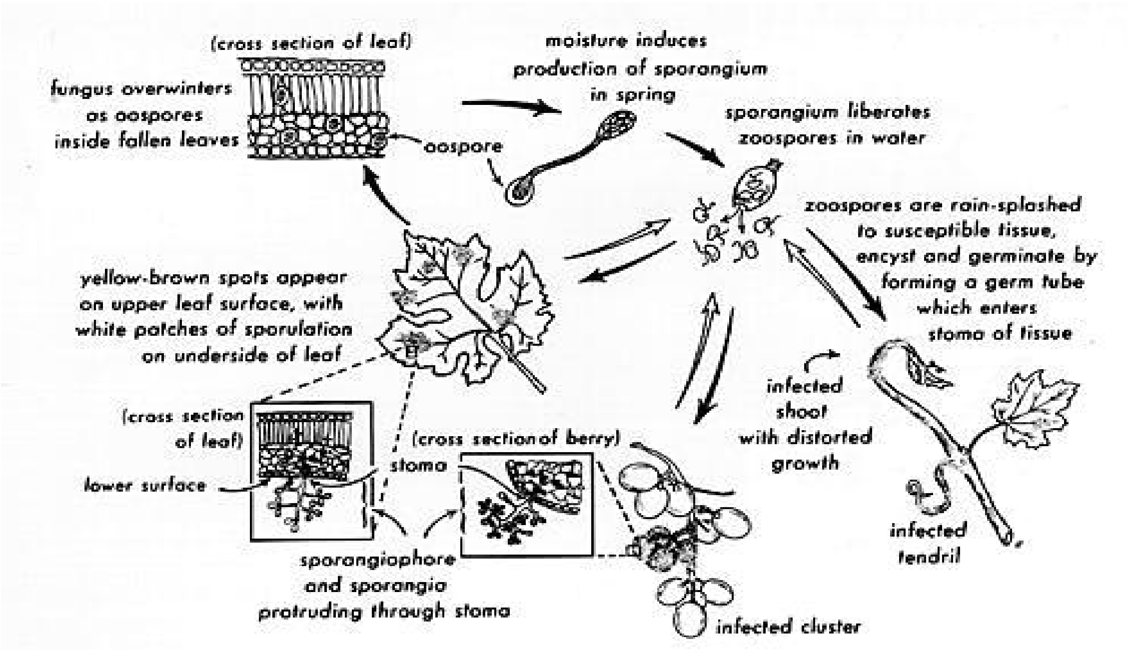


Figure 3.6: *Disease cycle of downy mildew on grapevine (Ellis, 1994).*

Any practice that shortens the drying time of leaves and grapes will reduce the possibility of the infection. Selecting a planting site where vines are exposed to all-day sun, with good air circulation and good soil drainage helps a lot. Spacing vines properly in the row, and, if possible, orienting the rows to maximize air movement down the row is an additional advantage. Sanitation is very important, e.g. removing of dead leaves and berries from vines and from the ground after leaf drop. It may be beneficial to cultivate the vineyard before bud break to cover old berries and other debris with soil. Cultivation also prevents overwintering spores from reaching developing vines in spring. In order to improve air circulation, controlling of weeds and tall grasses in the vineyard as well as in the surrounding areas can be helpful. When pruning, only strong, healthy, well-coloured vines of the previous year growth should be selected. Practices such as shoot position and leaf removal that help to open the canopy for improved air circulation and spray coverage are also very important (Ellis, 1994).

As mentioned before, grape varieties can exhibit rather different susceptibilities to downy mildew. A good fungicide spray program is extremely important to protect grapevine against downy mildew. It can be effectively controlled by properly timed and effective fungicides. In order to control *Plasmopara viticola*, fungicides with three types of activity can be used: contact (not transported within the plant), locally systemic (penetrating into the plant and transported within the treated organ) and systemic (transported to other parts of the plant). It is a good plant protection practice to apply contact fungicide sprays preventively, and to use locally systemic or systemic fungicides (with a curative effect) when climatic conditions are especially favourable for the development of downy mildew and the risk of infection is great. In any case, it is advised always to use locally systemic (azoxystrobin, cymoxanil, dimethomorph) and systemic compounds (benalaxyl, fosetil-Al, metalaxyl) in combination with a contact fungicide (captan, folpet, copper hydroxide, copper oxychloride, mancozeb, metiram, propineb).

The quantity and timing of the applications are critical and the efficiency of chemical control greatly depends on the quality of the application techniques. An adequate level or mean amount of plant protection product per area unit needs to be deposited in all zones of the treated plant/vine. The sprayer should uniformly deposit material on the canopy, with a minimum of off-target loss. So, it is very important to choose the right sprayer for a particular use, the right nozzle size, the right number of nozzles, a suitable pressure and ground speed as well as the right volume rate. If the operational parameters of the sprayer are correctly set, the maximum relative amount of spray emitted from the sprayer will be deposited on the treated plant/vine. Additionally, the minimum still acceptable level of deposit will be achieved in the most inaccessible parts of the treated plant/vine, usually the undersides of the leaves in the centre of the canopy.

So it becomes evident that the determination of spray deposit and spray coverage is far from being only an academic issue.

4 DEPOSIT TRACERS

A tracer is a substance used to mark the course of a process. This substance may be the active substance in a plant protection product mixture or a chemical selected to mimic the plant protection product. If we are interested only in determining the initial sites of spray deposition, it is reasonable to presuppose that non-plant protection products will suffice, but if it is desirable to follow the subsequent fate of spray deposits then measurement of the active substance of plant protection product, either by radiolabelling or by chemical analysis, is necessary (Cooke and Hislop, 1993).

Many spray technology researchers, growers, sprayer dealers, agrochemical companies and regulatory agencies are interested in comparing spray equipment and application parameters. The comparison often involves a quantitative method for assessment of spray coverage, deposit and/or drift. Some methods provide more reliable results than others, but all have some limitations under certain conditions. For most applications, the use of a particular method normally depends on the availability of human and financial resources, physical and biological characteristics of the crop, and expected degree of accuracy in comparison of the experimental treatments. However, none of the existing techniques is suitable for all applications. Therefore, the problems and limitations associated with each technique must be well understood and an appropriate methodology should be selected for a particular application (Salyani and Fox, 1999).

The selection of the most appropriate tracer is based on several criteria, the relative importance of which depends on the particular experiment being undertaken and desirable tracer properties. These include the physical and chemical stability of the tracer for the duration of the experiment, the ease of recovery of the tracer from the target, its subsequent quantification by an appropriate analytical method and, often its cost and availability (Murray *et al*., 2000). In practice, the tracers most commonly used belong to the following groups: visible dyes, food colorants, fluorescent compounds and metal tracers.

4.1 Types of deposit tracers

Fluorescent tracers and fluorometry have been extensively used by many researchers to quantify spray deposit and drift for various spray applications. Salyani *et al.* (1990) used fluorometry to assess spray deposit. The methodology is reasonably simple but most commonly used water soluble dyes are very sensitive to sunlight and their residues degrade rapidly under solar radiation (Salyani, 1993). Holownicki *et al.* (2000) used a fluorescent tracer (sodium salt of fluorescein) to evaluate spray deposit in canopy and off target loss recorded on the vertical frame using filter paper collectors. Cross *et al.* (1997b) showed that sodium fluorescein, rhodamine B and FB28, spotted onto glass slides at a surface concentration typical for field spray deposits, were degraded by 20 %, 50 % and 4 % respectively after 30 min exposure to bright sunlight. This may generate a serious problem for row crop and orchard applications where random orientation of the targets and their variable exposure levels may not allow any correction of the deposits for degradation. Nonetheless, most researchers have acknowledged the problem and have tried to minimize the error by collecting the samples shortly after spraying. The fluorescent tracers have been quantified on leaves (Cooke *et al*., 1976; Pergher and Gubiani, 1995; Kač, 1987; Furness and Newton, 1988; Antuniassi *et al.*, 1996; Cross *et al.*, 1997b) or artificial targets (Salyani and Farooq, 2003; Cross *et al.*, 1997a; Barber *et al.*, 2003; Holownicki *et al.*, 2000; Doruchowski *et al*., 2002). This problem is addressed extensively in the following paragraphs and chapter 5.

Fluorescent techniques can be qualitative/semiquantitative, with deposits assessed visually, or quantitative, by assessment of droplet size and their numbers, and by fluorometric measurement of the deposited pigment. Measurements of fluorescent residues on leaf samples or filter paper collectors were performed by many authors (Doruchowski *et al*., 2002; Cooke *et al*., 1976; Pergher and Gubiani, 1995; Kač, 1987; Furness and Newton, 1988). Antuniassi *et al.* (1996) applied a mixture of potassium chloride and a fluorescent dye and used the electrical conductivity of the leaf wash to quantify spray deposit. Derksen and Gray (1995) used micro-nutrients zinc and manganese as tracers and analyzed the leaf wash solutions with a plasma atomic emission spectrometer. Hoffmann and Salyani (1996) and Whitney *et al.* (1989) used manganese and copper tracers, respectively, and quantified the deposit on citrus leaves with corresponding colorimeters. Salyani and Whitney (1988) compared fluorometry and colorimetry and found a good correlation between fluorescent and copper deposits, using leaf and mylar targets. Cross (1991) and Planas *et al.* (1996) sampled fluorescent deposits on cylindrical nylon brushes and compared the results with those from leaf samples. Picot *et al.* (1993) measured canopy deposit on 'foliage simulators', which were cut from aluminium sheets to simulate various conifer type shoots. Whitney and Roth (1985) and Fox *et al.* (1993) used string collectors and fluorometry to compare different application treatments. Some researchers attempted a separated evaluation of the deposit on the upper and lower leaf sides. Whitney *et al.* (1989) applied an adhesive vinyl tape to the upper leaf side and separated the deposits by dual washing. Carlton (1992) developed a device for separate but simultaneous washing of both leaf sides, Howard *et al.* (1994) and Coates (1996) used the Carlton leaf washer for separated determination of the deposit on the upper and lower leaf side for different treatments. Farooq *et al.* (2002) and Farooq *et al.* (2003) used fluorescent tracer (Pyranine-10G) for measurement of the deposit on leaves performed by the analysis of wash solutions by fluorometer. Pergher and Gubiani (1997) used a fluorometric method as well.

Evaluation of the distribution patterns involved different techniques. Carman and Jeppson (1974) superimposed a perforated template on sprayed cards and estimated the percentage of the covered area. The cards were placed on different parts of the citrus canopy then sprayed with a fluorescent dye. Blandini and Schillaci (1993) and Val *et al.* (1993) applied adhesive plastic tape pieces on the leaf surface and sprayed the targets with iron chelate. The targets were first treated with vasaline or silicon spray to simulate leaf surface condition. They photographed the targets and studied the droplet distribution patterns by image analysis. Coates (1996) also photographed the leaf target after spraying it with a fluorescent dye and analyzed the images with a portable scanner. Derksen and Jiang (1995) developed a computer vision system to characterize fluorescent deposits on artificial targets.

To avoid the problems associated with fluorescent dye degradation, manganese or strontium salts can be used as tracers and the deposits can be analyzed with an atomic absorbtion spectrometer (Salyani, 1993). Metalic ion tracers do not degrade under solar radiation and for some applications they are indicated as more appropriate tracers (Salyani and Fox, 1999). Salyani and Whitney (1990) and Salyani and McCoy (1989) used cupric hydroxide and colorimetry in applications on citruses. The copper hydroxide was used by Kač (1987) to determine the deposit on hop leaves when the normal and three times lower spray volume was used. Salyani (2000b) used copper fungicide as deposit tracer when he tried to determine the effects of nozzle size, number of nozzles and ground speed as well as their combinations on deposit efficiency in the open. Similarly, a copper tracer was used and copper deposit on leaves was determined by colorimetry when Salyani *et al.* (1988) analyzed the effect of spray volume on deposit. The study showed that spray volume had no significant effects on mean deposit, but higher spray volumes resulted in more uniform coverage than low volume rates in citrus trees.

Chelates of metal ions are considered the most suitable tracers in experimental programmes to study the influence of orchard sprayer operating parameters on spray deposits and losses to the environment (Murray *et al*., 2000). The earliest examples of the use of metal ions as spray tracers arose from the use of copper ions as the analyte for the measurement of deposits of fungicides such as Bordeaux mixture and copper oxychloride (Large, 1940 *op cit* Cooke and Hislop, 1993; Large *et al.*, 1946; Williams and Morgan, 1954; Herrington *et al.,* 1981). The copper oxychloride had been determined by Cooke *et al.* (1976) on apple trees. Recovery of metal ion tracers directly from the surface of the leaves, by surface washing for example, would eliminate the problem of degradation but it brings the possibility of reduced recovery due to strong adsorption on the leaf. Hoffmann and Salyani (1994) studied the effects of the application time on spray deposit. Night time applications (lower temperature and higher relative humidity) resulted in a higher deposit than daytime applications (higher temperature and lower relative humidity). They used manganese sulphate monohydrate as tracer, it is a commercially available fertilizer used in citrus groves. Metal chelates (Walklate *et al.,* 2002), usually EDTA chelates, are sometimes used as spray tracers (Murray et al., 2000). Cross *et al.* (2001a; 2001b; 2003) used EDTA chelates of metal ions (zinc, manganese, strontium and copper) as spray tracers. They investigated the spray deposits and spray losses on different sized apple trees using an axial fan orchard sprayer. The effects of spray quality, the effects of spray liquid flow rate and the effects of droplet size were investigated. De Moor *et al.* (2002) used mineral chelates as tracers and filter paper, ICP (inductively coupled plasma) was used to determine the concentrations of minerals.

The utility of multiple tracers was enhanced when Cross *et al.* (1997b) demonstrated the feasibility of combining three visible dyes to measure spray deposits on apple trees. They showed that tartrazine, erythrosine and Green S could be measured in admixture following sequential spray application. Relative concentrations of up to 20:1 of different tracers in an aqueous sample extract could be analysed. Nevertheless, visible dyes have two disadvantages, the first one is the problem of poor recovery, and the second one that of their spectra exhibiting relatively broad absorbance bands.

4.2 Copper as deposit tracer

Historically, tracing sprays via active substances preceded the use of exotic additives. In the simplest and oldest technique an aqueous mixture of quick-lime and copper sulphate was applied to grape vines to discourage pilfering (Large, 1940 *op cit* Cooke and Hislop, 1993). The deposits were clearly visible, and thus the sites at which the liquid had been retained were traced. The copper-lime mixture turned out to be an excellent fungicide (known as Bordeaux mixture) and before long the active copper substance was being measured quantitatively and qualitatively by simple colorimetric procedures. In this example, initial copper deposits and subsequent residues can be measured with reasonable ease. However, most modern plant protection products do not lend themselves to such procedures and alternative techniques using dyes have evolved to determine the initial deposition sites of sprays. These have the advantage that potentially noxious plant protection products need not be included in the spray liquid. They do not require specialist analytical skills or sophisticated equipment and are thus quick and cheap to perform (Cooke and Hislop, 1993).

Copper as deposit tracer was widely used by many authors on various crops to compare different tracers (Hoffmann and Salyani, 1996; Whitney *et al.*, 1989), different determination techniques (Kač, 1993; Salyani and Whitney, 1988), or to avoid the problems associated with fluorescent dye degradation (Salyani and Whitney, 1990; Salyani and McCoy, 1989; Salyani, 2000b; Salyani *et al.*, 1988). But the earliest examples of the used of copper as spray tracers was observed by Large, 1940 *op cit* Cooke and Hislop, 1993; Large *et al.*, 1946; Williams and Morgan, 1954; Cooke *et al.*, 1976 and Herrington *et al.,* 1981.

5 SPRAY TARGETS

The advantages or disadvantages of working with natural plant surfaces versus artificial collecting surfaces for spray tracing depend upon circumstances of usage and investigative priorities. Frequently, natural surfaces will be preferred, but their complex and variable nature affects the retentiveness or spread of sprays. For example, retention and spread is often much lower on young compared to older leaves. Artificial targets are uniform and they can be placed precisely at predetermined positions, but do not necessarily mimic natural targets (Cooke and Hislop, 1993).

5.1 Natural targets

The leaves of plants, the shoots of trees and also the fruits were used as spray targets in several experiments. These are the so called natural targets or natural collectors.

When the tank mix contained an active substance as tracer or other tracers which were mentioned before, the leaves - natural targets could be used as deposit samples. Salyani (2000a) collected the samples of citrus leaves from different locations, from outside and inside of the canopy, from the centre of the tree, and from different heights and azimuths. Three to five leaves were used as samples. If it was intended to separate deposits on the upper and lower leaf surfaces, an adhesive vinyl tape was applied to the upper leaf surface and each individual leaf was placed in a separate bag (Whitney *et al*., 1989). Richardson *et al*. (2000) took samples of 25 apple leaves from each of 6 sampling zones. Jaeken *et al.* (2001) took up to 50 leaves per zone: at 4 height zones and 2 depth zones (once on the outer side and once in the centre) to evaluate the effect of the vertical spray distribution profile. A foliar nutrient was used as tracer on the leaves of fruit trees.

When the same tree or spatial structure was used for comparing different treatments or when there was not enough leaves in the centre of the tree, citrus tree shoots were used as spray targets. The shoots, having at least 10 leaves, were clipped from citrus trees, washed in 0.5 M nitric acid solution and de-ionized water, air dried, and placed at the intended locations (Whitney and Salyani, 1991; Salyani and Hoffmann, 1996).

When deposit on fruit surface was important (Koo *et al*., 1999), fruit samples of citrus trees were collected from different canopy locations. After washing-off the deposit, the surface area of the fruit was estimated by measuring three perpendicular diameters (Salyani, 2000a). Richardson *et al*. (2000) took samples of 10 to 25 fruitlets of apple trees from each sampling zone, 6 sampling zones were included. The deposit of spray tracers were extracted from the samples by wash-off with water.

5.2 Artificial targets

Mylar plastic sheets, cotton ribbons, filter paper, and water- or oil-sensitive papers or cards as well as plastic and acetate cards were also used as spray targets. These are so called artificial targets or artificial collectors.

Salyani and Whitney (1988) used mylar targets which were stapled to the ends of the clipped leaves at sample locations and they compared the deposit on leaf of oranges and that on mylar targets.

Salyani and Whitney (1990) used cotton ribbons as sampling targets to determine the deposit of copper hydroxide by colorimetry. They investigated ground speed effect on spray deposit on citrus trees. The cotton ribbons were used also by Salyani and Farooq (2003). They determined spray penetration using a fluorescent tracer and fluorometric analysis.

Filter papers were used by Salyani and Hoffmann (1996) in conjunction with leaf targets to determine the spray distribution at different distances from the sprayer. Doruchowski *et al.*

(2002) used filter paper collectors on the upper and lower surfaces of 7 leaves, they sampled at different heights. Vannucci *et al.* (2000) determined the residues of the active substance by gas chromatographic determination. Filter papers were set on the ground and on the vine, grapes were also sampled. The active substance (parathion methyl) was followed as a function of time (days) after application. Circular filter papers were used by Gil (2002). They were placed at the top, middle and bottom part of the vine canopy and also at the inner and outlet parts. The circles of filter paper were used by Planas *et al.* (2002) to measure spray deposit in vineyards and apple orchards. The filter paper was used as collector material by Vandermersch *et al.* (2001) to evaluate the effect of four different application techniques on deposit and distribution of plant protection products in blackberries. Pezzi and Rondelli (2000) assessed the spray deposit on the filter papers where the spray deposit was obtained by analysing the Mg ions by atomic absorption spectroscopy.

Water- and oil-sensitive papers (WSP and OSP) were used for quantitative assessment of spray coverage. WSP and/or OSP were stapled to both sides of citrus leaves (Salyani and Fox, 1999). Droplet spots on OSP were stabilized by acetone treatment soon after collection (Salyani, 1999). Luttrell (1985) captured droplets on WSP and OSP targets and used an image analyzer to characterize droplet size spectrum from aerial applications. Hill and Inaba (1989) measured spray droplet density on WSP, and then washed the targets to measure the pesticide residues by gas chromatography. Giles *et al.* (1989) quantified spray deposit on WSP, using a Hunter colorimeter. Howard *et al.* (1994) and Coates (1996) stapled WSP on leaf surfaces and determined the percentage of the area covered by an image scanner. Chiu *et al.* (1999) used image processing technique to measure the percentage of the area covered by the broth using water-sensitive papers. Szewczyk *et al.* (1999) showed the distribution of the spraying liquid on water-sensitive papers, on the lower and the upper leaf surface separately. The deposit was quantitatively evaluated also by Žolnir (1993) as well as by Raisigl and Felber (1991); they evaluated the impact density and the percentage of the leaf area covered by the broth using image analysis (Optomax V). Optomax V was used also by Cross *et al.* (1997a) and Barber *et al.* (2003) to determine the spray cover on the upper and on the lower side of the leaves by fluorescent tracer dye. Water-sensitive papers were used by Manktelow and Praat (2000) to examine spray deposits on different heights within the canopy. Nevertheless, both techniques, namely with WSP and OSP have met with serious problems in field applications. Air humidity, dew, sweat, water from other sources for WSP and spot enlarging and fading for OSP (Salyani and Fox, 1999).

Salyani (2003) used plastic and acetate card targets to present different deposit distribution patterns when determining the effects of the droplet size on rain wash-off and solar degradation of fine and coarse spray deposits.

After application, all the targets have to be collected very carefully, though this stage is usually taken very lightly and is only rarely referred to (Salyani, 2000a). Pre-coded bags are a must they can be paper bags, plastic bags (Salyani, 2000a; Planas *et al.*, 2002; Salyani and McCoy, 1989) or sealable bags (Farooq *et al.*, 2003; Salyani, 2000b).

5.3 Spray targets in vineyards

In vineyards, different deposit tracers were used to determine the deposit on natural (Planas *et al.*, 2002; Manktelow and Praat, 2000; Pergher, 2001; Pergher, 2004; Pergher *et al*, 1997; Pergher and Gubiani, 1995) as well as on artificial targets (Planas *et al.*, 2002; Gil, 2002; Manktelow and Praat, 2000; Pergher, 2001; Pergher *et al*, 1997; Pezzi and Rondelli, 2000; Pergher and Gubiani, 1995; Vannucci *et al.*, 2000), mostly in order to compare different spray techniques with various spray equipment.

6 SPRAY DRIFT

Environmental contamination due to the use of plant protection products in agriculture has been the subject of numerous studies also in recent years (Cross *et al.*, 2001a; Cross *et al.*, 2001b; Doruchowski and Holownicki, 2000; Doruchowski *et al.*, 2002; Holownicki *et al.*, 2000; Pergher *et al.*, 1997; Walklate *et al.*, 2002; Van de Zande, 2002 *op cit* Balsari and Marucco, 2004). One of the aspects most considered is spray drift, which is one of the main paths of plant protection products to non-target organisms. Spray drift is the physical movement of plant protection products through air at the time of application or soon thereafter, to any site other than that intended for application (often referred to as off-target) (Ozkan, 2000).

Drift is undesirable for economic, environmental and safety reasons. Efficient applicators do not spend money for plant protection products to watch them drift away from their target fields. Today's chemicals are more potent and require more precise application. Unsatisfactory pest control could result if a significant portion of the chemical is lost in drift. This could require respraying the same field (Ozkan, 2000).

The environmental effects of spray drift are equally costly and unacceptable. By reducing drift to a minimum, it is possible to reduce the potential pollution of streams, lakes and other water supplies (Ozkan, 2000).

Regardless of how accurately an application is made, the possibility of drift is always present. It is possible to minimize this possibility by selecting the right equipment and using sound judgment when applying pesticides. The judgment can mean the difference between an efficient, economical application and one that results in drift, damaging non-target crops and creating environmental pollution (Ozkan, 2000).

Reducing spray drift not only improves application efficiency, but also reduces the risk of safety and health-related problems caused by drift. Because it is impossible to eliminate drift altogether, it is recommend always to wear protective clothing when applying pesticides to reduce the exposure of the operator. A respirator is a must, especially if the tractor does not have a cab (Ozkan, 2000).

However, spray drift occurs wherever liquid sprays are applied and depends on many factors which are summarised in table 6.1 (Landers and Farooq, 2004; Ozkan, 2000).

Table 6.1: *Factors affecting pesticide drift and deposition.*

Sprayer	**Application**	**Target**	**Weather**	**Operator**
↳ Fan size and type	↳ Nozzle type	↳ Canopy structure	↳ Wind speed	↳ Care
↳ Air velocity and direction	↳ Droplet size (VMD*)	↳ Canopy density	↳ Wind direction	↳ Skill
↳ Air volume	↳ Spray pressure	↳ Variety	↳ Temperature	↳ Attitude
↳ Type	↳ Application rate	↳ Leaf area	↳ Humidity	
	↳ Nozzle orientation	↳ Every row	↳ Evaporation	
	↳ Forward speed	↳ Alternate row	↳ Rainfall	
	↳ Chemical formulation			

*VMD (volume median diameter) is used to characterize the relative droplet size of a spray volume from a nozzle. A VMD of 100 microns means that half of the spray volume will consist of droplets that have a diameter of less than 100 microns and the other half of the spray volume will consist of droplets larger than 100 microns (Casady *et al.*, 1999)

Therefore it is essential to evaluate basic drift values but also to improve sprayers so that drift can be reduced. Drift reducing sprayers are nowadays available for field crops as well as for vineyards, orchards and hops. Their ability to reduce drift varies from 50 % to more than 90 %. In vineyards the prototype tunnel sprayers are able to reduce drift more than 90 % (Ganzelmeier and Rautmann, 2000). In Slovenia, most vineyards are on locations where the use of that type of sprayer is not possible (they are on rather steep slopes).

6.1 Spray drift in vineyards

Pest control is a critical factor in most commercial vineyards. Though such a control may, in some seasons, represent only a small proportion of crop value, there is a demand from growers for increased efficiency of spraying: improving efficiency of deposition, reducing drift and increasing sprayer output.

Balsari and Marucco (2004) results indicate a considerable influence of the canopy characteristics on the amount of drift deposit on the ground in the area adjacent to the vineyard sprayed. The vineyard featured by a narrower spacing and compact vegetation gave lower drift than the vineyard featured by wider spacing and thinner canopy. Higher values of drift were always observed when fine droplets and high air flow rates were used. The use of air inclusion nozzles gave drift reductions up to 37 % of the reference value (conventional hollow cone nozzles).

Results (Landers and Farooq, 2004) of deposition measurements inside the canopy show that the spray coverage decreased with canopy growth. The decrease in coverage of water sensitive cards (water sensitive papers) was shown at each row with increasing canopy density, also the coverage of water sensitive cards decreased with the distance away from the sprayer. The coverage was recorded up to 4^{th} row on 18 June (middle growth stage) while it was only recorded on the first row on 2 and 10 July (full foliage development).

Increasing spray application rate and air output both led to higher losses to the ground and lower deposition on the foliage. Large plant protection product losses and unsatisfactory uniformity of distribution, which have often been reported for conventional axial-fan sprayers fitted with hydraulic nozzles, may reduce the effectiveness of the operation and increase environmental pollution. In vineyards, losses have been recorded by Siegfried and Raisigl, 1991 *op cit* Pergher and Gubiani, 1995; and Siegfried and Holliger, 1992 *op cit* Pergher and Gubiani, 1995; they ranged from 64 to 94 %, in the early growth stages of the vines (April to May). During the early growth stages of the vines (May to June) the total losses ranged from 46 to 69 %, and at full foliage development (July to August) from 43 to 67 %. These have been recorded for conventional axial-fan sprayers (Pergher and Gubiani, 1995; Siegfried and Raisigl, 1991 *op cit* Pergher *et al.*, 1997; Siegfried and Holliger, 1992 *op cit* Pergher *et al.*, 1997).

Pergher and Gubiani (1995) found out, that losses to the soil ranged from 34.5 to 36.8 % for the lower spray rates (313 to 391 L ha^{-1}), and from 41.3 to 48.9 % for the medium spray rates (648 L ha^{-1} to 782 L ha^{-1}). Losses due to drift outside the experimental plots and deposition on brunches, shoots and poles ranged from 6.5 to 10.5 % for the lower air output (7.0 $m^3 s^{-1}$), and from 7.8 to 19.8 % for the higher air output (8.6 $m^3 s^{-1}$), when the commercial, air assisted, axial-fan sprayer with seven hydraulic nozzles per side was used.

Part II

Experimental

7 MATERIALS AND METHODS

7.1 Study area

The field experiment was carried out in vineyard Križničevo, at Škalce, Zlati Grič d.d., Slovenske Konjice (Figure 7.1).

The tradition of vine-growing in Škalce reaches back to the 14th century. The area belongs to the wine-growing area of Maribor, on the slopes of the Pohorje region. The wine is produced from the grapes ripening in vineyards which cover an area of 80 hectares.

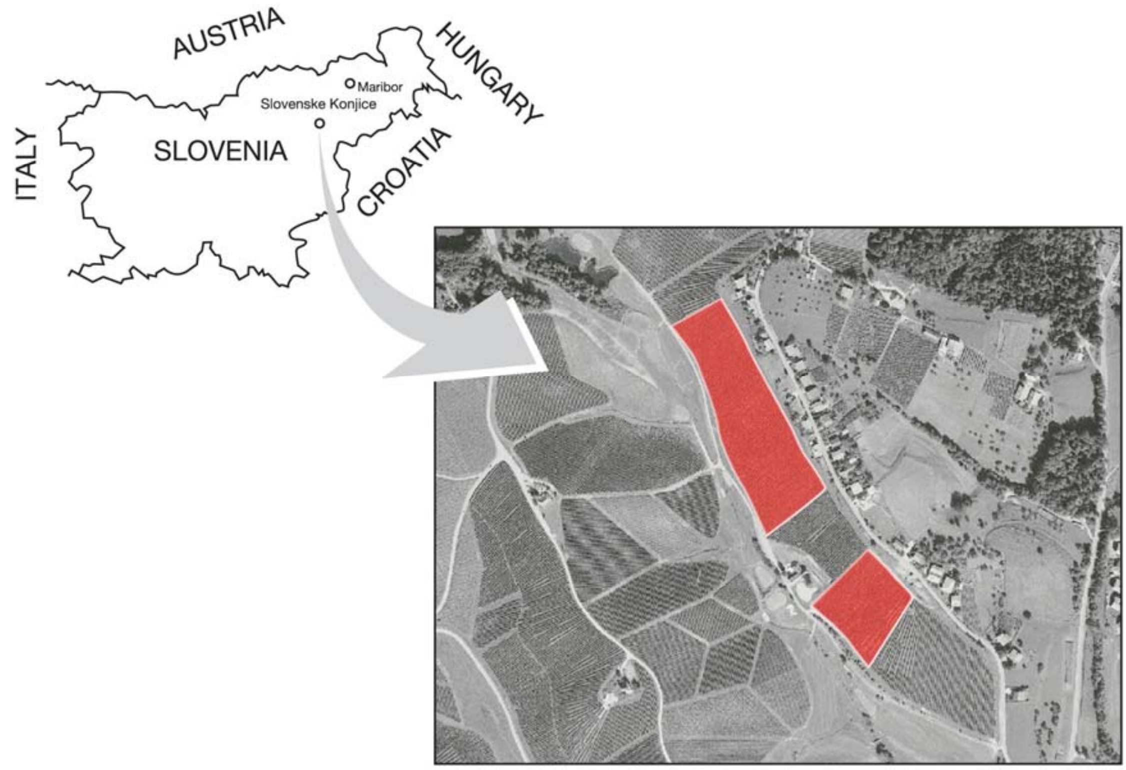


Figure 7.1: *Map of the study area, red colour indicates the location of the field experiment.*

The field experiment was carried out in year 2002: four consecutive spray applications were made in a vineyard (at full foliage development) in Slovenske Konjice on 20 and 30 July and also on 9 and 19 August 2002, in 10-day intervals. The developing stages of the grape vine were from berries pea-sized or bunches hang, BBCH 75 (Compendium of growth stage identification keys for mono- and dicotyledonous plants, 1997) to the beginning of ripening, berries began to develop the variety-specific colour, BBCH 81 (Compendium of growth stage identification keys for mono- and dicotyledonous plants, 1997).

General characteristics of the field experiment location are given in Appendix, in table App1.

7.2 Vineyard

The vineyard selected for our experiment was as uniform as possible in terms of vine size and structure. The plants used in field experiment were variety *Rheinriesling* (*Renski Rizling)* vines which were 18 years old. The planting distance was 2.8 m between the rows and 1.0 m in the row, with one vine planted at each pole, giving a density of 3,571 (three thousand five hundred and seventy-one) vines per ha (Figure 7.2). The form of breeding was two-pointed guyot.

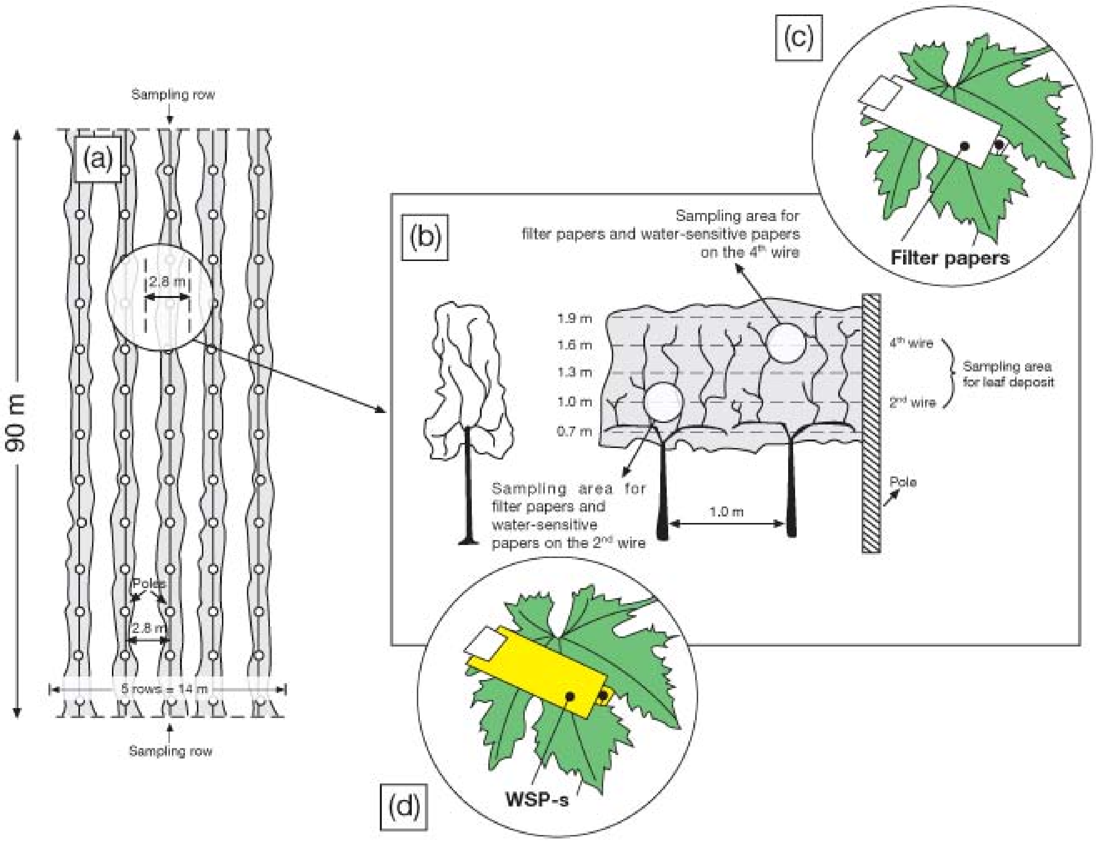


Figure 7.2: *The scheme of the treatment (plot) in the vineyard and sampling areas for spray deposit, coverage and impact density assessment: (a) scheme of one treatment (plot); (b) cross-sectional and side view, showing sampling locations; (c) position of filter papers on leaf and (d) position of water-sensitive papers on leaf.*

The length of rows was 90 meters and the width of one treatment (plot) was 14 meters (five rows). Seven treatments were included in this study as it is shown on figure 7.3 and table 7.3. The vineyard was divided into four replications, using a randomized complete block design (Figure 7.4). Therefore, the field experiment was carried out on a large scale of 3.528 ha (35 280 m^2). In each treatment, five rows were included, but only the middle row was sampled (Figure 7.2 and 7.3). As it is shown on figure 7.2b, there were two sampling areas per sampling row. The first was on the height of second wire (1.0 m from the ground) and the second one was on the height of the fourth wire (1.6 m from the ground).

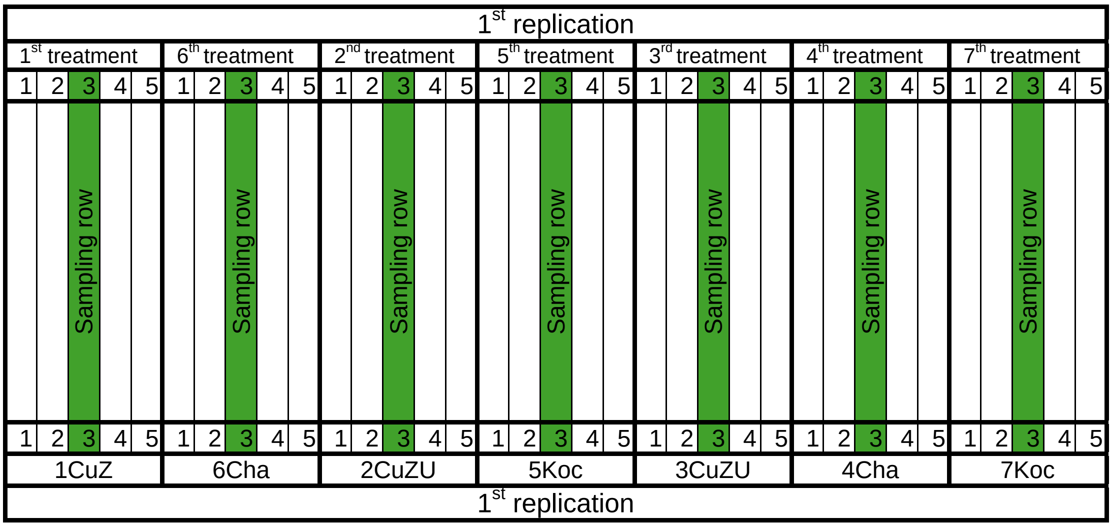


Figure 7.3: *The scheme of the first replication, numbers 1 to 5 in the scheme indicate five rows including the sampling row (3) in each treatment (plot).*

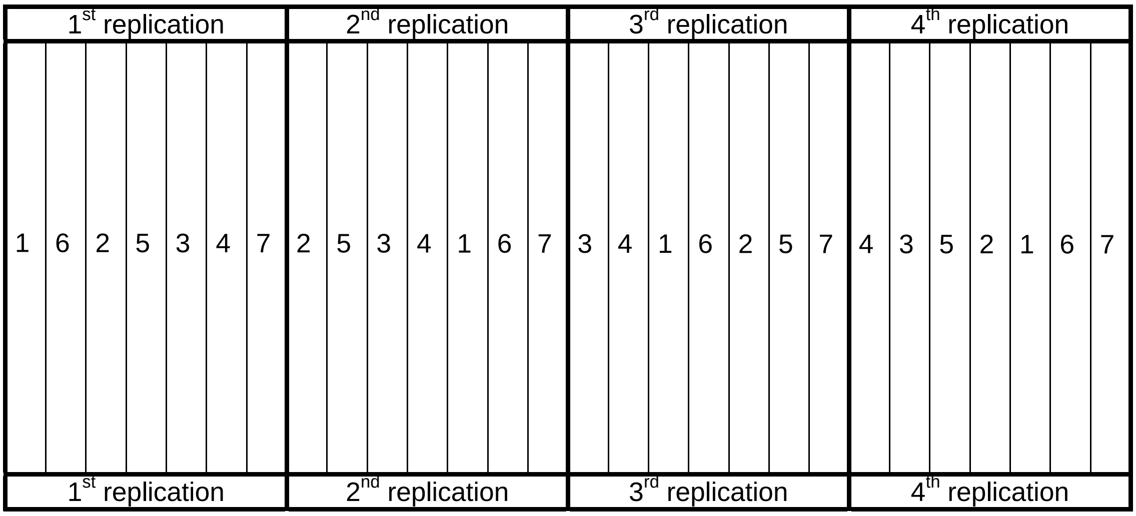


Figure 7.4: *The scheme of the field experiment, numbers in the scheme indicate seven treatments (plots) in four replications. (Each treatment consists of five rows as it is shown on the previous figure).*

7.3 Spray equipment and sprayer settings

All spray applications were carried out with a commercial axial sprayer, a tractor trailed sprayer for vine-growing type Zupan ZM 600 Ecologic with six hollow cone nozzles mounted on each side (Figure 7.5). The sprayer was calibrated to deliver 400 L (±5 %) of water per ha or 1000 L (±5 %) of water per ha. To obtain low and high spray volume rates Albuz ATR yellow and red hollow cone nozzles were fitted to double-jet holders. The nozzles used for the field experiment and the characteristics of the sprayer settings are presented in table 7.1.

Figure 7.5: *Axial sprayer for vine-growing used in field experiment (Photo: Simona Luskar).*

Table 7.1: *Characteristics of sprayer settings for two different spray volumes.*

	Zupan ZM 600 E	
	Low volume (400 L ha^{-1})	High volume (1000 L ha^{-1})
Ceramic hollow cone nozzles	Albuz ATR	Albuz ATR
Colour of the nozzles	Yellow	Red
Number of nozzles	6+6	6+6
Positions of nozzles on boom	In front of air stream	In front of air stream
Pressure (bar)	7	13
VMD (µm)*	83	92
Spray liquid flow rate per:		
nozzle (L min^{-1})	0.86	2.17
all nozzles (L min^{-1})	10.32	26.04
Orifice diameter (mm)	1.2	2.0
Forward speed (km h^{-1})	5.4	5.4
Spray volume (L ha^{-1})	400	1000

Legend: *Volume median diameter (Albuz San Oben, manufacturer data, France, 2005)

7.4 Spraying programme

Depending on seasonal and local factors, 8 to 12 applications per year are generally needed. In the vineyard in Slovenske Konjice 10 applications were made during the growing season in question (2002). All applications (also the four ones included in our field experiment) are shown in table 7.2 as well as in table 7.3.

Table 7.2: *Applications, plant protection products and their formulation, active substance and application rate of plant protection products used during the 2002 growing season (Brečko, 2002).*

Application No. and date	Plant protection product (PPP)	Formulation	Active substance (%)	Application rate of PPP (kg or L ha^{-1})
1st 18 May	Polyram DF	WG	metyram 70	1.50
	Kumulus DF	WG	sulphur 80	2.00
2nd 30 May	Antracol combi	WP	cymoxanil 6 + propineb 70	2.20
	Karathane (R) EC	EC	dinocap 35	0.35
	Borogreen L*			1.00
3rd 11 June	Equation pro	WG	cymoxanil 30 + famoxadone 22.5	0.40
	Crystal	SC	quinoxyfen 25	0.20
4th 21June	Curzate M	WG	cymoxanil 4 + mancozeb 40	3.00
	Falcon EC 460	EC	spiroxamine 25 + tebuconazole 16.7 + tridimenol 4.3	0.40
5th 4 July	Eclair 49 WG	WG	cymoxanil 24 + trifloxystrobin 25	0.50
	Match 050 EC	EC	lufenuron 5	1.00
	Teldor SC 500	SC	fenhexamid 50	1.00
6th 20 July	**Field experiment - 1st Application (see Table 7.3)**			
	Sabithane (R)	EC	dinocap 32.5 + myclobutanil 7.5	0.40
7th 30 July	**Field experiment - 2nd Application (see Table 7.3)**			
	Sabithane (R)	EC	dinocap 32.5 + myclobutanil 7.5	0.40
8th 9 August	**Field experiment- 3rd Application (see Table 7.3)**			
	Kumulus DF	WG	sulphur 80	3.00
9th 19 August	**Field experiment - 4th Application (see Table 7.3)**			
	Kumulus DF	WG	sulphur 80	3.00
10th 26 August	Switch 62.5 WG	WG	cyprodinil 37.5 + fludioxonil 25	0.50

Legend: *fertilizer (B-boron); WG, water dispersible granules; WP, wettable powder; EC, emulsifiable concentrate; SC, suspension concentrate

In table 7.3 the details on treatments: treatment code, fungicides tested in the study, application rate of fungicides, application rate of copper ions, application rate of water per ha and concentration of fungicides used in field experiment are shown in order to illustrate details about the copper fungicides used in our experiment. Only plant protection products used in applications 6, 7, 8 and 9 (see table 7.2) contained copper substances, other applications were 'copper free'.

Table 7.3: *Treatments, treatment code, fungicides tested in the study, application rate (AR) of fungicides, application rate of copper ions, application rate of water per ha and concentration of fungicides used in field experiment.*

T	TCode	Fungicides	AR of fungicides (g ha^{-1})	AR of copper ions (g ha^{-1})	AR of water (L ha^{-1})	Concentration of fungicide (%)
1	1CuZ	Cuprablau Z	3000	1050	400	0.75
2	2CuZU	Cuprablau Z Ultra	2500	875	400	0.63
3	3CuZU	Cuprablau Z Ultra	2500	875	1000	0.25
4	4Cha	Champion 50 WP	2500	1250	400	0.63
5	5Koc	Kocide DF	2000	800	400	0.50
6	6Cha	Champion 50 WP	2000	1000	400	0.50
7	7Koc	Kocide DF	2500	1000	400	0.63

Trade and company names used in this thesis are solely for providing specific information. Their mention does not constitute an endorsement over other products not mentioned.

7.5 Evaluation of downy mildew (*Plasmopara viticola*) on vine grapes

The severity (percentage of infected/attacked surface area) of downy mildew (*Plasmopara viticola*) on vine grapes (clusters) was evaluated for the first time between the 5th and the 6th application (i.e. before our field experiment, on 15 July) and for the second time before the 8th application (8 August). There were five rows in each treatment (plot) while only the middle row was evaluated. The severity of downy mildew symptoms was evaluated in accordance with the Field Trials Manual in Plant Protection (Ciba-Geigy Documenta, 1981), Guideline for the efficacy evaluation of plant protection products (EPPO, 1999) and Guideline for the efficacy evaluation of plant protection products for Plasmopara viticola (EPPO, 2001) on a 0-10 scale; 150 grapes were evaluated per treatment. From these data disease infection (in %) was then calculated according to the Townsend-Heuberger equation [1].

$$I(\%) = \left(\frac{\sum_{0}^{i} (n \cdot v)}{iN} \right) \times 100 \qquad [1]$$

Where *I(%)* is percent of disease infection, *v* is value of the category, *i* is the highest category value, *n* is number of plants (plant parts) in each category and *N* is total number of investigated plants (plant parts).

The percent of efficacy of plant protection products was calculated according to the Abbott equation [2].

$$E(\%) = \left(\frac{Ca - Ta}{Ca} \right) \times 100 \qquad [2]$$

Where *E(%)* is percent of efficacy, *Ca* is infection in the untreated plot after application and *Ta* is infection in the treated plot after application.

The biological efficacy of plant protection products used in our field experiment was calculated by using the untreated plots taken from the field experiment in Maribor (Matis, 2002), where the field experiment for evaluating biological efficacy of plant protection products was carried out on the same variety and under very similar and comparable climatic as well as growing conditions (see chapter 7.9.1). Where applied at all, also the spraying programme was similar: the fungicide Cuprablau Z Ultra was used three times during the growing season in 0.25 % concentration as well as in our treatments (see table 7.3).

7.6 Evaluation of downy mildew (*Plasmopara viticola*) on vine leaves

The evaluation of the severity (percentage of infected/attacked surface area) of downy mildew (*Plasmopara viticola*) on vine leaves took place 9 to 11 days after the last application of plant protection products against downy mildew (from 4 to 6 September 2002). The severity of downy mildew symptoms on vine leaves was evaluated in accordance with the above mentioned manual guidelines (Ciba-Geigy Documenta, 1981; EPPO, 1999; EPPO, 2001) on a 0-10 scale; 1,500 (a thousand and five hundred) leaves were evaluated per treatment (plot). From these data disease infection (in %) was then calculated according to the Townsend-Heuberger equation [1]. Biological efficacy was calculated according to the Abbott equation [2] (see chapter 7.5). In each treatment applications were made in five rows while only the middle row was evaluated.

7.7 Deposit tracer used

Copper ions (Cu^{2+}) included in copper formulations of four plant protection products were used as deposit tracer. All plant protection products contained copper in the form of copper hydroxide as active substance (Table 7.4). The fungicides tested in the study were commercial WP (wettable powder) and WG (water dispersible granules) formulations.

Table 7.4: *Fungicides tested in the study, their formulation, active substance, percentage of the active substance and the specific amount of copper ions for the substances in question (Priročnik…, 2002).*

Fungicides	F	Active substance	Percentage of active substance	Amount of Cu^{2+} (g kg^{-1})
Cuprablau Z	WP	Copper as 3 $Cu(OH)_2.CaCl_2$ + Zn	53.8 2.0	350
Cuprablau Z Ultra	WP	Copper as 3 $Cu(OH)_2.CaCl_2$ + Zn	53.8 2.0	350
Champion 50 WP	WP	$Cu(OH)_2$	77.0	500
Kocide DF	WG	$Cu(OH)_2$	61.4	400

Legend: F, formulation; WP, wettable powder; WG, water dispersible granules.

7.8 Spray targets

Several types of collectors, natural as well as artificial, have been used to evaluate spray deposit, coverage and impact density per area unit. In each treatment five rows at least 90 m long were sprayed as it is shown on the figures 7.2, 7.3 and 7.4 in chapter 7.2 and table 7.3 in chapter 7.4. Samples were taken from each middle row.

7.8.1 Natural collectors

7.8.1.1 Vine leaves

Vine leaves were used as natural collectors in the field experiment. The samples of leaves were taken from vines before and after each application. Sampling was performed between the 2nd and the 4th wire (between 1.0 and 1.6 m from the ground i.e. between the zones indicated in figure 7.2b) on both sides, the left one and right one of the middle row in each of the field experiment treatments (plots) in the vineyard (Figure 7.2 in chapter 7.2).

One day before each application, four samples of 150 leaves without stems were taken from each treatment plot to determine the leaf area. The leaf area was measured using the image analysis computer techniques (Optomax V image analyser) and the leaves were weighed; 60 of these 150 leaves were taken to determine the spray deposit. These ‘blank' samples were taken in such a way that the pre-spraying amounts of the copper ions used as tracer (expected to be near zero) could be determined. The leaf samples were stored in a cooler (at 10 °C) to prevent wilting.

After application, the sampling to determine deposits due to spray applications started as soon as the spray deposit of the last spray application (of a given experimental treatment) had dried. Composite samples of 60 leaves were taken from one sampling zone between the 2nd and the 4th wire on the left (30 leaves) and on right side (30 leaves) of the middle row for each treatment.

The samples collected before and after the application were stored in paper bags to prevent sweating. Collection of all samples was completed within 2 hours before the application, and within 7 hours after the application. The samples were stored at 10 °C in the warehouse at Slovenian Institute of Hop Research and Brewing (IHPS) overnight, until extraction was done the next day in the laboratory of Cinkarna Celje, the Metallurgical and Chemical Industry Celje.

The samples prepared in the laboratory of Cinkarna Celje according to Official Methods of Analysis (Helrich, 1990) were analysed in accordance with the method described in ISO standard 8288. The measurement of the spray deposit on the leaves was obtained by analysing copper ions by atomic absorption spectroscopy (AAS) using a Perkin Elmer 3110 spectrophotometer. The results obtained were expressed as tracer (copper ions) concentration in mg L^{-1}.

The amount of spray deposit per area unit ($Cu(\mu g\ cm^{-2})$) as determined for a particular treatment in a sample of 60 leaves is given by equation [3].

$$Cu(\mu g\ cm^{-2}) = \frac{[tracer] \times volume}{sample\ area} \times 1000 \qquad [3]$$

where [*tracer*] is the concentration of tracer (copper ions in mg L^{-1}) in the analysed extract, *volume* being the volume of solvent used for extracting the tracer (L), *sample area* stands for the total area of the 60 leaves in cm^2 and *1000* is factor for converting values from mg g^{-1} to µg g^{-1}.

7.8.1.2 Vine grapes

Vine grapes (clusters) were used as natural collectors too. The samples of grapes (weight about 1 kg) were taken from vines on 14 October 2002 (56 days after last treatment with copper fungicides) for each treatment and stored in deep freeze (at - 18 °C). Deposit in vine grapes was extracted from the samples by dry ashing of known amount of grapes in the laboratory at IHPS. From each sample three grapes of average size were taken and put in kiln for 24 hours at 70 °C. Each sample was transferred into a clean glazed, high-form porcelain crucible. The samples were crashed and ashed for two hours at 500 °C and let to cool. Afterwards, 10 mL of distilled water and 30 mL of HNO_3 (nitric(V) acid) (V_{water}:V_{acid} = 1:1) were added, the excess of HNO_3 was evaporated on a hot plate set at 100-120 °C. Crucibles were returned to furnace and ashed for additional one hour at 500 °C. To a cool crucible, 50 mL of HCl (hydrochloric acid) (V_{water}:V_{HCl} = 1:1) were added to dissolve the ash and the sample was filtered through filter paper (black ribbon). Finally, the solutions were quantitatively transferred into 250 mL volume flasks and filled up with distilled water to the mark. The samples prepared according to Official Methods of Analysis (Helrich, 1990) were analysed in accordance with the method described in ISO standard 8288.

The amount of spray deposit per unit weight ($Cu(\mu g\ g^{-1})$) as determined for a particular treatment in a sample of vine grapes is given by equation [4].

$$Cu(\mu g\ g^{-1}) = \frac{[tracer] \times volume}{W} \times 1000 \qquad [4]$$

where [*tracer*] is the concentration of tracer (copper ions in mg L^{-1}) in the analysed extract, *volume* being the volume of solvent used for extracting the tracer (L), *W* is the weight of sample and *1000* is factor for converting values from mg g^{-1} to µg g^{-1}.

7.8.2 Artificial collectors

7.8.2.1 Positions and number of the artificial collectors

In this field experiment filter paper strips and water-sensitive papers (WSP) were used as artificial collectors. These collectors were put into the right positions using paper clips. They were placed on both row sides in the middle row. Collectors in each sampling row were divided into two zones: 2^{nd} and 4^{th} wire (at 1.0 m and 1.6 m respectively), on the lower and upper leaf side as shown on the figure 7.2 in chapter 7.2.

There were as many as 24 strips of filter paper in each samping row and they were distributed as follows: 12 sampling points, 6 on the left and 6 on the right side of the row, 3 on each side at the 2^{nd} and 3 at the 4^{th} wire. Each of the 12 sampling points had a double strip (the upper ant the lower side of the leaf).

There were as many as 36 WSP in each sampling row and they were distributed as follows: 18 sampling points, 9 on the left and 9 on the right side of the row (half of them (once 5 and once 4) at the 2^{nd} and half at the 4^{th} wire). Each of the 18 sampling points had a double strip (the upper ant the lower side of the leaf).

For details about number and position of artificial collectors see figure 7.6.

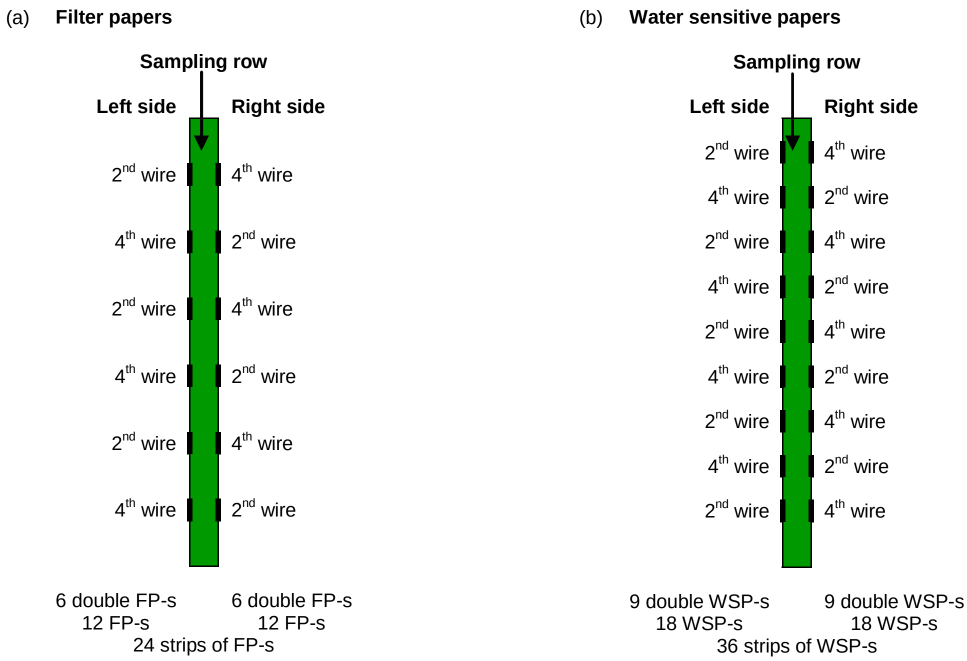


Figure 7.6: *Number and position of artificial collectors.*

7.8.2.2 Filter papers

The spray deposit on both row sides (of the middle row) of twenty-four strips for each test treatment was assessed by using filter paper strips (black ribbon) of 2.5 cm x 7.6 cm (Schleicher & Schuell, art. 604). Six double filter papers were attached to the right and six double papers to the left side of the middle row. Samples were taken from two different canopy zones: first zone (2^{nd} wire, 1.0 m) and second zone (4^{th} wire, 1.6 m; details on figure 7.2), on lower and upper leaf side for both zones. The double filter papers were stapled as it is shown in figure 7.7. After the application, the dried strips of filter paper were sampled and placed in pre-coded paper bags.

Figure 7.7: *Location of filter paper strips on vine leaves: (a) stapling filter paper strips on vine leaf, (b) position of filter paper strips on vine leaf, (c) filter paper strips on upper and lower leaf side (Photo: Simona Luskar).*

Deposit on filter papers was extracted from the samples by dry ashing in the laboratory at IHPS. Each sample was weighed and transferred into a clean glazed, high-form porcelain crucible (Figure 7.8a). The samples were ashed for two hours at 500 °C and let to cool (Figure 7.8b and c). Afterwards, 10 drops of distilled water and 4 mL of HNO_3 (V_{water}:V_{acid} = 1:1) were added, the excess of HNO_3 was evaporated on a hot plate set at 100-120 °C. Crucibles were returned to furnace and ashed for additional one hour at 500 °C. To a cool crucible, 10 mL of HCl (V_{water}:V_{HCl} = 1:1) were added to dissolve the ash. Finally, the solutions were quantitatively transferred into 50 mL volume flasks and filled up with distilled water to the mark. The samples prepared according to Official Methods of Analysis (Helrich, 1990) were analysed in laboratory in Cinkarna Celje.

The assessment of the spray deposit in/on the filter papers was obtained by analysing the copper ions by atomic absorption spectroscopy (AAS) using a Perkin Elmer 3110 spectrophotometer in laboratory in Cinkarna Celje in accordance with the method described in ISO standard 8288.

The amount of spray deposit per unit area as determined for a particular treatment in a sample of filter paper is given by equation [3] in chapter 7.8.1.

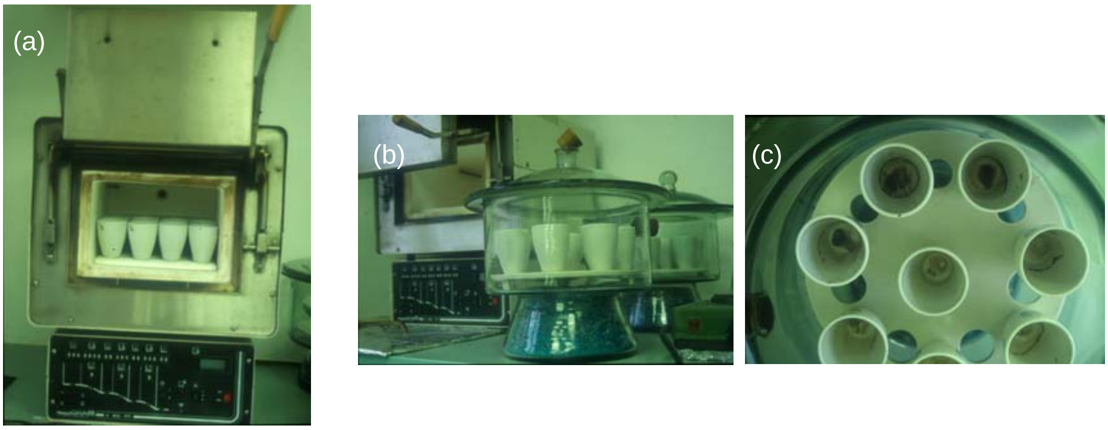


Figure 7.8: *Processing during dry ashing of filter papers: (a) porcelain crucibles with filter paper strips in kiln before ashing, (b) cooling porcelain crucibles, (c) ash of filter paper strips in crucibles (Photo: Simona Luskar).*

7.8.2.3 Water-sensitive papers (WSP)

In order to quantify the relative spray cover percentage with the spray broth and the impact density (number of impacts per area unit), water-sensitive papers (developed and marketed by Novartis, Corp., Basel, Switzerland) were placed in the vine canopy immediately before each treatment application and were collected immediately afterwards (Figure 7.2 and 7.9). Image analysis computer techniques (Optomax V image analyser) were used to determine the relative spray cover percentage of water-sensitive papers and the number of impacts per area unit.

The water-sensitive papers (thirty-six papers) of 2.5 cm x 7.6 cm were attached on the upper and lower leaf sides, with a paper clip per sampling row. Nine double papers were attached to the right and nine double papers to the left side of the middle row. Samples were taken from two different canopy zones: first zone (2nd wire, 1.0 m) and second zone (4th wire, 1.6 m), on lower and upper leaf side for both zones. The yellow coating of the water-sensitive papers turns blue after wetting (in our case with spray broth). After the application the water-sensitive papers were collected as soon as they dried and they were placed in pre-coded paper bags.

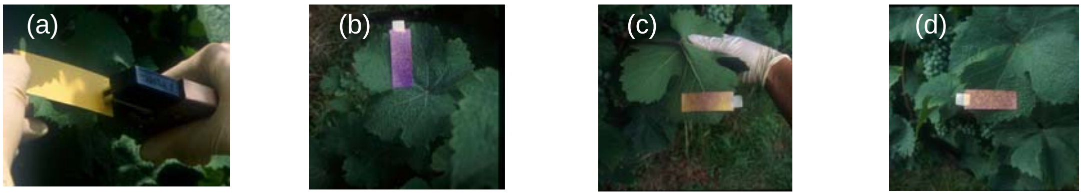


Figure 7.9: *Location of WSP on vine leaves: (a) stapling WSP on vine leaf, (b) position of WSP on vine leaf after application, (c) WSP on lower leaf side after application, (d) WSP on upper leaf side after application (Photo: Simona Luskar).*

After the spray application, the stained ribbons were collected and observed in UV light using image analysis computer software (Optomax V) to determine the percentage of coverage by spray broth and the impact density. Randomly, nine 1 cm^2 areas from the upper and nine 1 cm^2 areas from lower side of each leaf on two different sampling zones (2^{nd} and 4^{th} wire) were observed two times each. Altogether 18 measurements were done per sampling zone, leaf side and replication.

7.9 Meteorological conditions

The field experiments were performed to measure deposit on the leaves and artificial collectors as well as the spray coverage and the impact density in vineyard at different application dates, preferably under similar and uniform weather conditions. The measurements of meteorological conditions, given in table 7.5, and figures 7.10 to 7.13 were recorded by climatological station in Slovenske Konjice near the field experiment (the distance being 700 m). The measurements of decade meteorological conditions, given on figure 7.12 were recorded by climatological station in Slovenske Konjice and in Maribor.

Applications were made from 7 a.m. to 3 p.m. and the weather conditions were almost uniform. Temperatures were typical of that time of the year in Slovenske Konjice. The wind speed was low, 2.5 m s^{-1} or less.

Table 7.5: *Meteorological conditions at the time of spraying (Tepej, 2002).*

Application date	**1st (20 July)**	**2nd (30 July)**	**3rd (9 August)**	**4th (19 August)**
Wind speed (m s^{-1})	1.5	1	1.3	2.5
Wind direction	SE	NNW	SSE	ENE
Relative humidity (%)	72	71	81	73
Mean temperature (°C)	20.5	22.5	18.8	22.1
Max temperature (°C)	27	29	25	28
Min temperature (°C)	13.9	16	12.5	16.1
Cloudiness	0-2	3-7	5-8	3-4
Precipitation to the next application (mm)	-	23.8	88.1	96.2
1st precipitation (mm)	9	38	14*	0.6
1st precipitation (days)	2	2	2**	3

Legend: *first precipitation two hours after application until next morning, to 7a.m.
**two hours after application

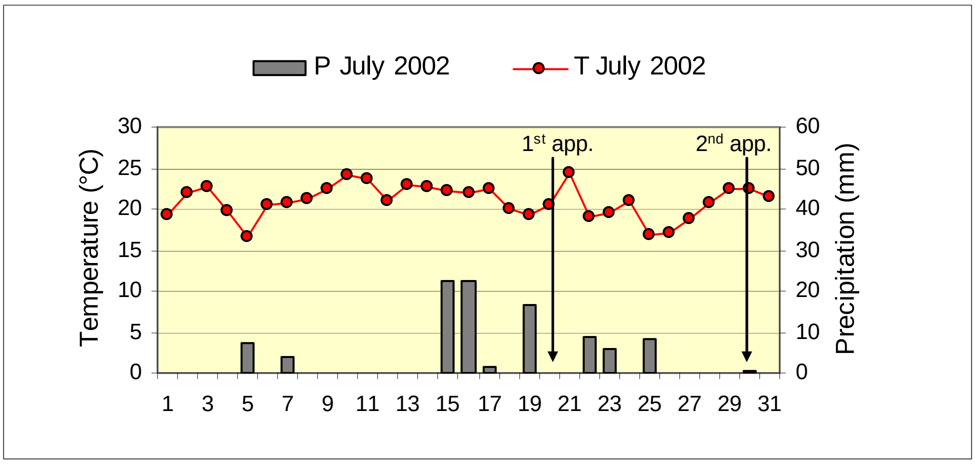


Figure 7.10: *Average daily air temperature in °C (T) and precipitation in mm (P) in Slovenske Konjice in July 2002 (Tepej, 2002).*

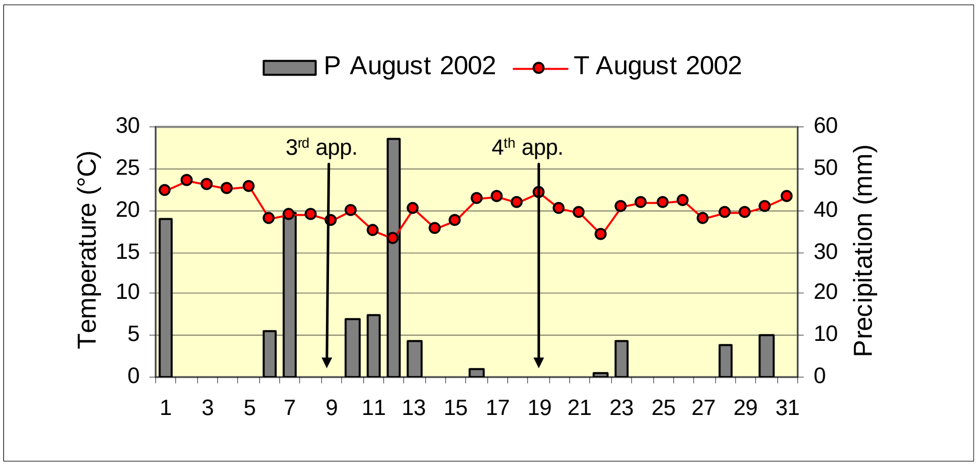
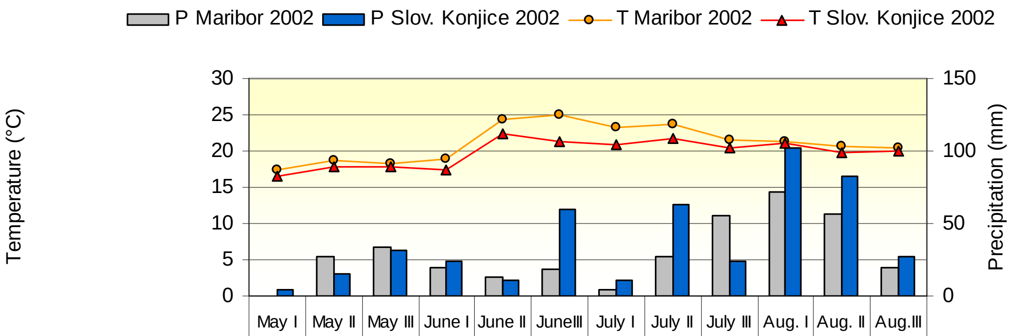


Figure 7.11: *Average daily air temperature in °C (T) and precipitation in mm (P) in Slovenske Konjice in August 2002 (Tepej, 2002).*

7.9.1 Comparison of meteorological conditions

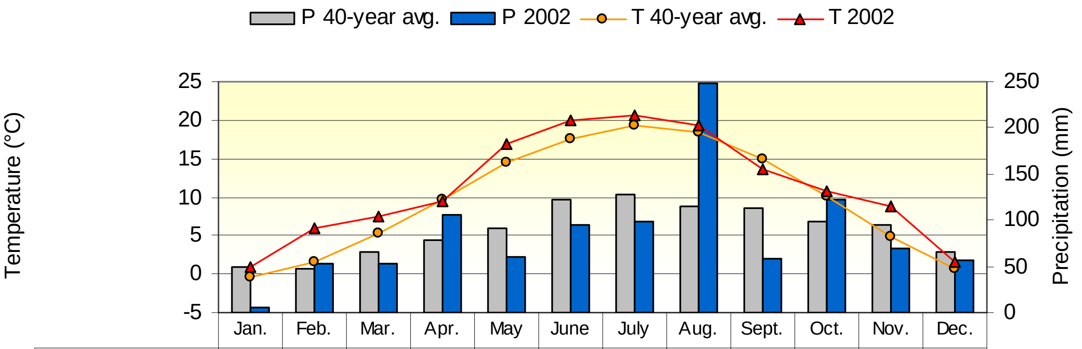
The vineyard Križničevo, where our field experiment was carried out, is a part of the wine-growing area of Maribor. For evaluation of biological efficacy of plant protection products used in this experiment, the untreated plots (the so called ‘control’) were taken from the untreated plots in Maribor (Matis, 2002), where the field experiment was carried out on the same variety (Rheinriesling) and under very similar climatic and growing conditions. The distance between Slovenske Konjice and Maribor is app. 40 km. For the illustration, on the figure 7.12 the comparison of climatic conditions (the mean decade air temperature (T) and precipitation (P)) in Slovenske Konjice with that in Maribor for the year 2002 is given.



	May I	May II	May III	June I	June II	JuneIII	July I	July II	July III	Aug. I	Aug. II	Aug.III
P Maribor 2002	0,4	27,4	33,6	20,0	12,8	18,0	4,6	27,2	55,8	71,2	56,2	19,4
P Slov. Konjice 2002	4,2	15,1	31,5	23,6	11,4	59,7	11,3	62,8	23,8	102,1	82,2	27,3
T Maribor 2002	17,4	18,7	18,3	18,9	24,4	25,0	23,3	23,6	21,6	21,4	20,7	20,5
T Slov. Konjice 2002	16,5	17,9	17,8	17,5	22,3	21,4	20,9	21,7	20,4	21,1	19,7	20,0

Figure 7.12: *Comparison of the mean decade air temperature in °C (T) and precipitation in mm (P) in Slovenske Konjice with that in Maribor for the year 2002 (Tepej, 2002; Matis, 2002).*

Figure 7.12 shows the similarity of mean decade temperature in Slovenske Konjice and in Maribor. Meanwhile, the amount of precipitation was higher in Slovenske Konjice than in Maribor in the third decade in June, the second decade in July and in first decade and second decade in August (the differences being: 41.7 mm, 35.6 mm, 30.9 and 26.0 mm). The opposite was true in the third decade in July when the precipitation was lower in Slovenske Konjice than in Maribor (the difference being: 32.0 mm). These differences were the consequences of local weather oscillation.



	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
P 40-year avg.	49,4	47,0	65,6	78,2	90,9	122,8	127,4	115,1	113,4	98,5	94,1	66,2
P 2002	6,0	52,9	53,6	106,3	60,2	94,7	98,0	247,6	58,2	122,5	69,1	55,8
T 40-year avg.	-0,3	1,5	5,2	9,6	14,4	17,5	19,2	18,5	15,0	10,1	4,8	0,6
T 2002	1,0	5,9	7,4	9,4	16,9	19,9	20,6	19,2	13,7	10,8	8,9	1,5

Figure 7.13: *Comparison of 40-year average (from 1962 to 2001) of mean monthly air temperature in °C (T) and precipitation in mm (P) in Slovenske Konjice with that for the year 2002 (Tepej, 2002; Štucin, 2005).*

The comparisons of 40-year average of mean monthly air temperature and precipitation in Slovenske Konjice with that of the year 2002 are shown in figure 7.13. The average of mean monthly air temperatures during the growing season (April to October) were for one to two degrees Celsius higher in year 2002 than for the 40-year average. The amount of precipitation during the same time was lower, except in April, October and August where the amount of precipitation was for 132.5 mm higher in year 2002 than for the 40-year average.

7.10 Data analysis

All data were transferred to Microsoft Excel before statistical analysis was done. The data were analysed using computer programme SAS (SAS/STAT Software, 1999) with the method of least squares using the GLM procedure in SAS. Means were further on evaluated by the Duncan's multiple range tests at the 5 % level. Variability of the data was expressed as the coefficient of variation (CV).

Parameters in statistical **model 1** included the effects of treatments (*T*) and number of replications (*R*) [5]. This statistical model was used to evaluate the infection of vine grapes and vine leaves, and also the deposit of copper ions in vine grapes.

$$y_{ijk} = \mu + T_i + R_j + e_{ijk} \qquad [5]$$

where y_{ijk} = the *ijk*th observation, μ = general mean, T_i = effect of the *i*th treatment (*i* = 1 Cuprablau Z, *i* = 2 Cuprablau Z Ultra, *i* = 3 Cuprablau Z Ultra, *i* = 4 Champion 50 WP, *i* = 5 Kocide DF, *i* = 6 Champion 50 WP and *i* = 7 Kocide DF), R_j = effect of the *j*th replication (*j* = 1, 2, 3, 4) and e_{ijk} = residual random term with variance σ^2_e.

Parameters in statistical **model 2** included the effects of treatments (*T*), number of replications (*R*), application dates (*AD*), sampling times (*ST*) and their interaction (*T*×*AT*×*ST*) [6]. This statistical model was used to evaluate the deposit of copper ions on vine leaves and the deposit of copper ions on leaves normalized to the same application rate of copper ions (i.e. 1 kg ha^{-1}).

$$y_{ijklm} = \mu + T_i + R_j + AD_k + ST_l + T{\times}AD{\times}ST_{ikl} + e_{ijklm} \qquad [6]$$

where y_{ijklm} = the *ijklm*th observation, μ = general mean, T_i = effect of the *i*th treatment (*i* = 1 Cuprablau Z, *i* = 2 Cuprablau Z Ultra, *i* = 3 Cuprablau Z Ultra, *i* = 4 Champion 50 WP, *i* = 5 Kocide DF, *i* = 6 Champion 50 WP and *i* = 7 Kocide DF), R_j = effect of the *j*th replication (*j* = 1, 2, 3, 4), AD_k = effect of the *k*th application date (*k* = 1, 2, 3, 4), ST_l = effect of the sampling time (*l* = before application and after application), and $T{\times}AT{\times}ST_{ikl}$ = interaction between treatment, application date and sampling time, and also e_{ijklm} = residual random term with variance σ^2_e.

Statistical **model 3** included the effects of treatments (*T*), number of replications (*R*), application dates (*AD*), sampling heights (*SH*), leaf-side (*LS*) and their interaction (*T*×*AD*×*SH*×*LS*) [7]. This statistical model was used to evaluate the deposit of copper ions on filter papers, deposit of copper ions on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), spray coverage of WSP (water-sensitive papers) with the spraying broth and impact density on WSP.

$$y_{ijklmn} = \mu + T_i + R_j + AD_k + SH_l + LS_m + T{\times}AD{\times}SH{\times}LS_{iklm} + e_{ijklmn} \qquad [7]$$

where y_{ijklmn} = the *ijklmn*th observation, μ = general mean, T_i = effect of the *i*th treatment (*i* = 1 Cuprablau Z, *i* = 2 Cuprablau Z Ultra, *i* = 3 Cuprablau Z Ultra, *i* = 4 Champion 50 WP, *i* = 5 Kocide DF, *i* = 6 Champion 50 WP and *i* = 7 Kocide DF), R_j = effect of the *j*th replication (*j* = 1, 2, 3, 4), AD_k = effect of the *k*th application date (*k* = 1, 2, 3, 4), SH_l = effect of sampling height (*l* = 2^{nd} wire and 4^{th} wire), LS_m = effect of the leaf-side (*m* = upper and lower leaf side), and $T{\times}AD{\times}SH{\times}LS_{iklm}$ = interaction between treatment, application date, sampling height, leaf-side, and also e_{ijklmn} = residual random term with variance σ^2_e.

Table 7.6 gives treatment codes (1CuZ, 2CuZU, 3CuZU, 4Cha, 5Koc, 6Cha and 7Koc), application rates of copper ions in plant protection products - fungicides (kg ha^{-1}) and application rate of water (L ha^{-1}) tested in the study.

Table 7.6: *Treatments (T), treatment code (TCode), fungicides, application rates (AR) of copper ions and application rates (AR) of water per ha used in field experiment.*

T	TCode	Fungicides	AR of copper ions (kg ha^{-1})	AR of water (L ha^{-1})
0	0con	control*		
1	1CuZ	Cuprablau Z	1.05	400
2	2CuZU	Cuprablau Z Ultra	0.875	400
3	3CuZU	Cuprablau Z Ultra	0.875	1000
4	4Cha	Champion 50 WP	1.25	400
5	5Koc	Kocide DF	0.8	400
6	6Cha	Champion 50 WP	1.0	400
7	7Koc	Kocide DF	1.0	400

*Untreated plots (the so called ‘control’) were taken from the untreated plots in Maribor (Matis, 2002), where the field experiment for evaluating biological efficacy of plant protection products was carried out on the same variety and under very similar and comparable climatic as well as growing conditions (see chapter 7.9.1). Also the spraying programme was similar.

8 RESULTS AND DISCUSSION

8.1 Infection of vine grapes (model 1)

Tables 8.1 and 8.2 summarize the evaluation of the infection of vine grapes. For details see chapter 7.5, equations [1] and [2], and also chapter 7.9.

In table 8.1, evaluation of the infection of vine grapes is summarized and basic statistical parameters are given: the number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation.

Table 8.1: *Evaluation of the infection of vine grapes with calculated basic statistical parameters.*

	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
Infection of vine grapes (%)	28	1.4	0.5	2.1	0.5	33.4

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of each effect (treatments (T) and replications (R)) is shown in table 8.2. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatment on infection of vine grapes. There were no statistically significant differences noted between treatments in the evaluation of the infection of vine grapes.

Table 8.2: *Significance (P-value) of individual parameters on the variability of the infection of vine grapes.*

	P-value	
Parameters / **Quantity measured**	**T** (DF = 6)	**R** (DF = 3)
Infection of vine grapes	0.0790	**0.0071**

T, treatment; R, replication; DF, degrees of freedom; Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-value indicating statistically different value is in bold print.

8.1.1 Effect of treatment on the infection of vine grapes and efficacy of plant protection products

Table 8.3 and figure 8.1 show the effect of treatment on the infection of vine grapes.

Table 8.3: *Effect of treatment on the infection of vine grapes, (Duncan's test, α=0.05); (Basic data in Appendix A, for details see chapter 7.5, esp. eq. [1]).*

TCode	n	Infection of vine grapes (%) x_{mean} ±SD
1CuZ	4	1.1 ± 0.5^{c}
2CuZU	4	1.4 ± 0.7^{abc}
3CuZU	4	1.8 ± 0.4^{a}
4Cha	4	1.6 ± 0.3^{ab}
5Koc	4	1.2 ± 0.2^{abc}
6Cha	4	1.4 ± 0.4^{abc}
7Koc	4	1.1 ± 0.2^{bc}

TCode, treatment code; n, number of replications; x_{mean}, mean value; SD, standard deviation. The same letter in the last column means that the values are not statistically significantly different (P>0.05).

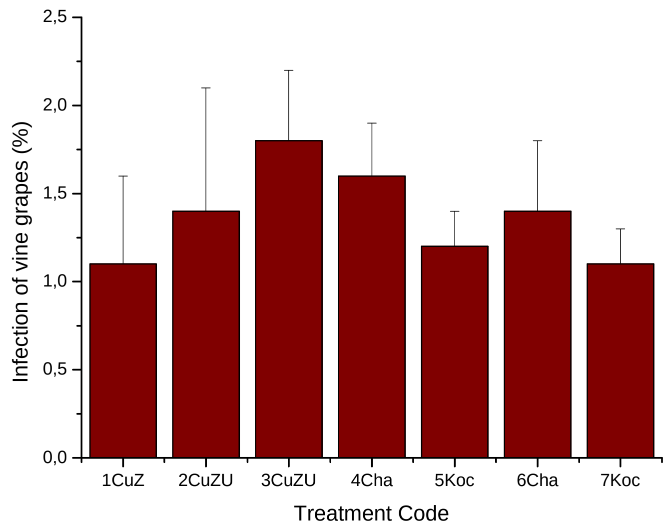


Figure 8.1: *Infection of vine grapes in Slovenske Konjice in year 2002.*

The infection of vine grapes caused by downy mildew ranged from 1.1 % to 1.8 %. Though some differences in table 8.3 are classified as statistically significant all these differences are very small, because we are dealing with 'healthy grapes'. In practice, this generally means that the level of infected vine grapes was more or less the same. The infection was very moderate, which means that the protection of vine grapes was good enough during the entire growing season.

Table 8.4 and figure 8.2 show the biological efficacy of plant protection products evaluated on vine grapes against downy mildew (*Plasmopara viticola*) in Slovenske Konjice and comparison with similar spraying programme in Maribor in year 2002 (MB). The data of untreated plots (0con) are from the field experiment carried out in Maribor in year 2002.

Table 8.4: *Efficacy of plant protection products against downy mildew on vine grapes in Slovenske Konjice and comparison with similar spraying programme in Maribor (MB) in year 2002; (Duncan's test, α=0.05; Basic data in Appendix B, for details see chapter 7.5, esp. eq. [2], and also chapter 7.9.1).*

TCode	n	Infection of vine grapes (%) x_{mean}	Efficacy by Abbott (%)
0con	4	56.5^{a}	-
1CuZ	4	1.1^{b}	98.1
2CuZU	4	1.4^{b}	97.5
3CuZU	4	1.8^{b}	96.8
4Cha	4	1.6^{b}	97.2
5Koc	4	1.2^{b}	97.9
6Cha	4	1.4^{b}	97.5
7Koc	4	1.1^{b}	98.1
MB	4	0.9^{b}	98.4

TCode, treatment code; n, number of replications; x_{mean}, mean value; %, efficacy calculated according to Abbott. The same letter in the middle column means that the values are not statistically significantly different (P>0.05).

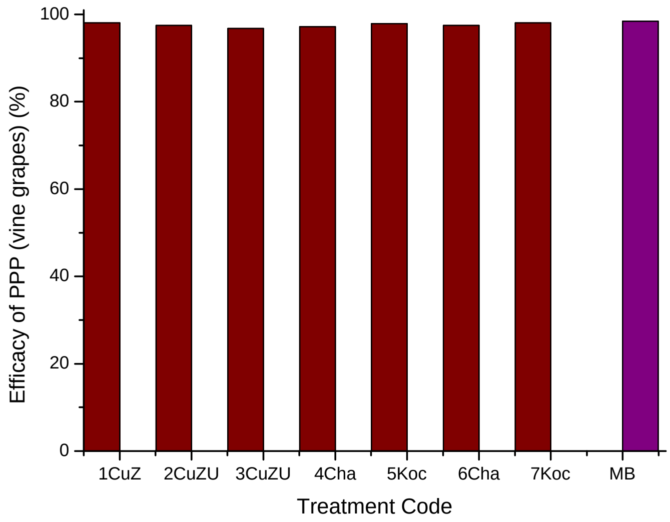


Figure 8.2: *Efficacy of plant protection products against downy mildew on vine grapes in Slovenske Konjice and comparison with similar spraying programme in Maribor (MB) in year 2002.*

The results summarized in table 8.4 and figure 8.2 show that the grapes on untreated plot in the field experiment carried out in Maribor were affected on 13 August 2002 by 56.5 % (Matis, 2002), meanwhile the average percent of grape area infected on treated plots on 8 August 2002 in Slovenske Konjice ranged from 1.1 to 1.8 %, the average infection for all the treatments being 1.4 % $\pm$ 0.5 %. Statistical analysis shows that there were statistically significant differences between treated and untreated plots, but there were no statistically significant differences between the treatments.

The efficacy of tested plant protection products against downy mildew (PLASVI) on vine grapes in Slovenske Konjice ranged from 96.8 to 98.1 %, the average being 97.6 %. The efficacy of the similar spray programme in Maribor was 98.4 %. We can conclude that all plant protection products used in our field experiment provide excellent disease control against downy mildew on vine grapes (nearly 98 %). Details are evident in table 8.4 and figure 8.2, basic data are in Appendix A.

8.2 Infection of vine leaves (model 1)

Tables 8.5 and 8.6 summarize the evaluation of the infection of vine leaves. For details see chapter 7.6, equations [1] and [2] in chapter 7.5 and chapter 7.9.

Table 8.5 gives the basic statistical parameters: number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation for the evaluation of the infection of vine leaves.

Table 8.5: *Evaluation of the infection of vine leaves with calculated basic statistical parameters.*

	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
Infection of vine leaves (%)	28	2.8	1.1	5.2	1.2	43.0

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of each effect (treatments (T) and replications (R)) is shown in table 8.6. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatment on infection of vine leaves. There were no statistically significant differences noted between treatments in the evaluation of the infection of vine leaves.

Table 8.6: *Significance (P-value) of individual parameters on the variability of the infection of vine leaves.*

	P-value	
Parameters / **Quantity measured**	**T** (DF = 6)	**R** (DF = 3)
Infection of vine leaves	0.5360	**<0.0001**

T, treatment; R, replication; DF, degrees of freedom; Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-value indicating statistically different value is in bold print.

8.2.1 Effect of treatment on the infection of vine leaves and efficacy of plant protection products

Table 8.7 and figure 8.3 show the effect of treatment on the infection of vine leaves.

Table 8.7: *Effect of treatment on the infection of vine leaves, (Duncan's test, α=0.05); (Basic data in Appendix B, for details see chapter 7.6 and 7.5, esp. eq. [1]).*

		Infection of vine leaves (%)
TCode	**n**	x_{mean} ±SD
1CuZ	4	2.2 ± 0.9^{a}
2CuZU	4	2.7 ± 1.2^{a}
3CuZU	4	2.9 ± 1.6^{a}
4Cha	4	2.8 ± 1.3^{a}
5Koc	4	3.3 ± 1.8^{a}
6Cha	4	2.6 ± 1.0^{a}
7Koc	4	2.9 ± 1.0^{a}

TCode, treatment code; n, number of replications; x_{mean}, mean value; SD, standard deviation. The same letter in the last column means that the values are not statistically significantly different (P>0.05).

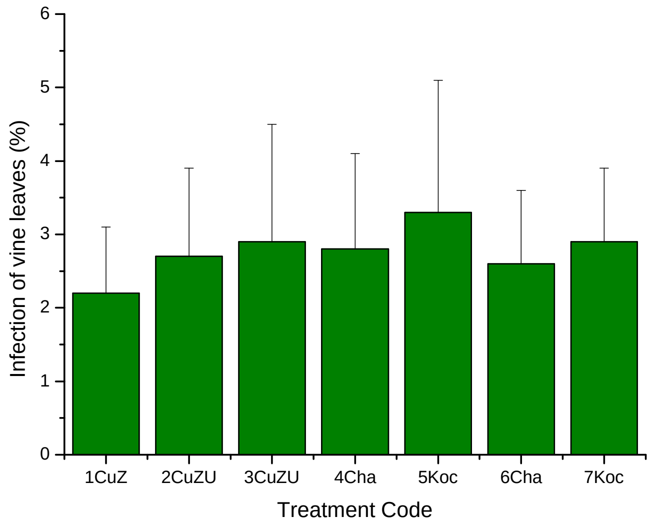


Figure 8.3: *Infection of vine leaves in Slovenske Konjice in year 2002.*

Evaluation of downy mildew symptoms on vine leaves was made at the beginning of September (4 to 6 September 2002). The symptoms of downy mildew were detected only on leaves of secondary shoots, while the leaves of primary shoots did not show any symptoms. The infection of vine leaves in field experiment ranged from 2.2 to 3.3 % and there were no statistically significant differences between the treatments (P = 0.5360). We can say that the spray programme and consequently the protection of vine leaves during the growing season were good enough.

Table 8.8 and figure 8.4 show the biological efficacy of plant protection products evaluated on vine leaves against PLASVI in Slovenske Konjice and comparison with similar spraying programme in Maribor in year 2002 (MB). The data of untreated plots (0con) are from the field experiment carried out in Maribor in year 2002 (see also chapter 7.9).

Table 8.8: *Efficacy of plant protection products against downy mildew on vine leaves in Slovenske Konjice and comparison with similar spraying programme in Maribor (MB) in year 2002; (Duncan's test, α=0.05; Basic data in Appendix B, for details see chapter 7.6 and 7.5, esp. eq. [2], and also chapter 7.9.1).*

TCode	n	Infection of vine leaves (%) x_{mean}	Efficacy by Abbott (%)
0con	4	79.2^{a}	-
1CuZ	4	2.2^{b}	97.2
2CuZU	4	2.7^{b}	96.6
3CuZU	4	2.9^{b}	96.3
4Cha	4	2.8^{b}	96.5
5Koc	4	3.3^{b}	95.8
6Cha	4	2.6^{b}	96.7
7Koc	4	2.9^{b}	96.3
MB	4	0.0^{c}	100.0

TCode, treatment code; n, number of replications; x_{mean}, mean value; %, efficacy calculated according to Abbott. The same letter in the middle column means that the values are not statistically significantly different (P>0.05).

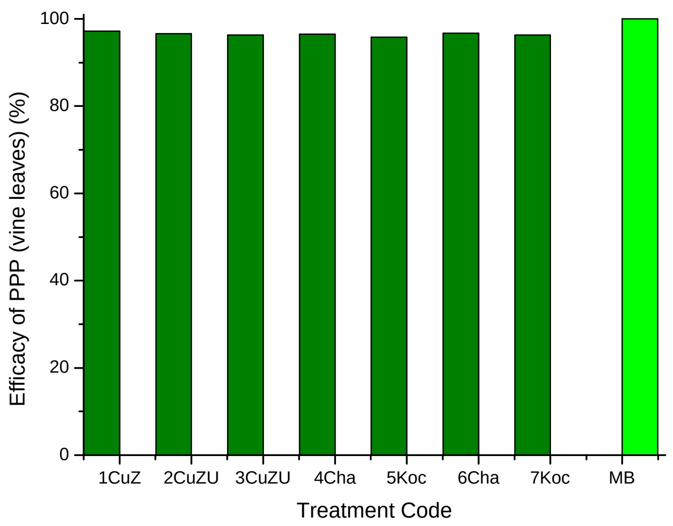


Figure 8.4: *Efficacy of plant protection products against downy mildew on vine leaves in Slovenske Konjice and comparison with similar spraying programme in Maribor (MB) in year 2002.*

The leaves on untreated plot in the field experiment carried out in Maribor were affected on 13 August 2002 by 79.2 % (Matis, 2002), meanwhile the average percent of leaf area infected on 4 to 6 September 2002 in Slovenske Konjice on treated plots ranged from 2.2 to 3.3 %, the average infection for all the treatments being 2.8 % $\pm$ 1.2 %. Statistical analysis shows that there were statistically significant differences between treated and untreated plots. There were no statistically significant differences between the treatments except between treatment MB and all other treatments.

The efficacy of tested plant protection products against downy mildew on vine leaves in Slovenske Konjice ranged from 95.8 to 97.2 %, the average being 96.5 %. The efficacy of the similar spray programme in Maribor was 100 %. We can conclude that all plant protection products used in our field experiment provide excellent disease control against downy mildew on vine leaves (nearly 97 %). Details are evident in table 8.8 and figure 8.4, basic data in Appendix B.

8.3 Deposit of copper ions in grapes (model 1)

Tables 8.9 and 8.10 summarize the analyses of copper ion deposit in vine grapes.

In table 8.9 the values of copper ion deposit in vine grapes with calculated basic statistical parameters are given: the number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation.

Table 8.9: *Copper ion deposit in vine grapes with calculated basic statistical parameters.*

	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
Deposit of Cu^{2+} (µg g^{-1})	28	1.3	0.1	3.1	0.9	72.0

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of each effect (treatments (T) and replications (R)) is shown in table 8.10. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatments on copper ion deposit in vine grapes. There were no statistically significant differences noted between treatments in the copper ion deposit in vine grapes.

Table 8.10: *Significance (P-value) of individual parameters on the variability of the copper ion deposit in vine grapes.*

	P-value	
Parameters / **Quantity measured**	**T** (DF = 6)	**R** (DF = 3)
Deposit of Cu^{2+}	0.9643	0.9957

T, treatment; R, replication; DF, degrees of freedom; Levels of significance: $P \leq 0.001$ statistically very highly significant difference; $P \leq 0.01$ statistically highly significant difference; $P \leq 0.05$ statistically significant difference; $P > 0.05$ statistically not significantly different.

8.3.1 Effect of treatment on copper ion deposit in vine grapes

Table 8.11 and figure 8.5 show the effect of treatment on copper ion deposit in vine grapes.

Table 8.11: *Effect of treatment on copper ion deposit in vine grapes, (Duncan's test, α=0.05); (Basic data in Appendix C).*

		Deposit of copper ions (µg g^{-1})
TCode	**n**	x_{mean} ±SD
1CuZ	4	1.4±1.4[a]
2CuZU	4	1.0±1.0[a]
3CuZU	4	1.6±1.0[a]
4Cha	4	1.2±0.9[a]
5Koc	4	1.3±0.4[a]
6Cha	4	1.2±1.3[a]
7Koc	4	0.9±0.4[a]

TCode, treatment code; n, number of replications; x_{mean}, mean value; SD, standard deviation. The same letter in the last column means that the values are not statistically significantly different (P>0.05).

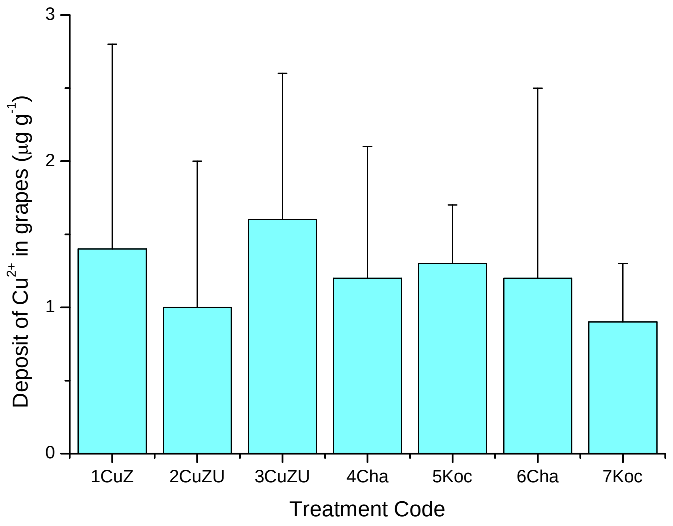


Figure 8.5: *Deposit of copper ions in vine grapes.*

The mean value of four replications of copper ion analysis in vine grapes ranged from 0.9 to 1.6 µg g^{-1}. Statistical analysis showed that there were no significant differences (P = 0.9643) between the treatments. Consequently, one can conclude that neither different plant protection products nor their application rate (as long as it remains within the recommended limits) or other smaller differences in vineyard treatment noticeably affect the copper content in grapes.

In case of 1CuZ and 2CuZU the standard deviation was the same as the mean value, and in the case of 6Cha the standard deviation was higher than the mean value. The reason for such high differences in the standard deviation is to our best knowledge the non-uniformity of grapes and the preparation of samples for analysis.

8.4 Deposit of copper ions on vine leaves (model 2)

Tables 8.12 to 8.17 summarize the analyses of copper ion deposit on vine leaves.

In table 8.12 the values of copper ion deposit on vine leaves with calculated basic statistical parameters are given: the number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation. The samples were taken before and after each application from both sides of the sampling row. The overall coefficient of variation was 48.7 %; before the application the coefficient of variation was 39.6 % and after the application it was 26.5 %. The coefficient of variation shows that the deposit uniformity of copper ions on vine leaves is worse before the application than after the application. It can be said that before the application the quantity of spray deposit on vine leaves depended noticeably on the processes in/on leaves during the 10-day intervals. The coefficient of variation of foliar deposits in vineyards reported by Pergher and Gubiani (1995) and Pergher et al. (1997) ranged from 30 % to 61 %.

Table 8.12: *Copper ion deposit on vine leaves with calculated basic statistical parameters.*

	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
Deposit of Cu^{2+} (µg cm^{-2})	224	5.8	1.6	15.1	2.8	48.7
Deposit of Cu^{2+} (µg cm^{-2}) before application	112	3.7	1.6	11.5	1.4	39.6
Deposit of Cu^{2+} (µg cm^{-2}) after application	112	8.0	4.0	15.1	2.1	26.5

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of individual effects (treatments (T), replications (R), application date (AD), sampling time (ST) and their interaction T×AD×ST) are shown in table 8.13. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatments, replications, application date, sampling time and their interaction T×AD×ST on copper ion deposit on vine leaves. There were statistically significant differences noted for all parameters (treatments, application dates, sampling times as well as for interaction between treatments, application dates and sampling times).

Table 8.13: *Significance (P-value) of individual parameters on the variability of the copper ion deposit on vine leaves.*

	P-value				
Parameters / **Quantity measured**	**T** (DF = 6)	**R** (DF = 3)	**AD** (DF = 3)	**ST** (DF = 1)	**T×AD×ST** (DF = 45)
Deposit of Cu^{2+}	**<0.0001**	**0.0002**	**<0.0001**	**<0.0001**	**<0.0001**

T, treatment; R, replication; AD, application date; ST, sampling time; T×AD×ST, interaction between treatment, application date and sampling time; DF, degrees of freedom. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print.

8.4.1 Effect of treatment on copper ion deposit on vine leaves

Table 8.14 and figure 8.6 show the effect of treatment on copper ion deposit on vine leaves.

Table 8.14: *Effect of treatment on copper ion deposit on vine leaves, mean value ± standard deviation, (Duncan's test, α=0.05); (Basic data in Appendix D).*

	Deposit of copper ions (µg cm^{-2})			
AD	**1 (20 July)**		**2 (30 July)**	
ST	**Before**	**After**	**Before**	**After**
TCode				
1CuZ	2.9±1.1[a]	10.2±0.9[a]	4.6±1.3[a]	9.1±0.7[ab]
2CuZU	2.4±0.5[ab]	9.1±1.5[a]	4.4±1.0[a]	8.7±1.8[abc]
3CuZU	2.2±0.5[ab]	6.6±0.5[b]	2.9±0.6[bc]	4.6±0.6[e]
4Cha	2.5±0.4[a]	10.3±1.4[a]	3.5±0.7[ab]	7.5±0.8[cd]
5Koc	2.3±0.4[ab]	4.6±0.2[c]	2.2±0.2[c]	6.2±0.7[d]
6Cha	2.3±0.3[ab]	6.2±0.6[b]	2.4±0.2[bc]	7.9±1.0[bc]
7Koc	1.8±0.1[b]	6.3±1.6[b]	3.3±0.6[abc]	9.9±1.3[a]
P-value	0.0554	**<0.0001**	**0.0027**	**<0.0001**
AD	**3 (9 August)**		**4 (19 August)**	
ST	**Before**	**After**	**Before**	**After**
TCode				
1CuZ	4.8±0.8[a]	9.7±2.4[a]	7.1±2.9[a]	12.0±2.5[a]
2CuZU	4.5±0.6[a]	7.7±1.5[bcd]	5.3±0.7[ab]	9.0±1.3[b]
3CuZU	3.8±0.3[abc]	7.7±1.5[bcd]	4.6±0.7[b]	8.6±1.0[b]
4Cha	4.9±1.3[a]	9.1±2.2[ab]	4.8±0.2[b]	9.1±1.5[b]
5Koc	3.2±0.4[bc]	6.4±0.8[d]	4.0±0.6[b]	6.2±0.7[c]
6Cha	2.9±0.6[c]	7.2±1.7[cd]	3.9±0.6[b]	7.3±1.5[bc]
7Koc	4.1±0.9[ab]	8.7±2.9[abc]	5.0±1.0[b]	8.7±1.0[b]
P-value	**0.0049**	**0.0019**	**0.0315**	**0.0004**

AD, application date; ST, sampling time (before and after application); TCode, treatment code. Levels of significance: $P \leq 0.001$ statistically very highly significant difference; $P \leq 0.01$ statistically highly significant difference; $P \leq 0.05$ statistically significant difference; $P > 0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in each (sub)column are not statistically significantly different ($P > 0.05$).

The analysis of copper ion deposit on (in) vine leaves before the first application (20 July) showed no statistically significant differences (P = 0.0554), i.e. at the beginning of the field experiment all samples were as uniform as possible. After the first application statistically significant differences were noted between all treatments, but the differences were not big enough to decide straightforwardly about the best application from these data only.

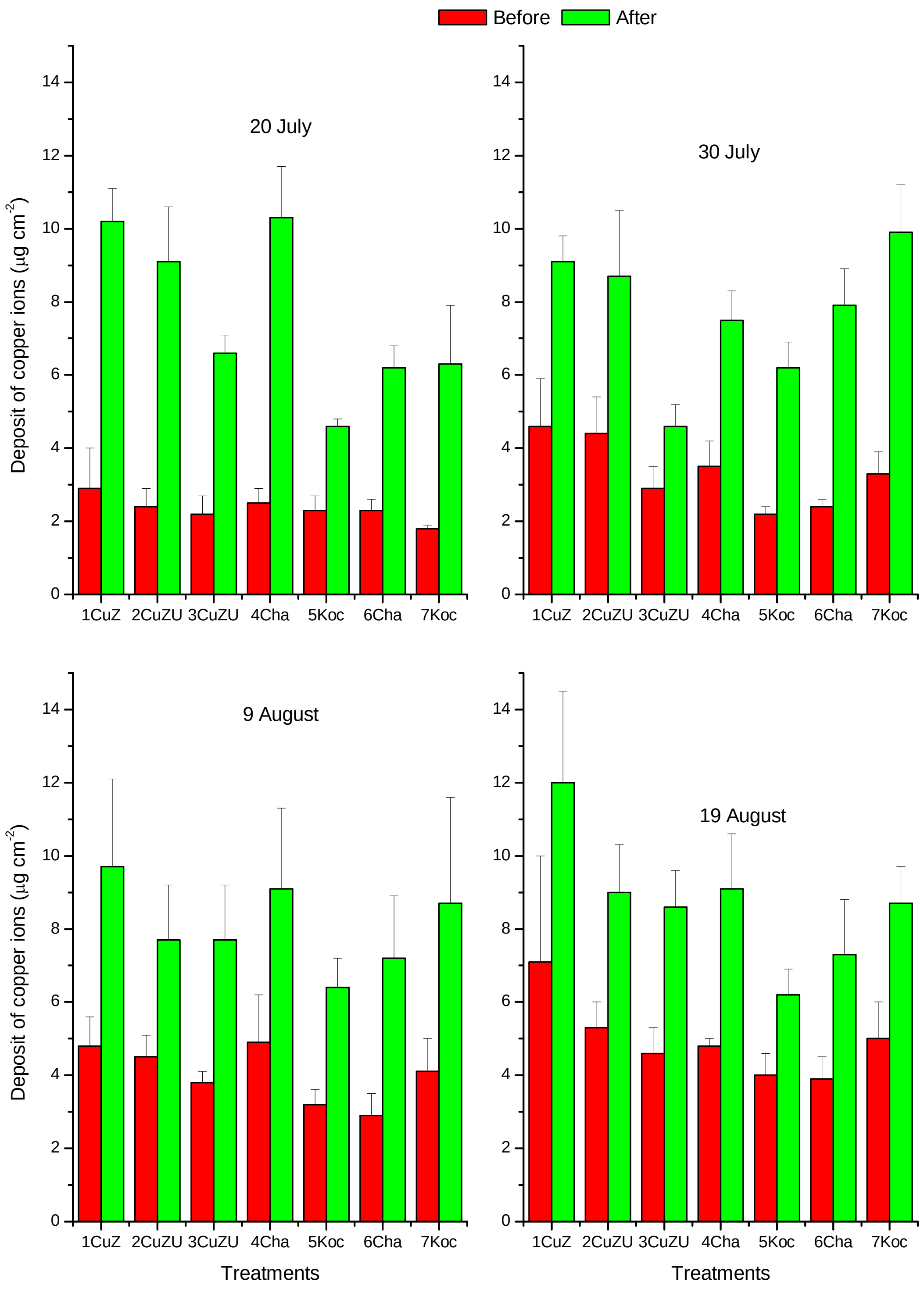


Figure 8.6: *Deposit of copper ions on vine leaves for different treatments, its mean value and standard deviation.*

8.4.2 Effect of application date on copper ion deposit on vine leaves

Table 8.15 shows the effect of application date on copper ion deposit on vine leaves.

Table 8.15: *Effect of application date on copper ion deposit on vine leaves, (Duncan's test, α=0.05).*

TCode	Sampling time	Deposit of copper ions (µg cm^{-2}) Application date 1 (20 July)	2 (30 July)	3 (9 August)	4 (19 August)	Significance of the effect (P-value)
1CuZ	Before	2.9^{b}	4.6^{b}	4.8^{ab}	7.1^{a}	**0.0199**
	After	10.2^{a}	9.1^{a}	9.7^{a}	12.0^{a}	0.1751
2CuZU	Before	2.4^{c}	4.4^{b}	4.5^{b}	5.3^{a}	**<0.0001**
	After	9.1^{a}	8.7^{ab}	7.7^{b}	9.0^{ab}	0.1255
3CuZU	Before	2.2^{d}	2.9^{c}	3.8^{b}	4.6^{a}	**<0.0001**
	After	6.6^{b}	4.6^{c}	7.7^{ab}	8.6^{a}	**0.0008**
4Cha	Before	2.5^{c}	3.5^{b}	4.9^{a}	4.8^{a}	**0.0011**
	After	10.3^{a}	7.5^{b}	9.1^{a}	9.1^{a}	**0.0039**
5Koc	Before	2.3^{c}	2.2^{c}	3.2^{b}	4.0^{a}	**0.0002**
	After	4.6^{b}	6.2^{a}	6.4^{a}	6.2^{a}	**0.0044**
6Cha	Before	2.3^{b}	2.4^{b}	2.9^{b}	3.9^{a}	**0.0043**
	After	6.2^{b}	7.9^{a}	7.2^{ab}	7.3^{ab}	0.1725
7Koc	Before	1.8^{c}	3.3^{b}	4.1^{ab}	5.0^{a}	**0.0003**
	After	6.3^{b}	9.9^{a}	8.7^{a}	8.7^{a}	**0.0149**

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different (P>0.05).

The results of the effect that application date had on the copper ion deposit on vine leaves showed an increase in the amount of copper ions from the first to the fourth application. How significant these differences are is shown by the letter following the mean values within the line, those with the same letter are not statistically significantly different and those with different letters are statistically significantly different.

Table 8.16: *Relative wash-off of copper ions between the applications for different treatments.*

TCode	Relative wash-off 20 July - 30 July	30 July - 9 August	9 August - 19 August	Average±SD
1CuZ	55 %	47 %	27 %	**43 % ± 14 %**
2CuZU	53 %	49 %	31 %	**44 % ± 12 %**
3CuZU	56 %	20 %	42 %	**39 % ± 18 %**
4Cha	66 %	33 %	48 %	**49 % ± 17 %**
5Koc	52 %	48 %	38 %	**46 % ± 7 %**
6Cha	61 %	63 %	46 %	**57 % ± 9 %**
7Koc	47 %	60 %	43 %	**52 % ± 9 %**
Average±SD	**56 % ± 6 %**	**46 % ± 15 %**	**39 % ± 8 %**	

TCode, treatment code; SD, standard deviation.

Between the first and second application there was 23.8 mm of precipitation (see table 7.5 and figure 7.10). For the 7Koc the minimum relative wash-off of copper ion deposit on leaves was measured (47 %), while the 4Cha treatment suffered the maximum relative wash-off of copper ion deposit during this period (66 %) (see table 8.16).

Between the second and the third application there was 88.1 mm of precipitation (see table 7.5 and figures 7.10 and 7.11). For the 3CuZU treatment the minimum relative wash-off of copper ion deposit on leaves was measured (20 %), while the 6Cha treatment suffered the maximum relative wash-off of copper ion deposit during this period (63 %) (see table 8.16).

Between the third and the fourth application there was 96.2 mm of precipitation (see table 7.5 and figure 7.11). For the 1CuZ treatment the minimum relative wash-off of copper ion deposit on leaves was measured (27 %), while the 4Cha treatment suffered the maximum relative wash-off of copper ion deposit during this period (48 %) (see table 8.16).

There is some indication that, on the average, Champion 50 WP and possibly Kocide DF suffer more wash-off of copper ion deposit (53 % and 49 % respectively) compared to Cuprablau Z (43 %) and Cuprablau Z Ultra (42 %).

Because of rather scattered values results of further statistical analyses are neither presented not commented on this point.

8.4.3 Effect of spraying on copper ion deposit on vine leaves

Table 8.17 and figure 8.7 show the effect of spraying on copper ion deposit on vine leaves.

Table 8.17: *Effect of spraying on copper ion deposit on vine leaves, (Duncan's test, α=0.05).*

TCode	Application date	Deposit of copper ions (µg cm^{-2}) Sampling time Before	After	Significance of the effect (P-value)
1CuZ	1 (20 July)	2.9[b]	10.2[a]	**0.0033**
	2 (30 July)	4.6[b]	9.1[a]	**0.0047**
	3 (9 August)	4.8[b]	9.7[a]	**0.0122**
	4 (19 August)	7.1[b]	12.0[a]	**0.0067**
2CuZU	1 (20 July)	2.4[b]	9.1[a]	**0.0040**
	2 (30 July)	4.4[b]	8.7[a]	**0.0062**
	3 (9 August)	4.5[b]	7.7[a]	**0.0303**
	4 (19 August)	5.3[b]	9.0[a]	**0.0023**
3CuZU	1 (20 July)	2.2[b]	6.6[a]	**0.0030**
	2 (30 July)	2.9[b]	4.6[a]	**0.0030**
	3 (9 August)	3.8[b]	7.7[a]	**0.0207**
	4 (19 August)	4.6[b]	8.6[a]	**0.0034**
4Cha	1 (20 July)	2.5[b]	10.3[a]	**0.0017**
	2 (30 July)	3.5[b]	7.5[a]	**<0.0001**
	3 (9 August)	4.9[b]	9.1[a]	**0.0261**
	4 (19 August)	4.8[b]	9.1[a]	**0.0121**
5Koc	1 (20 July)	2.3[b]	4.6[a]	**0.0008**
	2 (30 July)	2.2[b]	6.2[a]	**0.0009**
	3 (9 August)	3.2[b]	6.4[a]	**0.0079**
	4 (19 August)	4.0[b]	6.2[a]	**0.0164**
6Cha	1 (20 July)	2.3[b]	6.2[a]	**0.0014**
	2 (30 July)	2.4[b]	7.9[a]	**0.0014**
	3 (9 August)	2.9[b]	7.2[a]	**0.0130**
	4 (19 August)	3.9[b]	7.3[a]	**0.0151**
7Koc	1 (20 July)	1.8[b]	6.3[a]	**0.0105**
	2 (30 July)	3.3[b]	9.9[a]	**0.0006**
	3 (9 August)	4.1[b]	8.7[a]	**0.0363**
	4 (19 August)	5.0[b]	8.7[a]	**0.0280**

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with different letters in the line are statistically significantly different (P≤0.05).

As foreseen spraying drastically increased the deposit of copper ions on vine leaves.

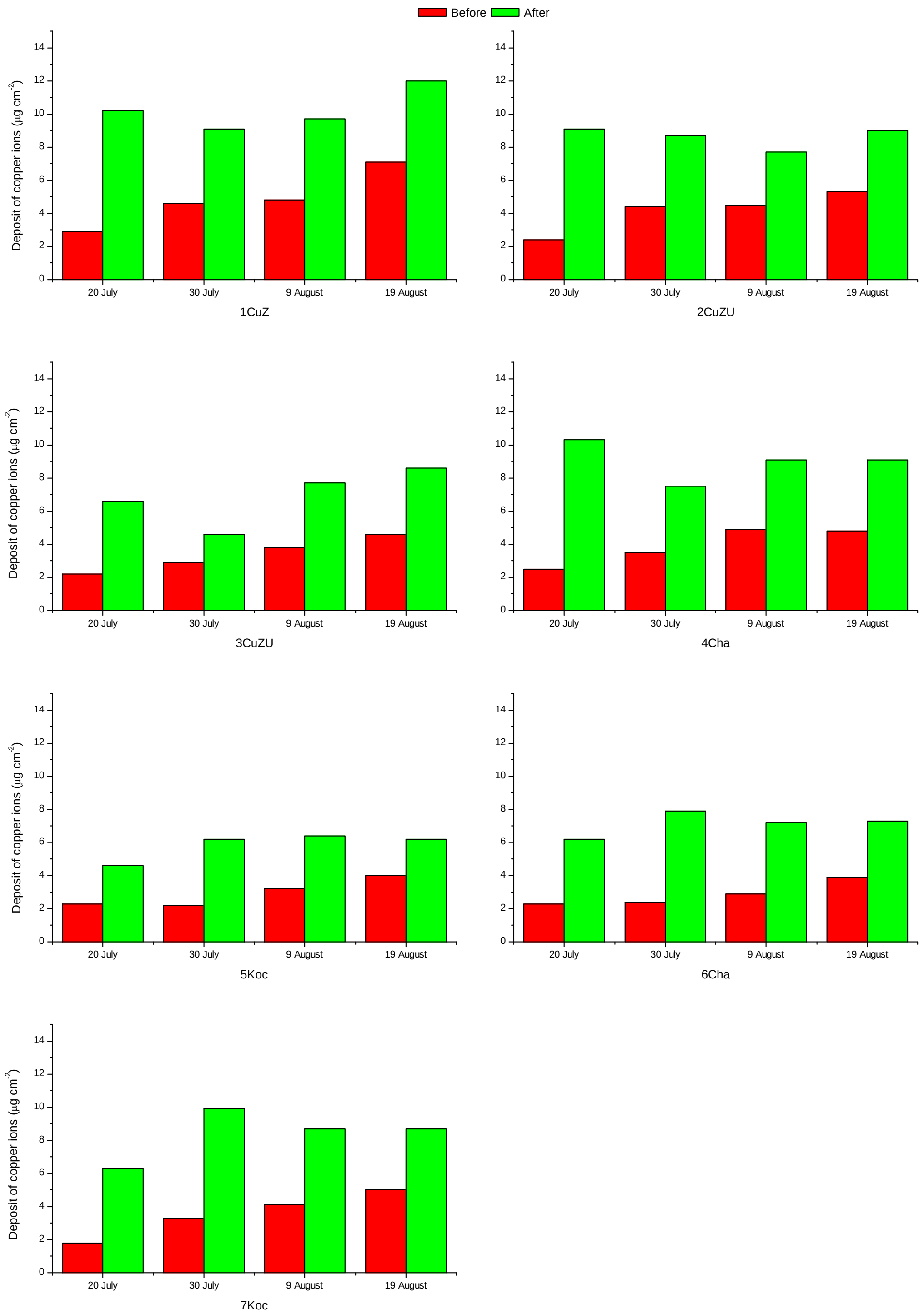


Figure 8.7: *Deposit of copper ions on vine leaves for different treatments.*

8.5 Deposit of copper ions on vine leaves normalized to the same application rate of copper ions (model 2)

Tables 8.18 to 8.22 show the copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}). These, i.e. normalized values were introduced to compare all plant protection products used. Namely, they contain different relative amounts of copper ions i.e. active substances (see table 7.6).

In table 8.18, the values of copper ion deposit on vine leaves normalized to the same application rate of copper ions with calculated basic statistical parameters are given: the number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation.

Table 8.18: *Copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}) with calculated basic statistical parameters.*

	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
Deposit of Cu^{2+} (µg cm^{-2})	224	6.0	1.6	14.4	2.8	47.4

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of individual effects (treatments (T), replications (R), application date (AD), sampling time (ST) and their interaction T×AD×ST) are shown in table 8.19. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatments, replications, application date, sampling time and their interaction T×AD×ST on copper ion deposit on vine leaves normalized to the same application rate of copper ions. The statistically significant differences noted for all parameters (treatments, application dates, sampling times as well as for interaction between treatments, application dates and sampling times) were very high.

Table 8.19: *Significance (P-value) of individual parameters on the variability of the copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).*

	P-value				
Parameters / **Quantity measured**	**T** (DF = 6)	**R** (DF = 3)	**AD** (DF = 3)	**ST** (DF = 1)	**T×AD×ST** (DF = 45)
Deposit of Cu^{2+}	**<0.0001**	**0.0002**	**<0.0001**	**<0.0001**	**<0.0001**

T, treatment; R, replication; AD, application date; ST, sampling time; T×AD×ST, interaction between treatment, application date and sampling time; DF, degrees of freedom. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print.

8.5.1 Effect of plant protection product (and water application rate) on copper ion deposit on vine leaves normalized to the same application rate of copper ions

Table 8.20 and figure 8.8 show the effect of plant protection product (and water application rate) on copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).

Table 8.20: *Effect of plant protection product (and water application rate) on copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), mean value ± standard deviation, (Duncan's test, α=0.05); (Basic data in Appendix D).*

	Normalized deposit of copper ions (µg cm^{-2})			
AD	**1 (20 July)**		**2 (30 July)**	
ST	**Before**	**After**	**Before**	**After**
TCode				
1CuZ	2.9 ± 1.1^{a}	9.7 ± 0.9^{a}	4.4 ± 1.2^{ab}	8.7 ± 0.7^{ab}
2CuZU	2.4 ± 0.5^{ab}	10.4 ± 1.7^{a}	5.0 ± 1.1^{a}	10.0 ± 2.0^{a}
3CuZU	2.2 ± 0.5^{ab}	7.6 ± 0.6^{cb}	3.3 ± 0.7^{bc}	5.3 ± 0.7^{c}
4Cha	2.5 ± 0.4^{a}	8.2 ± 1.1^{b}	2.8 ± 0.6^{c}	6.0 ± 0.6^{c}
5Koc	2.3 ± 0.4^{ab}	5.8 ± 0.2^{d}	2.8 ± 0.3^{c}	7.8 ± 0.8^{b}
6Cha	2.3 ± 0.3^{ab}	6.2 ± 0.6^{cd}	2.4 ± 0.2^{c}	7.9 ± 1.0^{b}
7Koc	1.8 ± 0.1^{b}	6.3 ± 1.5^{cd}	3.3 ± 0.6^{bc}	9.9 ± 1.3^{a}
P-value	0.0554	**<0.0001**	**0.0023**	**<0.0001**
AD	**3 (9 August)**		**4 (19 August)**	
ST	**Before**	**After**	**Before**	**After**
TCode				
1CuZ	4.6 ± 0.8^{a}	9.3 ± 2.3^{a}	6.8 ± 2.8^{a}	11.4 ± 2.4^{a}
2CuZU	5.1 ± 0.7^{a}	8.8 ± 1.7^{a}	6.1 ± 0.8^{a}	10.3 ± 1.4^{ab}
3CuZU	4.3 ± 0.4^{a}	8.8 ± 1.7^{a}	5.2 ± 0.8^{ab}	9.9 ± 1.2^{ab}
4Cha	4.0 ± 1.0^{a}	7.3 ± 1.8^{b}	3.8 ± 0.2^{b}	7.3 ± 1.2^{c}
5Koc	4.0 ± 0.5^{a}	8.0 ± 1.0^{ab}	5.0 ± 0.7^{ab}	7.8 ± 0.8^{c}
6Cha	2.9 ± 0.6^{b}	7.2 ± 1.7^{b}	3.9 ± 0.6^{b}	7.3 ± 1.5^{c}
7Koc	4.1 ± 0.9^{a}	8.7 ± 2.9^{a}	5.0 ± 1.0^{ab}	8.7 ± 1.0^{bc}
P-value	**0.0122**	**0.0236**	**0.0279**	**0.0009**

AT, application date; ST, sampling time (before and after application); TCode, treatment code. Levels of significance: $P\leq0.001$ statistically very highly significant difference; $P\leq0.01$ statistically highly significant difference; $P\leq0.05$ statistically significant difference; $P>0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in each (sub)column are not statistically significantly different ($P>0.05$).

The deposit (content) of copper ions on vine leaves before the first application (20 July) showed no statistically significant differences (P = 0.0554). After the first application, statistically significant differences of copper ion deposit on vine leaves normalized to the same application rate of copper ions between all treatments were observed. In most cases, the highest normalized copper ion deposit for all applications was determined for 1CuZ and 2CuZU treatments (before as well as after applications). The 1CuZ treatment was performed using the highest application rate of copper ions (1050 g ha^{-1}, see table 7.6) and 2CuZU treatment was performed using 17 % lower application rate of copper ions (875 g ha^{-1}, see table 7.6).

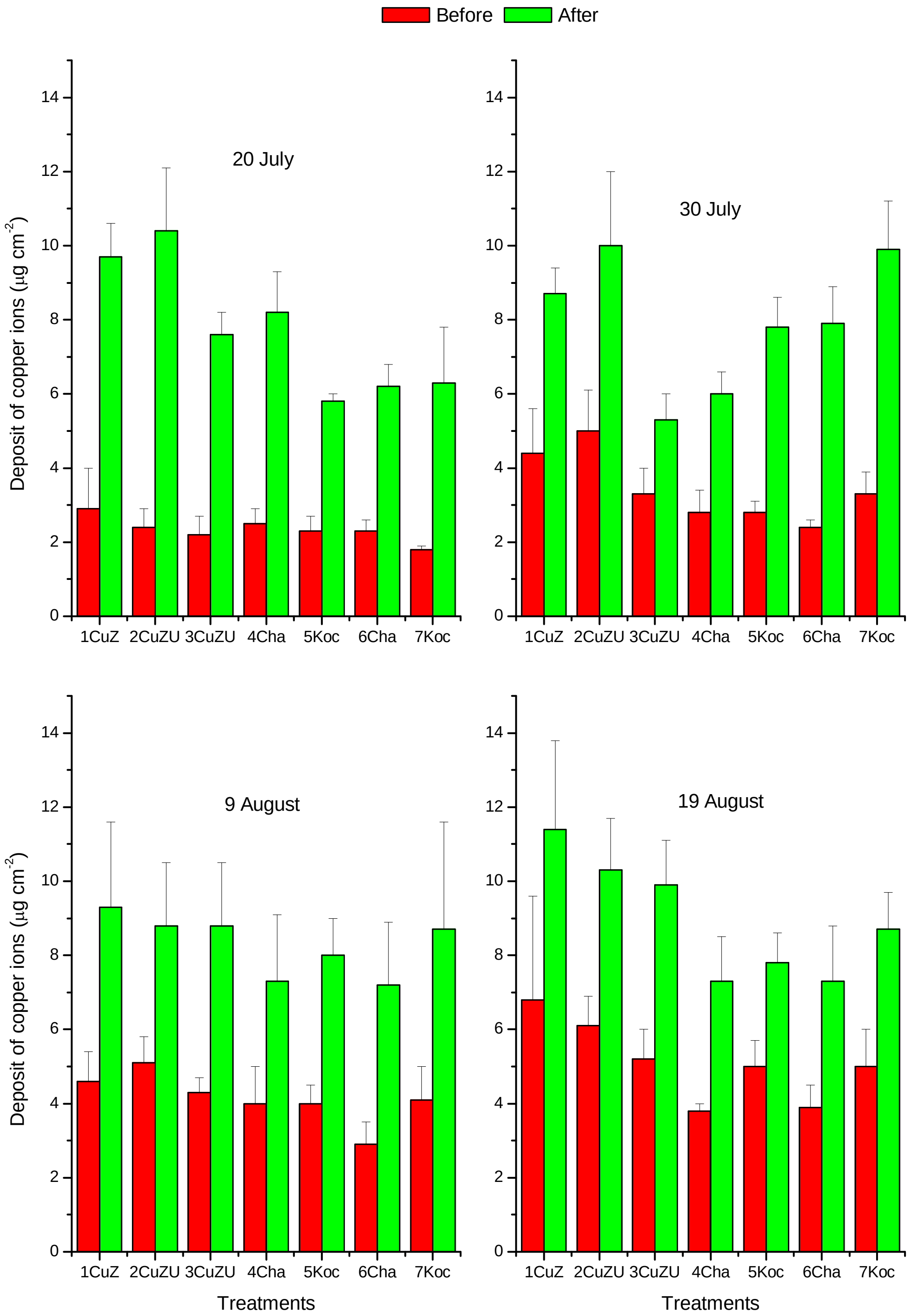


Figure 8.8: *Deposit of copper ions for different plant protection products (and water application rate) on vine leaves normalized to the same application rate of copper ions, its mean value and standard deviation.*

8.5.2 Effect of application date on copper ion deposit on vine leaves normalized to the same application rate of copper ions

Table 8.21 shows the effect of application date on copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).

Table 8.21: *Effect of application date on copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), (Duncan's test, α=0.05).*

TCode	**Sampling time**	**Normalized deposit of copper ions (µg cm^{-2})** Application date: **1 (20 July)**	**2 (30 July)**	**3 (9 August)**	**4 (19 August)**	**Significance of the effect (P-value)**
1CuZ	Before	2.9^{b}	4.4^{b}	4.6^{ab}	6.8^{a}	**0.0237**
	After	9.7^{a}	8.7^{a}	9.3^{a}	11.4^{a}	0.1751
2CuZU	Before	2.4^{c}	5.0^{b}	5.1^{b}	6.1^{a}	**<0.0001**
	After	10.4^{a}	10.0^{ab}	8.8^{b}	10.3^{ab}	0.1242
3CuZU	Before	2.2^{d}	3.3^{c}	4.3^{b}	5.2^{a}	**<0.0001**
	After	7.6^{b}	5.3^{c}	8.8^{ab}	9.9^{a}	**0.0008**
4Cha	Before	2.5^{b}	2.8^{b}	4.0^{a}	3.8^{a}	**0.0057**
	After	8.2^{a}	6.0^{b}	7.3^{a}	7.3^{a}	**0.0039**
5Koc	Before	2.3^{c}	2.8^{c}	4.0^{b}	5.0^{a}	**<0.0001**
	After	5.8^{b}	7.8^{a}	8.0^{a}	7.8^{a}	**0.0044**
6Cha	Before	2.3^{b}	2.4^{b}	2.9^{b}	3.9^{a}	**0.0043**
	After	6.2^{b}	7.9^{a}	7.2^{ab}	7.3^{ab}	0.1725
7Koc	Before	1.8^{c}	3.3^{b}	4.1^{ab}	5.0^{a}	**0.0003**
	After	6.3^{b}	9.9^{a}	8.7^{a}	8.7^{a}	**0.0149**

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different (P>0.05).

The effect of application date on copper ion deposit on vine leaves normalized to the same application rate of copper ions showed an increase in the amount of copper ions per area unit from the first to the fourth application. Statistically significant differences are shown in table 8.21 where in the same line the mean values with the same letter are not statistically significantly different and the mean values with a different letter are statistically significantly different.

Data on relative wash-off are the same as in table 8.16.

8.5.3 Effect of spraying on copper ion deposit on vine leaves normalized to the same application rate of copper ions

Table 8.22 and figure 8.9 show the effect of spraying on copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).

Table 8.22: *Effect of spraying on copper ion deposit on vine leaves normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), (Duncan's test, α=0.05).*

TCode	**Application date**	**Normalized deposit of copper ions (µg cm^{-2}) Sampling time Before**	**After**	**Significance of the effect (P-value)**
1CuZ	1 (20 July)	2.9[b]	9.7[a]	**0.0038**
	2 (30 July)	4.4[b]	8.7[a]	**0.0047**
	3 (9 August)	4.6[b]	9.3[a]	**0.0122**
	4 (19 August)	6.8[b]	11.4[a]	**0.0067**
2CuZU	1 (20 July)	2.4[b]	10.4[a]	**0.0034**
	2 (30 July)	5.0[b]	10.0[a]	**0.0062**
	3 (9 August)	5.1[b]	8.8[a]	**0.0304**
	4 (19 August)	6.1[b]	10.3[a]	**0.0023**
3CuZU	1 (20 July)	2.2[b]	7.6[a]	**0.0021**
	2 (30 July)	3.3[b]	5.3[a]	**0.0030**
	3 (9 August)	4.3[b]	8.8[a]	**0.0207**
	4 (19 August)	5.2[b]	9.9[a]	**0.0034**
4Cha	1 (20 July)	2.5[b]	8.2[a]	**0.0022**
	2 (30 July)	2.8[b]	6.0[a]	**<0.0001**
	3 (9 August)	4.0[b]	7.3[a]	**0.0262**
	4 (19 August)	3.8[b]	7.3[a]	**0.0122**
5Koc	1 (20 July)	2.3[b]	5.8[a]	**0.0002**
	2 (30 July)	2.8[b]	7.8[a]	**0.0009**
	3 (9 August)	4.0[b]	8.0[a]	**0.0079**
	4 (19 August)	5.0[b]	7.8[a]	**0.0164**
6Cha	1 (20 July)	2.3[b]	6.2[a]	**0.0014**
	2 (30 July)	2.4[b]	7.9[a]	**0.0014**
	3 (9 August)	2.9[b]	7.2[a]	**0.0130**
	4 (19 August)	3.9[b]	7.3[a]	**0.0151**
7Koc	1 (20 July)	1.8[b]	6.3[a]	**0.0105**
	2 (30 July)	3.3[b]	9.9[a]	**0.0006**
	3 (9 August)	4.1[b]	8.7[a]	**0.0363**
	4 (19 August)	5.0[b]	8.7[a]	**0.0280**

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with different letters in the line are statistically significantly different (P≤0.05).

As foreseen spraying drastically increased the deposit of copper ions.

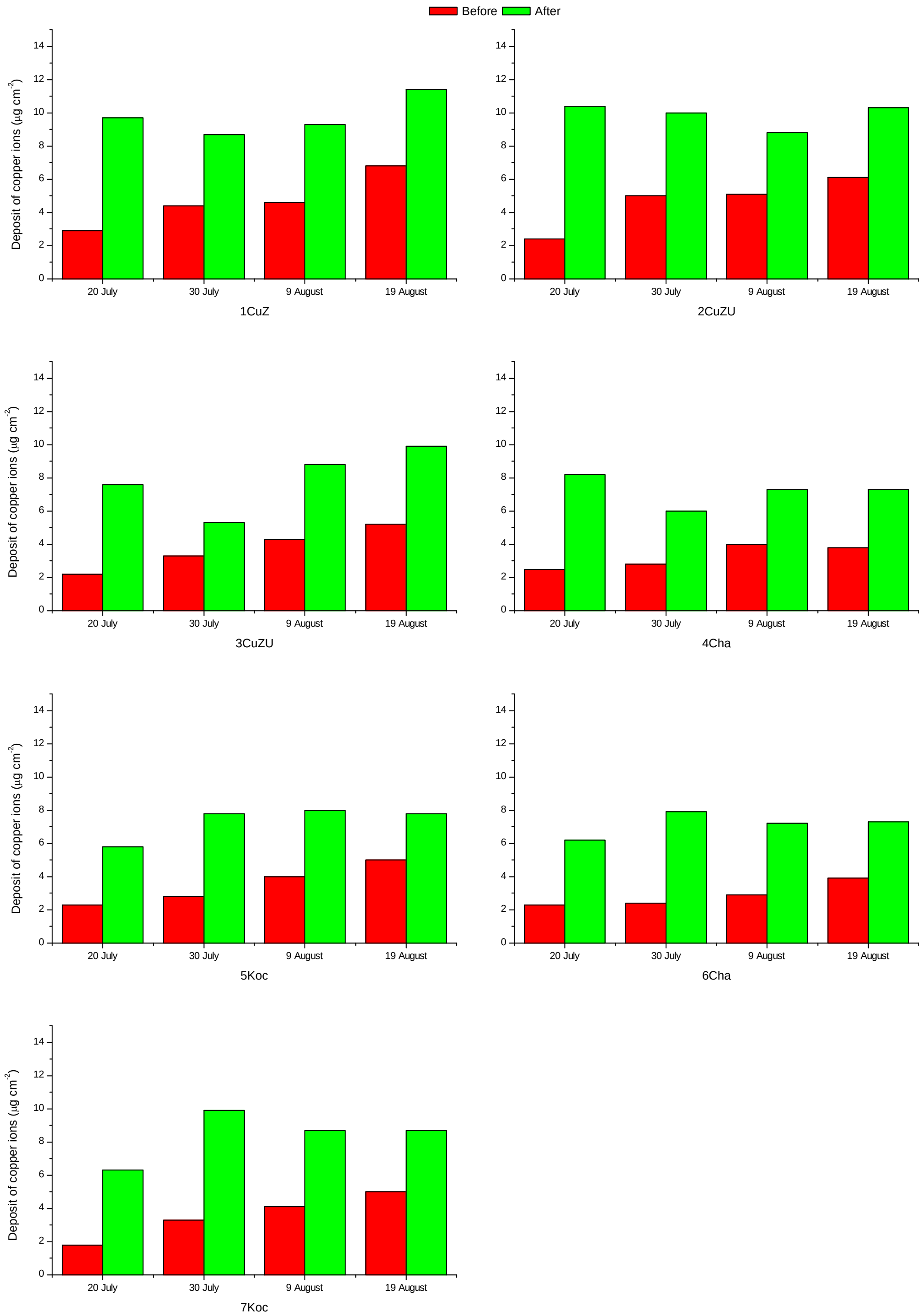


Figure 8.9: *Deposit of copper ions on vine leaves normalized to the same application rate of copper ions for different treatments.*

8.6 Deposit of copper ions on filter papers (model 3)

Tables 8.23 to 8.28 show the results of copper ion deposit on filter papers.

In table 8.23, the results of copper ion deposit on filter papers with calculated basic statistical parameters are given: the number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation.

Table 8.23: *Results of copper ion deposit on filter papers with calculated basic statistical parameters.*

	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
Deposit of Cu^{2+} (µg cm^{-2})	448	1.9	0.4	5.1	0.9	50.3

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of individual effects (treatments (T), replications (R), application date (AD), sampling height (SH), leaf-side (LS) and their interaction T×AD×SH×LS) are shown in table 8.24. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatments, replications, application date, sampling height, leaf-side and their interaction T×AD×SH×LS on copper ion deposit on filter papers. Copper ion deposit on filter papers was not statistically significantly different for different sampling heights. All other parameters (treatments, application dates, leaf-side and interaction between treatments, application dates, sampling heights and leaf-side) showed statistically significant differences.

Table 8.24: *Significance (P-value) of individual parameters on the variability of the copper ion deposit on filter papers.*

	P-value					
Parameters / **Quality measured**	**T** (DF = 6)	**R** (DF = 3)	**AD** (DF = 3)	**SH** (DF = 1)	**LS** (DF = 1)	**T×AD×SH×LS** (DF = 100)
Deposit of Cu^{2+}	**<0.0001**	0.1094	**0.0021**	0.2408	**<0.0001**	**<0.0001**

T, treatment; R, replication; AD, application date; SH, sampling height; LS, leaf-side; T×AD×SH×LS, interaction between treatment, application date, sampling height and leaf-side; DF, degrees of freedom. Levels of significance: $P \leq 0.001$ statistically very highly significant difference; $P \leq 0.01$ statistically highly significant difference; $P \leq 0.05$ statistically significant difference; $P > 0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print.

8.6.1 Effect of treatment on copper ion deposit on filter papers

Table 8.25 and figure 8.10 show the effect of treatment on copper ion deposit on filter papers.

Table 8.25: *Effect of treatment on copper ion deposit on filter papers, (Duncan's test, α=0.05); (Basic data in Appendix E).*

Sampling height		**Deposit of copper ions (µg cm^{-2})**			
		2nd wire		**4th wire**	
	Application	**Leaf-side**		**Leaf-side**	
TCode	**date**	**Lower**	**Upper**	**Lower**	**Upper**
1CuZ	1	$0.8{\pm}0.2^{a}$	$2.7{\pm}0.1^{b}$	$1.4{\pm}0.4^{b}$	$2.6{\pm}0.7^{ab}$
2CuZU	1	$0.7{\pm}0.2^{a}$	$2.8{\pm}0.6^{b}$	$1.5{\pm}0.3^{b}$	$2.4{\pm}0.3^{abc}$
3CuZU	1	$1.0{\pm}0.3^{a}$	$3.4{\pm}0.3^{a}$	$1.0{\pm}0.3^{bc}$	$2.6{\pm}0.2^{ab}$
4Cha	1 (20 July)	$1.1{\pm}0.3^{a}$	$3.4{\pm}0.7^{a}$	$2.3{\pm}0.6^{a}$	$3.0{\pm}1.1^{a}$
5Koc	1	$0.8{\pm}0.4^{a}$	$1.6{\pm}0.2^{c}$	$0.8{\pm}0.1^{c}$	$1.4{\pm}0.3^{c}$
6Cha	1	$0.7{\pm}0.2^{a}$	$2.2{\pm}0.4^{b}$	$1.0{\pm}0.1^{bc}$	$2.0{\pm}0.4^{bc}$
7Koc	1	$0.9{\pm}0.2^{a}$	$2.5{\pm}0.5^{b}$	$0.8{\pm}0.3^{c}$	$2.5{\pm}0.4^{ab}$
P-value		0.3296	**<0.0001**	**0.0003**	**0.0385**
1CuZ	2	$1.1{\pm}0.4^{ab}$	$2.4{\pm}0.5^{ab}$	$1.1.{\pm}0.3^{b}$	$3.2{\pm}1.4^{a}$
2CuZU	2	$1.2{\pm}0.3^{ab}$	$2.3{\pm}0.9^{ab}$	$1.5{\pm}0.2^{ab}$	$2.3{\pm}0.5^{ab}$
3CuZU	2	$0.7{\pm}0.2^{b}$	$2.4{\pm}0.3^{ab}$	$0.9{\pm}0.3^{b}$	$1.7{\pm}0.3^{b}$
4Cha	2 (30 July)	$1.0{\pm}0.3^{ab}$	$3.2{\pm}1.3^{a}$	$1.4{\pm}0.5^{ab}$	$3.2{\pm}1.0^{a}$
5Koc	2	$0.9{\pm}0.4^{ab}$	$1.7{\pm}0.3^{b}$	$0.9{\pm}0.2^{b}$	$1.8{\pm}0.6^{b}$
6Cha	2	$1.2{\pm}0.4^{ab}$	$2.3{\pm}0.4^{ab}$	$0.9{\pm}0.2^{b}$	$2.4{\pm}0.3^{ab}$
7Koc	2	$1.3{\pm}0.4^{a}$	$2.3{\pm}0.7^{ab}$	$1.8{\pm}0.5^{a}$	$2.1{\pm}0.7^{ab}$
P-value		0.1943	0.1948	**0.0112**	0.0654
1CuZ	3	$1.1{\pm}0.3^{ab}$	$2.6{\pm}0.6^{bc}$	$1.7{\pm}0.9^{a}$	$2.2{\pm}0.3^{b}$
2CuZU	3	$0.7{\pm}0.2^{b}$	$2.5{\pm}0.6^{bc}$	$1.2{\pm}0.2^{a}$	$2.1{\pm}0.3^{b}$
3CuZU	3	$1.5{\pm}0.7^{a}$	$4.5{\pm}0.4^{a}$	$1.4{\pm}0.5^{a}$	$3.9{\pm}1.4^{a}$
4Cha	3 (9 August)	$1.5{\pm}0.4^{a}$	$2.7{\pm}0.3^{b}$	$1.8{\pm}1.0^{a}$	$2.0{\pm}0.8^{b}$
5Koc	3	$1.5{\pm}1.0^{a}$	$1.8{\pm}1.0^{c}$	$0.9{\pm}0.5^{a}$	$2.2{\pm}0.7^{b}$
6Cha	3	$1.0{\pm}0.4^{ab}$	$3.0{\pm}0.9^{b}$	$1.3{\pm}0.3^{a}$	$2.3{\pm}0.3^{b}$
7Koc	3	$1.2{\pm}0.4^{ab}$	$3.0{\pm}0.6^{b}$	$1.5{\pm}1.0^{a}$	$2.6{\pm}0.9^{b}$
P-value		0.1749	**<0.0001**	0.5955	**0.0376**
1CuZ	4	$2.1{\pm}0.5^{a}$	$2.9{\pm}0.5^{b}$	$1.8{\pm}0.4^{a}$	$2.6{\pm}0.9^{ab}$
2CuZU	4	$1.2{\pm}0.5^{b}$	$2.4{\pm}0.6^{bc}$	$1.3{\pm}0.4^{ab}$	$2.4{\pm}0.1^{bc}$
3CuZU	4	$2.1{\pm}0.5^{a}$	$4.0{\pm}0.5^{a}$	$0.9{\pm}0.3^{b}$	$3.3{\pm}0.5^{a}$
4Cha	4 (19 August)	$1.7{\pm}0.6^{ab}$	$2.4{\pm}1.0^{bc}$	$1.3{\pm}0.2^{ab}$	$2.7{\pm}0.7^{ab}$
5Koc	4	$1.2{\pm}0.2^{b}$	$1.8{\pm}0.5^{c}$	$0.8{\pm}0.3^{b}$	$1.6{\pm}0.5^{c}$
6Cha	4	$1.3{\pm}0.4^{b}$	$2.3{\pm}0.5^{bc}$	$1.5{\pm}0.2^{a}$	$2.0{\pm}0.3^{bc}$
7Koc	4	$1.4{\pm}0.3^{b}$	$2.2{\pm}0.9^{bc}$	$1.8{\pm}0.5^{a}$	$1.7{\pm}0.8^{c}$
P-value		**0.0149**	**0.0024**	**0.0038**	**0.0024**

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in each (sub)column are not statistically significantly different (P>0.05).

The effect of treatment on copper ion deposit on filter papers was statistically significant, which is shown in table 8.25 where the mean values with the same letter in each (sub)column are not statistically significantly different, and the mean values with a different letter in each (sub)column are statistically significantly different.

Though, statistically very highly significant differences were obtained for all treatments as seen in table 8.24, table 8.25 clearly indicates that statistically significant differences were obtained in 10 of 16 cases where the differences between different treatments were observed. Generaly, there were minor differences due to different treatments in deposit of copper ions on filter papers.

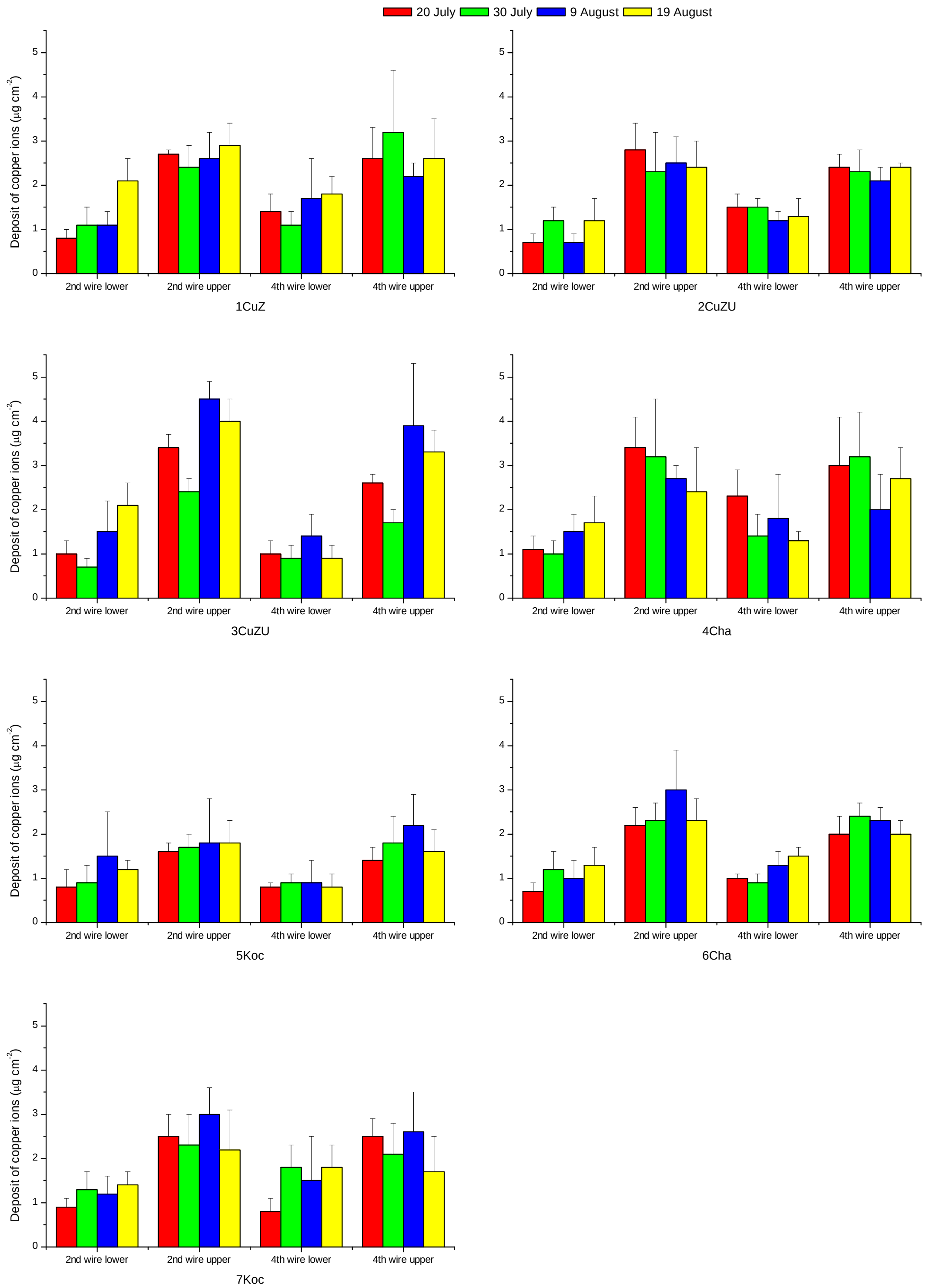


Figure 8.10: *Copper ion deposit for different treatments, application dates, leaf-sides and heights measured on filter paper, its mean value and standard deviation.*

8.6.2 Effect of application date on copper ion deposit on filter papers

Table 8.26 shows the effect of application date on copper ion deposit on filter papers.

Table 8.26: *Effect of application date on copper ion deposit on filter papers, (Duncan's test, α=0.05).*

			Deposit of copper ions (µg cm^{-2})				
			Application date				**Significance of the effects**
TCode	**SH**	**LS**	**1 (20 July)**	**2 (30 July)**	**3 (9 August)**	**4 (19 August)**	**(P-value)**
1CuZ	2^{nd} wire	Lower	0.8^{b}	1.1^{b}	1.1^{b}	2.1^{a}	**0.0061**
		Upper	2.7^{a}	2.4^{a}	2.6^{a}	2.9^{a}	0.5869
	4^{th} wire	Lower	1.4^{a}	1.1^{a}	1.7^{a}	1.8^{a}	0.1790
		Upper	2.6^{a}	3.2^{a}	2.2^{a}	2.6^{a}	0.6005
2CuZU	2^{nd} wire	Lower	0.7^{a}	1.2^{a}	0.7^{a}	1.2^{a}	0.0952
		Upper	2.8^{a}	2.3^{a}	2.5^{a}	2.4^{a}	0.8156
	4^{th} wire	Lower	1.5^{a}	1.5^{a}	1.2^{a}	1.3^{a}	0.4035
		Upper	2.4^{a}	2.3^{a}	2.1^{a}	2.4^{a}	0.5101
3CuZU	2^{nd} wire	Lower	1.0^{b}	0.7^{b}	1.5^{ab}	2.1^{a}	**0.0191**
		Upper	3.4^{b}	2.4^{c}	4.5^{a}	4.0^{ab}	**0.0004**
	4^{th} wire	Lower	1.0^{a}	0.9^{a}	1.4^{a}	0.9^{a}	0.3454
		Upper	2.6^{bc}	1.7^{c}	3.9^{a}	3.3^{ab}	**0.0171**
4Cha	2^{nd} wire	Lower	1.1^{ab}	1.0^{b}	1.5^{ab}	1.7^{a}	0.0953
		Upper	3.4^{a}	3.2^{a}	2.7^{a}	2.4^{a}	0.3802
	4^{th} wire	Lower	2.3^{a}	1.4^{b}	1.8^{ab}	1.3^{b}	**0.0494**
		Upper	3.0^{a}	3.2^{a}	2.0^{a}	2.7^{a}	0.2319
5Koc	2^{nd} wire	Lower	0.8^{a}	0.9^{a}	1.5^{a}	1.2^{a}	0.4129
		Upper	1.6^{a}	1.7^{a}	1.8^{a}	1.8^{a}	0.9783
	4^{th} wire	Lower	0.8^{a}	0.9^{a}	0.9^{a}	0.8^{a}	0.8393
		Upper	1.4^{a}	1.8^{a}	2.2^{a}	1.6^{a}	0.2616
6Cha	2^{nd} wire	Lower	0.7^{b}	1.2^{ab}	1.0^{ab}	1.3^{a}	0.1305
		Upper	2.2^{a}	2.3^{a}	2.9^{a}	2.3^{a}	0.1477
	4^{th} wire	Lower	1.0^{bc}	0.9^{c}	1.3^{ab}	1.5^{a}	**0.0223**
		Upper	2.0^{a}	2.4^{a}	2.3^{a}	2.0^{a}	0.0927
7Koc	2^{nd} wire	Lower	0.9^{a}	1.3^{a}	1.2^{a}	1.4^{a}	0.2868
		Upper	2.5^{a}	2.3^{a}	3.0^{a}	2.2^{a}	0.5091
	4^{th} wire	Lower	0.8^{a}	1.8^{a}	1.5^{a}	1.8^{a}	0.1503
		Upper	2.5^{a}	2.1^{a}	2.6^{a}	1.7^{a}	0.1574

TCode, treatment code; SH, sampling height (2^{nd} wire and 4^{th} wire); LS, leaf-side (lower and upper side of leaves). Levels of significance: $P \leq 0.001$ statistically very highly significant difference; $P \leq 0.01$ statistically highly significant difference; $P \leq 0.05$ statistically significant difference; $P > 0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in line are not statistically significantly different ($P > 0.05$).

The effect of the application date on the copper ion deposit on filter papers was only rarely statistically significant. Details are shown in table 8.26 where the mean values with the same letter in the line are not statistically significantly different, and the mean values with a different letter in the line are statistically significantly different. Statistically significant differences were noted just in 6 out of 28 cases (indicated with bold P-values in the last column).

We expected that the deposit on filter papers will be approximately the same for individual treatments irrespective of the application dates. In most cases (in 22 out of 28 cases) the expected results were verified, i.e. there were no statistically significantly differences ($P > 0.05$) between different application dates.

8.6.3 Effect of sampling height on copper ion deposit on filter papers

Table 8.27 shows the effect of sampling height on copper ion deposit on filter papers.

Table 8.27: *Effect of sampling height on copper ion deposit on filter papers, (Duncan's test, α=0.05).*

TCode	Application date	Leaf-side	Deposit of copper ions (µg cm^{-2}) Sampling height 2nd wire	4th wire	Significance of the effects (P-value)
1CuZ	1 (20 July)	Lower	0.8^{a}	1.4^{a}	0.1366
		Upper	2.7^{a}	2.6^{a}	0.7536
	2 (30 July)	Lower	1.1^{a}	1.1^{a}	0.8689
		Upper	2.4^{a}	3.2^{a}	0.4225
	3 (9 August)	Lower	1.1^{a}	1.7^{a}	0.1578
		Upper	2.6^{a}	2.2^{a}	0.2884
	4 (19 August)	Lower	2.1^{a}	1.8^{a}	0.4769
		Upper	2.9^{a}	2.6^{a}	0.6869
2CuZU	1 (20 July)	Lower	0.7^{b}	1.5^{a}	**0.0182**
		Upper	2.8^{a}	2.4^{a}	0.3611
	2 (30 July)	Lower	1.2^{a}	1.5^{a}	0.2115
		Upper	2.3^{a}	2.3^{a}	0.9261
	3 (9 August)	Lower	0.7^{a}	1.2^{a}	0.0612
		Upper	2.5^{a}	2.1^{a}	0.0576
	4 (19 August)	Lower	1.2^{a}	1.3^{a}	0.7410
		Upper	2.4^{a}	2.4^{a}	0.8333
3CuZU	1 (20 July)	Lower	1.0^{a}	1.0^{a}	0.9795
		Upper	3.9^{a}	2.6^{b}	**0.0209**
	2 (30 July)	Lower	0.7^{a}	0.9^{a}	0.4804
		Upper	2.4^{a}	1.7^{a}	0.0929
	3 (9 August)	Lower	1.5^{a}	1.4^{a}	0.7160
		Upper	4.5^{a}	3.9^{a}	0.4520
	4 (19 August)	Lower	2.1^{a}	0.9^{b}	**0.0286**
		Upper	4.0^{a}	3.3^{a}	0.2271
4Cha	1 (20 July)	Lower	1.1^{a}	2.3^{a}	0.0792
		Upper	3.4^{a}	3.0^{a}	0.5088
	2 (30 July)	Lower	1.0^{b}	1.4^{a}	**0.0389**
		Upper	3.2^{a}	3.2^{a}	0.9601
	3 (9 August)	Lower	1.5^{a}	1.8^{a}	0.4317
		Upper	2.7^{a}	2.0^{b}	**0.0446**
	4 (19 August)	Lower	1.7^{a}	1.3^{a}	0.2563
		Upper	2.4^{a}	2.7^{a}	0.4138
5Koc	1 (20 July)	Lower	0.8^{a}	0.8^{a}	0.8815
		Upper	1.6^{a}	1.4^{a}	0.1652
	2 (30 July)	Lower	0.9^{a}	0.9^{a}	0.7664
		Upper	1.7^{a}	1.8^{a}	0.8406
	3 (9 August)	Lower	1.5^{a}	0.9^{a}	0.4396
		Upper	1.8^{a}	2.2^{a}	0.6297
	4 (19 August)	Lower	1.2^{a}	0.8^{a}	0.1348
		Upper	1.8^{a}	1.6^{a}	0.7487
6Cha	1 (20 July)	Lower	0.7^{b}	1.0^{a}	**0.0203**
		Upper	2.2^{a}	2.0^{a}	0.3975
	2 (30 July)	Lower	1.2^{a}	0.9^{a}	0.2127
		Upper	2.3^{a}	2.4^{a}	0.4917
	3 (9 August)	Lower	1.0^{a}	1.3^{a}	0.1579
		Upper	2.9^{a}	2.3^{a}	0.2746
	4 (19 August)	Lower	1.3^{a}	1.5^{a}	0.5155
		Upper	2.3^{a}	2.0^{a}	0.1506
7Koc	1 (20 July)	Lower	0.9^{a}	0.8^{a}	0.3869
		Upper	2.5^{a}	2.5^{a}	0.9827
	2 (30 July)	Lower	1.3^{a}	1.8^{a}	0.0656
		Upper	2.3^{a}	2.1^{a}	0.7939
	3 (9 August)	Lower	1.2^{a}	1.5^{a}	0.4492
		Upper	3.0^{a}	2.6^{a}	0.6600
	4 (19 August)	Lower	1.4^{a}	1.8^{a}	0.2498
		Upper	2.2^{a}	1.7^{a}	0.2172

TCode, treatment code. Levels of significance: $P\leq0.001$ statistically very highly significant difference; $P\leq0.01$ statistically highly significant difference; $P\leq0.05$ statistically significant difference; $P>0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different ($P>0.05$).

As indicated already in table 8.24 the sampling height had no statistically significant effect on copper ion deposit (P = 0.2408). Further analysis of the deposit on filter papers taken from the 2nd and those taken from the 4th wire proved that the deposit was statistically significantly different only in 6 of 56 cases (table 8.27, indicated with bold P-values in the last column).

The deposit generally did not depend on sampling height, so we can conclude that application was uniform to the whole plant as we expected before applications.

8.6.4 Effect of leaf-side on copper ion deposit on filter papers

Table 8.28 shows the effect of leaf-side on copper ion deposit on filter papers.

Table 8.28: *Effect of leaf-side on copper ion deposit on filter papers, (Duncan's test, α=0.05).*

TCode	Application date	Wire	Deposit of copper ions (µg cm^{-2}) Leaf-side: Lower	Upper	Significance of the effects (P-value)
1CuZ	1 (20 July)	2nd	0.8^b	2.7^a	**0.0003**
		4th	1.4^a	2.6^a	0.1120
	2 (30 July)	2nd	1.1^b	2.4^a	**0.0172**
		4th	1.1^a	3.2^a	0.0788
	3 (9 August)	2nd	1.1^b	2.6^a	**0.0433**
		4th	1.7^a	2.2^a	0.4480
	4 (19 August)	2nd	2.1^a	2.9^a	0.1907
		4th	1.8^a	2.6^a	0.1414
2CuZU	1 (20 July)	2nd	0.7^b	2.8^a	**0.0037**
		4th	1.5^b	2.4^a	**0.0014**
	2 (30 July)	2nd	1.2^a	2.3^a	0.1045
		4th	1.5^a	2.3^a	0.0849
	3 (9 August)	2nd	0.7^b	2.5^a	**0.0171**
		4th	1.2^b	2.1^a	**0.0275**
	4 (19 August)	2nd	1.2^a	2.4^a	0.1034
		4th	1.3^b	2.4^a	**0.0206**
3CuZU	1 (20 July)	2nd	1.0^b	3.4^a	**<0.0001**
		4th	1.0^b	2.6^a	**0.0017**
	2 (30 July)	2nd	0.7^b	2.4^a	**0.0038**
		4th	0.9^a	1.7^a	0.0873
	3 (9 August)	2nd	1.5^b	4.5^a	**0.0079**
		4th	1.4^a	3.9^a	0.0588
	4 (19 August)	2nd	2.1^b	4.0^a	**0.0120**
		4th	0.9^b	3.3^a	**0.0113**
4Cha	1 (20 July)	2nd	1.1^b	3.4^a	**0.0161**
		4th	2.3^a	3.0^a	0.4330
	2 (30 July)	2nd	1.0^b	3.2^a	**0.0423**
		4th	1.4^a	3.2^a	0.0828
	3 (9 August)	2nd	1.5^b	2.7^a	**0.0385**
		4th	1.8^a	2.0^a	0.9046
	4 (19 August)	2nd	1.7^a	2.4^a	0.3789
		4th	1.3^b	2.7^a	**0.0230**
5Koc	1 (20 July)	2nd	0.8^b	1.6^a	**0.0368**
		4th	0.8^b	1.4^a	**0.0141**
	2 (30 July)	2nd	0.9^a	1.7^a	0.0527
		4th	0.9^b	1.8^a	**0.0318**
	3 (9 August)	2nd	1.5^a	1.8^a	0.7648
		4th	0.9^a	2.2^a	0.0957
	4 (19 August)	2nd	1.2^a	1.8^a	0.1587
		4th	0.8^b	1.6^a	**0.0449**
6Cha	1 (20 July)	2nd	0.7^b	2.2^a	**0.0134**
		4th	1.0^b	2.0^a	**0.0323**
	2 (30 July)	2nd	1.2^b	2.3^a	**0.0033**
		4th	0.9^b	2.4^a	**0.0056**
	3 (9 August)	2nd	1.0^b	2.9^a	**0.0449**
		4th	1.3^b	2.3^a	**0.0203**
	4 (19 August)	2nd	1.3^a	2.3^a	0.0611
		4th	1.5^a	2.0^a	0.1456
7Koc	1 (20 July)	2nd	0.9^b	2.5^a	**0.0104**
		4th	0.8^b	2.5^a	**0.0081**
	2 (30 July)	2nd	1.3^a	2.3^a	0.1774
		4th	1.8^a	2.1^a	0.5273
	3 (9 August)	2nd	1.2^b	3.0^a	**0.0068**
		4th	1.5^a	2.6^a	0.2592
	4 (19 August)	2nd	1.4^a	2.2^a	0.1599
		4th	1.8^a	1.7^a	0.8432

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the different letter in the line are statistically significantly different (P≤0.05).

As foreseen (table 8.24) the leaf-side has statistically a very highly significant influence on copper ion deposit (P-value in table 6.22 <0.0001). The deposit on the lower side of leaves is always less compared to that on the upper side. Further analysis (as presented in table 8.28) indicated that these differences may not be statistically significant in each case. Nevertheless considering the infectional pathways of downy mildew one could consider the deposit on lower side of the leaf more critical for general protection against this disease, especially for contact plant protection products.

It is worth mentioning that this type of discrimination (upper vs. lower side of the leaf) is possible only if the deposit is determined on filter papers (or other artificial collectors) but (unless in special cases) not on vine leaves.

8.7 Deposit of copper ions on filter papers normalized to the same application rate of copper ions (model 3)

Tables 8.29 to 8.34 summarize the analyses of copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}). These, i.e. normalized values were introduced to compare all plant protection products used. Namely, they contain different relative amounts of copper ions i.e. active substances (see table 7.6).

In table 8.29, the values of copper ion deposit on filter papers normalized to the same application rate of copper ions with calculated basic statistical parameters are given: the number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation.

Table 8.29: *Copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}) with calculated basic statistical parameters.*

	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
Deposit of Cu^{2+} (µg cm^{-2})	448	1.9	0.4	5.9	1.0	50.6

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of individual effects (treatments (T), replications (R), application date (AD), sampling height (SH), leaf-side (LS) and their interaction T×AD×SH×LS) are shown in table 8.30. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatments, replications, application date, sampling height, leaf-side and their interaction T×AD×SH×LS on copper ion deposit on filter papers normalized to the same application rate of copper ions. There were no statistically significant differences for different sampling heights, but analyses of all other parameters (treatments, application dates, leaf-side and their interaction) showed statistically significant differences.

Table 8.30: *Significance (P-value) of individual parameters on the variability of the copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).*

	P-value					
Parameters / **Quality measured**	**T** (DF = 6)	**R** (DF = 3)	**AD** (DF = 3)	**SH** (DF = 1)	**LS** (DF = 1)	**T×AD×SH×LS** (DF = 100)
Deposit of Cu^{2+}	**<0.0001**	0.1262	**0.0002**	0.1528	**<0.0001**	**<0.0001**

T, treatment; R, replication; AD, application date; SH, sampling height; LS, leaf-side; T×AD×SH×LS, interaction between treatment, application date, sampling height and leaf-side; DF, degrees of freedom. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print.

8.7.1 Effect of treatment on copper ion deposit on filter papers normalized to the same application rate of copper ions

Table 8.31 and figure 8.11 show the effect of treatment on copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).

The effect of treatment on copper ion deposit on filter papers normalized to the same application rate of copper ions was statistically significantly different between treatments, which is shown in table 8.31 where the mean values with the same letter in each (sub)column are not statistically significantly different, and the mean values with a different letter in each (sub)column are statistically significantly different.

Table 8.31: *Effect of treatment on copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), mean value ± standard deviation, (Duncan's test, α=0.05); (Basic data in Appendix E).*

Sampling height		Normalized deposit of copper ions (µg cm^{-2})			
		2^{nd} wire		4^{th} wire	
	Application date	**Leaf-side**		**Leaf-side**	
TCode		**Lower**	**Upper**	**Lower**	**Upper**
1CuZ	1	$0.8±0.2^{a}$	$2.6±0.1^{bcd}$	$1.4±0.4^{abc}$	$2.5±0.6^{abc}$
2CuZU	1	$0.8±0.2^{a}$	$3.2±0.7^{b}$	$1.7±0.3^{ab}$	$2.7±0.3^{ab}$
3CuZU	1	$1.2±0.3^{a}$	$3.9±0.3^{a}$	$1.2±0.4^{bcd}$	$2.9±0.2^{a}$
4Cha	1 (20 July)	$0.9±0.3^{a}$	$2.7±0.6^{bc}$	$1.8±0.5^{a}$	$2.4±0.9^{abc}$
5Koc	1	$1.0±0.5^{a}$	$2.0±0.2^{d}$	$1.0±0.1^{cd}$	$1.8±0.3^{c}$
6Cha	1	$0.7±0.2^{a}$	$2.2±0.4^{cd}$	$1.0±0.1^{cd}$	$2.0±0.4^{bc}$
7Koc	1	$0.9±0.2^{a}$	$2.5±0.5^{cd}$	$0.8±0.3^{d}$	$2.5±0.4^{abc}$
P-value		0.3582	**<0.0001**	**0.0050**	0.1031
1CuZ	2	$1.1±0.3^{a}$	$2.3±0.5^{a}$	$1.0±0.3^{b}$	$3.0±1.3^{a}$
2CuZU	2	$1.3±0.3^{a}$	$2.7±1.1^{a}$	$1.7±0.2^{a}$	$2.6±0.5^{a}$
3CuZU	2	$0.8±0.2^{a}$	$2.7±0.4^{a}$	$1.1±0.4^{b}$	$1.9±0.4^{a}$
4Cha	2 (30 July)	$0.8±0.2^{a}$	$2.6±1.0^{a}$	$1.1±0.4^{b}$	$2.5±0.8^{a}$
5Koc	2	$1.1±0.5^{a}$	$2.2±0.4^{a}$	$1.2±0.3^{b}$	$2.2±0.7^{a}$
6Cha	2	$1.2±0.4^{a}$	$2.3±0.4^{a}$	$0.9±0.2^{b}$	$2.4±0.3^{a}$
7Koc	2	$1.3±0.4^{a}$	$2.3±0.7^{a}$	$1.8±0.5^{a}$	$2.1±0.7^{a}$
P-value		0.2093	0.8299	**0.0107**	0.5105
1CuZ	3	$1.1±0.3^{ab}$	$2.4±0.6^{b}$	$1.6±0.8^{a}$	$2.1±0.3^{b}$
2CuZU	3	$0.8±0.2^{b}$	$2.9±0.7^{b}$	$1.4±0.3^{a}$	$2.4±0.4^{b}$
3CuZU	3	$1.7±0.8^{a}$	$5.1±0.5^{a}$	$1.5±0.6^{a}$	$4.5±1.6^{a}$
4Cha	3 (9 August)	$1.2±0.3^{ab}$	$2.2±0.3^{b}$	$1.5±0.8^{a}$	$1.6±0.6^{b}$
5Koc	3	$1.8±1.3^{a}$	$2.2±1.2^{b}$	$1.1±0.6^{a}$	$2.8±0.9^{b}$
6Cha	3	$1.0±0.4^{ab}$	$2.9±0.9^{b}$	$1.3±0.3^{a}$	$2.3±0.3^{b}$
7Koc	3	$1.2±0.4^{ab}$	$3.0±0.6^{b}$	$1.5±1.0^{a}$	$2.6±0.9^{b}$
P-value		0.1312	**<0.0001**	0.9708	**0.0045**
1CuZ	4	$2.0±0.5^{ab}$	$2.8±0.5^{b}$	$1.7±0.4^{a}$	$2.5±0.9^{bc}$
2CuZU	4	$1.4±0.6^{b}$	$2.8±0.7^{b}$	$1.5±0.5^{ab}$	$2.7±0.1^{b}$
3CuZU	4	$2.4±0.6^{a}$	$4.6±0.5^{a}$	$1.1±0.4^{b}$	$3.7±0.6^{a}$
4Cha	4 (19 August)	$1.3±0.4^{b}$	$1.9±0.8^{b}$	$1.1±0.1^{b}$	$2.1±0.6^{bc}$
5Koc	4	$1.5±0.3^{b}$	$2.2±0.6^{b}$	$1.1±0.4^{b}$	$2.0±0.6^{bc}$
6Cha	4	$1.3±0.4^{b}$	$2.3±0.5^{b}$	$1.5±0.2^{ab}$	$2.0±0.3^{bc}$
7Koc	4	$1.4±0.3^{b}$	$2.2±0.9^{b}$	$1.8±0.5^{a}$	$1.7±0.8^{c}$
P-value		**0.0117**	**0.0002**	**0.0303**	**0.0004**

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the column are not statistically significantly different (P>0.05).

In spite of statistically very highly significant differences for all treatments as seen in table 8.30, table 8.31 clearly shows that in 9 of 16 cases there were statistically significant differences between different treatments when the normalized values to the same application rate of copper ions (i.e. to 1 kg ha^{-1}) were taken into account. Generaly, there were minor differences between different treatments in deposit of copper ions on filter papers.

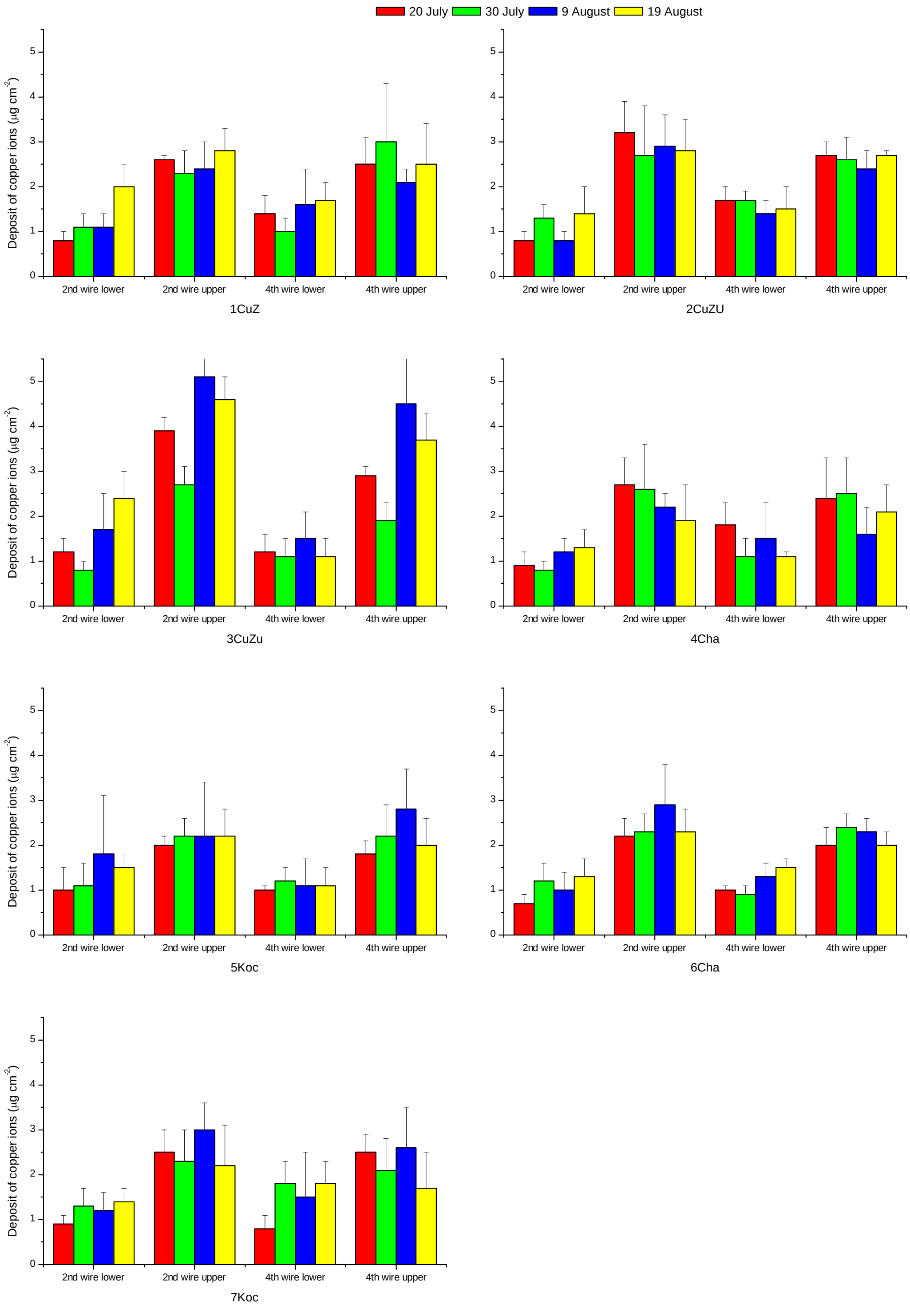


Figure 8.11: *Copper ion deposit for different treatments, application dates, leaf-sides and heights measured on filter paper normalized to the same application rate of copper ions, its mean value and standard deviation.*

8.7.2 Effect of application date on copper ion deposit on filter papers normalized to the same application rate of copper ions

Table 8.32 shows the effect of application date on copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).

Table 8.32: *Effect of application date on copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), (Duncan's test, α=0.05).*

TCode	SH	LS	Normalized deposit of copper ions (µg cm^{-2}) Application date 1 (20 July)	2 (30 July)	3 (9 August)	4 (19 August)	Significance of the effects (P-value)
1CuZ	2nd wire	Lower	0.8^{b}	1.1^{b}	1.1^{b}	2.0^{a}	**0.0061**
		Upper	2.6^{a}	2.3^{a}	2.4^{a}	2.8^{a}	0.5837
	4th wire	Lower	1.4^{a}	1.0^{a}	1.6^{a}	1.7^{a}	0.1789
		Upper	2.5^{a}	3.0^{a}	2.1^{a}	2.5^{a}	0.6007
2CuZU	2nd wire	Lower	0.8^{a}	1.3^{a}	0.8^{a}	1.4^{a}	0.0966
		Upper	3.2^{a}	2.7^{a}	2.9^{a}	2.8^{a}	0.8127
	4th wire	Lower	1.7^{a}	1.7^{a}	1.4^{a}	1.5^{a}	0.3966
		Upper	2.7^{a}	2.6^{a}	2.4^{a}	2.7^{a}	0.5100
3CuZU	2nd wire	Lower	1.2^{b}	0.8^{b}	1.7^{ab}	2.4^{a}	**0.0189**
		Upper	3.9^{b}	2.7^{c}	5.1^{a}	4.6^{ab}	**0.0004**
	4th wire	Lower	1.2^{a}	1.1^{a}	1.5^{a}	1.1^{a}	0.3462
		Upper	2.9^{bc}	1.9^{c}	4.5^{a}	3.7^{ab}	**0.0171**
4Cha	2nd wire	Lower	0.9^{ab}	0.8^{b}	1.2^{ab}	1.3^{a}	0.0917
		Upper	2.7^{a}	2.6^{a}	2.2^{a}	1.9^{a}	0.3788
	4th wire	Lower	1.8^{a}	1.1^{b}	1.5^{ab}	1.1^{b}	**0.0491**
		Upper	2.4^{a}	2.5^{a}	1.6^{a}	2.1^{a}	0.2306
5Koc	2nd wire	Lower	1.0^{a}	1.1^{a}	1.8^{a}	1.5^{a}	0.4144
		Upper	2.0^{a}	2.2^{a}	2.2^{a}	2.2^{a}	0.9776
	4th wire	Lower	1.0^{a}	1.2^{a}	1.1^{a}	1.1^{a}	0.8418
		Upper	1.8^{a}	2.2^{a}	2.8^{a}	2.0^{a}	0.2562
6Cha	2nd wire	Lower	0.7^{b}	1.2^{ab}	1.0^{ab}	1.3^{a}	0.1305
		Upper	2.2^{a}	2.3^{a}	2.9^{a}	2.3^{a}	0.1477
	4th wire	Lower	1.0^{bc}	0.9^{c}	1.3^{ab}	1.5^{a}	**0.0223**
		Upper	2.0^{a}	2.4^{a}	2.3^{a}	2.0^{a}	0.0927
7Koc	2nd wire	Lower	0.9^{a}	1.3^{a}	1.2^{a}	1.4^{a}	0.2868
		Upper	2.5^{a}	2.3^{a}	3.0^{a}	2.2^{a}	0.5091
	4th wire	Lower	0.8^{a}	1.8^{a}	1.5^{a}	1.8^{a}	0.1503
		Upper	2.5^{a}	2.1^{a}	2.6^{a}	1.7^{a}	0.1574

TCode, treatment code; SH, sampling height (2nd wire and 4th wire); LS, leaf-side (lower and upper side of leaves). Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different (P>0.05).

The effect of the application date on copper ion deposit on filter papers normalized to the same application rate of copper ions is exactly the same (looking from the viewpoint of statistically significant differences – P-values) as for the non normalized values (table 8.26) and is given here only for the sake of clarity.

8.7.3 Effect of sampling height on copper ion deposit on filter papers normalized to the same application rate of copper ions

Table 8.33: *Effect of sampling height on copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), (Duncan's test, α=0.05).*

TCode	Application date	Leaf-side	Normalized deposit of copper ions (µg cm^{-2}) Sampling height: 2nd wire	Normalized deposit of copper ions (µg cm^{-2}) Sampling height: 4th wire	Significance of the effects (P-value)
1CuZ	1 (20 July)	Lower	0.8[a]	1.4[a]	0.1366
		Upper	2.6[a]	2.5[a]	0.7532
	2 (30 July)	Lower	1.1[a]	1.0[a]	0.8688
		Upper	2.3[a]	3.0[a]	0.4226
	3 (9 August)	Lower	1.1[a]	1.6[a]	0.1556
		Upper	2.4[a]	2.1[a]	0.2904
	4 (19 August)	Lower	2.0[a]	1.7[a]	0.4770
		Upper	2.8[a]	2.5[a]	0.6819
2CuZU	1 (20 July)	Lower	0.8[b]	1.7[a]	**0.0178**
		Upper	3.2[a]	2.7[a]	0.3590
	2 (30 July)	Lower	1.3[a]	1.7[a]	0.2146
		Upper	2.7[a]	2.6[a]	0.9298
	3 (9 August)	Lower	0.8[a]	1.4[a]	0.0622
		Upper	2.9[a]	2.4[a]	0.0568
	4 (19 August)	Lower	1.4[a]	1.5[a]	0.7446
		Upper	2.8[a]	2.7[a]	0.8362
3CuZU	1 (20 July)	Lower	1.2[a]	1.2[a]	0.9700
		Upper	3.9[a]	2.9[b]	**0.0212**
	2 (30 July)	Lower	0.8[a]	1.1[a]	0.4785
		Upper	2.7[a]	1.9[a]	0.0948
	3 (9 August)	Lower	1.7[a]	1.5[a]	0.7140
		Upper	5.1[a]	4.5[a]	0.4510
	4 (19 August)	Lower	2.4[a]	1.1[b]	**0.0280**
		Upper	4.6[a]	3.7[a]	0.2292
4Cha	1 (20 July)	Lower	0.9[a]	1.8[a]	0.0779
		Upper	2.7[a]	2.4[a]	0.5092
	2 (30 July)	Lower	0.8[b]	1.1[a]	**0.0423**
		Upper	2.6[a]	2.5[a]	0.9608
	3 (9 August)	Lower	1.2[a]	1.5[a]	0.4314
		Upper	2.2[a]	1.6[b]	**0.0436**
	4 (19 August)	Lower	1.3[a]	1.1[a]	0.2485
		Upper	1.9[a]	2.1[a]	0.4110
5Koc	1 (20 July)	Lower	1.0[a]	1.0[a]	0.8731
		Upper	2.0[a]	1.8[a]	0.1633
	2 (30 July)	Lower	1.1[a]	1.2[a]	0.7736
		Upper	2.2[a]	2.2[a]	0.8446
	3 (9 August)	Lower	1.8[a]	1.1[a]	0.4370
		Upper	2.2[a]	2.8[a]	0.6268
	4 (19 August)	Lower	1.5[a]	1.1[a]	0.1372
		Upper	2.2[a]	2.0[a]	0.7446
6Cha	1 (20 July)	Lower	0.7[b]	1.0[a]	**0.0203**
		Upper	2.2[a]	2.0[a]	0.3975
	2 (30 July)	Lower	1.2[a]	0.9[a]	0.2127
		Upper	2.3[a]	2.4[a]	0.4917
	3 (9 August)	Lower	1.0[a]	1.3[a]	0.1579
		Upper	2.9[a]	2.3[a]	0.2746
	4 (19 August)	Lower	1.3[a]	1.5[a]	0.5155
		Upper	2.3[a]	2.0[a]	0.1506
7Koc	1 (20 July)	Lower	0.9[a]	0.8[a]	0.3869
		Upper	2.5[a]	2.5[a]	0.9827
	2 (30 July)	Lower	1.3[a]	1.8[a]	0.0656
		Upper	2.3[a]	2.1[a]	0.7939
	3 (9 August)	Lower	1.2[a]	1.5[a]	0.4492
		Upper	3.0[a]	2.6[a]	0.6600
	4 (19 August)	Lower	1.4[a]	1.8[a]	0.2498
		Upper	2.2[a]	1.7[a]	0.2172

TCode, treatment code. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different (P>0.05).

Table 8.33 shows the effect of sampling height on copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).

As indicated already in tables 8.24 and 8.30 the sampling height had no statistically significant effect on copper ion deposit. The effects presented in table 8.33 are exactly the same as for the non normalized values (table 8.27) and are given here only for the sake of clarity.

8.7.4 Effect of leaf-side on copper ion deposit on filter papers normalized to the same application rate of copper ions

Table 8.34: *Effect of leaf-side on copper ion deposit on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}), (Duncan's test, α=0.05).*

			Normalized deposit of copper ions (µg cm^{-2}) Leaf-side		Significance of the effects
TCode	**Application date**	**Wire**	**Lower**	**Upper**	**(P-value)**
1CuZ	1 (20 July)	2nd	0.8^{b}	2.6^{a}	**0.0003**
		4th	1.4^{a}	2.5^{a}	0.1127
	2 (30 July)	2nd	1.1^{b}	2.3^{a}	**0.0168**
		4th	1.0^{a}	3.0^{a}	0.0786
	3 (9 August)	2nd	1.1^{b}	2.4^{a}	**0.0437**
		4th	1.6^{a}	2.1^{a}	0.4505
	4 (19 August)	2nd	2.0^{a}	2.8^{a}	0.1900
		4th	1.7^{a}	2.5^{a}	0.1403
2CuZU	1 (20 July)	2nd	0.8^{b}	3.2^{a}	**0.0036**
		4th	1.7^{b}	2.7^{a}	**0.0014**
	2 (30 July)	2nd	1.3^{a}	2.7^{a}	0.1049
		4th	1.7^{a}	2.6^{a}	0.0852
	3 (9 August)	2nd	0.8^{b}	2.9^{a}	**0.0173**
		4th	1.4^{b}	2.4^{a}	**0.0290**
	4 (19 August)	2nd	1.4^{a}	2.8^{a}	0.1034
		4th	1.5^{b}	2.7^{a}	**0.0206**
3CuZU	1 (20 July)	2nd	1.2^{b}	3.9^{a}	**<0.0001**
		4th	1.2^{b}	2.9^{a}	**0.0017**
	2 (30 July)	2nd	0.8^{b}	2.7^{a}	**0.0038**
		4th	1.1^{a}	1.9^{a}	0.0881
	3 (9 August)	2nd	1.7^{b}	5.1^{a}	**0.0079**
		4th	1.5^{a}	4.5^{a}	0.0584
	4 (19 August)	2nd	2.4^{b}	4.6^{a}	**0.0121**
		4th	1.1^{b}	3.7^{a}	**0.0114**
4Cha	1 (20 July)	2nd	0.9^{b}	2.7^{a}	**0.0159**
		4th	1.8^{a}	2.4^{a}	0.4342
	2 (30 July)	2nd	0.8^{b}	2.6^{a}	**0.0419**
		4th	1.1^{a}	2.5^{a}	0.0839
	3 (9 August)	2nd	1.2^{b}	2.2^{a}	**0.0381**
		4th	1.5^{a}	1.6^{a}	0.9107
	4 (19 August)	2nd	1.3^{a}	1.9^{a}	0.3796
		4th	1.1^{b}	2.1^{a}	**0.0229**
5Koc	1 (20 July)	2nd	1.0^{b}	2.0^{a}	**0.0378**
		4th	1.0^{b}	1.8^{a}	**0.0145**
	2 (30 July)	2nd	1.1^{a}	2.2^{a}	0.0531
		4th	1.2^{b}	2.2^{a}	**0.0321**
	3 (9 August)	2nd	1.8^{a}	2.2^{a}	0.7675
		4th	1.1^{a}	2.8^{a}	0.0951
	4 (19 August)	2nd	1.5^{a}	2.2^{a}	0.1566
		4th	1.1^{b}	2.0^{a}	**0.0450**
6Cha	1 (20 July)	2nd	0.7^{b}	2.2^{a}	**0.0134**
		4th	1.0^{b}	2.0^{a}	**0.0323**
	2 (30 July)	2nd	1.2^{b}	2.3^{a}	**0.0033**
		4th	0.9^{b}	2.4^{a}	**0.0056**
	3 (9 August)	2nd	1.0^{b}	2.9^{a}	**0.0449**
		4th	1.3^{b}	2.3^{a}	**0.0203**
	4 (19 August)	2nd	1.3^{a}	2.3^{a}	0.0611
		4th	1.5^{a}	2.0^{a}	0.1456
7Koc	1 (20 July)	2nd	0.9^{b}	2.5^{a}	**0.0104**
		4th	0.8^{b}	2.5^{a}	**0.0081**
	2 (30 July)	2nd	1.3^{a}	2.3^{a}	0.1774
		4th	1.8^{a}	2.1^{a}	0.5273
	3 (9 August)	2nd	1.2^{b}	3.0^{a}	**0.0068**
		4th	1.5^{a}	2.6^{a}	0.2592
	4 (19 August)	2nd	1.4^{a}	2.2^{a}	0.1599
		4th	1.8^{a}	1.7^{a}	0.8432

TCode, treatment code. Levels of significance: $P \leq 0.001$ statistically very highly significant difference; $P \leq 0.01$ statistically highly significant difference; $P \leq 0.05$ statistically significant difference; $P > 0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the different letter in the line are statistically significantly different ($P \leq 0.05$).

Table 8.34 shows the effect of leaf-side on the deposit of copper ions on filter papers normalized to the same application rate of copper ions (i.e. to 1 kg ha^{-1}).

As indicated already in tables 8.24 and 8.30 the leaf-side has a statistically very highly significant influence on copper ion deposit (P-value in both tables <0.0001). The detailed dates on normalized values are given only for the sake of clarity (as it was already the case for chapters 8.7.2 and 8.7.3).

8.8 Spray coverage and impact density on water-sensitive papers (model 3)

The spray coverage (i.e. the percentage of the surface covered by the spraying broth) and the impact density (i.e. the number of impacts (droplets) per unit area) were determined using water-sensitive papers (WSP) as described in 7.8.2.3. Tables 8.35 to 8.44 summarize the results of these measurements.

Table 8.35 gives the spray coverage and the impact density with calculated basic statistical parameters: the number of measurements, mean value, the minimum and the maximum, standard deviation and coefficient of variation.

Table 8.35: *Spray coverage and impact density with calculated basic statistical parameters.*

	Parameters					
	n	x_{mean}	Min	Max	SD	CV(%)
Spray coverage (%)	7920	42.4	0.1	136.5	28.7	67.6
Impact density (number of impacts per cm^2)	7920	53.8	0	190.2	40.1	74.5

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

Significance of individual effects (treatments (T), replications (R), application date (AD), sampling height (SH), leaf-side (LS) and their interaction T×AD×SH×LS) are shown in table 8.36. The P-value shows the significance of each parameter considered, in other words the importance of its contribution to the overall variability of the quantity measured: in this case the effect of treatments, replications, application date, sampling height, leaf-side and their interaction T×AD×SH×LS on the spray coverage of WSP and the impact density. There were significant differences for all parameters (treatments, application dates, sampling heights, leaf-side and interaction between treatments, application dates, sampling heights and leaf-side).

Table 8.36: *Significance (P-value) of individual parameters on the variability of spray coverage and impact density.*

	P-value					
Parameters / Quantity measured	T (DF = 6)	R (DF = 3)	AD (DF = 3)	SH (DF = 1)	LS (DF = 1)	T×AD×SH×LS (DF = 100)
Spray coverage	**<0.0001**	**0.0032**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Impact density	**<0.0001**	**0.0200**	**<0.0001**	**0.0004**	**<0.0001**	**<0.0001**

T, treatment; R, replication; AD, application date; SH, sampling height; LS, leaf-side; T×AD×SH×LS, interaction between treatment, application date, sampling height and leaf-side; DF, degrees of freedom. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print.

8.8.1 Effect of treatment on spray coverage

Table 8.37 and figure 8.12 show the effect of treatment on spray coverage.

Table 8.37: *Effect of treatment on spray coverage on WSP, mean value ± standard deviation, (Duncan's test, α=0.05); (Basic data in Appendix F).*

TCode	Application date	Spray coverage (%) 2nd wire Lower	2nd wire Upper	4th wire Lower	4th wire Upper
1CuZ	1	25.9±15.0[b]	52.2±34.3[bc]	33.9±20.1[a]	41.0±25.3[bc]
2CuZU	1	22.6±22.3[bc]	58.8±22.0[b]	34.4±25.7[a]	46.4±25.1[b]
3CuZU	1	43.3±28.1[a]	90.0±14.3[a]	37.4±23.2[a]	79.8±23.4[a]
4Cha	1 (20 July)	17.4±16.4[c]	45.2±17.3[cd]	19.7±20.3[b]	44.3±23.5[bc]
5Koc	1	17.8±17.4[c]	42.5±17.8[d]	20.3±16.1[b]	42.7±19.1[bc]
6Cha	1	15.1±17.7[c]	46.6±17.2[cd]	30.5±26.1[a]	36.4±17.6[c]
7Koc*	1	18.0±13.9[c]	39.7±13.5[d]	21.0±15.4[b]	38.8±17.2[bc]
P-value		**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
1CuZ	2	28.4±26.4[bc]	43.3±29.9[d]	20.6±17.2[d]	49.3±19.0[cd]
2CuZU	2	21.2±18.9[c]	51.9±18.3[bc]	29.6±22.9[bc]	58.4±25.7[b]
3CuZU	2	51.0±25.4[a]	58.9±33.4[b]	36.2±27.9[b]	80.4±23.8[a]
4Cha	2 (30 July)	30.8±21.6[b]	71.4±26.9[a]	45.0±30.6[a]	45.3±27.4[d]
5Koc	2	26.1±17.4[bc]	60.5±21.6[b]	18.8±19.6[d]	47.9±18.6[cd]
6Cha	2	21.6±12.8[c]	47.5±18.1[cd]	23.2±21.4[cd]	48.3±28.5[cd]
7Koc	2	22.7±15.6[c]	53.5±24.5[bc]	24.6±22.0[cd]	54.1±19.7[bc]
P-value		**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
1CuZ	3	18.1±16.4[d]	66.7±23.8[b]	20.6±18.6[d]	51.8±28.8[bc]
2CuZU	3	35.0±27.6[b]	52.7±24.2[cd]	31.4±25.8[b]	43.5±22.4[d]
3CuZU	3	56.0±24.2[a]	91.4±13.9[a]	65.7±28.1[a]	90.0±17.0[a]
4Cha	3 (9 August)	29.7±25.2[bc]	51.9±25.2[cd]	30.2±20.7[bc]	43.7±24.2[d]
5Koc	3	19.5±12.4[d]	47.0±23.7[d]	28.0±22.8[bcd]	47.3±20.9[cd]
6Cha	3	26.8±18.7[c]	49.0±19.7[cd]	32.3±19.2[b]	41.8±24.1[d]
7Koc	3	29.9±19.4[bc]	56.3±23.3[c]	22.8±16.0[acd]	56.3±22.8[b]
P-value		**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
1CuZ	4	28.5±18.8[b]	64.0±23.1[c]	28.5±20.4[bc]	49.0±24.9[bc]
2CuZU	4	27.3±16.5[b]	65.1±22.9[bc]	25.1±17.9[c]	47.0±19.7[bcd]
3CuZU	4	75.1±26.1[a]	79.8±23.2[a]	60.1±28.4[a]	93.8±10.4[a]
4Cha	4 (19 August)	27.6±22.2[b]	52.8±26.3[d]	25.1±19.1[c]	41.3±23.4[de]
5Koc	4	28.3±25.0[b]	53.0±24.8[d]	16.1±11.7[d]	34.4±18.9[e]
6Cha	4	22.0±15.3[b]	72.3±24.2[ab]	29.4±20.1[bc]	42.4±22.4[cd]
7Koc	4	24.8±19.7[b]	57.9±24.3[cd]	34.5±23.5[b]	52.3±27.5[b]
P-value		**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**

TCode, treatment code; *, means of only two replications. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in each (sub)column are not statistically significantly different (P>0.05).

Different treatments have a statistically significant influence on spray coverage, which is shown in table 8.37. Here, the mean values with the same letter in each (sub)column are not statistically significantly different, and the mean values with a different letter in each (sub)column are statistically significantly different.

Maximum spray coverage was obtained for the four applications of the 3CuZU treatment. This was expected because higher spray volume was used in this treatment (1000 L ha^{-1}). For other treatments the spray volume of 400 L ha^{-1} was used.

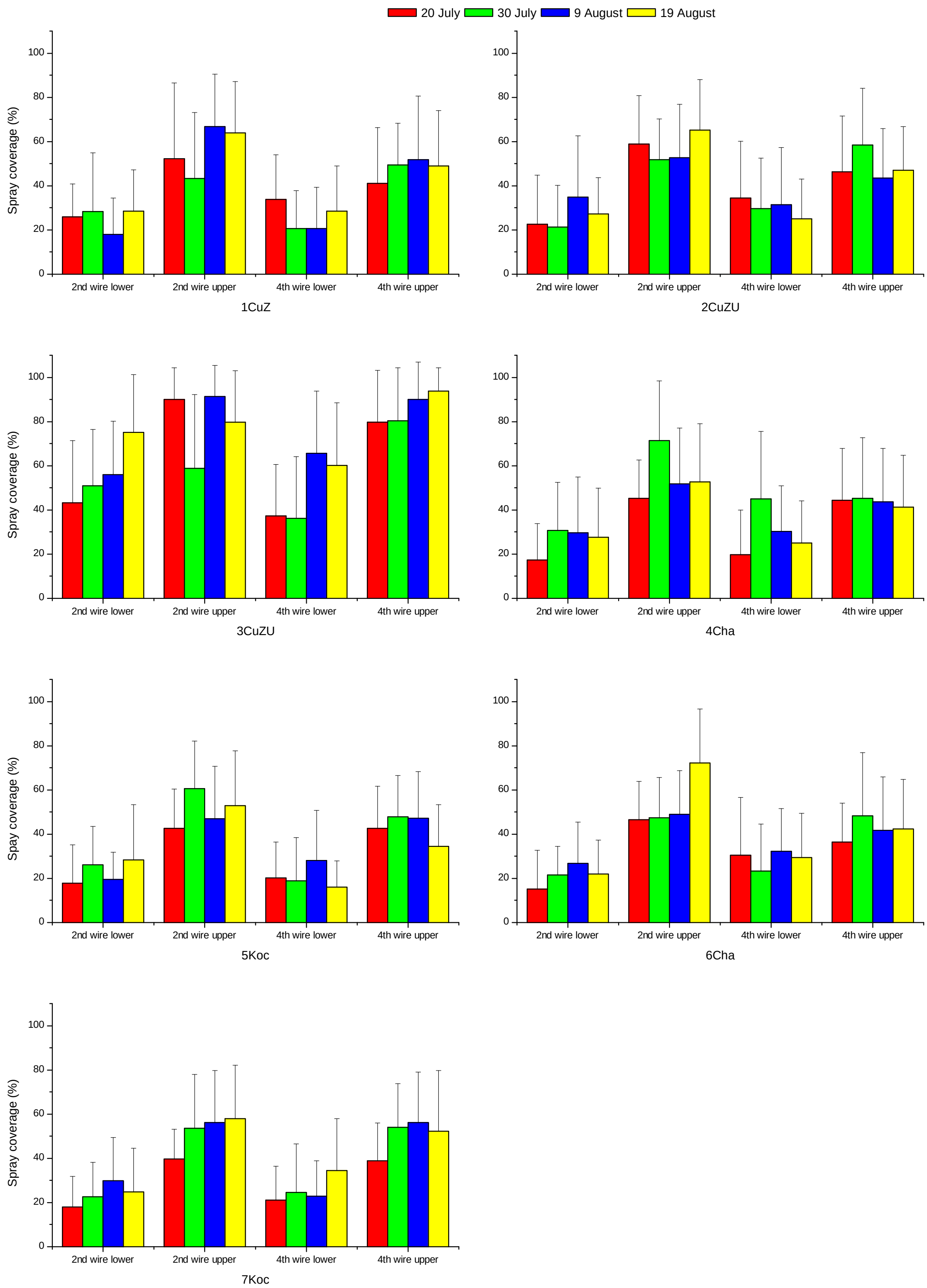


Figure 8.12: *Spray coverage for different treatments, application dates, leaf-sides and heights measured on WSP, its mean value and standard deviation.*

8.8.2 Effect of application date on spray coverage

Table 8.38 shows the effect of application date on spray coverage.

Table 8.38: *Effect of application date on spray coverage on WSP, (Duncan's test, α=0.05).*

TCode	SH	LS	Spray coverage (%) Application date 1 (20 July)	2 (30 July)	3 (9 August)	4 (19 August)	Significance of the effects (P-value)
1CuZ	2nd wire	Lower	25.9^{a}	28.4^{a}	18.1^{b}	28.5^{a}	**0.0018**
		Upper	52.2^{b}	43.3^{b}	66.7^{a}	64.0^{a}	**<0.0001**
	4th wire	Lower	33.9^{a}	20.6^{b}	20.6^{b}	28.5^{a}	**<0.0001**
		Upper	41.0^{b}	49.3^{a}	51.8^{a}	49.0^{a}	**0.0435**
2CuZU	2nd wire	Lower	22.6^{b}	21.2^{b}	35.0^{a}	27.3^{b}	**0.0007**
		Upper	58.8^{ab}	51.9^{b}	52.7^{b}	65.1^{a}	**0.0009**
	4th wire	Lower	34.4^{a}	29.6^{ab}	31.4^{ab}	25.1^{b}	0.1069
		Upper	46.4^{b}	58.4^{a}	43.5^{b}	47.0^{b}	**0.0008**
3CuZU	2nd wire	Lower	43.3^{c}	51.0^{bc}	56.0^{b}	75.1^{a}	**<0.0001**
		Upper	90.0^{a}	58.9^{c}	91.4^{a}	79.8^{b}	**<0.0001**
	4th wire	Lower	37.4^{b}	36.2^{b}	65.7^{a}	60.1^{a}	**<0.0001**
		Upper	79.8^{b}	80.4^{b}	90.0^{a}	93.8^{a}	**<0.0001**
4Cha	2nd wire	Lower	17.4^{b}	30.8^{a}	29.7^{a}	27.6^{a}	**0.0008**
		Upper	45.2^{b}	71.4^{a}	51.9^{b}	52.8^{b}	**<0.0001**
	4th wire	Lower	19.7^{c}	45.0^{a}	30.2^{b}	25.1^{bc}	**<0.0001**
		Upper	44.3^{a}	45.3^{a}	43.7^{a}	41.3^{a}	0.7759
5Koc	2nd wire	Lower	17.8^{b}	26.1^{a}	19.5^{b}	28.3^{a}	**0.0012**
		Upper	42.5^{c}	60.5^{a}	47.0^{bc}	53.0^{b}	**<0.0001**
	4th wire	Lower	20.3^{b}	18.8^{b}	28.0^{a}	16.1^{b}	**0.0007**
		Upper	42.7^{a}	47.9^{a}	47.3^{a}	34.4^{b}	**<0.0001**
6Cha	2nd wire	Lower	15.1^{b}	21.6^{a}	26.8^{a}	22.0^{a}	**0.0003**
		Upper	46.6^{b}	47.5^{b}	49.0^{b}	72.3^{a}	**<0.0001**
	4th wire	Lower	30.5^{ab}	23.2^{b}	32.3^{a}	29.4^{ab}	0.0756
		Upper	36.4^{b}	48.3^{a}	41.8^{ab}	42.4^{ab}	**0.0262**
7Koc	2nd wire	Lower	*18.0^{b}	22.7^{b}	29.9^{a}	24.8^{ab}	**0.0141**
		Upper	*39.7^{b}	53.5^{a}	56.3^{a}	57.9^{a}	**<0.0001**
	4th wire	Lower	*21.0^{b}	24.6^{b}	22.8^{b}	34.5^{a}	**0.0007**
		Upper	*38.8^{b}	54.1^{a}	56.3^{a}	52.3^{a}	**<0.0001**

TCode, treatment code; *, means of only two replications; T, treatment; SH, sampling height (2nd wire and 4th wire); LS, leaf-side (lower and upper side of leaves). Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different (P>0.05).

Application dates have statistically significant effects on spray coverage. This is shown in table 8.38 where the mean values with the same letter in the line are not statistically significantly different and the mean values with a different letter in the line are statistically significantly different.

We expect that the spray coverage will be more or less tha same in spite of different application dates where the same spraying volume was used. This could be explained by different position of vine leaves meaning consequently different position of WSP on vine leaves during the application.

8.8.3 Effect of sampling height on spray coverage

Table 8.39 shows the effect of sampling height on spray coverage.

Table 8.39: *Effect of sampling height on spray coverage on WSP, (Duncan's test, α=0.05).*

TCode	Application date	Leaf-side	Spray coverage (%) Sampling height: 2 wire	Spray coverage (%) Sampling height: 4 wire	Significance of the effects (P-value)
1CuZ	1 (20 July)	Lower	25.9^{b}	33.9^{a}	**0.0041**
		Upper	52.2^{a}	41.0^{b}	**0.0141**
	2 (30 July)	Lower	28.4^{a}	20.6^{b}	**0.0291**
		Upper	43.3^{a}	49.3^{a}	0.1406
	3 (9 August)	Lower	18.1^{a}	20.6^{a}	0.3817
		Upper	66.7^{a}	51.8^{b}	**0.0010**
	4 (19 August)	Lower	28.5^{a}	28.5^{a}	0.9991
		Upper	64.0^{a}	49.0^{b}	**0.0001**
2CuZU	1 (20 July)	Lower	22.6^{b}	34.4^{a}	**0.0030**
		Upper	58.8^{a}	46.4^{b}	**0.0019**
	2 (30 July)	Lower	21.2^{b}	29.6^{a}	**0.0171**
		Upper	51.9^{a}	58.4^{a}	0.0866
	3 (9 August)	Lower	35.0^{a}	31.4^{a}	0.4094
		Upper	52.7^{a}	43.5^{b}	**0.0182**
	4 (19 August)	Lower	27.2^{a}	25.1^{a}	0.4580
		Upper	65.1^{a}	47.0^{b}	**<0.0001**
3CuZU	1 (20 July)	Lower	43.3^{a}	37.4^{a}	0.1543
		Upper	90.0^{a}	79.8^{b}	**0.0012**
	2 (30 July)	Lower	51.0^{a}	36.2^{b}	**0.0009**
		Upper	58.9^{b}	80.4^{a}	**<0.0001**
	3 (9 August)	Lower	56.0^{b}	65.7^{a}	**0.0238**
		Upper	91.4^{a}	90.0^{a}	0.5922
	4 (19 August)	Lower	75.1^{a}	60.1^{b}	**0.0009**
		Upper	79.8^{b}	93.8^{a}	**<0.0001**
4Cha	1 (20 July)	Lower	17.4^{a}	19.7^{a}	0.4412
		Upper	45.2^{a}	44.3^{a}	0.7925
	2 (30 July)	Lower	30.8^{b}	45.0^{a}	**0.0011**
		Upper	71.4^{a}	45.3^{b}	**<0.0001**
	3 (9 August)	Lower	29.7^{a}	30.2^{a}	0.8822
		Upper	51.9^{a}	43.7^{b}	**0.0240**
	4 (19 August)	Lower	27.6^{a}	25.1^{a}	0.4609
		Upper	52.8^{a}	41.3^{b}	**0.0052**
5Koc	1 (20 July)	Lower	17.8^{a}	20.3^{a}	0.3327
		Upper	42.5^{a}	42.7^{a}	0.9450
	2 (30 July)	Lower	26.1^{a}	18.8^{b}	**0.0164**
		Upper	60.5^{a}	47.9^{b}	**0.0002**
	3 (9 August)	Lower	19.5^{b}	28.0^{a}	**0.0064**
		Upper	47.0^{a}	47.3^{a}	0.9218
	4 (19 August)	Lower	28.3^{a}	16.1^{b}	**0.0001**
		Upper	53.0^{a}	34.4^{b}	**<0.0001**
6Cha	1 (20 July)	Lower	15.1^{b}	30.5^{a}	**<0.0001**
		Upper	46.6^{a}	36.4^{b}	**0.0002**
	2 (30 July)	Lower	21.6^{a}	23.2^{a}	0.5713
		Upper	47.5^{a}	48.3^{a}	0.8478
	3 (9 August)	Lower	26.8^{a}	32.3^{a}	0.0876
		Upper	49.0^{a}	41.8^{b}	**0.0491**
	4 (19 August)	Lower	22.0^{b}	29.4^{a}	**0.0114**
		Upper	72.3^{a}	42.4^{b}	**<0.0001**
7Koc	1 (20 July)	Lower	*18.0^{a}	*21.0^{a}	0.3650
		Upper	*39.7^{a}	*38.8^{a}	0.8122
	2 (30 July)	Lower	22.7^{a}	24.6^{a}	0.5510
		Upper	53.5^{a}	54.1^{a}	0.8566
	3 (9 August)	Lower	29.9^{a}	22.8^{b}	**0.0135**
		Upper	56.3^{a}	56.3^{a}	0.9875
	4 (19 August)	Lower	24.8^{b}	34.5^{a}	**0.0057**
		Upper	57.9^{a}	52.3^{a}	0.0999

TCode, treatment code; *, means of only two replications. Levels of significance: $P \le 0.001$ statistically very highly significant difference; $P \le 0.01$ statistically highly significant difference; $P \le 0.05$ statistically significant difference; $P > 0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the different letter in the line are statistically significantly different ($P > 0.05$).

As indicated in table 8.36 spray coverage was very highly statistically significantly different for different sampling heights ($P < 0.0001$), also table 8.39 shows that the P-value is ≤ 0.05 for 32 of total 56 samples. Taking into consideration also the results given in tables 8.27 (Chapter 8.6.3) and 8.33 (Chapter 8.7.3) which indicate only statistically non significant differences for the deposit of copper ions on different sampling heights, we conclude that these statistically significant differences have more to do with technical (dis)advantages of WSP and image analyzing than with actual state of affairs.

As we have no really representative and reliable evaluation of biological efficacy of our treatments against downy mildew it is not possible to decide which evaluation of spraying is better (spray coverage determination or deposit determination).

8.8.4 Effect of leaf-side on spray coverage

Table 8.40 shows the effect of leaf-side on spray coverage.

Table 8.40: *Effect of leaf-side on spray coverage on WSP, (Duncan's test, α=0.05).*

			Spray coverage (%)		Significance of the effects
			Leaf-side		
TCode	**Application date**	**Wire**	**Lower**	**Upper**	**(P-value)**
1CuZ	1 (20 July)	2nd	25.9[b]	52.2[a]	**<0.0001**
		4th	33.9[a]	41.0[a]	0.0603
	2 (30 July)	2nd	28.4[b]	43.3[a]	**0.0019**
		4th	20.6[b]	49.3[a]	**<0.0001**
	3 (9 August)	2nd	18.1[b]	66.7[a]	**<0.0001**
		4th	20.6[b]	51.8[a]	**<0.0001**
	4 (19 August)	2nd	28.5[b]	64.0[a]	**<0.0001**
		4th	28.5[b]	49.0[a]	**<0.0001**
2CuZU	1 (20 July)	2nd	22.6[b]	58.8[a]	**<0.0001**
		4th	34.4[b]	46.4[a]	**0.0041**
	2 (30 July)	2nd	21.2[b]	51.9[a]	**<0.0001**
		4th	29.6[b]	58.4[a]	**<0.0001**
	3 (9 August)	2nd	35.0[b]	52.7[a]	**<0.0001**
		4th	31.4[b]	43.5[a]	**0.0030**
	4 (19 August)	2nd	27.2[b]	65.1[a]	**<0.0001**
		4th	25.1[b]	47.0[a]	**<0.0001**
3CuZU	1 (20 July)	2nd	43.3[b]	90.0[a]	**<0.0001**
		4th	37.4[b]	79.8[a]	**<0.0001**
	2 (30 July)	2nd	51.0[a]	58.9[a]	0.1113
		4th	36.2[b]	80.4[a]	**<0.0001**
	3 (9 August)	2nd	56.0[b]	91.4[a]	**<0.0001**
		4th	65.7[b]	90.0[a]	**<0.0001**
	4 (19 August)	2nd	75.1[a]	79.8[a]	0.2486
		4th	60.1[b]	93.8[a]	**<0.0001**
4Cha	1 (20 July)	2nd	17.4[b]	45.2[a]	**<0.0001**
		4th	19.7[b]	44.3[a]	**<0.0001**
	2 (30 July)	2nd	30.8[b]	71.4[a]	**<0.0001**
		4th	45.0[a]	45.3[a]	0.9494
	3 (9 August)	2nd	29.7[b]	51.9[a]	**<0.0001**
		4th	30.2[b]	43.7[a]	**0.0004**
	4 (19 August)	2nd	27.6[b]	52.8[a]	**<0.0001**
		4th	25.1[b]	41.3[a]	**<0.0001**
5Koc	1 (20 July)	2nd	17.8[b]	42.5[a]	**<0.0001**
		4th	20.3[b]	42.7[a]	**<0.0001**
	2 (30 July)	2nd	26.1[b]	60.5[a]	**<0.0001**
		4th	18.8[b]	47.9[a]	**<0.0001**
	3 (9 August)	2nd	19.5[b]	47.0[a]	**<0.0001**
		4th	28.0[b]	47.3[a]	**<0.0001**
	4 (19 August)	2nd	28.3[b]	53.0[a]	**<0.0001**
		4th	16.1[b]	34.4[a]	**<0.0001**
6Cha	1 (20 July)	2nd	15.1[b]	46.6[a]	**<0.0001**
		4th	30.5[a]	36.4[a]	0.1152
	2 (30 July)	2nd	21.6[b]	47.5[a]	**<0.0001**
		4th	23.2[b]	48.3[a]	**<0.0001**
	3 (9 August)	2nd	26.8[b]	49.0[a]	**<0.0001**
		4th	32.3[b]	41.8[a]	**0.0095**
	4 (19 August)	2nd	22.0[b]	72.3[a]	**<0.0001**
		4th	29.4[b]	42.4[a]	**0.0001**
7Koc	1 (20 July)	2nd	*18.0[b]	*39.7[a]	**<0.0001**
		4th	*21.0[b]	*38.8[a]	**<0.0001**
	2 (30 July)	2nd	22.7[b]	53.5[a]	**<0.0001**
		4th	24.6[b]	54.1[a]	**<0.0001**
	3 (9 August)	2nd	29.9[b]	56.3[a]	**<0.0001**
		4th	22.8[b]	56.3[a]	**<0.0001**
	4 (19 August)	2nd	24.8[b]	57.9[a]	**<0.0001**
		4th	34.5[b]	52.3[a]	**<0.0001**

TCode, treatment code; *, means of only two replications. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the different letter in the line are statistically significantly different (P>0.05).

Spay coverage was always much better (i.e. higher) on the upper side of leaves compared to the lower side. For 51 of 56 comparisons this difference is very highly (46 cases) or highly (5 cases) statistically significant. For the remaining five cases (statistically not significantly different), two are in the group of the high spray volume (1000 L ha^{-1} vs. 400 L ha^{-1}) and only three were observed for a treatment with the so-called normal spray volume (400 L ha^{-1}).

The obtained results were expected. The higher spray coverage was determined on the upper leaf side compared to the lower leaf side. The reason for this is the position of leaves on vines. The leaves of vines usually make a wall like hedgerow where the upper sides of leaves are turned to the outer side of row. During the application the air output from sprayer moves the leaves but not in such a way that the deposit could be higher on the lower side or at least equal on both sides. The first symptoms of downy mildew are observed on the lower leaf side and where also the mycelium develops.

Higher spray coverage (and lower impact density, see table 8.44) was obtained for the four applications of the 3CuZU treatment. Lower spray coverage (and higher impact density) was obtained for all other treatments. This was expected because in the 3CuZU treatment higher spray volume was used (1000 L ha^{-1}) and for all other treatments lower spray volume (400 L ha^{-1}) was used.

8.8.5 Effect of treatment on impact density

Table 8.41 and figure 8.13 show the effect of treatment on impact density.

Table 8.41: *Effect of treatment on impact density on WSP, mean value ± standard deviation, (Duncan's test, α=0.05); (Basic data in Appendix F).*

TCode	Application date	Impact density (No. of impacts per cm^2)			
		2^{nd} wire		4^{th} wire	
		Lower	**Upper**	**Lower**	**Upper**
1CuZ	1	68.8 ± 28.8^{b}	66.8 ± 38.3^{a}	67.6 ± 41.6^{ab}	54.5 ± 43.0^{a}
2CuZU	1	67.2 ± 29.8^{b}	25.1 ± 26.6^{c}	56.0 ± 34.1^{ab}	49.0 ± 42.4^{a}
3CuZU	1	63.3 ± 40.9^{bc}	4.7 ± 11.0^{d}	57.1 ± 41.7^{ab}	14.0 ± 25.5^{b}
4Cha	1 (20 July)	72.5 ± 30.7^{b}	44.3 ± 26.4^{b}	67.8 ± 30.1^{ab}	54.5 ± 39.5^{a}
5Koc	1	83.6 ± 29.5^{a}	47.1 ± 35.5^{b}	69.1 ± 31.6^{a}	49.2 ± 35.2^{a}
6Cha	1	70.1 ± 32.0^{b}	38.2 ± 27.9^{b}	62.5 ± 33.6^{ab}	52.6 ± 29.7^{a}
7Koc*	1	53.7 ± 26.4^{c}	43.8 ± 21.6^{b}	54.8 ± 20.3^{b}	44.4 ± 25.1^{a}
P-value		**<0.0001**	**<0.0001**	0.0820	**<0.0001**
1CuZ	2	39.8 ± 22.3^{d}	31.1 ± 25.9^{abc}	64.8 ± 28.5^{abc}	35.4 ± 26.2^{cd}
2CuZU	2	61.5 ± 23.1^{c}	34.8 ± 26.9^{ab}	61.8 ± 31.0^{abc}	29.5 ± 27.3^{d}
3CuZU	2	46.2 ± 39.4^{d}	37.0 ± 36.8^{ab}	58.6 ± 39.6^{cd}	13.7 ± 21.7^{e}
4Cha	2 (30 July)	73.5 ± 33.7^{ab}	24.5 ± 32.5^{c}	48.2 ± 35.9^{d}	49.7 ± 37.2^{ab}
5Koc	2	74.5 ± 29.6^{ab}	27.8 ± 25.6^{bc}	71.3 ± 31.1^{ab}	41.9 ± 35.9^{bc}
6Cha	2	83.5 ± 25.7^{a}	39.6 ± 24.1^{a}	59.9 ± 27.5^{bc}	53.7 ± 35.9^{a}
7Koc	2	69.8 ± 31.8^{bc}	33.6 ± 29.8^{abc}	71.8 ± 31.2^{a}	28.9 ± 23.9^{d}
P-value		**<0.0001**	**0.0217**	**0.0001**	**<0.0001**
1CuZ	3	73.5 ± 43.9^{c}	27.3 ± 33.1^{b}	86.6 ± 33.0^{a}	45.2 ± 44.3^{bc}
2CuZU	3	78.5 ± 49.7^{bc}	50.1 ± 46.8^{a}	74.2 ± 45.3^{ab}	59.8 ± 46.9^{a}
3CuZU	3	58.2 ± 41.2^{d}	7.8 ± 19.5^{c}	45.8 ± 45.3^{c}	7.7 ± 21.1^{d}
4Cha	3 (9 August)	90.8 ± 51.4^{ab}	46.9 ± 49.7^{a}	83.2 ± 45.7^{ab}	55.1 ± 44.7^{ab}
5Koc	3	103.7 ± 31.9^{a}	40.6 ± 32.5^{a}	77.8 ± 44.5^{ab}	51.3 ± 40.7^{ab}
6Cha	3	82.1 ± 36.8^{bc}	42.6 ± 35.5^{a}	69.7 ± 35.6^{b}	62.3 ± 43.4^{a}
7Koc	3	81.3 ± 35.8^{bc}	39.3 ± 35.8^{ab}	88.1 ± 33.6^{a}	37.2 ± 36.1^{c}
P-value		**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
1CuZ	4	73.7 ± 35.1^{a}	28.1 ± 32.7^{bcd}	78.0 ± 33.5^{abc}	47.5 ± 34.6^{b}
2CuZU	4	76.4 ± 32.9^{a}	25.4 ± 29.6^{bcd}	79.7 ± 31.4^{ab}	43.5 ± 32.0^{b}
3CuZU	4	23.1 ± 30.0^{b}	21.7 ± 31.7^{d}	42.6 ± 38.4^{d}	3.4 ± 7.5^{c}
4Cha	4 (19 August)	73.2 ± 34.3^{a}	36.8 ± 32.6^{ab}	70.3 ± 35.9^{bc}	54.3 ± 36.7^{b}
5Koc	4	74.5 ± 38.9^{a}	39.8 ± 37.6^{a}	86.4 ± 24.4^{a}	66.2 ± 34.1^{a}
6Cha	4	79.9 ± 29.8^{a}	23.2 ± 28.8^{cd}	72.5 ± 34.0^{bc}	46.9 ± 29.6^{b}
7Koc	4	74.3 ± 32.3^{a}	33.8 ± 32.6^{abc}	66.1 ± 37.6^{c}	43.6 ± 39.9^{b}
P-value		**<0.0001**	**0.0025**	**<0.0001**	**<0.0001**

TCode, treatment code; *, means of only two replications. Levels of significance: $P\leq0.001$ statistically very highly significant difference; $P\leq0.01$ statistically highly significant difference; $P\leq0.05$ statistically significant difference; $P>0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in each (sub)column are not statistically significantly different ($P>0.05$).

Different treatments have a statistically significant influence on impact density, which is shown in table 8.41. Here, the mean values with the same letter in each (sub)column are not statistically significantly different, and the mean values with a different letter in each (sub)column are statistically significantly different.

Minimum impact density was obtained for the four applications of the 3CuZU treatment. This was expected because higher spray volume was used in this treatment (1000 L ha^{-1}).

Consequently the number of impacts was smaller as they were bigger (larger) compared to the impacts for other treatments (400 L ha^{-1}).

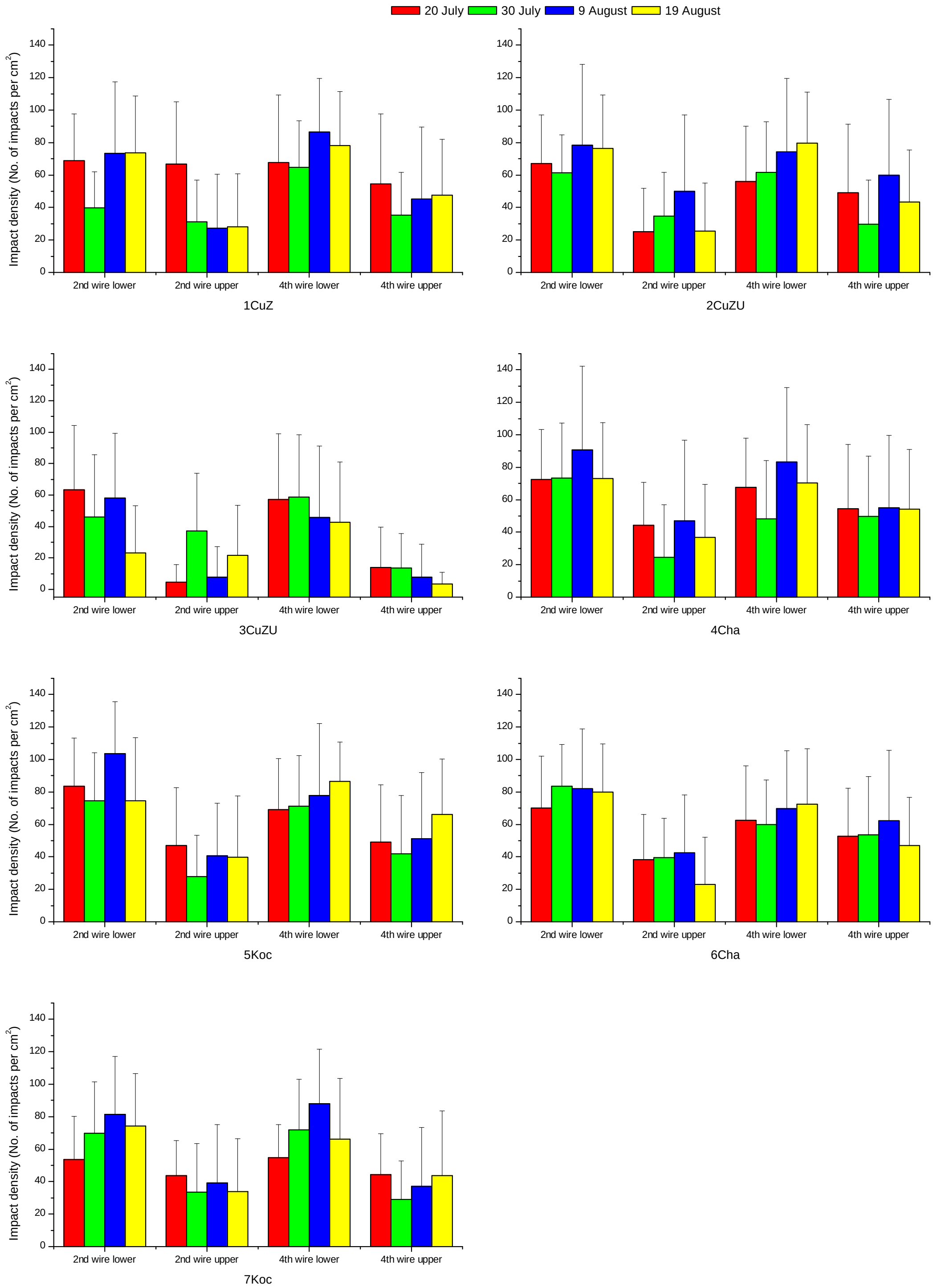


***Figure 8.13:** Impact density for different treatments, application dates, leaf-sides and heights measured on WSP, its mean value and standard deviation.*

8.8.6 Effect of application date on impact density

Table 8.42 shows the effect of application date on impact density.

Table 8.42: *Effect of application date on impact density on WSP, (Duncan's test, α=0.05).*

TCode	SH	LS	Impact density (No. of impacts per cm²) Application date 1 (20 July)	2 (30 July)	3 (9 August)	4 (19 August)	Significance of the effects (P-value)
1CuZ	2nd wire	Lower	68.8[a]	39.8[b]	73.5[a]	73.7[a]	**<0.0001**
		Upper	66.8[a]	31.2[b]	27.3[b]	28.1[b]	**<0.0001**
	4th wire	Lower	67.6[bc]	64.8[c]	86.6[a]	78.0[ab]	**0.0004**
		Upper	54.5[a]	35.4[b]	45.2[ab]	47.5[ab]	**0.0213**
2CuZU	2nd wire	Lower	67.2[ab]	61.5[b]	78.5[a]	76.4[a]	**0.0109**
		Upper	25.1[b]	34.8[b]	50.1[a]	25.4[b]	**<0.0001**
	4th wire	Lower	56.0[b]	61.8[b]	74.2[a]	79.7[a]	**0.0002**
		Upper	49.0[ab]	29.5[c]	59.8[a]	43.5[b]	**<0.0001**
3CuZU	2nd wire	Lower	63.3[a]	46.2[b]	58.2[ab]	23.1[c]	**<0.0001**
		Upper	4.7[c]	37.0[a]	7.8[c]	21.7[b]	**<0.0001**
	4th wire	Lower	57.1[a]	58.6[a]	45.8[ab]	42.6[b]	**0.0384**
		Upper	14.0[a]	13.7[a]	7.7[ab]	3.4[b]	**0.0028**
4Cha	2nd wire	Lower	72.5[b]	73.5[b]	90.8[a]	73.2[b]	**0.0099**
		Upper	44.3[a]	24.5[b]	46.9[a]	36.8[a]	**0.0009**
	4th wire	Lower	67.8[b]	48.2[c]	83.2[a]	70.3[b]	**<0.0001**
		Upper	54.5[a]	49.7[a]	55.1[a]	54.3[a]	0.8216
5Koc	2nd wire	Lower	83.6[b]	74.5[b]	103.7[a]	74.5[b]	**<0.0001**
		Upper	47.1[a]	27.8[b]	40.6[a]	39.8[a]	**0.0055**
	4th wire	Lower	69.1[b]	71.3[b]	77.8[ab]	86.4[a]	**0.0095**
		Upper	49.2[b]	41.9[b]	51.3[b]	66.2[a]	**0.0009**
6Cha	2nd wire	Lower	70.1[b]	83.5[a]	82.1[a]	79.9[ab]	**0.0448**
		Upper	38.2[a]	39.6[a]	42.6[a]	23.2[b]	**0.0003**
	4th wire	Lower	62.5[ab]	59.9[b]	69.7[ab]	72.5[a]	0.0756
		Upper	52.6[ab]	53.7[ab]	62.3[a]	46.9[b]	0.0715
7Koc	2nd wire	Lower	*53.7[b]	69.8[a]	81.3[a]	74.3[a]	**0.0017**
		Upper	*43.8[a]	33.6[a]	39.3[a]	33.8[a]	0.1821
	4th wire	Lower	*54.8[c]	71.8[b]	88.1[a]	66.1[bc]	**<0.0001**
		Upper	*44.4[a]	28.9[ab]	37.2[ab]	43.6[a]	**0.0008**

TCode, treatmant code; *, means of only two replications; T, treatments; SH, sampling height (2nd wire and 4th wire); LS, leaf-side (lower and upper side of leaves). Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different (P>0.05).

Application dates have statistically significant effects on impact density. This is shown in table 8.42 where the mean values with the same letter in the line are not statistically significantly different, and the mean values with a different letter in the line are statistically significantly different.

We expected that the impact density will be more or less tha same in spite of different application dates where the same spraying volume was used. This could be explained by different position of vine leaves meaning consequently different position of WSP on vine leaves during the application.

8.8.7 Effect of sampling height on impact density

Table 8.43 shows the effect of sampling height on impact density.

Table 8.43: *Effect of sampling height on impact density on WSP, (Duncan's test, α=0.05).*

			Impact density (No. of impacts per cm^2)		
			Sampling height		
TCode	**Application date**	**Leaf-side**	**2^{nd} wire**	**4^{th} wire**	**Significance of the effects (P-value)**
1CuZ	1 (20 July)	Lower	68.8^{a}	67.6^{a}	0.8439
		Upper	66.8^{a}	54.5^{a}	0.0703
	2 (30 July)	Lower	39.8^{b}	64.8^{a}	**<0.0001**
		Upper	31.2^{a}	35.4^{a}	0.3044
	3 (9 August)	Lower	73.5^{b}	86.6^{a}	**0.0280**
		Upper	27.3^{b}	45.2^{a}	**0.0070**
	4 (19 August)	Lower	73.7^{a}	78.0^{a}	0.4491
		Upper	28.1^{b}	47.5^{a}	**0.0005**
2CuZU	1 (20 July)	Lower	67.2^{a}	56.0^{b}	**0.0360**
		Upper	25.1^{b}	49.0^{a}	**<0.0001**
	2 (30 July)	Lower	61.5^{a}	61.8^{a}	0.9345
		Upper	34.8^{a}	29.5^{a}	0.2441
	3 (9 August)	Lower	78.5^{a}	74.2^{a}	0.5738
		Upper	50.1^{a}	59.8^{a}	0.2109
	4 (19 August)	Lower	76.4^{a}	79.7^{a}	0.5516
		Upper	25.4^{b}	43.5^{a}	**0.0006**
3CuZU	1 (20 July)	Lower	63.3^{a}	57.1^{a}	0.3666
		Upper	4.7^{b}	14.0^{a}	**0.0032**
	2 (30 July)	Lower	46.2^{a}	58.6^{a}	0.0549
		Upper	37.0^{a}	13.7^{b}	**<0.0001**
	3 (9 August)	Lower	58.2^{a}	45.8^{a}	0.0849
		Upper	7.8^{a}	7.7^{a}	0.9728
	4 (19 August)	Lower	23.1^{b}	42.6^{a}	**0.0006**
		Upper	21.7^{a}	3.4^{b}	**<0.0001**
4Cha	1 (20 July)	Lower	72.5^{a}	67.8^{a}	0.3231
		Upper	44.3^{a}	54.5^{a}	0.0688
	2 (30 July)	Lower	73.5^{a}	48.2^{b}	**<0.0001**
		Upper	24.5^{b}	49.7^{a}	**<0.0001**
	3 (9 August)	Lower	90.8^{a}	83.2^{a}	0.3506
		Upper	46.9^{a}	55.1^{a}	0.2531
	4 (19 August)	Lower	73.2^{a}	70.3^{a}	0.6272
		Upper	36.8^{b}	54.3^{a}	**0.0023**
5Koc	1 (20 July)	Lower	83.6^{a}	69.1^{b}	**0.0033**
		Upper	47.1^{a}	49.2^{a}	0.7323
	2 (30 July)	Lower	74.5^{a}	71.3^{a}	0.5272
		Upper	27.8^{b}	41.9^{a}	**0.0064**
	3 (9 August)	Lower	103.7^{a}	77.8^{b}	**<0.0001**
		Upper	40.6^{a}	51.3^{a}	0.0772
	4 (19 August)	Lower	74.5^{b}	86.4^{a}	**0.0287**
		Upper	39.8^{b}	66.2^{a}	**<0.0001**
6Cha	1 (20 July)	Lower	70.1^{a}	62.5^{a}	0.1695
		Upper	38.2^{b}	52.6^{a}	**0.0016**
	2 (30 July)	Lower	83.5^{a}	59.9^{b}	**<0.0001**
		Upper	39.6^{b}	53.7^{a}	**0.0058**
	3 (9 August)	Lower	82.1^{a}	69.7^{b}	**0.0429**
		Upper	42.6^{b}	62.3^{a}	**0.0026**
	4 (19 August)	Lower	79.9^{a}	72.5^{a}	0.1631
		Upper	23.2^{b}	46.9^{a}	**<0.0001**
7Koc	1 (20 July)	Lower	$*53.7^{a}$	$*54.8^{a}$	0.8365
		Upper	$*43.8^{a}$	$*44.4^{a}$	0.9112
	2 (30 July)	Lower	69.8^{a}	71.8^{a}	0.7054
		Upper	33.6^{a}	28.9^{a}	0.2911
	3 (9 August)	Lower	81.3^{a}	88.1^{a}	0.2414
		Upper	39.3^{a}	37.2^{a}	0.7135
	4 (19 August)	Lower	74.3^{a}	66.1^{a}	0.1473
		Upper	33.8^{a}	43.6^{a}	0.0582

TCode, treatment code; *, means of only two replications. Levels of significance: $P \leq 0.001$ statistically very highly significant difference; $P \leq 0.01$ statistically highly significant difference; $P \leq 0.05$ statistically significant difference; $P > 0.05$ statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different ($P > 0.05$).

As indicated in table 8.36 impact density was highly statistically significantly different for different sampling heights ($P = 0.0004$), also table 8.43 shows that the P-value is ≤ 0.05 for 25 of total 56 samples. The same arguments as in chapter 8.8.3 can be given for taking or not taking this data into consideration.

Generally speaking, on the height of the second wire (1.0 m from the ground) the impact density was somewhat lower than on the height of the fourth wire (1.6 m from the ground).

8.8.8 Effect of leaf-side on impact density

Table 8.44 shows the effect of leaf-side on impact density.

Table 8.44: *Effect of leaf-side on impact density on WSP, (Duncan's test, α=0.05).*

TCode	Application date	Wire	Impact density (No. of impacts per cm^2) Leaf-side: Lower	Impact density (No. of impacts per cm^2) Leaf-side: Upper	Significance of the effects (P-value)
1CuZ	1 (20 July)	2nd	68.8^a	66.8^a	0.7124
		4th	67.6^a	54.5^a	0.0623
	2 (30 July)	2nd	39.8^a	31.2^b	**0.0271**
		4th	64.8^a	35.4^b	**<0.0001**
	3 (9 August)	2nd	73.5^a	27.3^b	**<0.0001**
		4th	86.6^a	45.2^a	**<0.0001**
	4 (19 August)	2nd	73.7^a	28.1^b	**<0.0001**
		4th	78.0^a	47.5^b	**<0.0001**
2CuZU	1 (20 July)	2nd	67.2^a	25.1^b	**<0.0001**
		4th	56.0^a	49.0^a	0.2804
	2 (30 July)	2nd	61.5^a	34.8^b	**<0.0001**
		4th	61.8^a	29.5^b	**<0.0001**
	3 (9 August)	2nd	78.5^a	50.1^b	**0.0006**
		4th	74.2^a	59.8^a	0.0619
	4 (19 August)	2nd	76.4^a	25.4^b	**<0.0001**
		4th	79.7^a	43.5^b	**<0.0001**
3CuZU	1 (20 July)	2nd	63.3^a	4.7^b	**<0.0001**
		4th	57.1^a	14.0^b	**<.0001**
	(30 July)	2nd	46.2^a	37.0^a	0.1517
		4th	58.6^a	13.7^b	**<0.0001**
	3 (9 August)	2nd	58.2^a	7.8^b	**<0.0001**
		4th	45.8^a	7.7^b	**<0.0001**
	4 (19 August)	2nd	23.1^a	21.7^a	0.7764
		4th	42.6^a	3.4^b	**<0.0001**
4Cha	1 (20 July)	2nd	72.5^a	44.3^b	**<0.0001**
		4th	67.8^a	54.5^b	**0.0231**
	2 (30 July)	2nd	73.5^a	24.5^b	**<0.0001**
		4th	48.2^a	49.7^a	0.8144
	3 (9 August)	2nd	90.8^a	46.9^b	**<0.0001**
		4th	83.2^a	55.1^b	**0.0003**
	4 (19 August)	2nd	73.2^a	36.8^b	**<0.0001**
		4th	70.3^a	54.3^b	**0.0081**
5Koc	1 (20 July)	2nd	83.6^a	47.1^b	**<0.0001**
		4th	69.1^a	49.2^b	**0.0005**
	2 (30 July)	2nd	74.5^a	27.8^b	**<0.0001**
		4th	71.3^a	41.9^b	**<0.0001**
	3 (9 August)	2nd	103.7^a	40.6^b	**<0.0001**
		4th	77.8^a	51.3^b	**0.0002**
	4 (19 August)	2nd	74.5^a	39.8^b	**<0.0001**
		4th	86.4^a	66.2^b	**<0.0001**
6Cha	1 (20 July)	2nd	70.1^a	38.2^b	**<0.0001**
		4th	62.5^a	52.6^a	0.0553
	2 (30 July)	2nd	83.5^a	39.6^b	**<0.0001**
		4th	59.9^a	53.7^a	0.2475
	3 (9 August)	2nd	82.1^a	42.6^b	**<0.0001**
		4th	69.7^a	62.3^a	0.2646
	4 (19 August)	2nd	79.9^a	23.2^b	**<0.0001**
		4th	72.5^a	46.9^b	**<0.0001**
7Koc	1 (20 July)	2nd	*53.7^a	*43.8^a	0.0861
		4th	*54.8^a	*44.4^a	0.0561
	2 (30 July)	2nd	69.8^a	33.6^b	**<0.0001**
		4th	71.8^a	28.9^b	**<0.0001**
	3 (9 August)	2nd	81.3^a	39.3^b	**<0.0001**
		4th	88.1^a	37.2^b	**<0.0001**
	4 (19 August)	2nd	74.3^a	33.8^b	**<0.0001**
		4th	66.1^a	43.6^b	**0.0003**

TCode, treatment code; *, means of only two replications. Levels of significance: P≤0.001 statistically very highly significant difference; P≤0.01 statistically highly significant difference; P≤0.05 statistically significant difference; P>0.05 statistically not significantly different. P-values indicating statistically different values are in bold print. Means with the same letter in the line are not statistically significantly different (P>0.05).

The impact density was always (with only one significant exception) higher on the lower side of the leaf. This is only the most striking example of the fact that lower spray coverage means higher impact density and vice versa. Namely, an impact results from a drop (small or big) reaching the WSP. Consequently, a mist of small droplets gives many impacts but a poor coverage. On the other hand, more big droplets close together result only in one big deformed impact. Extremely low impact density (in our case 3.4; 4.7 and the like) result from a totally covered (soaked) paper (coverage being 93.8 %; 90.0 %, see table 8.40).

All the above taken into consideration, one can obviously conclude that impact density is a rather non reliable method for spraying evaluation under extreme conditions (high application rate of water, very small droplets and the like).

The comparison of spray coverage and impact density on WSP for two different treatments, using high- (3CuZU) and low- (5Koc) water application rate, on different heights and leaf-sides is shown on figure 8.14. See also Appendix F where figures AppF1 to AppF7 for all treatments are given.

Higher spray coverage (and lower impact density) was obtained for the four applications of the 3CuZU treatment. Lower spray coverage (and higher impact density) was obtained for all other treatments. This was expected because in the 3CuZU treatment higher spray volume was used (1000 L ha^{-1}) and for all other treatments lower spray volume (400 L ha^{-1}) was used.

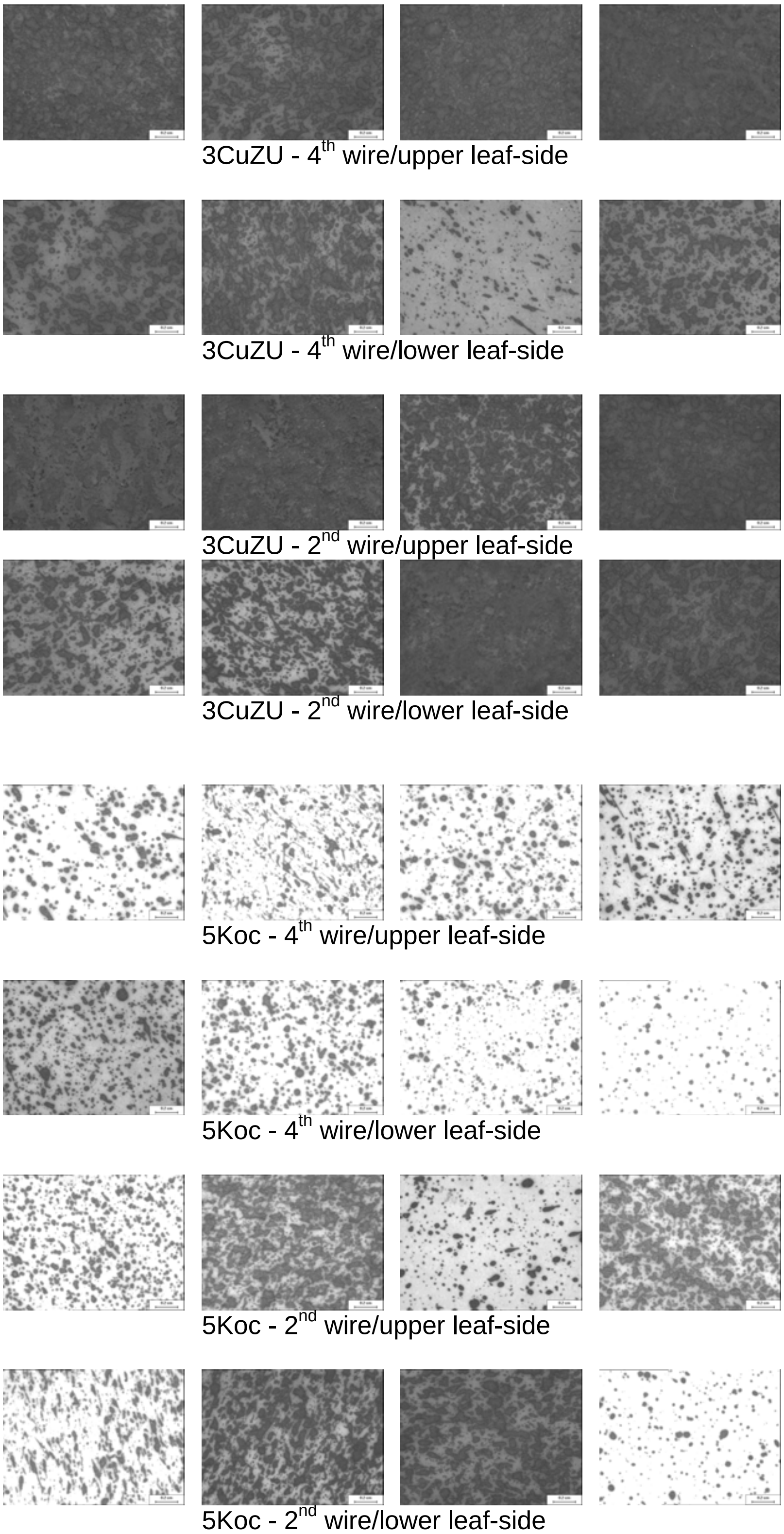


Figure 8.14: *Spray coverage for 3CuZU (water application rate 1000 L ha^{-1}) and 5Koc (water application rate 400 L ha^{-1}) treatments on WSP on different heights and leaf-sides.*

8.9 Comparison of copper ion deposit on vine leaves and filter papers

In order to compare the copper ion deposit on vine leaves with that on filter papers the values given in Appendix G (Table AppG) and summarized in table 8.45 were statistically evaluated. The value for the copper ion deposit on vine leaves before each application was subtracted from the value obtained after each application; these values are given as copper ion deposit on vine leaves in Appendix G (Table AppG) and are considered to be a realistic value of the deposit due to each application. Consequently they can be directly compared to the value obtained from the filter papers due to the same application. Each value for the filter paper was obtained by summation of two measurements (lower and upper leaf side for one and the same leaf). These values are also given in Appendix G (Table AppG).

Further on, for the sake of clarity, the results presented here do not discriminate between the second and the fourth wire and they include only the treatments with the same application rate of water (400 L ha^{-1}). The evaluation was performed also for each wire separately and also for the high water application rate (1000 L ha^{-1}), all evaluations giving practically the same results.

Table 8.45: *Comparison of copper ion deposit on vine leaves and filter papers with calculated basic statistical parameters.*

	Copper ion deposit					
	Parameters					
	n	**x_{mean}**	**Min**	**Max**	**SD**	**CV(%)**
on vine leaves (µg cm^{-2})	192	4.5	1.1	9.2	1.9	41.1
on filter papers (µg cm^{-2})	192	3.6	1.5	6.4	0.8	23.2

n, number of measurements; x_{mean}, mean value; Min, minimum; Max, maximum; SD, standard deviation; CV(%), coefficient of variation

The values were highly statistically significantly ($P<0.001$), higher for vine leaves compared with filter papers, higher standard deviation and coefficient of variation for deposit evaluation on vine leaves compared to filter papers is obviously due to greater variability of the first method.

The comparison of the 192 values is presented on figure 8.15. It is a generally accepted fact (Salyani, 2000a; Salyani and Hoffmann, 1996) that the deposit on filter papers is higher compared to the deposit on green leaves. The soaking of filter paper and the dripping from the green leaves provided a plausible explanation. In our case it is clearly the opposite: the deposit on green leaves is considerably higher compared to the deposit on filter papers. The only exception to this rule was observed for relatively low values of the deposit, in this case the deposit on the filter paper was higher than the deposit on vine leaves. On the other hand, as the difference in favour of vine leaves for high deposit values was far more pronounced that the difference in favour of filter papers for low deposit values, there can be no doubt about the general trend.

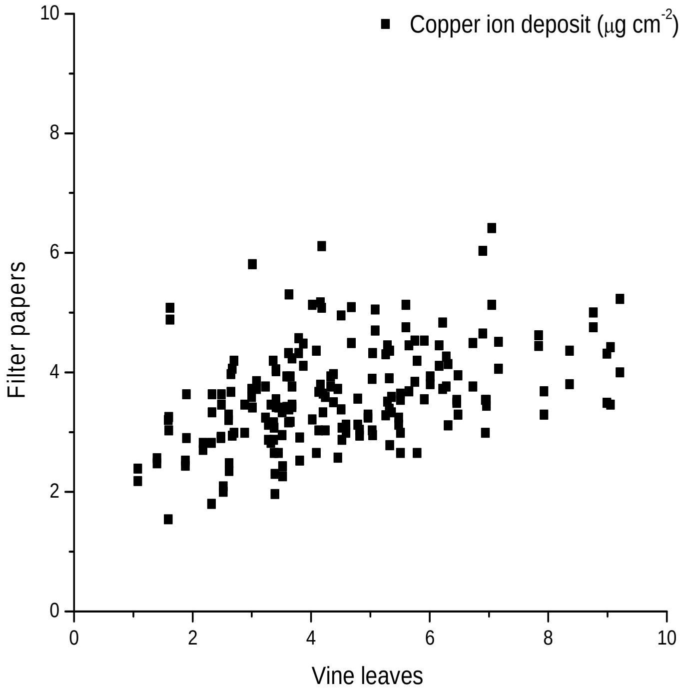


Figure 8.15: *Comparison of copper ion deposit on vine leaves (after – before*) and filter papers (upper + lower*).*
**for detailed explanation see text*

One of the possible explanations could include the texture of leaves. Most published data were obtained on citruses (Salyani, 2000a; Salyani, 2000b, Salyani and Whitney, 1988; Salyani and McCoy, 1989; Salyani *et al.*, 1988; Whitney and Salyani, 1991) and apple trees (Herrington *et al.*, 1981; Cooke et al., 1976; Cross *et al.*, 2001a; Cross *et al.*, 2001b; Cross *et al.*, 2003; Whitney et al., 1989), where the leaves are very 'slippery' and even 'wax polished', meanwhile the vine leaves are usually waxy on the upper side and hairy on the lower side. One of the possible reasons could also be the crop structure: canopy (which is particularly dense for vine) and position of the leaves on different crops (outer leaves of vine usually make a wall like hedgerow). Additionally, a very dry filter paper can soak some spraying mist which is not adhered to green leaves, but this soaking does not seriously influence the results of measurements of deposit on filter paper for higher deposit.

8.10 General discussion

In order to reduce the environmental pollution the most appropriate spray equipment was used in vineyard where our field experiment carried out. The vineyard sprayer used was carefully and correctly set up. The nozzles used were conventional hollow cone nozzles which are recommended for applications in vineyards and their use is considered a good agricultural practice.

With the lower spray volume (400 L ha^{-1}), during the four applications (at full foliage development) the spray drift was recorded to the first or to the second row as it was observed also by Landers&Farooq (2004). For the treatment where the high spray volume (1000 L ha^{-1}) was used, the spray drift was recorded up to the forth row. So, we can estimate that the maximum spray drift was approximately 2 % of the applied volume rate up to 5.0 meters from the sample (middle) row when the lower water volume (400 L ha^{-1}) was used. Basic drift values reported by Rautmann *et al.* (2001), which are used in the authorisation procedure for plant protection products in Europe and also in Slovenia, show that from the distance of 5 meters, the ground sediment for one application in late growing stage is considered 3.62 %, 1.23 % for 10 meters and 0.03 % for 100 meters from the treated area.

Balsari and Marucco (2004) observed higher values of drift when fine droplets and high air flow rates were used. The use of ATR yellow nozzles (Balsari and Marucco, 2004), in similar sizes of canopy and in similar weather conditions as in our field experiment gave a ground deposit of spray drift up to 2.9 % of the applied volume rate at 5 to 20 meters from the last row. Meanwhile, the ground deposit of spray drift was up to 1.8 % of the applied volume rate at 5 meters from the last row.

On the other side, Pergher and Gubiani (1995) observed that the increasing of spray application rate and air output both led to higher losses to the ground and lower deposition on the foliage. They concluded, that losses to the soil ranged from 34.5 to 36.8 % for the lower spray rates (313 to 391 L ha^{-1}), and from 41.3 to 48.9 % for the medium spray rates (648 to 782 L ha^{-1}). Losses due to drift outside the experimental plots and deposition on brunches, shoots and poles ranged from 6.5 to 10.5 % for the lower air output (7.0 m^3 s^{-1}), and from 7.8 to 19.8 % for the higher air output (8.6 m^3 s^{-1}), when the commercial, air assisted, axial-fan sprayer with seven hydraulic nozzles per side was used.

On the basis of our field experiment and reported references we can suggest that the limit for yearly use deposit of copper fungicides, the use of which must for the time being not exceed 5 kg per year as it is stated in regulative of integrated pest management, in integrated production of grapes and vine (Tehnološka …, 2004-2007) should be lower. The reduced amount of copper compounds brought to the vineyard would result in diminished copper accumulation in the ground, and thereby contribute to less polluted soils.

Generally, the shallow soils and especially shallow groundwater levels are typical for Slovenia and therefore contribute the major part to environmental pollution. Besides, industrial and agricultural contaminations of soil have to be considered. It is reasonable to conclude that because of all these the plant protection products are not directly responsible for environmental pollution of Slovenian soils. On the other hand, because of frequent and wide use of copper it becomes one of the serious pollutant in soil.

The main reasons for pollution of soil with copper are physical and chemical properties of copper. Copper is a heavy metal which is not recommended to use in large amounts because of its accumulation in soil and resulting long term pollution of soils. Copper belongs to the group of less mobile elements in soil because of its binding on organic matter and on humus.

With supervision and controlled use of plant protection products it is possible to reduce soil and environmental pollution. Integrated pest management is one of the tools to supervise and limit or reduce the use of plant protection products. In Slovenia integrated pest management, integrated production of grapes and vine is officially recognized since 2000 and consequently enables control over plant protection products used.

9 CONCLUSIONS

The main objective of any application of plant protection product is to ensure optimal status of cultural plants and crop on one hand and minimal environmental damage on the other. For spraying against diseases as downy mildew, which is caused by ubiquitous spores and therefore presents an always threatening infection, preventive fungicides, preferably those which are very persistent have to be used regularly. Consequently the infection pressure on locally non-treated plants grown in generally treated areas is not the same (i. e. is much lower) as in the areas, which have not been exposed to fungicides for a long time. Because of this reason the untreated plots under similar growing and meteorological conditions were taken to evaluate biological efficacy of tested plant protection products. This has to be taken into consideration when trying to comment the results on biological efficacy in a really meaningful way. Consequently, lower application rate of copper substances which could result from optimal selection of plant protection products and optimal application procedures is equally if not more important from the environmental point of view and has a less obvious impact as a direct plant protection measure. The aim of preventive spraying with fungicides is to keep the downy mildew infection of grapevines on the level, which does not cause any damage on grapevines.

The field experiments presented in this study included seven different treatments: these included four different plant protection products. They were used in recommended and sometimes also in slightly lower or slightly higher application rates. As a rule water application rate was 400 L ha^{-1} and, just for comparison, only one treatment was performed at the water application rate of 1000 L ha^{-1}.

Biological efficacy of all plant protection products used in this field experiment against downy mildew was approximately 98 % for vine grapes and approximately 97 % for vine leaves. It can be concluded that all treatments were perfectly biologically efficient against downy mildew.

Deposit of copper ions in vine grapes for all the treatments showed no statistically significant differences. We can conclude that neither different plant protection products nor differences in their application rate affected copper content in grapes.

The amount of copper ions for green leaves increased from the first to the fourth application. As expected, rainfall had a pronounced effect on the amount of remaining deposit of copper ions, but, generally speaking, its effect for different plant protection products was different for different applications dates and a straightforward commentary is not possible. The numbers indicate though, that application with Champion 50 WP suffered most relative wash-off of copper ions compared to treatments with Cuprablau Z, Cuprablau Z Ultra and Kocide DF.

In order to compare the copper ion deposit on vine leaves for different plant protection products the values were normalized to the application rate of 1 kg of copper ions per ha. The highest relative (i. e. normalized) deposit on vine leaves was determined for the treatment with Cuprablau Z and Cuprablau Z Ultra (at an application rate of water of 400 L ha^{-1}).

None statistically significant differences for copper ion deposit on filter papers were established between sampling heights in the canopy, but it is important to point out, that the deposit was always higher on the upper side of the leaves, compared to the lower side of the leaves. For diseases as downy mildew, which starts development on the lower side of the leaf, the opposite would be better but this disadvantage of the application can not be overcome even by improving the spraying technique as it is very probably related to the shape of the two-pointed guyot breeding form in which the hanging leaves make a rather solid green wall.

In spite of prevailing and generally established practice of spraying with the so called ‘reduced application rate’ of water (400 L ha^{-1}), the majority of the recommendations on the labels are still done using the ‘recommended application rate’ of water (1000 L ha^{-1}). These two ways of spraying were compared also in the field experiments presented in this study and evaluated with water sensitive papers by comparing the spray coverage and impact density. These values have to do with spray broth (better to say water in it) not with the active ingredient of the plant protection product. As expected, the spray coverage was better for spraying with 1000 L ha^{-1}

compared to 400 L ha^{-1} the impact density was lower for the higher water application rate, because several impacts fuse to one in this case. Though better spray coverage is considered advantageous (if we prevent run-off from the wet leaves) we must on the other hand consider, that best spraying is usually done early in the morning or late in the evening at high relative humidity (and lower temperature) when the coverage is optimal but can not be measured by water sensitive papers because of dew or other interfering droplets or even mist (Hoffmann and Salyani, 1994). Measurements with water sensitive papers also confirmed the results about lower and higher deposits on lower and upper leaf sides.

Though the following statement has not been verified by straightforward measurements, which would prove it beyond any doubt, the data gathered speak strongly in favour of the fact that the deposit of plant protection product, which protects the plant, depends as well on the initial deposit as on the persistence of it. Consequently, it is very important to consider the actual amount of copper ions per unit area, which is the sum of the deposit prior to application (the remaining amount of the previous application) and the amount added during the last application. The kinetics of the 'disappearing' of the deposit plays a very important role in this interpretation and in this case determination of the deposit via any artificial collectors is useless.

All plant protection products used in this study (Cuprablau Z, Cuprablau Z Ultra, Champion 50 WP and Kocide DF) gave excellent results as far as biological efficacy was concerned. One can assume that preventive fungicides containing copper ions are the substances of choice in protecting vine from downy mildew for the last applications. They were all used in accordance to integrated pest management and they are all generally considered as safe, still effective after more than 200 years of use and relatively inexpensive. In spite of all positive properties of copper fungicides, other substances appeared in last forty years, but they can not replace the use of copper substances against a wide range of diseases. The copper fungicides are beside the sulphur fungicides also recommended in ecological pest management. On the other hand, the problem of copper in the environment is becoming more and more serious. Though it is not directly toxic, one has to be aware of its ever increasing amount in the surroundings where copper substances are regularly used for decades. In this context one has to consider the advantages of the substances that can be used at lower application rates and suffer as little wash-off from the leaves as possible.

The data suggest that intensive viticulture practice is one of the pollution sources in regarding copper contamination. Therefore it is recommended to reconsider the regulation of integrated pest management, integrated production of grapes and vine, especially in the view of reduction of the use of plant protection products which are problematical in environment contamination. This will be the first step to reduce the environmental pollution and to reduce the ground soil pollution with copper substances. Consequently, the list of plant protection products could get shorter and the growers might have problems what to use to protect cultivated plants, especially nowadays when the climatic changes and resulting by increased pressure of pests are becoming more and more important.

10 REFERENCES

Adriano D.C. 1986. Trace Elements in the Terrestrial Environment, Springer-Verlag New York Berlin Heidelberg Tokyo,p.532.

Albuz San Oben, France. 2005. Nozzle characteristics. (manufacturer data, personal communication, January 2005).

Antuniassi U.R., Velini E.D. and Martins D. 1996. Spray depositoin and drift evaluation of air-carrier peach orchard sprayers. *AgEng96*, Madrid, Spain. Paper No. 96A-136.

Balsari P. and Marucco P. 2004. Influence of canopy parameters on spray drift in vineyard. *Aspects of Applied Biology* 71: 157-164.

Barber J.A.S., Parkin C.S. and Chowdhury A.B.M.N.U. 2003. Effect of application method on the control of powdery mildew (Bulmeria graminis) on spring barley. *Crop Protection*, Vol. 22, Issue 7, August 2003, 949-957.

Bergman W. 1992. Nutritional Disorders of plants, Gustav Fischer Verlag Jena Stuttgart New York, p.741.

Besnard E., Chenu C. and Robert M. 2001. Influence of organic amendments on copper distribution among particle-size and density fractions in Champagne vineyard soils. *Environmental pollution* 112:329-337.

Blandini G. and Schillaci G. 1993. Parameters influencing spray deposition in citrus pest control. In Proc. 4th Int. Symp. *On Fruit, Nut, & Vegetable Production Engng.* 1: 133-140.

Brečko D. 2002. Spraying programme. Slovenske Konjice, Zlati Grič d.d., (personal communication, August 2002).

Brun L.A., Le Corff J. and Maillet J. 2003. Effects of elevated soil copper phenology, growth and reproduction of five ruderal plant species. *Environmental pollution* 122:361-368.

Carlton J.B. 1992. Simple techniques for measuring spray deposit in the field II: Dual side leaf washer. *ASAE Paper No. 92-1618*. St. Joseph, Michigan.

Carman G.E. and Jeppson L.R. 1974. Low volume applications to citrus trees: Method for evaluation of spray droplet distributions. *J. Econ. Entomol.* 67: 397-402.

Casady B., Downs W. and Fishel F. 1999. Controlling drift of crop protection materials. *Agricultural MU Guide*. Extension, University of Missouri-columbia. G 1886

Center za pedologijo in varstvo okolja. 2005. Raziskave onesnaženosti tal Slovenije v letu 2005. Baker (Cu) v tleh. Naročnik: Ministrstvo za okolje in proctor, Agencija Republike Slovenije za okolje. Izvajalec: Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za agronomijo, Center za pedologijo in varstvo okolja. Št. Pogodbe: 2523-500352.

Chaignon V., Sanchez-Neira I., Herrmann P., Jillard B. and Hinsinger P. 2003. Copper bioavailability and extractability as related to chemical properties of contaminated soils from a vine-growing area. *Environmental pollution* 123:229-238.

Chiu H.W. , Lee F.F. and Liang L.S. 1999. Using image processing technique to measure spray coverage. *Journal of Agriculture Research of China*, 48:4,96-110.

Ciba-Geigy Documenta. 1981. Manual for Field Trials in Plant Protection. Second Edition, Revised and Enlarged, 205 p.

Coates W. 1996. Spraying technologies for cotton: Deposition and efficacy. *Applied Engineering in Agriculture* 12(3): 287-296.

Compendium of growth stage identification keys for mono- and dicotyledonous plants. Extended BBCH scale, 2nd edition 1997, a joint publication of BBA, BSA, IGZ, IVA, AgrEvo, BASF, Bayer and Novartis.

Cooke B.K., Herrington P.J., Jones K.G. and Morgan N.G. 1976. Spray deposit cover and fungicide distribution obtained by low and ultralow volume spraying of intensive apple trees. Pesticide Science 7:35-40.

Cooke B.K. and Hislop E.C. 1993. Spray tracing techniques. Application technology for crop protection. Edited by G.A. Matthews and E.C. Hislop, 1993, 85-100.

Cross J.V. 1991. Patternation of spray mass flux from axial fan airblast sprayers in the orchard. In Air-assisted Spraying in Crop Protection, 15-22. *British Crop Protection Council*.

Cross J.V., Ridout, M.S. and Walklate P.J. 1997a. Adjustment of axial fan spayers to orchard structure. *Proceedings of the IV International Workshop on Integrated Control of Orchard Diseases,* Croydon, England, IOBC Bulletin, volume 20(9), 86-94.

Cross J.V., Murray R.A., Ridout M.S. and Walklate P.J. 1997b. Quantification of spray deposits and their variability on apple trees. *Aspects of Applied Biology*, 48:217-224.

Cross J. V., Walklate P. J., Muray R. A. and Richardson G. M. 2001a. Spray deposits and losses in different sized apple trees from an axial fan orchard sprayer: 1. Effects of spray liquid flow rate, *Crop Protection* 20, 13-30.

Cross J. V., Walklate P. J., Muray R. A. and Richardson G. M. 2001b. Spray deposits and losses in different sized apple trees from an axial fan orchard sprayer: 2. Effects of spray quality, *Crop Protection* 20, 333-343.

Cross J.V., Walklate P.J., Murray R.A. and Richardson G. 2003. Spray deposits and losses in different sized apple trees from an axial fan orchard sprayer: 3. Effects of air volumetric flow rate. *Crop protection*, Vol. 22, Issue 2, March 2003, 381-394.

De Moor A., Langenakens J., Vereecke E. and Jaeken P. 2000a. Measurements of the air pattern and the vertical spray distribution as tools for the adjustment of orchard sprayers. *8th International Conference on Liquid Atomization and Spray Systems*, Pasadena, CA, USA, July 2000.

De Moor A., Langenakens J., Vereecke E., Jaeken P., Lootens P. and Vandecasteele P. 2000b. Image analysis of water sensitive paper as a tool for the evaluation of spray distribution of orchard sprayers. *Aspects of Applied Biology*, 57:329-341.

De Moor A., Vergauwe G. and Langenakens J. 2002. Evaluation of chemical analysis of minerals for the assessment of spray deposits. *Aspects of Applied Biology*, 66:409-420.

Derksen R.C. and Gray R.L. 1995. Deposition and air speed patterns of air-carrier apple orchard sprayers. *Transactions of the ASAE* 38(1): 5-11.

Derksen R.C. and Jiang C. 1995. Automated detection of fluoroscent spray deposits with a computer vision system. Transactions of the ASAE 38(6): 1647-1653.

Directive of limited, warning and critical values of dangerous substances in the soils of Slovenia. 1996. Official Gazette of the Republic of Slovenia, No. 68/1996, 29.November 1996

Doruchowski G. and Holownicki R. 2000. Environmentally friendly spray techniques for tree crops. *Crop Protection* 19, 617-622.

Doruchowski G., Labanowska B., Goszczynski W., Godyn A. and Holownicki R. 2002. Spray deposit, spray loss and biological efficacy of chemicals applied with different spraying techniques in black currants. *Electronic journal of Polish Agricultural Universities, Agricultural Engineering,* Volume 5, Issue 2

Ellis M. A. 1994. Extension fact sheet. Downy mildew of grape. The Ohio State University Extension. Plant pathology, HYG-3013-94

European and Mediterranean Plant Protection Organization (EPPO).1999. Guideline for the efficacy evaluation of plant protection products. Design and analysis of efficacy evaluation trials. PP 1/152(2). *Bulletin OEPP/EPPO* 29: 297-317.

European and Mediterranean Plant Protection Organization (EPPO). 2001. Guideline for the efficacy evaluation of plant protection products. *Plasmopara viticola.* PP 1/31(3). *Bulletin OEPP/EPPO* 31: 313 -317.

European and Mediterranean Plant Protection Organization (EPPO). 2002. Good plant protection practice. Grapevine. PP 2/23(1). *Bulletin OEPP/EPPO* 32:371-392.

Farooq M., Salyani M. and Whitney J.D. 2002. Improving efficacy of abscission sprays for mechanical harvesting of oranges. *Proc. Fla. State Hort. Soc.* 115:247-252.2002.

Farooq M., Salyani M. and Whitney J.D. 2003. Effect of application techniques on abscission chemical deposition and mechanical harvesting of 'Valencia' oranges, *Horttechnology*, April-June 2003 13(2):344-351.

Fox R.D., Reichard D.L., Brazee R.D., Krause C.R. and Hall F.R. 1993. Downwind residues from spraying a semi-dwarf apple orchard. *Transactions of the ASAE* 36(5): 1271-1278.

Furness G.O. and Newton M.R. 1988. A leaf surface scanning technique using a fluorescence spectrophotometer for the measurement of spray deposits. *Pesticide Science* 24:123-137.

Furness G.O., Magarey P.A., Miller P.H. and Drew H.J. 1998. Fruit tree and vine sprayer calibration based on canopy size and length of row: unit canopy row method. *Crop protection*, Vol. 17, Issue 8, 639-644.

Ganzelmeier H. and Rautmann D. 2000. Drift, drift reducing sprayers and sprayer testing. *Aspects of Applied Biology* 57:1-10.

Gil E. 2002. Crop adapted spraying in vineyard. Leaf area distribution (crop profile) and uniformity of deposition (CV) as a tools to evaluate the quality of applications, *AgEng Budapest*, Paper Number: 02-PM-014

Giles D.K., Delwwiche M.J. and Dodd R.B. 1989. Spatial distribution of spray deposition from an air-carrier sprayer. *Transactions of the ASAE* 32(3): 807-811.

Graedel T.E., Bertram M., Fuse K., Gordon R.B., Lifset R., Rechberger H., Spatari S. 2002. The contemporary European copper cycle: The characterization of tehnological copper cycles. *Ecological Economics* 42:9-26.

Helrich K. 1990. Official Methods of Analysis of the Association of official Analytical Chemists. 15th edition, Published by the Association of official Analytical Chemists, Virginia, USA.

Herrington P.J., Mapother H.R. and Stringer A. 1981. Spray retention and distribution in apple trees. *Pesticide Science* 12:515-520.

Hill B.D. and Inaba D.J. 1989. Use of water-sensitive paper to monitor the deposition of aerially applied insecticides. *J. Econ. Entomol.* 82(3): 974-980.

Hoffmann W.C. and M. Salyani. 1994. Spray deposition from day and night applications, *ASAE Paper No. 94-1026*. St Joseph, Michigan.

Hoffmann W.C. and M. Salyani. 1996. Spray deposition on citrus canopies under different meteorological conditions. *American Society of Agricultural Engineers*, vol. 39(1):17-22.

Holownicki R., Doruchowski G. and Godyn A. 1996. Efficient spray deposition in the orchard using a tunnel sprayer with a new concept of air jet emission. *IOBC/WPRS Bulletin*, Vol. 19(4), 284-288.

Holownicki R., Doruchowski G., Godyn A. and Swiechowski W. 2000. Variation of Spray Deposit and Loss with Air-jet Directions applied in Orchards, *J. agric. Engng Res.* 77(2):129-136.

Holownicki R., Doruchowski G., Swiechowski W. and Jaeken P. 2002. Methods of evaluation of spray deposit and coverage on artificial targets. *Electronic journal of Polish Agricultural Universities, Agricultural Engineering*, Volume 5, Issue 1

Howard K.D., Mulrooney J.E. and Gaultney L.D. 1994. Penetration and deposition of air-assisted sprayers. *ASAE Paper No. 94-1024*. St. Joseph, Michigan.

Huijsmans J. F. M., Porskamp H. A. J. and Heijne B. 1993. Orchard tunnel sprayers with reduced emission to the environment. *Proc. of Second International Symposium on Pesticide Application Techniques*, Strasbourg, 297-304.

http://www.webelements.com/webelements/elements/text/Cu/hist.html, 31.01.2007.

Jaeken P., Vandermersch M., De Moor A. and Landenakens J. 2001. Vertical spray distribution and influence on foliar nutrient distribution in fruit trees. *Parasitica*, 57(1-2-3):99-113.

Jiang C. and Derksen C. R. 1995. Morphological image processing for spray deposit analysis. *Transactions of the ASAE* 38(5), 1581-1591.

Joseph G. 1999. Copper: Its Trade, Manufacture, Use, and Environmental Status. ASTM International. 451 p.

Kač M. 1987. Depozit bakrenega hidroksida na hmeljnih listih pri pršenju z normalno in 3 krat zmanjšano količino vode merjen s poljskim fluorofotometrom PFM-2. *VI. Jugoslovanski simpozij za hmeljarstvo*, 221-232.

Kač M. 1993. Comparison of various methods for determination of the deposit of pesticides on leaves of the treated plants. *Zbornik biotehniške fakultete Univerze v Ljubljani*, 61, 199-204.

Koo Y.M. Salyani M. and Whitney J.D. 1999. Effects of abscission chemical spray deposition on mechanical harvest efficacy of Hamlin oranges. *Proc. Fla. State Hort. Soc.* 112: 28-33.

Landers A. and Farooq M. 2004. Reducing drift and improving deposition in vineyards. In Proc. International meeting on spray drift. Kona, Hawaii, 26-29th October. Pullman: Washington State University 385-391.

Large E.C., Beer W.J. and Petterson J.B.E. 1946. Field trials of copper fungicides for the control of potato blight. II. Spray retention. *Annals of Applied Biology* 33:54-63.

Luttrell R.G. 1985. Efficacy of insecticides applied ultra-low volume in vegetable oils. Pesticide Formulations and Application systems 4, 67-77. ASTM STP 875. West Conshohocken, Pa.: American Society for Testing and Materials.

Manktelow D. W. and Praat J-P. 2000. Spray deposit variability in New Zealand wingrape canopies and implications for agrichemical application practices. *New Zealand Plant Protection*, 53:235-240.

Maček J., Cencelj J. and Dorer M. 1976a. Kontaminacija zemlje vinogradov ter grozdja z rezidui bakra, DDT, HCH, lindana, captana + folpeta ter difolatana v Sloveniji. *Zbornik biotehniške fakultete Univerze v Ljubljani*, 28:73-84.

Maček J., Cencelj J. and Dorer M. 1976b. Kontaminacija zemlje iz hmeljišč ter storžkov hmelja z rezidui bakra, DDT, HCH, lindana, captana + folpeta ter difolatana v Sloveniji. *Zbornik biotehniške fakultete Univerze v Ljubljani*, 28:61-72.

Matis G. 2002. Poročilo o preizkušanju fungicidov proti peronospori vinske trte (Plasmopara viticola) v letu 2002. Kmetijsko gozdarska zbornica Slovenije, Kmetijsko gozdarski zavod Maribor, Svetovalna služba za varstvo rastlin.

Murray R.A., Cross J.V. and Ridout M.S. 2000. The measurement of multiple spray deposits by sequential application of metal chelate traces. *Ann. App. Biol*. 137 (3):245-252.

Ozkan H. E. 2000. Reducing spray drift. *Bulletin* 816-00.

Pavlovič M. 1988. Vsebnost bakra v vinogradnih tleh, vnesenega s sredstvi za varstvo rastlin, na območju ožjega vinorodnega okoliša Bizeljsko. Diplomsko delo, Ljubljana, Univerza Edvarda Kardelja v Ljubljani, VDO Biotehniška fakulteta, VTOZD za agronomijo. 51 p.

Pergher G. and Gubiani R. 1995. The Effect of Spray Application Rate and Airflow Rate on Foliar Deposition in a Hergerow Vineyard. *J. agric. Engng. Res*, 61:205-216.

Pergher G. and Gubiani R. 1997. A comparison of methods for assessing vertical spray distributions from air-assisted sprayers. *Bulletin OEPP/EPPO* 27: 227-234.

Pergher G., Gubiani R. and Tonetto G. 1997. Foliar deposition and pesticide losses from three air-assisted sprayers in a hedgerow vineyard. *Crop Protection*, Vol.16, No. 1, 25-33.

Pergher G. 2001. Recovery rate of tracer dyes used for spray deposit assessment. *Transactions of the ASAE* 44(4):787-794.

Pergher G. 2004. Field evaluation of a calibration method for air-assisted sprayers involving the use of a vertical patternator. *Crop Protection*, 23, 437-446.

Pezzi F. and Rondelli V. 2000. The Performance of an Air-assisted Sprayer operating in Vines, *J. agric. Engng. Res.*, 76:331-340.

Phytosanitary administration of the Republic of Slovenia. 2007. Wholesale of copper used as fungicides. (personal communication, February 2007).

Picot J.J.C., Kristmanson D.D., Mickle R.E., Dickson R.B.B., Riley C.M. and Wiesner C.J. 1993. Measurements of folial and ground deposits in forestry aerial spraying. *Transactions of the ASAE* 36(4):1013-1024.

Planas S., Solanelles F., Fillat A. and Pifarre C. 1996. A proposal of metodology for air assisted sprayer assessment in apple orchard. *AgEng96*, Madrid, Spain. Paper No. 96A-149, 305-306.

Planas S., Solanelles F. and Fillat A. 2002. Assessment of Recycling Tunnel Sprayers in Mediterranean Vineyards and Apple Orchards, *Biosystem Engineering*, 82 (1): 45-52.

Plant Protection Products Directive (91/414/EEC) of 15 July 1991 concerning the placing of plant protection products on the market. Official Journal of the European Communities no. L230, ISSN 0378 6978

Praat J-P., Manktelow D., Suckling D. M. and Maber J. 1996. Can application technology help to manage pesticide resistance?, *Proc. 49th N.Z. Plant Protection Conf.*:177-182.

Priročnik o fitofarmacevtskih sredstvih v Republiki Sloveniji. 2002. Ljubljana. Društvo za varstvo rastlin Slovenije. MKGP Uprava za varstvo rastlin in semenarstvo. 2002. 814 p.

Raisigl U. and Felber H. 1991. Comparison of different mistblowers and volume rates for orchard spraying, BCPC Mono. No. 46 Air-assisted spraying in crop protection

Rautmann D., Streloke M. and Winkler R. 2001. New basic drift values in the authorization. procedure for plant protection products. In: Forster, R.; Streloke, M. (eds): Workshop on risk assessment and risk mitigation measures in the context of authorization of plant protection (WORMM): 27. -29. September 1999, Mitteilg. BBA Heft 383, S. 133 – 141, Berlin 2001

Richardson H.W. 1997. Handbook of Copper Compounds and Applications. 432 p. Marcel Dekker, New York

Richardson G.M., Walklate P.J., Cross J.V. and Murray R.A. 2000. Field Performance measurements of axial fan orchard sprayers. *Aspects of Appl. Biol*. 57, 321-327.

Rusjan D. 2004. Vpliv bakrovih spojin na izbrane fiziološke in biokemijske procese pri. vinski trti (Vitis vinifera L.). Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za agronomijo, 83 p.

Rusjan D., Strlič M., Pucko D., Šelih V.S. and Korošec-Koruza Z. 2006. Vineyard soil characteristics related to content of transition metals in a sub-Mediterranean winegrowing region of Slovenia. *Geoderma* 136, 930-936.

Salyani M. and Whitney J. D. 1988. Evaluation of methodologies for field studies of spray deposition. *Transactions of the ASAE* 31(2), 390-395.

Salyani M., McCoy C.W. and Hedden S.L. 1988. Spray volume effects on depositoin and citrus rust mite control. ASTM STP 980: *Pesticide Formulations and Application Systems 8*: 254-263. West Conshohocken, PA.: American Society for Testing and Materials.

Salyani M. and McCoy C.W. 1989. Deposition of different spray volumes on citrus trees. *Proc. Fla. State Hort. Soc.* 102:32-36.

Salyani M., BenSalem E. and Whitney J.D. 1990. Spray deposition and abscission efficacy of CMN-pyrazole in mechanical harvesting of Valencia orange. *Transactions of the ASAE* 45(2): 265-271.

Salyani M. and Whitney J.D. 1990. Ground speed effect on spray deposition inside citrus trees. *Transactions of the ASAE* 33(2): 361-366.

Salyani M. 1993. Degradation of fluorescent tracer dyes used in spray applications. ASTM STP 1183. *Pesticide Formulations and Application systems* 13, 215-226.

Salyani M. and Fox R. D. 1994. Performance of image analysis for assessment of simulated spray droplet distribution. *Transactions of the ASAE* 37(4): 1083-1089.

Salyani M. and Hoffmann W.C. 1996. Air and spray distribution from an air-carrier sprayer. *Applied Engineering in Agriculture* 12(5): 539-545.

Salyani M. 1999. A technique for stabilizing droplet spots on oil-sensitive paper. Transactions of the ASAE 42(1): 45-48.

Salyani M. and Fox R.D. 1999. Evaluation of spray quality by oil- and water-sensitive papers. *Transactions of the ASAE* 42 (1):37-43.

Salyani M. 2000a. Methodologies for assessment of spray deposit in orchard applications. ASAE Meeting Presentation, Milwaukee, Wisconsin, USA, July 9-12, 2000, Paper No. 00-1031.

Salyani M. 2000b. Optimization of deposition efficiency for airblast sprayers. Transactions of the ASAE 43 (2):247-253.

Salyani M. 2003. Droplet size affects durability of spray deposits. *Pesticide Formulations and Applications Systems*, 221-233. American Society for Testing and Materials: ASTM, Philadelphia, Pa.

Salyani M. and Farooq M. 2003. Sprayer air energy demand for satisfactory spray coverage in citrus applications. *Proc. Fla. State Hort. Soc.* 116:298-304.

SAS/STAT Software. Version 8.01. 1999. Cary, SAS Institute Inc:software.

Sharp R. B. 1955. The determination of spray deposit using fluorescent tracers. NIAE Techn. Memo. 119, 3-7.

Szewczyk A., Banasiak J., and Stawirej J. 1999. Level and uniformity of working liquid distribution at spray strip grown apple trees. Problemy, Inzynierii, Rolniczej, 7/3 (25):13-19.

Stritar A. and Pavlovič M. 1988. Vsebnost bakra v vinogradnih tleh vnesenega s fungicidi na območju ožjega vinorodnega okoliša Bizeljsko. *Zbornik Bioteh. fak. Univ. Edvarda Kardelja Ljubl., Kmet.*, 1988. 51: 143-152.

Štucin F. 2005. Meteorological conditions. Environmental Agency of the Republic of Slovenia (personal communication, April 2005).

Tehnološka navodila za integrirano pridelavo grozdja. 2004-2007. Ministrstvo za kmetijstvo, gozdarstvo in prehrano.

Tepej F. 2002. Meteorological conditions. Slovenske Konjice (personal communication, December 2002).

Val L., de Miquel E., Palacios P., Segura A., Pellicer J. and Juste F. 1993. The use of air-assisted equipment spraying citrus orchards in the Valencia region. *In Proc. 4th Int. Symp. On Fruit, Nut, & Vegetable Production Engng.* 1:187-194.

Val L., Rocamora M. C., Pérez M. and de Miquel E. 1996. Optimisation of the air assisted spraying on horticultural crops. *International Conference on Agricultural Engineering AgEng 96*-Madrid, paper 96A-142, 291-292.

Vandermersch M., Jaeken P., De Moor A. and Langenakens J. 2001. Influence of application technique on deposition and distribution of crop protection products (CPP) in black berry. *Parasitica*, 57(1-2-3):186-193.

Vannucci D., Pompi V., Leandri A. and Forchielli L. 2000. Ground losses and residues on grapes subsequent to phytoiathric treatments in a vineyard. Effects of formulations and of application methods. ATTI, Giornate, Fitopatologiche, Perugia, 16-20 aprile 2000, volume primo, 171-176.

Vršič S. and Lešnik M. 2001. Vinogradništvo. Založba Kmečki glas, Ljubljana, 240-248.

Walklate P. J., Cross J. V., Richardson G. M., Murray R. A. and Baker D. E. 2002. Comparison of Different Spray Volume Deposition Models Using LIDAR Measurements of Apple Orchards. *Biosystems Engineering* , 82(3):253-267.

Whitney R. W. and Roth L.O. 1985. String collectors for spray pattern analysis. *Transactions of the ASAE* 28(6):1749-1753.

Whitney J.D., Salyani M., Churchill D.B., Knapp J.L., Whiteside J.O. and Littell R.C. 1989. A field investigation to examine the effects of sprayer type, ground speed, and volume rate on spray deposition in Florida citrus. *J. Agric. Engng. Res.* 42:275-283.

Whitney J.D. and Salyani M. 1991. Deposition characteristics of two air-carrier sprayers in citrus trees. *Transactions of the ASAE* 34(1):47-50

Williams T.R. and Morgan R.R.T. 1954. A rapid method for the determination of copper in plant material. *Chemistry and Industry* 16:461.

Žolnir M., 1993. Nekatere kvalitativne značilnosti nanosa škropiva v območju pršilnika pri pršenju hmeljišč. *Zbornik predavanj in referatov 1. slovenskega posvetovanja o varstvu rastlin*, 237-248.

Part III

Appendices

APPENDICES

LIST OF APPENDICES

Appendices show figure App1 and figure App2 in full size of figure 2.1: The copper amount in soils over Slovenia in 2003(a) and 2005 (b) (see chapter 2.5.2). Under figure App2 also the legend is explained.

Appendices show table App1 where the general characteristics of the field experiment location are given (see chapter 7.1).

Appendices show table App2 which is the same table as table given in chapter 7.4 as table 7.4.

Appendices A to F show the basic data in tables AppA to AppF, while Appendix F shows basic data in tables as well as figures of spray coverage for different treatments on water sensitive papers and Appendix G shows the data as already explained in chapter 8.9.

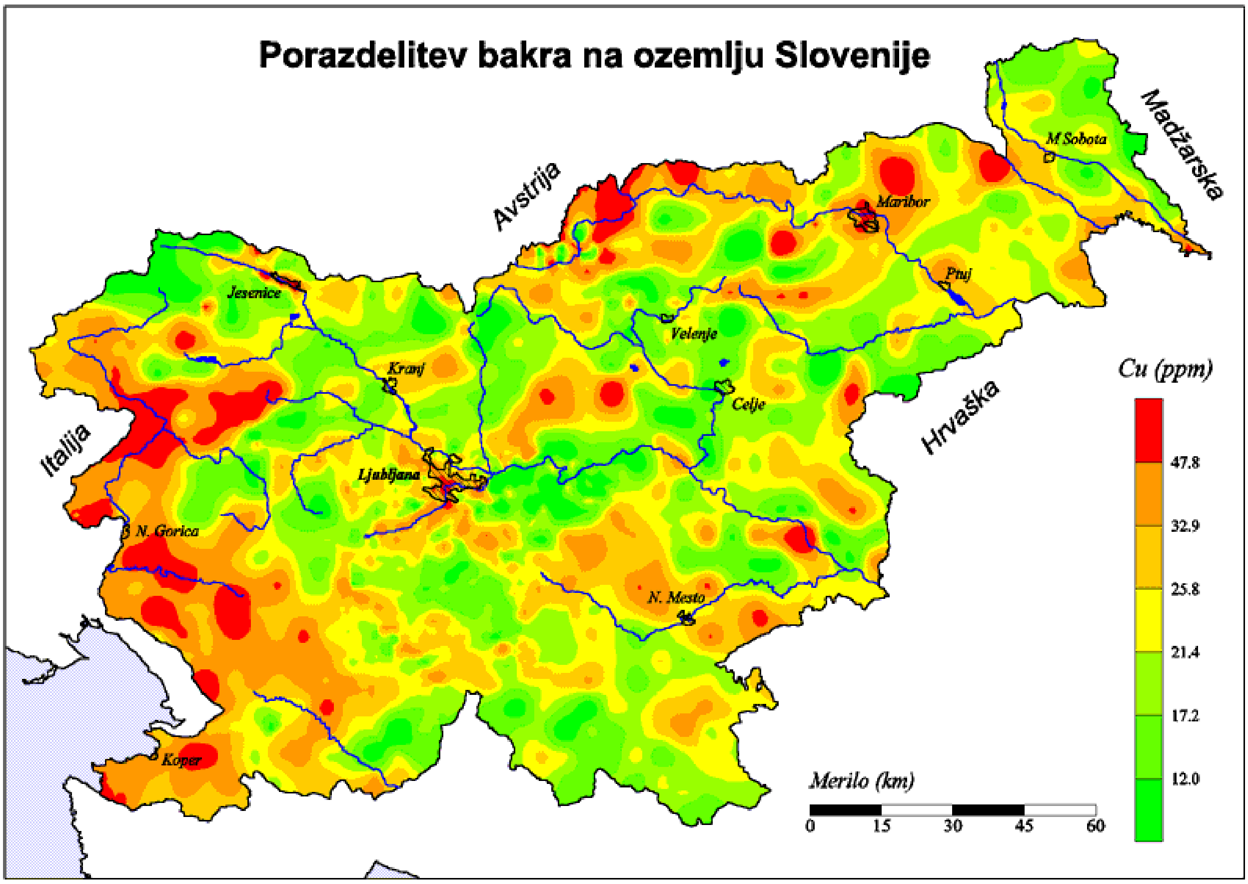


Figure App1: *The copper amount in soils over Slovenia in 2003.*

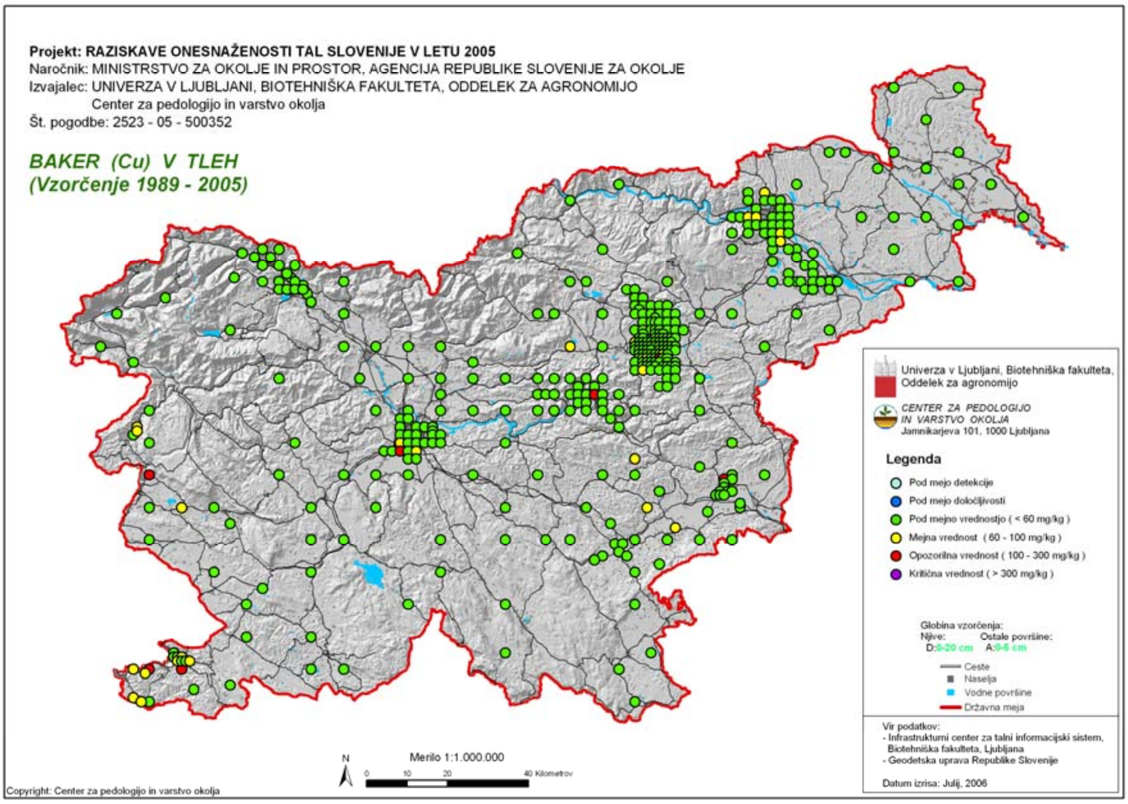


Figure App2: *The copper amount in soils over Slovenia in 2005.*

Legend different colour circles are represent as colour text of the same colour as in legend on the Figure App2):

- Below the detection limit
- Below the limit of quantification
- Below the limit value (< 60 mg kg^{-1})
- Limit value (60 - 100 mg kg^{-1})
- Warning value (100 - 300 mg kg^{-1})
- Critical value (>300 mg kg^{-1})

The table App1 is part of the chapter 7.1.

Table App1: *General characteristics of the field experiment location.*

	Vineyard Križničevo
Height above sea level (m)	340-360
Geographical position of the vineyard	SE
Coordinate - Gauss-Kruger's projection (National coordinate system)	x = 533334.3 m y = 133903.3 m
Slope (%)	25
Relief	slopping
Texture	SL, SCL
Parent rock	marl
Description of horizons	P - A_b - B_v - CB
Depth of horizons (cm)	0-45; 46-63; 64-93; >93

Legend: SE, south east; SL, silty loam ; SCL, silty clay loam; P, anthropogenic horizon; A_b, humus horizon; B_v, iluvial horizon; CB, a transition horizon from B to C horizons.

The table App2 is part of the chapter 7.4.

Table App2: *Treatments, treatment code, fungicides tested in the study, application rate (AR) of fungicides, application rate of copper ions, application rate of water per ha and concentration of fungicides used in field experiment.*

T	**TCode**	**Fungicides**	**AR of fungicides ($g\ ha^{-1}$)**	**AR of copper ions ($g\ ha^{-1}$)**	**AR of water ($L\ ha^{-1}$)**	**Concentration of fungicides (%)**
1	1CuZ	Cuprablau Z	3000	1050	400	0.75
2	2CuZU	Cuprablau Z Ultra	2500	875	400	0.63
3	3CuZU	Cuprablau Z Ultra	2500	875	1000	0.25
4	4Cha	Champion 50 WP	2500	1250	400	0.63
5	5Koc	Kocide DF	2000	800	400	0.50
6	6Cha	Champion 50 WP	2000	1000	400	0.50
7	7Koc	Kocide DF	2500	1000	400	0.63

The same table has been given as table 7.4 in chapter 7.4.

Appendix A

Infection of vine grapes

Table AppA: *Infection of vine grapes (%).*

TCode	Replication 1	2	3	4	x_{mean}
0con	54.7	73.5	44.2	53.5	56.5
1CuZ	1.1	0.8	1.8	0.5	1.1
2CuZU	0.8	2.1	1.8	0.7	1.4
3CuZU	1.3	1.8	2.1	1.8	1.8
4Cha	1.7	1.3	2.1	1.5	1.6
5Koc	0.9	1.5	1.3	1.3	1.2
6Cha	1.1	1.5	2.0	1.1	1.4
7Koc	1.2	0.9	1.4	0.9	1.1
MB	0.4	0.0	1.7	1.5	0.9

Tcode, treatment code (see table App1); x_{mean}, mean value.

The values for infection of vine grapes were calculated as shown in equation [1] and values for biological efficacy of plant protection products were calculated as shown in equation [2] in chapter 7.5.

Treatment 0con was taken from the field trial carried out in Maribor as it was already explained in chapters 7.5 and 7.9.1.

Appendix B

Infection of vine leaves

Table AppB: *Infection of vine leaves (%).*

TCode	Replication 1	2	3	4	x_{mean}
0con	78.5	78.3	80.0	80.0	79.2
1CuZ	1.1	2.5	3.2	2.0	2.2
2CuZU	1.1	2.7	4.0	3.2	2.7
3CuZU	1.2	1.9	3.9	4.5	2.9
4Cha	1.2	2.7	2.9	4.4	2.8
5Koc	1.2	2.6	4.3	5.2	3.3
6Cha	1.3	2.8	3.7	2.4	2.6
7Koc	1.6	3.7	3.8	2.7	2.9
MB	0.0	0.0	0.0	0.0	0.0

Tcode, treatment code (see table App1); x_{mean}, mean value.

The values for infection of vine leaves were calculated as shown in equation [1] and values for biological efficacy of plant protection products were calculated as shown in equation [2] in chapter 7.5, see also chapter 7.6.

Treatment 0con was taken from the field trial carried out in Maribor as it was already explained in chapters 7.6 and 7.9.1.

Appendix C

Copper ion deposit in vine grapes

Table AppC: *The weight of vine grapes and amount of copper ion deposit in vine grapes in mg L^{-1} (L of solution measured) and µg g^{-1} (g of grapes).*

TCode	Replication	Weight (g)	Cu (mg L^{-1})	Cu (µg g^{-1})
1CuZ	1	374.98	3.2	2.13
1CuZ	2	233.07	0.3	0.32
1CuZ	3	316.69	0.3	0.24
1CuZ	4	349.94	4.3	3.07
2CuZU	1	362.36	0.2	0.14
2CuZU	2	419.78	1.2	0.72
2CuZU	3	193.50	1.9	2.46
2CuZU	4	193.84	0.5	0.65
3CuZU	1	385.64	0.3	0.20
3CuZU	2	373.08	3.8	2.55
3CuZU	3	163.53	1.2	1.84
3CuZU	4	223.32	1.8	2.02
4Cha	1	241.51	2.4	2.49
4Cha	2	239.54	0.3	0.31
4Cha	3	216.56	1.2	1.39
4Cha	4	252.34	0.8	0.79
5Koc	1	185.44	1.3	1.75
5Koc	2	233.77	0.7	0.75
5Koc	3	405.57	1.9	1.17
5Koc	4	225.40	1.3	1.44
6Cha	1	366.60	1.6	1.09
6Cha	2	220.79	2.7	3.06
6Cha	3	199.86	0.5	0.63
6Cha	4	259.09	0.2	0.19
7Koc	1	242.60	1.4	1.44
7Koc	2	211.98	0.5	0.59
7Koc	3	229.98	0.8	0.87
7Koc	4	198.31	0.6	0.76

Tcode, treatment code (see table App1).

The values for copper ion deposit in vine grapes were calculated as shown in equation [4] in chapter 7.8.1.2.

Appendix D

Copper ion deposit on vine leaves

Table AppD: *Copper ion deposit on vine leaves.*

Legend:
T - treatment code (see table App1)

R - replication

A - application date (1 – 20 July, 2 – 30 July, 3 – 9 August, 4 – 19 August)

mg Cu L^{-1}_BeforeA - copper ion deposit on vine leaves in mg L^{-1} before application (L of solution measured)

mg Cu L^{-1}_AfterA - copper ion deposit on vine leaves in mg L^{-1} after application (L of solution measured)

LA (cm^2) – leaf area of 60 vine leaves

µg Cu cm^{-2}_BeforeA - copper ion deposit on vine leaves in µg cm^{-2} before application (cm^2 of vine leaf)

µg Cu cm^{-2}_AfterA - copper ion deposit on vine leaves in µg cm^{-2} after application (cm^2 of vine leaf)

Cu_1kgci_BeforeA - copper ion deposit on vine leaves normalized to the same application rate of copper ions in µg cm^{-2} before application (cm^2 of vine leaf)

Cu_1kgci_AfterA - copper ion deposit on vine leaves normalized to the same application rate of copper ions in µg cm^{-2} after application (cm^2 of vine leaf)

The values for copper ion deposit on vine leaves were calculated as shown by equation [3] in chapter 7.8.1.1.

T	R	A	mg Cu L^{-1} BeforeA	mg Cu L^{-1} AfterA	LA (cm^2)	µg Cu cm^{-2} BeforeA	µg Cu cm^{-2} AfterA	Cu_1kgci BeforeA	Cu_1kgci AfterA
1	1	1	18	79	7302.60	2.46	10.82	2.46	10.30
1	2	1	16	84	7560.00	2.12	11.11	2.12	10.58
1	3	1	20	70	7735.20	2.59	9.05	2.59	8.62
1	4	1	37	80	8079.60	4.58	9.90	4.58	9.43
2	1	1	13	72	6514.80	2.00	11.05	2.00	12.63
2	2	1	15	62	6757.20	2.22	9.18	2.22	10.49
2	3	1	19	67	9122.00	2.08	7.34	2.08	8.39
2	4	1	28	80	8980.77	3.12	8.91	3.12	10.18
3	1	1	17	61	8475.20	2.01	7.20	2.01	8.23
3	2	1	14	53	7924.80	1.77	6.69	1.77	7.65
3	3	1	17	54	8144.40	2.09	6.63	2.09	7.58
3	4	1	27	54	9041.60	2.99	5.97	2.99	6.82
4	1	1	18	89	7710.80	2.33	11.54	2.33	9.23
4	2	1	21	90	7874.00	2.67	11.43	2.67	9.14
4	3	1	16	70	7656.40	2.09	9.14	2.09	7.31
4	4	1	23	72	7951.60	2.89	9.05	2.89	7.24
5	1	1	19	41	9466.00	2.01	4.33	2.01	5.41
5	2	1	15	33	7140.00	2.10	4.62	2.10	5.78
5	3	1	17	38	8014.80	2.12	4.74	2.12	5.93
5	4	1	26	43	9076.00	2.86	4.74	2.86	5.93
6	1	1	14	47	6852.00	2.04	6.86	2.04	6.86
6	2	1	23	54	8822.40	2.61	6.12	2.61	6.12
6	3	1	19	47	7360.40	2.58	6.39	2.58	6.39
6	4	1	18	46	8446.80	2.13	5.45	2.13	5.45
7	1	1	14	61	8527.60	1.64	7.15	1.64	7.15
7	2	1	16	60	8748.00	1.83	6.86	1.83	6.86
7	3	1	13	52	7268.00	1.79	7.15	1.79	7.15
7	4	1	14	31	7836.80	1.78	3.96	1.78	3.96
1	1	2	39	106	11852.80	3.29	8.94	3.13	8.51
1	2	2	50	108	10889.58	4.59	9.92	4.37	9.45
1	3	2	42	86	10374.40	4.05	8.29	3.86	7.90
1	4	2	57	84	8965.60	6.36	9.37	6.06	8.92
2	1	2	49	117	10938.40	4.48	10.70	5.12	12.23
2	2	2	39	83	11982.00	3.25	6.93	3.71	7.92
2	3	2	44	81	10727.20	4.10	7.55	4.69	8.63
2	4	2	57	99	10164.80	5.61	9.74	6.41	11.13
3	1	2	29	52	11900.80	2.44	4.37	2.79	4.99
3	2	2	30	53	12851.20	2.33	4.12	2.66	4.71
3	3	2	37	50	11247.20	3.29	4.45	3.76	5.09
3	4	2	40	63	11365.60	3.52	5.54	4.02	6.33
4	1	2	53	103	12944.00	4.09	7.96	3.27	6.37
4	2	2	56	113	13626.60	4.11	8.29	3.29	6.63
4	3	2	34	86	12959.60	2.62	6.64	2.10	5.31
4	4	2	40	85	12205.20	3.28	6.96	2.62	5.57
5	1	2	21	61	8977.20	2.34	6.79	2.93	8.49
5	2	2	22	53	8804.00	2.50	6.02	3.13	7.53
5	3	2	18	49	9142.80	1.97	5.36	2.46	6.70
5	4	2	21	65	9745.20	2.15	6.67	2.69	8.34
6	1	2	23	67	8872.80	2.59	7.55	2.59	7.55
6	2	2	24	86	9215.60	2.60	9.33	2.60	9.33
6	3	2	22	66	9580.80	2.30	6.89	2.30	6.89
6	4	2	21	74	9673.60	2.17	7.65	2.17	7.65
7	1	2	31	95	8068.40	3.84	11.77	3.84	11.77
7	2	2	28	83	8757.20	3.20	9.48	3.20	9.48
7	3	2	30	78	7992.00	3.75	9.76	3.75	9.76
7	4	2	20	71	8085.60	2.47	8.78	2.47	8.78

T	R	A	mg Cu L^{-1} BeforeA	mg Cu L^{-1} AfterA	LA (cm^2)	µg Cu cm^{-2} BeforeA	µg Cu cm^{-2} AfterA	Cu_1kgci BeforeA	Cu_1kgci AfterA
1	1	3	47	114	9663.40	4.86	11.80	4.63	11.24
1	2	3	61	122	10321.20	5.91	11.82	5.63	11.26
1	3	3	59	103	13094.80	4.51	7.87	4.30	7.50
1	4	3	50	93	12606.80	3.97	7.38	3.78	7.03
2	1	3	45	101	10163.60	4.43	9.94	5.06	11.36
2	2	3	38	73	10286.00	3.69	7.10	4.22	8.11
2	3	3	60	92	12828.40	4.68	7.17	5.35	8.19
2	4	3	60	79	11844.40	5.07	6.67	5.79	7.62
3	1	3	33	93	9576.40	3.45	9.71	3.94	11.10
3	2	3	36	81	10160.40	3.54	7.97	4.05	9.11
3	3	3	50	81	12068.00	4.14	6.71	4.73	7.67
3	4	3	43	71	10880.00	3.95	6.53	4.51	7.46
4	1	3	47	116	9632.80	4.88	12.04	3.90	9.63
4	2	3	65	95	9740.39	6.67	9.75	5.34	7.80
4	3	3	47	98	13445.60	3.50	7.29	2.80	5.83
4	4	3	49	77	10381.20	4.72	7.42	3.78	5.94
5	1	3	29	73	10036.00	2.89	7.27	3.61	9.09
5	2	3	33	65	9476.80	3.48	6.86	4.35	8.58
5	3	3	36	79	13091.20	2.75	6.03	3.44	7.54
5	4	3	45	69	12628.40	3.56	5.46	4.45	6.83
6	1	3	26	83	8791.60	2.96	9.44	2.96	9.44
6	2	3	34	85	11297.20	3.01	7.52	3.01	7.52
6	3	3	27	75	13163.20	2.05	5.70	2.05	5.70
6	4	3	37	66	10918.40	3.39	6.04	3.39	6.04
7	1	3	37	116	10066.40	3.68	11.52	3.68	11.52
7	2	3	58	115	11318.00	5.12	10.16	5.12	10.16
7	3	3	56	108	12700.80	4.41	8.50	4.41	8.50
7	4	3	39	59	12351.60	3.16	4.78	3.16	4.78
1	1	4	61	115	11538.00	5.29	9.97	5.04	9.50
1	2	4	72	156	12166.89	5.92	12.82	5.64	12.21
1	3	4	63	108	10821.60	5.82	9.98	5.54	9.50
1	4	4	79	104	6882.91	11.48	15.11	10.93	14.39
2	1	4	59	99	9506.80	6.21	10.41	7.10	11.90
2	2	4	54	103	11302.80	4.78	9.11	5.46	10.41
2	3	4	56	88	12005.83	4.66	7.33	5.33	8.38
2	4	4	50	82	8908.40	5.61	9.20	6.41	10.51
3	1	4	43	97	9830.40	4.37	9.87	4.99	11.28
3	2	4	45	92	12416.80	3.62	7.41	4.14	8.47
3	3	4	51	87	10268.80	4.97	8.47	5.68	9.68
3	4	4	49	82	9336.55	5.25	8.78	6.00	10.03
4	1	4	48	108	10719.60	4.48	10.08	3.58	8.06
4	2	4	62	134	12526.00	4.95	10.70	3.96	8.56
4	3	4	54	88	11330.80	4.77	7.77	3.82	6.22
4	4	4	54	86	11122.80	4.85	7.73	3.88	6.18
5	1	4	45	71	10470.80	4.30	6.78	5.38	8.48
5	2	4	38	76	11295.60	3.36	6.73	4.20	8.41
5	3	4	43	61	11339.60	3.79	5.38	4.74	6.73
5	4	4	46	60	9985.60	4.61	6.01	5.76	7.51
6	1	4	51	85	10514.90	4.85	8.08	4.85	8.08
6	2	4	47	114	12661.60	3.71	9.00	3.71	9.00
6	3	4	41	70	11105.54	3.69	6.30	3.69	6.30
6	4	4	41	69	12000.96	3.42	5.75	3.42	5.75
7	1	4	44	91	9805.43	4.49	9.28	4.49	9.28
7	2	4	54	114	11795.60	4.58	9.66	4.58	9.66
7	3	4	78	91	12060.41	6.47	7.55	6.47	7.55
7	4	4	43	77	9377.60	4.59	8.21	4.59	8.21

Appendix E

Copper ion deposit on filter papers

Table AppE: *Copper ion deposit on filter papers.*

Legend:
T - treatment code (see table App1)

R - replication

A - application date (1 – 20 July, 2 – 30 July, 3 – 9 August, 4 – 19 August)

Wire - 2nd wire, 4th wire

L_side - leaf-side (lower, upper)

W_FP - weight of filter papers

No. FP - number of filter papers

Area - area of collectors used in extraction

Cu L^{-1} - copper ion deposit on filter papers in miligrams per liter (L of solution measured)

Cu_0.05 - copper ion deposit on filter papers in miligrams per filter paper

Cu_mg cm^{-2} - copper ion deposit on filter papers in mg cm^{-2} (cm^2 of filter paper)

µg Cu cm^{-2} - copper ion deposit on filter papers in µg cm^{-2} (cm^2 of filter paper)

µg Cu cm^{-2}_1kgci - copper ion deposit on filter papers normalized to the same application rate of copper ions in µg cm^{-2} (cm^2 of filter paper)

The values for copper ion deposit on filter papers were calculated as shown by equation [3] in chapter 7.8.1.1.

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
1	1	1	2	lower	0.71	5	97.5	2.1	0.105	0.001076923	1.08	1.03
1	2	1	2	lower	0.73	5	97.5	1.6	0.08	0.000820513	0.82	0.78
1	3	1	2	lower	0.755	5	97.5	1.4	0.07	0.000717949	0.72	0.68
1	4	1	2	lower	0.718	5	97.5	1.5	0.075	0.000769231	0.77	0.73
2	1	1	2	lower	0.591	4	78	1.2	0.06	0.000769231	0.77	0.88
2	2	1	2	lower	0.767	5	97.5	1	0.05	0.000512821	0.51	0.59
2	3	1	2	lower	0.733	5	97.5	1.8	0.09	0.000923077	0.92	1.05
2	4	1	2	lower	0.894	6	117	1.4	0.07	0.000598291	0.60	0.68
3	1	1	2	lower	0.881	6	117	2	0.1	0.000854701	0.85	0.98
3	2	1	2	lower	0.909	6	117	3.4	0.17	0.001452991	1.45	1.66
3	3	1	2	lower	0.89	6	117	2	0.1	0.000854701	0.85	0.98
3	4	1	2	lower	0.88	6	117	2.2	0.11	0.000940171	0.94	1.07
4	1	1	2	lower	0.718	5	97.5	2.1	0.105	0.001076923	1.08	0.86
4	2	1	2	lower	0.885	6	117	1.4	0.07	0.000598291	0.6	0.48
4	3	1	2	lower	0.885	6	117	2.9	0.145	0.001239316	1.24	0.99
4	4	1	2	lower	0.883	6	117	3.2	0.16	0.001367521	1.37	1.09
5	1	1	2	lower	0.719	5	97.5	2.5	0.125	0.001282051	1.28	1.60
5	2	1	2	lower	0.9	6	117	0.9	0.045	0.000384615	0.38	0.48
5	3	1	2	lower	0.885	6	117	2	0.1	0.000854701	0.85	1.07
5	4	1	2	lower	0.867	6	117	1.6	0.08	0.000683761	0.68	0.85
6	1	1	2	lower	0.844	6	117	1.6	0.08	0.000683761	0.68	0.68
6	2	1	2	lower	0.889	6	117	1	0.05	0.00042735	0.43	0.43
6	3	1	2	lower	0.873	6	117	2.1	0.105	0.000897436	0.90	0.90
6	4	1	2	lower	0.856	6	117	2.2	0.11	0.000940171	0.94	0.94
7	1	1	2	lower	0.735	5	97.5	2.2	0.11	0.001128205	1.13	1.13
7	2	1	2	lower	0.882	6	117	1.8	0.09	0.000769231	0.77	0.77
7	3	1	2	lower	0.892	6	117	2.3	0.115	0.000982906	0.98	0.98
7	4	1	2	lower	0.833	6	117	1.9	0.095	0.000811966	0.81	0.81
1	1	2	2	lower	0.915	6	117	2.9	0.145	0.001239316	1.24	1.18
1	2	2	2	lower	0.745	6	117	1.4	0.07	0.000598291	0.60	0.57
1	3	2	2	lower	0.89	6	117	3.4	0.17	0.001452991	1.45	1.38
1	4	2	2	lower	0.907	6	117	2.7	0.135	0.001153846	1.15	1.10
2	1	2	2	lower	0.927	6	117	2.6	0.13	0.001111111	1.11	1.27
2	2	2	2	lower	0.919	6	117	3.3	0.165	0.001410256	1.41	1.61
2	3	2	2	lower	0.891	6	117	1.9	0.095	0.000811966	0.81	0.93
2	4	2	2	lower	0.899	6	117	3.1	0.155	0.001324786	1.32	1.51
3	1	2	2	lower	0.885	6	117	1.7	0.085	0.000726496	0.73	0.83
3	2	2	2	lower	0.922	6	117	1.8	0.09	0.000769231	0.77	0.88
3	3	2	2	lower	0.928	6	117	2.1	0.105	0.000897436	0.9	1.03
3	4	2	2	lower	0.913	6	117	1.2	0.06	0.000512821	0.51	0.59
4	1	2	2	lower	0.91	6	117	3.2	0.16	0.001367521	1.37	1.09
4	2	2	2	lower	0.874	6	117	2.3	0.115	0.000982906	0.98	0.79
4	3	2	2	lower	0.916	6	117	1.8	0.09	0.000769231	0.77	0.62
4	4	2	2	lower	0.901	6	117	2.1	0.105	0.000897436	0.9	0.72
5	1	2	2	lower	0.931	6	117	1	0.05	0.00042735	0.43	0.53
5	2	2	2	lower	0.91	6	117	1.9	0.095	0.000811966	0.81	1.01
5	3	2	2	lower	0.917	6	117	2	0.1	0.000854701	0.85	1.06
5	4	2	2	lower	0.891	6	117	3.1	0.155	0.001324786	1.32	1.66
6	1	2	2	lower	0.925	6	117	3	0.15	0.001282051	1.28	1.28
6	2	2	2	lower	0.918	6	117	4	0.2	0.001709402	1.71	1.71
6	3	2	2	lower	0.918	6	117	2	0.1	0.000854701	0.85	0.85
6	4	2	2	lower	0.905	6	117	2.7	0.135	0.001153846	1.15	1.15

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
7	1	2	2	lower	0.896	6	117	2.1	0.105	0.000897436	0.90	0.90
7	2	2	2	lower	0.911	6	117	2.6	0.13	0.001111111	1.11	1.11
7	3	2	2	lower	0.899	6	117	3.6	0.18	0.001538462	1.54	1.54
7	4	2	2	lower	0.873	6	117	4.2	0.21	0.001794872	1.79	1.79
1	1	3	2	lower	0.902	6	117	2.2	0.11	0.000940171	0.94	0.90
1	2	3	2	lower	0.906	6	117	3.3	0.165	0.001410256	1.41	1.34
1	3	3	2	lower	0.964	6	117	1.8	0.09	0.000769231	0.77	0.73
1	4	3	2	lower	0.908	6	117	3.3	0.165	0.001410256	1.41	1.34
2	1	3	2	lower	0.899	6	117	2.1	0.105	0.000897436	0.9	1.03
2	2	3	2	lower	0.894	6	117	1.4	0.07	0.000598291	0.6	0.68
2	3	3	2	lower	0.949	6	117	1.1	0.055	0.000470085	0.47	0.54
2	4	3	2	lower	0.953	6	117	1.9	0.095	0.000811966	0.81	0.93
3	1	3	2	lower	0.898	6	117	3.9	0.195	0.001666667	1.67	1.91
3	2	3	2	lower	0.926	6	117	2.1	0.105	0.000897436	0.9	1.03
3	3	3	2	lower	0.896	6	117	2.7	0.135	0.001153846	1.15	1.32
3	4	3	2	lower	0.929	6	117	5.6	0.28	0.002393162	2.39	2.74
4	1	3	2	lower	0.743	5	97.5	4.2	0.21	0.002153846	2.15	1.72
4	2	3	2	lower	0.918	6	117	2.8	0.14	0.001196581	1.2	0.96
4	3	3	2	lower	0.886	6	117	3.4	0.17	0.001452991	1.45	1.16
4	4	3	2	lower	0.882	6	117	3	0.15	0.001282051	1.28	1.03
5	1	3	2	lower	0.905	6	117	7	0.35	0.002991453	2.99	3.74
5	2	3	2	lower	0.924	6	117	3.1	0.155	0.001324786	1.32	1.66
5	3	3	2	lower	0.847	6	117	1.7	0.085	0.000726496	0.73	0.91
5	4	3	2	lower	0.924	6	117	2	0.1	0.000854701	0.85	1.07
6	1	3	2	lower	0.903	6	117	3.4	0.17	0.001452991	1.45	1.45
6	2	3	2	lower	0.904	6	117	2.7	0.135	0.001153846	1.15	1.15
6	3	3	2	lower	0.903	6	117	1.1	0.055	0.000470085	0.47	0.47
6	4	3	2	lower	0.929	6	117	2.3	0.115	0.000982906	0.98	0.98
7	1	3	2	lower	0.929	6	117	3.6	0.18	0.001538462	1.54	1.54
7	2	3	2	lower	0.909	6	117	1.9	0.095	0.000811966	0.81	0.81
7	3	3	2	lower	0.919	6	117	2.2	0.11	0.000940171	0.94	0.94
7	4	3	2	lower	0.943	6	117	3.9	0.195	0.001666667	1.67	1.67
1	1	4	2	lower	0.933	6	117	3.9	0.195	0.001666667	1.67	1.59
1	2	4	2	lower	0.887	6	117	4.9	0.245	0.002094017	2.09	1.99
1	3	4	2	lower	0.947	6	117	6.5	0.325	0.002777778	2.78	2.65
1	4	4	2	lower	0.943	6	117	4.5	0.225	0.001923077	1.92	1.83
2	1	4	2	lower	0.9296	6	117	1.3	0.065	0.000555556	0.56	0.63
2	2	4	2	lower	0.924	6	117	2.7	0.135	0.001153846	1.15	1.32
2	3	4	2	lower	0.924	6	117	3.1	0.155	0.001324786	1.32	1.51
2	4	4	2	lower	0.967	6	117	4.1	0.205	0.001752137	1.75	2.00
3	1	4	2	lower	0.877	6	117	4.6	0.23	0.001965812	1.97	2.25
3	2	4	2	lower	0.879	6	117	4.7	0.235	0.002008547	2.01	2.30
3	3	4	2	lower	0.934	6	117	6.6	0.33	0.002820513	2.82	3.22
3	4	4	2	lower	0.923	6	117	3.8	0.19	0.001623932	1.62	1.86
4	1	4	2	lower	0.901	6	117	3.7	0.185	0.001581197	1.58	1.26
4	2	4	2	lower	0.916	6	117	3.1	0.155	0.001324786	1.32	1.06
4	3	4	2	lower	0.887	6	117	5.8	0.29	0.002478632	2.48	1.98
4	4	4	2	lower	0.901	6	117	3	0.15	0.001282051	1.28	1.03
5	1	4	2	lower	0.758	5	97.5	2.3	0.115	0.001179487	1.18	1.47
5	2	4	2	lower	0.908	6	117	3.3	0.165	0.001410256	1.41	1.76
5	3	4	2	lower	0.879	6	117	2	0.1	0.000854701	0.85	1.07
5	4	4	2	lower	0.946	6	117	2.9	0.145	0.001239316	1.24	1.55

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
6	1	4	2	lower	0.899	6	117	2.7	0.135	0.001153846	1.15	1.15
6	2	4	2	lower	0.915	6	117	3.5	0.175	0.001495726	1.5	1.50
6	3	4	2	lower	0.902	6	117	2	0.1	0.000854701	0.85	0.85
6	4	4	2	lower	0.922	6	117	4.2	0.21	0.001794872	1.79	1.79
7	1	4	2	lower	0.902	6	117	2.6	0.13	0.001111111	1.11	1.11
7	2	4	2	lower	0.907	6	117	4.1	0.205	0.001752137	1.75	1.75
7	3	4	2	lower	0.888	6	117	3.3	0.165	0.001410256	1.41	1.41
7	4	4	2	lower	0.913	6	117	3.2	0.16	0.001367521	1.37	1.37
1	1	1	2	upper	0.738	5	97.5	5.3	0.265	0.002717949	2.72	2.59
1	2	1	2	upper	0.71	5	97.5	5.2	0.26	0.002666667	2.67	2.54
1	3	1	2	upper	0.734	5	97.5	5.5	0.275	0.002820513	2.82	2.69
1	4	1	2	upper	0.731	5	97.5	5.1	0.255	0.002615385	2.62	2.49
2	1	1	2	upper	0.577	4	78	4.2	0.21	0.002692308	2.69	3.08
2	2	1	2	upper	0.755	5	97.5	5.9	0.295	0.003025641	3.03	3.46
2	3	1	2	upper	0.747	5	97.5	6.6	0.33	0.003384615	3.38	3.87
2	4	1	2	upper	0.89	6	117	4.8	0.24	0.002051282	2.05	2.34
3	1	1	2	upper	0.859	6	117	7.2	0.36	0.003076923	3.08	3.52
3	2	1	2	upper	0.875	6	117	8.7	0.435	0.003717949	3.72	4.25
3	3	1	2	upper	0.876	6	117	7.6	0.38	0.003247863	3.25	3.71
3	4	1	2	upper	0.862	6	117	8.2	0.41	0.003504274	3.50	4.00
4	1	1	2	upper	0.719	5	97.5	5.7	0.285	0.002923077	2.92	2.34
4	2	1	2	upper	0.864	6	117	9.7	0.485	0.004145299	4.15	3.32
4	3	1	2	upper	0.889	6	117	9.1	0.455	0.003888889	3.89	3.11
4	4	1	2	upper	0.88	6	117	6.4	0.32	0.002735043	2.74	2.19
5	1	1	2	upper	0.726	5	97.5	3	0.15	0.001538462	1.54	1.92
5	2	1	2	upper	0.884	6	117	3.8	0.19	0.001623932	1.62	2.03
5	3	1	2	upper	0.886	6	117	3.5	0.175	0.001495726	1.5	1.87
5	4	1	2	upper	0.853	6	117	4.3	0.215	0.001837607	1.84	2.30
6	1	1	2	upper	0.873	6	117	5.3	0.265	0.002264957	2.26	2.26
6	2	1	2	upper	0.904	6	117	5.9	0.295	0.002521368	2.52	2.52
6	3	1	2	upper	0.865	6	117	3.8	0.19	0.001623932	1.62	1.62
6	4	1	2	upper	0.842	6	117	5.9	0.295	0.002521368	2.52	2.52
7	1	1	2	upper	0.727	5	97.5	4.7	0.235	0.002410256	2.41	2.41
7	2	1	2	upper	0.875	6	117	7.3	0.365	0.003119658	3.12	3.12
7	3	1	2	upper	0.89	6	117	5.5	0.275	0.002350427	2.35	2.35
7	4	1	2	upper	0.864	6	117	4.7	0.235	0.002008547	2.01	2.01
1	1	2	2	upper	0.917	6	117	7.5	0.375	0.003205128	3.21	3.05
1	2	2	2	upper	0.778	6	117	5.1	0.255	0.002179487	2.18	2.08
1	3	2	2	upper	0.883	6	117	5	0.25	0.002136752	2.14	2.04
1	4	2	2	upper	0.891	6	117	5.3	0.265	0.002264957	2.26	2.16
2	1	2	2	upper	0.913	6	117	8.7	0.435	0.003717949	3.72	4.25
2	2	2	2	upper	0.887	6	117	4.7	0.235	0.002008547	2.01	2.30
2	3	2	2	upper	0.91	6	117	4.3	0.215	0.001837607	1.84	2.10
2	4	2	2	upper	0.921	6	117	4	0.2	0.001709402	1.71	1.95
3	1	2	2	upper	0.855	6	117	5	0.25	0.002136752	2.14	2.44
3	2	2	2	upper	918	6	117	4.8	0.24	0.002051282	2.05	2.34
3	3	2	2	upper	0.92	6	117	6.3	0.315	0.002692308	2.69	3.08
3	4	2	2	upper	0.901	6	117	6.3	0.315	0.002692308	2.69	3.08
4	1	2	2	upper	0.899	6	117	6.4	0.32	0.002735043	2.74	2.19
4	2	2	2	upper	0.905	6	117	12	0.6	0.005128205	5.13	4.10
4	3	2	2	upper	0.893	6	117	5.7	0.285	0.002435897	2.44	1.95
4	4	2	2	upper	0.92	6	117	6	0.3	0.002564103	2.56	2.05

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
5	1	2	2	upper	0.917	6	117	5	0.25	0.002136752	2.14	2.67
5	2	2	2	upper	0.926	6	117	3.8	0.19	0.001623932	1.62	2.03
5	3	2	2	upper	0.926	6	117	3.4	0.17	0.001452991	1.45	1.82
5	4	2	2	upper	0.908	6	117	4.1	0.205	0.001752137	1.75	2.19
6	1	2	2	upper	0.889	6	117	4.7	0.235	0.002008547	2.01	2.01
6	2	2	2	upper	0.922	6	117	6.5	0.325	0.002777778	2.78	2.78
6	3	2	2	upper	0.905	6	117	5	0.25	0.002136752	2.14	2.14
6	4	2	2	upper	0.904	6	117	4.9	0.245	0.002094017	2.09	2.09
7	1	2	2	upper	0.938	6	117	6.5	0.325	0.002777778	2.78	2.78
7	2	2	2	upper	0.922	6	117	6.2	0.31	0.002649573	2.65	2.65
7	3	2	2	upper	0.893	6	117	5.3	0.265	0.002264957	2.26	2.26
7	4	2	2	upper	0.87	6	117	3.1	0.155	0.001324786	1.32	1.32
1	1	3	2	upper	0.898	6	117	4.8	0.24	0.002051282	2.05	1.95
1	2	3	2	upper	0.926	6	117	5	0.25	0.002136752	2.14	2.04
1	3	3	2	upper	0.954	6	117	8	0.4	0.003418803	3.42	3.26
1	4	3	2	upper	0.908	6	117	6.1	0.305	0.002606838	2.61	2.48
2	1	3	2	upper	0.902	6	117	4.1	0.205	0.001752137	1.75	2.00
2	2	3	2	upper	0.913	6	117	6.9	0.345	0.002948718	2.95	3.37
2	3	3	2	upper	0.955	6	117	7	0.35	0.002991453	2.99	3.42
2	4	3	2	upper	0.928	6	117	5.7	0.285	0.002435897	2.44	2.78
3	1	3	2	upper	0.923	6	117	9.6	0.48	0.004102564	4.1	4.69
3	2	3	2	upper	0.927	6	117	10.3	0.515	0.004401709	4.4	5.03
3	3	3	2	upper	0.05	6	117	11.9	0.595	0.00508547	5.09	5.81
3	4	3	2	upper	0.938	6	117	10.1	0.505	0.004316239	4.32	4.93
4	1	3	2	upper	0.741	5	97.5	4.6	0.23	0.002358974	2.36	1.89
4	2	3	2	upper	0.888	6	117	5.9	0.295	0.002521368	2.52	2.02
4	3	3	2	upper	0.901	6	117	7.3	0.365	0.003119658	3.12	2.50
4	4	3	2	upper	0.886	6	117	6.8	0.34	0.002905983	2.91	2.32
5	1	3	2	upper	0.912	6	117	1.2	0.06	0.000512821	0.51	0.64
5	2	3	2	upper	0.899	6	117	4.1	0.205	0.001752137	1.75	2.19
5	3	3	2	upper	0.848	6	117	5	0.25	0.002136752	2.14	2.67
5	4	3	2	upper	0.955	6	117	6.5	0.325	0.002777778	2.78	3.47
6	1	3	2	upper	0.899	6	117	4.3	0.215	0.001837607	1.84	1.84
6	2	3	2	upper	0.919	6	117	8.9	0.445	0.003803419	3.80	3.80
6	3	3	2	upper	0.89	6	117	8.1	0.405	0.003461538	3.46	3.46
6	4	3	2	upper	0.922	6	117	6.3	0.315	0.002692308	2.69	2.69
7	1	3	2	upper	0.922	6	117	7.2	0.36	0.003076923	3.08	3.08
7	2	3	2	upper	0.898	6	117	5	0.25	0.002136752	2.14	2.14
7	3	3	2	upper	0.909	6	117	8	0.4	0.003418803	3.42	3.42
7	4	3	2	upper	0.957	6	117	7.5	0.375	0.003205128	3.21	3.21
1	1	4	2	upper	0.941	6	117	8	0.4	0.003418803	3.42	3.26
1	2	4	2	upper	0.898	6	117	6	0.3	0.002564103	2.56	2.44
1	3	4	2	upper	0.946	6	117	5.6	0.28	0.002393162	2.39	2.28
1	4	4	2	upper	0.956	6	117	7.9	0.395	0.003376068	3.38	3.22
2	1	4	2	upper	0.926	6	117	7.2	0.36	0.003076923	3.08	3.52
2	2	4	2	upper	0.935	6	117	6.5	0.325	0.002777778	2.78	3.17
2	3	4	2	upper	0.937	6	117	3.8	0.19	0.001623932	1.62	1.86
2	4	4	2	upper	0.961	6	117	5.1	0.255	0.002179487	2.18	2.49
3	1	4	2	upper	0.919	6	117	11	0.55	0.004700855	4.7	5.37
3	2	4	2	upper	0.866	6	117	8.7	0.435	0.003717949	3.72	4.25
3	3	4	2	upper	3.93	6	117	9.1	0.455	0.003888889	3.89	4.44
3	4	4	2	upper	0.93	6	117	8.6	0.43	0.003675214	3.68	4.20

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
4	1	4	2	upper	0.918	6	117	8.3	0.415	0.003547009	3.55	2.84
4	2	4	2	upper	0.922	6	117	5.9	0.295	0.002521368	2.52	2.02
4	3	4	2	upper	0.878	6	117	2.9	0.145	0.001239316	1.24	0.99
4	4	4	2	upper	0.914	6	117	5.1	0.255	0.002179487	2.18	1.74
5	1	4	2	upper	0.756	5	97.5	3.4	0.17	0.00174359	1.74	2.18
5	2	4	2	upper	0.912	6	117	4.1	0.205	0.001752137	1.75	2.19
5	3	4	2	upper	0.883	6	117	5.5	0.275	0.002350427	2.35	2.94
5	4	4	2	upper	0.938	6	117	2.9	0.145	0.001239316	1.24	1.55
6	1	4	2	upper	0.883	6	117	4.9	0.245	0.002094017	2.09	2.09
6	2	4	2	upper	0.915	6	117	6.9	0.345	0.002948718	2.95	2.95
6	3	4	2	upper	0.886	6	117	5.5	0.275	0.002350427	2.35	2.35
6	4	4	2	upper	0.907	6	117	4.3	0.215	0.001837607	1.84	1.84
7	1	4	2	upper	0.886	6	117	4.7	0.235	0.002008547	2.01	2.01
7	2	4	2	upper	0.916	6	117	6.9	0.345	0.002948718	2.95	2.95
7	3	4	2	upper	0.894	6	117	2.3	0.115	0.000982906	0.98	0.98
7	4	4	2	upper	0.917	6	117	6.9	0.345	0.002948718	2.95	2.95
1	1	1	4	lower	0.739	5	97.5	1.6	0.08	0.000820513	0.82	0.78
1	2	1	4	lower	0.747	5	97.5	3.6	0.18	0.001846154	1.85	1.76
1	3	1	4	lower	0.737	5	97.5	2.9	0.145	0.001487179	1.49	1.42
1	4	1	4	lower	0.721	5	97.5	3	0.15	0.001538462	1.54	1.47
2	1	1	4	lower	0.565	4	78	2.8	0.14	0.001794872	1.79	2.05
2	2	1	4	lower	0.748	5	97.5	2.3	0.115	0.001179487	1.18	1.35
2	3	1	4	lower	0.742	5	97.5	2.5	0.125	0.001282051	1.28	1.47
2	4	1	4	lower	0.886	6	117	3.9	0.195	0.001666667	1.67	1.90
3	1	1	4	lower	0.87	6	117	3.4	0.17	0.001452991	1.45	1.66
3	2	1	4	lower	0.887	6	117	1.8	0.09	0.000769231	0.77	0.88
3	3	1	4	lower	0.878	6	117	2.4	0.12	0.001025641	1.03	1.17
3	4	1	4	lower	0.873	6	117	1.9	0.095	0.000811966	0.81	0.93
4	1	1	4	lower	0.73	5	97.5	5.8	0.29	0.002974359	2.97	2.38
4	2	1	4	lower	0.889	6	117	6.2	0.31	0.002649573	2.65	2.12
4	3	1	4	lower	0.876	6	117	4	0.2	0.001709402	1.71	1.37
4	4	1	4	lower	0.883	6	117	4	0.2	0.001709402	1.71	1.37
5	1	1	4	lower	0.695	5	97.5	1.4	0.07	0.000717949	0.72	0.90
5	2	1	4	lower	0.856	6	117	1.6	0.08	0.000683761	0.68	0.85
5	3	1	4	lower	0.878	6	117	2.2	0.11	0.000940171	0.94	1.18
5	4	1	4	lower	0.872	6	117	1.7	0.085	0.000726496	0.73	0.91
6	1	1	4	lower	0.853	6	117	2.5	0.125	0.001068376	1.07	1.07
6	2	1	4	lower	0.9	6	117	2	0.1	0.000854701	0.85	0.85
6	3	1	4	lower	0.87	6	117	2.4	0.12	0.001025641	1.03	1.03
6	4	1	4	lower	0.879	6	117	2.8	0.14	0.001196581	1.20	1.20
7	1	1	4	lower	0.873	6	117	1.3	0.065	0.000555556	0.56	0.56
7	2	1	4	lower	0.883	6	117	1.8	0.09	0.000769231	0.77	0.77
7	3	1	4	lower	0.901	6	117	2.7	0.135	0.001153846	1.15	1.15
7	4	1	4	lower	0.847	6	117	1.3	0.065	0.000555556	0.56	0.56
1	1	2	4	lower	0.904	6	117	2.4	0.12	0.001025641	1.03	0.98
1	2	2	4	lower	0.881	6	117	3.3	0.165	0.001410256	1.41	1.34
1	3	2	4	lower	0.902	6	117	2.6	0.13	0.001111111	1.11	1.06
1	4	2	4	lower	0.914	6	117	1.6	0.08	0.000683761	0.68	0.65
2	1	2	4	lower	0.89	6	117	3.9	0.195	0.001666667	1.67	1.90
2	2	2	4	lower	0.89	6	117	3.2	0.16	0.001367521	1.37	1.56
2	3	2	4	lower	0.912	6	117	3.8	0.19	0.001623932	1.62	1.86
2	4	2	4	lower	0.904	6	117	3.1	0.155	0.001324786	1.32	1.51

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
3	1	2	4	lower	0.892	6	117	2.1	0.105	0.000897436	0.9	1.03
3	2	2	4	lower	0.927	6	117	2.5	0.125	0.001068376	1.07	1.22
3	3	2	4	lower	0.937	6	117	1.1	0.055	0.000470085	0.47	0.54
3	4	2	4	lower	0.89	6	117	2.9	0.145	0.001239316	1.24	1.42
4	1	2	4	lower	0.92	6	117	4.9	0.245	0.002094017	2.09	1.68
4	2	2	4	lower	0.883	6	117	3	0.15	0.001282051	1.28	1.03
4	3	2	4	lower	0.927	6	117	2.2	0.11	0.000940171	0.94	0.75
4	4	2	4	lower	0.894	6	117	3.3	0.165	0.001410256	1.41	1.13
5	1	2	4	lower	0.919	6	117	2.8	0.14	0.001196581	1.2	1.50
5	2	2	4	lower	0.915	6	117	1.5	0.075	0.000641026	0.64	0.80
5	3	2	4	lower	0.873	6	117	2	0.1	0.000854701	0.85	1.07
5	4	2	4	lower	0.896	6	117	2.4	0.12	0.001025641	1.03	1.28
6	1	2	4	lower	0.904	6	117	1.6	0.08	0.000683761	0.68	0.68
6	2	2	4	lower	0.933	6	117	2.6	0.13	0.001111111	1.11	1.11
6	3	2	4	lower	0.887	6	117	2.6	0.13	0.001111111	1.11	1.11
6	4	2	4	lower	0.739	6	117	1.9	0.095	0.000811966	0.81	0.81
7	1	2	4	lower	0.95	6	117	4	0.2	0.001709402	1.71	1.71
7	2	2	4	lower	0.732	5	97.5	2.3	0.115	0.001179487	1.18	1.18
7	3	2	4	lower	0.893	6	117	4.5	0.225	0.001923077	1.92	1.92
7	4	2	4	lower	0.873	6	117	5.3	0.265	0.002264957	2.26	2.26
1	1	3	4	lower	0.914	6	117	2.7	0.135	0.001153846	1.15	1.10
1	2	3	4	lower	0.906	6	117	5.9	0.295	0.002521368	2.52	2.40
1	3	3	4	lower	0.964	6	117	1.6	0.08	0.000683761	0.68	0.65
1	4	3	4	lower	0.894	6	117	5.3	0.265	0.002264957	2.26	2.16
2	1	3	4	lower	0.765	6	117	3.1	0.155	0.001324786	1.32	1.51
2	2	3	4	lower	0.909	6	117	2.4	0.12	0.001025641	1.03	1.17
2	3	3	4	lower	0.926	6	117	3.4	0.17	0.001452991	1.45	1.66
2	4	3	4	lower	0.91	6	117	2.3	0.115	0.000982906	0.98	1.12
3	1	3	4	lower	0.749	5	97.5	2.7	0.135	0.001384615	1.38	1.58
3	2	3	4	lower	0.943	6	117	4.6	0.23	0.001965812	1.97	2.25
3	3	3	4	lower	0.912	6	117	1.6	0.08	0.000683761	0.68	0.78
3	4	3	4	lower	0.901	6	117	3.2	0.16	0.001367521	1.37	1.56
4	1	3	4	lower	0.906	6	117	7.1	0.355	0.003034188	3.03	2.43
4	2	3	4	lower	0.927	6	117	5.1	0.255	0.002179487	2.18	1.74
4	3	3	4	lower	0.901	6	117	3.3	0.165	0.001410256	1.41	1.13
4	4	3	4	lower	0.899	6	117	1.8	0.09	0.000769231	0.77	0.62
5	1	3	4	lower	0.907	6	117	2	0.1	0.000854701	0.85	1.07
5	2	3	4	lower	0.91	6	117	1	0.05	0.00042735	0.43	0.53
5	3	3	4	lower	0.843	6	117	1.9	0.095	0.000811966	0.81	1.01
5	4	3	4	lower	0.949	6	117	3.7	0.185	0.001581197	1.58	1.98
6	1	3	4	lower	0.854	5	97.5	3.4	0.17	0.00174359	1.74	1.74
6	2	3	4	lower	0.919	6	117	2.5	0.125	0.001068376	1.07	1.07
6	3	3	4	lower	0.92	6	117	2.8	0.14	0.001196581	1.20	1.20
6	4	3	4	lower	0.949	6	117	3	0.15	0.001282051	1.28	1.28
7	1	3	4	lower	0.924	6	117	5.2	0.26	0.002222222	2.22	2.22
7	2	3	4	lower	0.899	6	117	1.1	0.055	0.000470085	0.47	0.47
7	3	3	4	lower	0.914	6	117	1.8	0.09	0.000769231	0.77	0.77
7	4	3	4	lower	0.936	6	117	6	0.3	0.002564103	2.56	2.56
1	1	4	4	lower	0.955	6	117	4.4	0.22	0.001880342	1.88	1.79
1	2	4	4	lower	0.926	6	117	5.1	0.255	0.002179487	2.18	2.08
1	3	4	4	lower	0.794	5	97.5	2.4	0.12	0.001230769	1.23	1.17
1	4	4	4	lower	0.891	6	117	4.3	0.215	0.001837607	1.84	1.75

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
2	1	4	4	lower	0.902	6	117	2.2	0.11	0.000940171	0.94	1.07
2	2	4	4	lower	0.936	6	117	3.1	0.155	0.001324786	1.32	1.51
2	3	4	4	lower	0.918	6	117	4.3	0.215	0.001837607	1.84	2.10
2	4	4	4	lower	0.944	6	117	2.5	0.125	0.001068376	1.07	1.22
3	1	4	4	lower	0.917	6	117	3.3	0.165	0.001410256	1.41	1.61
3	2	4	4	lower	0.884	6	117	1.7	0.085	0.000726496	0.73	0.83
3	3	4	4	lower	0.942	6	117	2	0.1	0.000854701	0.85	0.98
3	4	4	4	lower	0.938	6	117	1.6	0.08	0.000683761	0.68	0.78
4	1	4	4	lower	0.914	6	117	3.2	0.16	0.001367521	1.37	1.09
4	2	4	4	lower	0.903	6	117	3.3	0.165	0.001410256	1.41	1.13
4	3	4	4	lower	0.898	6	117	3.3	0.165	0.001410256	1.41	1.13
4	4	4	4	lower	0.914	6	117	2.5	0.125	0.001068376	1.07	0.85
5	1	4	4	lower	0.893	6	117	3	0.15	0.001282051	1.28	1.60
5	2	4	4	lower	0.906	6	117	1.7	0.085	0.000726496	0.73	0.91
5	3	4	4	lower	0.903	6	117	1.2	0.06	0.000512821	0.51	0.64
5	4	4	4	lower	0.935	6	117	2	0.1	0.000854701	0.85	1.07
6	1	4	4	lower	0.883	6	117	3.8	0.19	0.001623932	1.62	1.62
6	2	4	4	lower	0.904	6	117	2.8	0.14	0.001196581	1.20	1.20
6	3	4	4	lower	0.883	6	117	3.7	0.185	0.001581197	1.58	1.58
6	4	4	4	lower	0.945	6	117	3.8	0.19	0.001623932	1.62	1.62
7	1	4	4	lower	0.897	6	117	2.7	0.135	0.001153846	2.15	2.15
7	2	4	4	lower	0.904	6	117	5	0.25	0.002136752	2.14	2.14
7	3	4	4	lower	0.903	6	117	2.8	0.14	0.001196581	1.20	1.20
7	4	4	4	lower	0.891	6	117	3.8	0.19	0.001623932	1.62	1.62
1	1	1	4	upper	0.74	5	97.5	6.9	0.345	0.003538462	3.54	3.37
1	2	1	4	upper	0.723	5	97.5	4.8	0.24	0.002461538	2.46	2.34
1	3	1	4	upper	0.752	5	97.5	3.9	0.195	0.002	2.00	1.90
1	4	1	4	upper	0.744	5	97.5	4.6	0.23	0.002358974	2.36	2.25
2	1	1	4	upper	0.573	4	78	4.1	0.205	0.002628205	2.63	3.00
2	2	1	4	upper	0.743	5	97.5	4.4	0.22	0.00225641	2.26	2.58
2	3	1	4	upper	0.727	5	97.5	3.9	0.195	0.002	2.00	2.29
2	4	1	4	upper	0.858	6	117	5.9	0.295	0.002521368	2.52	2.88
3	1	1	4	upper	0.894	6	117	6.3	0.315	0.002692308	2.69	3.08
3	2	1	4	upper	0.874	6	117	6.3	0.315	0.002692308	2.69	3.08
3	3	1	4	upper	0.885	6	117	6	0.3	0.002564103	2.56	2.93
3	4	1	4	upper	0.871	6	117	5.3	0.265	0.002264957	2.26	2.59
4	1	1	4	upper	0.716	5	97.5	4.4	0.22	0.00225641	2.26	1.81
4	2	1	4	upper	0.875	6	117	5.5	0.275	0.002350427	2.35	1.88
4	3	1	4	upper	0.895	6	117	11	0.55	0.004700855	4.7	3.76
4	4	1	4	upper	0.873	6	117	6.4	0.32	0.002735043	2.74	2.19
5	1	1	4	upper	0.717	5	97.5	2.1	0.105	0.001076923	1.08	1.35
5	2	1	4	upper	0.886	6	117	3.3	0.165	0.001410256	1.41	1.76
5	3	1	4	upper	0.889	6	117	3.6	0.18	0.001538462	1.54	1.92
5	4	1	4	upper	0.866	6	117	4	0.2	0.001709402	1.71	2.14
6	1	1	4	upper	0.864	6	117	4.6	0.23	0.001965812	1.97	1.97
6	2	1	4	upper	0.898	6	117	5.8	0.29	0.002478632	2.48	2.48
6	3	1	4	upper	0.888	6	117	4.4	0.22	0.001880342	1.88	1.88
6	4	1	4	upper	0.894	6	117	3.8	0.19	0.001623932	1.62	1.62
7	1	1	4	upper	0.878	6	117	7.2	0.36	0.003076923	3.08	3.08
7	2	1	4	upper	0.885	6	117	5.3	0.265	0.002264957	2.26	2.26
7	3	1	4	upper	0.893	6	117	5.7	0.285	0.002435897	2.44	2.44
7	4	1	4	upper	0.873	6	117	5	0.25	0.002136752	2.14	2.14

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
1	1	2	4	upper	0.915	6	117	6.2	0.31	0.002649573	2.65	2.52
1	2	2	4	upper	0.903	6	117	6.9	0.345	0.002948718	2.95	2.81
1	3	2	4	upper	0.904	6	117	4.5	0.225	0.001923077	1.92	1.83
1	4	2	4	upper	0.915	6	117	12	0.6	0.005128205	5.13	4.88
2	1	2	4	upper	0.901	6	117	4.8	0.24	0.002051282	2.05	2.34
2	2	2	4	upper	0.897	6	117	6.7	0.335	0.002863248	2.86	3.27
2	3	2	4	upper	0.92	6	117	4.2	0.21	0.001794872	1.79	2.05
2	4	2	4	upper	0.907	6	117	5.5	0.275	0.002350427	2.35	2.69
3	1	2	4	upper	0.865	6	117	4.1	0.205	0.001752137	1.75	2.00
3	2	2	4	upper	0.935	6	117	4.4	0.22	0.001880342	1.88	2.15
3	3	2	4	upper	0.934	6	117	4.5	0.225	0.001923077	1.92	2.20
3	4	2	4	upper	0.884	6	117	2.8	0.14	0.001196581	1.2	1.37
4	1	2	4	upper	0.906	6	117	5.6	0.28	0.002393162	2.39	1.91
4	2	2	4	upper	0.88	6	117	8.9	0.445	0.003803419	3.8	3.04
4	3	2	4	upper	0.901	6	117	9.8	0.49	0.004188034	4.19	3.35
4	4	2	4	upper	0.886	6	117	5.5	0.275	0.002350427	2.35	1.88
5	1	2	4	upper	0.942	6	117	5.9	0.295	0.002521368	2.52	3.15
5	2	2	4	upper	0.906	6	117	3.8	0.19	0.001623932	1.62	2.03
5	3	2	4	upper	0.944	6	117	2.6	0.13	0.001111111	1.11	1.39
5	4	2	4	upper	0.906	6	117	4.3	0.215	0.001837607	1.84	2.30
6	1	2	4	upper	0.873	6	117	6	0.3	0.002564103	2.56	2.56
6	2	2	4	upper	0.925	6	117	6.2	0.31	0.002649573	2.65	2.65
6	3	2	4	upper	0.869	6	117	4.7	0.235	0.002008547	2.01	2.01
6	4	2	4	upper	0.734	6	117	5.4	0.27	0.002307692	2.31	2.31
7	1	2	4	upper	0.92	6	117	3.7	0.185	0.001581197	1.58	1.58
7	2	2	4	upper	0.761	5	97.5	6	0.3	0.003076923	3.08	3.08
7	3	2	4	upper	0.905	6	117	4.7	0.235	0.002008547	2.01	2.01
7	4	2	4	upper	0.872	6	117	4.4	0.22	0.001880342	1.88	1.88
1	1	3	4	upper	0.929	6	117	5.6	0.28	0.002393162	2.39	2.28
1	2	3	4	upper	0.92	6	117	4.7	0.235	0.002008547	2.01	1.91
1	3	3	4	upper	0.963	6	117	5.8	0.29	0.002478632	2.48	2.36
1	4	3	4	upper	0.883	6	117	4.2	0.21	0.001794872	1.79	1.71
2	1	3	4	upper	0.766	6	117	3.9	0.195	0.001666667	1.67	1.91
2	2	3	4	upper	0.916	6	117	5.6	0.28	0.002393162	2.39	2.74
2	3	3	4	upper	0.941	6	117	5.1	0.255	0.002179487	2.18	2.49
2	4	3	4	upper	0.928	6	117	4.8	0.24	0.002051282	2.05	2.34
3	1	3	4	upper	0.772	5	97.5	10	0.5	0.005128205	5.13	5.86
3	2	3	4	upper	0.936	6	117	7.4	0.37	0.003162393	3.16	3.61
3	3	3	4	upper	0.924	6	117	11.7	0.585	0.005	5.0	5.71
3	4	3	4	upper	0.914	6	117	5.5	0.275	0.002350427	2.35	2.69
4	1	3	4	upper	0.886	6	117	2.4	0.12	0.001025641	1.03	0.82
4	2	3	4	upper	0.907	6	117	3.9	0.195	0.001666667	1.67	1.33
4	3	3	4	upper	0.902	6	117	6.8	0.34	0.002905983	2.91	2.32
4	4	3	4	upper	0.903	6	117	5.2	0.26	0.002222222	2.22	1.78
5	1	3	4	upper	0.919	6	117	7.3	0.365	0.003119658	3.12	3.90
5	2	3	4	upper	0.909	6	117	5.2	0.26	0.002222222	2.22	2.78
5	3	3	4	upper	0.891	6	117	5.4	0.27	0.002307692	2.31	2.88
5	4	3	4	upper	0.933	6	117	3.1	0.155	0.001324786	1.32	1.66
6	1	3	4	upper	0.749	5	97.5	4.3	0.215	0.002205128	2.21	2.21
6	2	3	4	upper	0.92	6	117	5.4	0.27	0.002307692	2.31	2.31
6	3	3	4	upper	0.926	6	117	4.6	0.23	0.001965812	1.97	1.97
6	4	3	4	upper	0.946	6	117	6.3	0.315	0.002692308	2.69	2.69

T	R	A	Wire	L_side	W_FP	No. FP	Area	Cu L^{-1}	Cu_0.05	Cu_mg cm^{-2}	µg Cu cm^{-2}	µg Cu cm^{-2}_1kgci
7	1	3	4	upper	0.909	6	117	5.2	0.26	0.002222222	2.22	2.22
7	2	3	4	upper	0.919	6	117	9	0.45	0.003846154	3.85	3.85
7	3	3	4	upper	0.93	6	117	4.4	0.22	0.001880342	1.88	1.88
7	4	3	4	upper	0.935	6	117	5.9	0.295	0.002521368	2.52	2.52
1	1	4	4	upper	0.948	6	117	6.1	0.305	0.002606838	2.61	2.48
1	2	4	4	upper	0.885	6	117	9	0.45	0.003846154	3.85	3.66
1	3	4	4	upper	0.783	5	97.5	5	0.25	0.002564103	2.56	2.44
1	4	4	4	upper	0.901	6	117	3.6	0.18	0.001538462	1.54	1.47
2	1	4	4	upper	0.92	6	117	5.6	0.28	0.002393162	2.39	2.74
2	2	4	4	upper	0.921	6	117	5.7	0.285	0.002435897	2.44	2.78
2	3	4	4	upper	0.931	6	117	5.2	0.26	0.002222222	2.22	2.54
2	4	4	4	upper	0.954	6	117	5.5	0.275	0.002350427	2.35	2.69
3	1	4	4	upper	0.907	6	117	6.1	0.305	0.002606838	2.61	2.98
3	2	4	4	upper	0.888	6	117	8	0.4	0.003418803	3.42	3.91
3	3	4	4	upper	0.917	6	117	7.4	0.37	0.003162393	3.16	3.61
3	4	4	4	upper	0.9	6	117	9	0.45	0.003846154	3.85	4.40
4	1	4	4	upper	0.914	6	117	7.9	0.395	0.003376068	3.38	2.70
4	2	4	4	upper	0.896	6	117	7.3	0.365	0.003119658	3.12	2.50
4	3	4	4	upper	0.897	6	117	5.1	0.255	0.002179487	2.18	1.74
4	4	4	4	upper	0.919	6	117	4.5	0.225	0.001923077	1.92	1.54
5	1	4	4	upper	0.89	6	117	3.8	0.19	0.001623932	1.62	2.03
5	2	4	4	upper	0.913	6	117	5	0.25	0.002136752	2.14	2.67
5	3	4	4	upper	0.919	6	117	2.4	0.12	0.001025641	1.03	1.28
5	4	4	4	upper	0.934	6	117	4	0.2	0.001709402	1.71	2.14
6	1	4	4	upper	0.885	6	117	5	0.25	0.002136752	2.14	2.14
6	2	4	4	upper	0.914	6	117	5.4	0.27	0.002307692	2.31	2.31
6	3	4	4	upper	0.877	6	117	4	0.2	0.001709402	1.71	1.71
6	4	4	4	upper	0.964	6	117	4	0.2	0.001709402	1.71	1.71
7	1	4	4	upper	0.917	6	117	3.3	0.165	0.001410256	1.41	1.41
7	2	4	4	upper	0.927	6	117	6.8	0.34	0.002905983	2.91	2.91
7	3	4	4	upper	0.906	6	117	2.3	0.115	0.000982906	0.98	0.98
7	4	4	4	upper	0.901	6	117	3.6	0.18	0.001538462	1.54	1.54

Appendix F

Spray coverage and impact density on water-sensitive papers

Table AppF: *Spray coverage and impact density on water-sensitive papers.*

Legend:
T - treatment code (see table App1)

R - replication

A - application date (1 – 20 July, 2 – 30 July, 3 – 9 August, 4 – 19 August)

2LowerA - 2^{nd} wire, lower leaf-side, spray coverage (percentage of WSP surface)

2UpperA - 2^{nd} wire, upper leaf-side, spray coverage (percentage of WSP surface)

4LowerA - 4^{th} wire, lower leaf-side, spray coverage (percentage of WSP surface)

4UpperA - 4^{th} wire, upper leaf-side, spray coverage (percentage of WSP surface)

2LowerN - 2^{nd} wire, lower leaf-side, impact density (number of impacts per cm^2) (cm^2 of WSP)

2UpperN - 2^{nd} wire, upper leaf-side, impact density (number of impacts per cm^2) (cm^2 of WSP)

4LowerN - 4^{th} wire, lower leaf-side, impact density (number of impacts per cm^2) (cm^2 of WSP)

4UpperN - 4^{th} wire, upper leaf-side, impact density (number of impacts per cm^2) (cm^2 of WSP)

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
1	1	1	11.588	26.376	54.368	7.7904	113.571	74.623	22.911	99.006	1	1	3	6.5371	19.924	12.138	13.675	106.833	165.283	109.593	90.435
1	1	1	8.3297	27.423	44.177	9.0503	118.48	74.492	33.22	100.806	1	1	3	4.4671	19.183	14.244	15.23	92.058	165.608	110.405	92.87
1	1	1	29.321	21.798	27.114	53.932	78.714	108.334	78.387	16.103	1	1	3	14.797	62.134	15.965	69.088	119.497	15.749	107.353	9.0922
1	1	1	32.686	21.377	17.201	70.856	67.324	105.716	72.004	5.4003	1	1	3	15.858	63.087	3.3284	73.439	124.53	21.659	82.317	8.118
1	1	1	7.2281	27.767	30.323	72.828	62.022	76.096	63.658	9.1642	1	1	3	9.7791	76.052	2.2697	64.661	84.752	16.561	64.132	12.664
1	1	1	7.5205	27.811	31.681	65.267	70.695	69.713	55.803	12.47	1	1	3	6.8271	99.049	2.7656	32.742	92.058	0.7481	54.228	55.268
1	1	1	44.232	39.917	24.807	13.329	28.638	47.065	118.644	116.68	1	1	3	3.0215	96.894	1.9062	26.792	76.309	1.786	45.623	71.763
1	1	1	45.365	40.772	26.879	10.529	32.369	44.348	102.934	116.025	1	1	3	4.9521	87.888	59.445	20.59	93.357	2.7601	25.328	80.856
1	1	1	16.441	57.127	12.738	14.941	64.804	16.692	147.118	98.515	1	1	3	20.098	97.392	90.721	47.287	116.477	1.1365	4.611	35.07
1	1	1	17.919	40.763	25.347	22.61	72.332	32.893	123.717	92.951	1	1	3	23.051	48.828	20.352	42.523	115.179	35.07	98.228	56.664
1	1	1	35.028	73.715	69.091	15.696	33.253	3.6002	19.31	117.335	1	1	3	9.9209	48.509	21.007	50.043	136.708	33.349	97.741	27.601
1	1	1	62.739	71.896	50.345	18.095	12.601	5.8913	27.82	120.771	1	1	3	9.2477	50.009	21.545	51.205	132.649	32.472	115.763	26.952
1	1	1	2.4026	34.591	54.747	40.913	35.184	60.877	16.037	42.123	1	1	3	27.465	98.905	25.681	54.298	122.225	0.3247	104.398	20.198
1	1	1	1.5967	40.269	92.73	39.169	25.529	39.439	1.3092	48.276	1	1	3	26.248	97.8	32.398	52.478	124.238	0.4871	75.173	27.634
1	1	1	16.912	43.636	19.021	57.251	64.149	35.675	107.516	15.874	1	1	3	4.7022	69.956	7.5779	9.0973	72.25	10.553	106.346	126.641
1	1	1	6.9032	45.492	23.604	40.25	68.077	36.526	77.568	45.003	1	1	3	3.5189	58.205	11.093	9.7108	59.099	23.218	115.114	136.383
1	1	1	21.36	31.681	26.227	7.658	83.787	71.186	84.278	93.279	1	1	3	10.379	96.121	8.7371	48.912	102.287	0.1624	124.206	38.967
1	1	1	13.974	31.191	19.802	13.291	124.699	67.422	130.263	91.642	1	1	3	10.42	95.828	6.5366	19.303	91.571	1.6236	98.715	104.073
1	2	1	44.471	74.623	44.77	69.331	45.886	22.649	29.293	9.9824	1	2	3	28.557	50.946	9.5028	31.654	76.959	28.965	105.534	83.778
1	2	1	33.638	74.492	40.258	51.349	58.095	20.129	29.129	17.51	1	2	3	32.449	54.873	8.2272	33.478	74.718	23.867	97.579	74.848
1	2	1	18.695	108.334	45.268	47.646	119.298	83.132	40.912	26.511	1	2	3	27.808	58.308	54.633	77.991	85.889	23.055	31.498	10.553
1	2	1	24.691	105.716	41.373	45.098	103.588	87.715	38.13	28.311	1	2	3	11.674	95.829	41.363	92.885	102.125	0.4871	55.69	2.338
1	2	1	42.099	76.096	34.691	25.422	58.585	114.716	42.875	96.715	1	2	3	19.655	97.197	2.5708	36.407	98.066	0.6494	71.926	71.926
1	2	1	42.366	69.713	50.023	24.943	55.803	121.098	41.73	96.879	1	2	3	22.1	29.23	3.0542	35.512	101.638	100.339	75.011	71.504
1	2	1	35.87	47.065	28.225	3.943	62.84	73.805	112.098	67.75	1	2	3	16.294	50.15	15.386	60.548	114.302	64.295	102.287	20.457
1	2	1	41.166	44.348	28.94	5.4251	48.276	48.112	116.025	61.204	1	2	3	13.643	90.641	22.64	53.356	115.438	1.2989	110.405	34.258
1	2	1	28.488	16.692	63.374	66.989	82.151	0.3273	18.983	12.699	1	2	3	4.8582	98.701	7.0637	53.118	89.461	0.1624	86.376	26.66
1	2	1	25.911	32.893	43.328	51.853	90.66	0	36.002	20.456	1	2	3	7.2885	98.814	18.152	54.827	111.996	0.3247	98.878	16.074
1	2	1	8.2079	3.6002	62.901	17.404	75.768	39.275	18.328	101.297	1	2	3	17.673	97.793	9.6774	56.812	97.092	0.4871	138.981	19.321
1	2	1	16.528	5.8913	45.401	14.175	85.587	30.929	37.802	103.588	1	2	3	13.196	62.919	9.6005	66.888	83.129	16.723	140.117	10.229
1	2	1	41.65	60.877	28.485	16.321	46.967	7.7241	111.116	104.897	1	2	3	4.8318	87.89	26.374	7.8034	57.8	4.8708	65.269	119.335
1	2	1	36.289	39.439	47.633	58.915	40.093	18.328	34.366	11.946	1	2	3	1.597	40.951	34.612	6.6668	31.011	58.774	56.566	112.516
1	2	1	27.359	35.675	49.085	4.7415	87.224	96.06	27.82	69.877	1	2	3	25.099	38.829	52.75	70.349	90.5	65.756	23.542	8.2804
1	2	1	23.997	36.526	51.59	23.2	85.914	35.675	28.998	103.261	1	2	3	20.948	41.243	84.657	72.873	104.235	53.806	7.8907	6.4944
1	2	1	31.454	71.186	67.751	72.778	68.732	0.1636	14.565	10.015	1	2	3	7.5299	43.667	4.8397	34.256	96.475	44.162	60.398	63.97
1	2	1	21.248	67.422	44.604	51.14	78.387	28.147	30.766	18.656	1	2	3	9.8377	44.145	5.1722	30.861	133.46	42.051	90.76	77.608

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
1	3	1	9.949	9.4625	9.4242	15.205	123.062	136.481	162.174	132.554
1	3	1	13.126	6.978	12.964	14.719	130.754	113.734	157.264	124.535
1	3	1	38.56	30.22	23.187	16.274	37.475	79.859	109.807	120.28
1	3	1	70.078	38.068	20.511	19.043	8.1823	63.986	131.081	123.226
1	3	1	28.152	29.032	65.939	19.485	74.623	95.144	14.401	120.444
1	3	1	20.94	18.265	59.396	22.756	74.95	116.189	22.092	111.934
1	3	1	46.398	30.664	33.919	97.665	25.856	55.64	62.677	0.1636
1	3	1	45.946	34.928	35.307	96.003	29.62	51.549	63.658	1.1455
1	3	1	42.724	19.996	33.949	97.987	25.889	103.425	74.296	0.3273
1	3	1	37.265	21.972	34.462	56.961	47.948	95.733	75.114	20.456
1	3	1	41.618	11.409	39.296	87.332	44.185	95.242	56.949	3.9275
1	3	1	44.53	6.8225	38.941	79.808	38.653	95.242	60.549	4.7457
1	3	1	45.897	19.67	35.21	48.605	44.512	130.263	70.204	21.438
1	3	1	38.448	16.501	40.994	52.764	52.04	124.699	67.586	19.834
1	3	1	19.803	25.738	17.528	47.298	63.331	94.751	173.629	28.638
1	3	1	19.973	6.062	26.95	48.62	64.804	100.643	117.825	20.947
1	3	1	11.374	33.473	46.999	35.652	122.735	87.06	40.748	51.221
1	3	1	49.46	42.627	47.354	43.331	22.911	43.53	58.913	42.057
1	4	1	8.9742	136.481	82.745	47.448	60.386	130.917	3.6002	35.02
1	4	1	16.432	113.734	50.768	48.058	72.168	112.262	15.055	29.784
1	4	1	13.061	79.859	2.654	50.464	102.77	20.619	55.967	31.093
1	4	1	9.1092	63.986	2.2623	34.534	87.224	21.732	47.13	79.892
1	4	1	8.9623	95.144	28.027	27.531	91.969	94.097	75.277	99.006
1	4	1	4.8919	116.189	26.746	27.553	68.732	91.478	85.587	95.57
1	4	1	32.535	55.64	14.909	66.683	62.022	77.405	103.097	7.2004
1	4	1	31.788	51.549	13.315	76.686	65.786	85.587	111.116	6.3822
1	4	1	16.166	103.425	4.9143	66.414	99.988	62.349	70.041	7.855
1	4	1	15.718	95.733	4.0719	6.6109	99.497	91.184	64.313	95.57
1	4	1	20.024	95.242	8.4583	6.6396	97.206	92.951	85.096	97.206
1	4	1	15.094	95.242	4.4024	46.289	102.934	101.624	59.731	27.82
1	4	1	22.019	130.263	9.1751	46.232	71.514	15.546	92.788	27.493
1	4	1	27.523	124.699	6.0237	64.979	76.161	7.9859	114.88	13.91
1	4	1	8.8071	94.751	4.7463	81.521	77.732	99.497	71.841	7.6914
1	4	1	9.638	100.643	18.292	35.47	90.497	67.455	110.625	35.74
1	4	1	38.975	87.06	59.429	44.354	50.403	119.462	11.619	42.352
1	4	1	17.672	43.53	6.0615	52.28	94.751	33.057	81.005	35.348

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
1	3	3	24.085	38.544	40.43	52.909	100.176	56.664	41.889	26.14
1	3	3	19.268	91.907	39.015	55.643	108.944	2.4354	52.15	17.697
1	3	3	90.966	74.322	44.919	54.694	3.2472	10.911	48.708	21.269
1	3	3	95.326	96.016	7.6798	60.085	2.273	0.4871	84.59	15.749
1	3	3	34.327	98.1	16.649	64.967	79.427	0.3247	128.914	11.268
1	3	3	32.452	40.46	16.557	14.28	77.771	65.464	140.117	121.608
1	3	3	42.671	36.43	13.381	16.816	43.675	77.446	141.416	128.752
1	3	3	41.07	96.161	21.943	17.661	53.579	1.6236	117.874	115.925
1	3	3	41.67	95.251	26.373	87.29	54.423	1.9483	117.549	6.3321
1	3	3	24.979	75.677	6.0402	92.177	96.442	14.872	84.59	1.9483
1	3	3	18.108	95.497	4.58	72.432	87.999	2.5978	75.011	26.627
1	3	3	5.0375	97.813	3.8794	97.732	123.556	0.1624	80.368	0.3247
1	3	3	11.314	98.927	36.65	79.762	161.062	0	75.011	4.3837
1	3	3	6.982	53.519	38.778	69.612	141.578	23.135	74.848	7.6309
1	3	3	18.32	84.242	50.371	27.737	88.162	6.6568	46.305	90.922
1	3	3	24.985	90.627	12.997	23.345	90.922	2.9874	108.944	97.254
1	3	3	22.388	68.566	11.59	5.5852	96.604	15.911	109.593	69.328
1	3	3	5.8376	46.687	9.7471	5.1776	103.261	42.863	105.372	65.918
1	4	3	5.1588	34.334	41.148	97.402	5.1588	80.044	58.287	0
1	4	3	5.1745	47.635	41.07	88.61	5.1745	40.915	53.254	3.0848
1	4	3	18.843	75.908	21.185	86.943	18.843	7.1439	117.062	3.8967
1	4	3	9.4945	58.805	17.181	94.988	9.4945	17.697	131.025	1.4612
1	4	3	11.356	44.668	19.04	60.578	11.356	41.142	139.955	22.081
1	4	3	32.014	53.308	3.7508	66.15	32.014	35.719	69.977	11.56
1	4	3	24.821	64.732	3.822	98.255	24.821	13.833	78.907	0.3247
1	4	3	30.068	57.371	11.858	98.237	30.068	15.424	119.822	0
1	4	3	26.648	48.086	6.0547	78.174	26.648	35.882	102.937	12.437
1	4	3	8.5034	55.964	4.3337	66.872	8.5034	24.906	94.819	10.716
1	4	3	9.8681	51.519	26.739	93.968	9.8681	33.803	103.099	1.6236
1	4	3	8.3784	50.246	14.342	79.453	8.3784	34.258	109.821	12.015
1	4	3	10.073	63.977	1.0643	7.3065	10.073	14.97	37.83	134.922
1	4	3	4.2606	65.234	1.355	7.1898	4.2606	12.339	35.07	143.202
1	4	3	4.3524	56.427	28.119	26.075	4.3524	30.394	87.999	112.516
1	4	3	11.175	42.893	16.156	24.609	11.175	49.52	116.575	103.261
1	4	3	13.773	40.211	28.671	84.172	13.773	53.806	94.981	2.5978
1	4	3	16.027	40.978	30.882	93.201	16.027	42.246	95.306	1.6236

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	1	1	40.087	15.408	36.573	27.125	51.712	80.35	54.331	78.55
2	1	1	38.035	19.106	34.459	35.003	56.622	89.842	59.731	64.149
2	1	1	42.713	17.714	31.586	34.045	49.258	91.969	70.695	67.259
2	1	1	5.8081	47.483	4.7755	83.168	68.732	28.835	73.477	4.4185
2	1	1	6.9569	53.843	7.8998	69.873	70.041	22.256	92.133	6.7095
2	1	1	6.374	58.651	11.644	63.77	71.514	15.874	104.734	11.783
2	1	1	7.9906	56.12	3.7779	67.621	96.715	14.892	51.549	12.601
2	1	1	10.945	89.635	2.1309	61.109	111.28	3.6002	21.11	16.365
2	1	1	9.7943	57.867	13.548	32.42	111.607	16.037	104.799	80.841
2	1	1	15.326	41.538	20.69	34.91	106.861	44.021	101.624	79.827
2	1	1	14.414	44.722	5.7878	92.499	106.043	36.82	62.84	0.8181
2	1	1	11.998	44.512	4.2601	69.994	113.898	36.82	56.131	17.183
2	1	1	19.111	18.567	14.308	60.602	101.134	94.588	104.406	24.056
2	1	1	27.528	25.861	11.988	60.173	93.213	79.369	106.207	21.929
2	1	1	29.151	28.566	42.401	21.503	81.496	74.132	34.038	88.205
2	1	1	43.62	91.935	59.802	26.704	34.038	2.4874	13.419	89.351
2	1	1	43.823	73.511	1.8103	25.591	36.166	13.419	40.257	71.841
2	1	1	42.147	87.889	9.2489	18.498	35.184	3.1093	68.077	86.078
2	2	1	30.032	63.166	30.333	77.093	86.569	9.0333	81.005	7.7241
2	2	1	32.632	61.11	30.456	83.637	83.852	9.3279	81.823	3.6002
2	2	1	17.2	59.404	29.12	64.584	109.316	10.801	86.733	7.855
2	2	1	96.983	71.3	5.9996	17.241	0.6546	4.1894	68.241	129.935
2	2	1	94.312	76.688	6.5891	18.366	2.2911	2.9129	73.968	123.226
2	2	1	93.652	73.601	7.7712	18.316	2.2911	4.4185	73.641	129.935
2	2	1	4.4475	73.595	41.925	72.607	81.66	6.2186	32.729	6.3822
2	2	1	4.4927	75.451	58.951	73.779	103.752	6.0549	13.91	6.5459
2	2	1	4.8912	74.477	60.864	74.035	77.405	7.855	12.11	6.3822
2	2	1	11.504	13.748	75.76	17.589	86.896	84.605	8.8369	139.59
2	2	1	10.094	10.635	87.064	16	86.242	80.35	4.8112	126.008
2	2	1	6.5204	10.152	80.456	14.899	72.986	78.223	3.9275	122.408
2	2	1	3.2569	51.227	7.1213	13.019	54.331	29.293	107.188	98.352
2	2	1	4.0227	70.106	9.4212	22.443	61.858	11.783	85.587	84.278
2	2	1	38.032	40.725	48.434	71.87	77.241	54.854	34.824	9.1642
2	2	1	24.78	38.869	29.623	77.183	105.388	55.64	74.95	4.7457
2	2	1	8.2952	93.196	68.178	81.996	81.496	2.2911	13.91	2.9456
2	2	1	8.7142	93.256	71.775	56.302	78.878	0.9819	7.0368	15.219

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	1	3	61.777	62.72	45.763	77.33	15.587	10.911	43.837	7.9557
2	1	3	49.928	49.982	68.0651	90.907	42.863	26.627	15.262	0.8118
2	1	3	13.437	54.859	4.6725	31.626	155.379	23.867	78.745	92.87
2	1	3	20.28	52.833	10	24.094	150.183	18.022	100.988	119.01
2	1	3	71.798	31.146	72.196	29.802	14.937	89.298	14.937	98.553
2	1	3	63.489	30.725	61.583	36.975	12.826	94.494	16.723	76.147
2	1	3	87.993	58.612	7.0056	51.002	3.7343	17.86	110.892	27.439
2	1	3	78.871	81.48	6.8862	48.857	6.3321	4.059	105.047	32.992
2	1	3	19.992	30.926	39.891	44.141	111.055	96.442	55.073	45.136
2	1	3	18.261	25.512	31.629	49.179	114.464	119.173	74.686	32.992
2	1	3	7.1264	66.446	43.266	20.246	65.269	13.314	54.391	89.136
2	1	3	6.7725	62.963	42.541	15.576	107.807	13.314	63.97	97.903
2	1	3	8.1326	19.904	47.031	74.959	77.933	121.77	47.085	17.697
2	1	3	8.5631	13.275	54.981	46.32	117.711	123.719	20.133	38.155
2	1	3	24.386	20.005	26.961	46.327	126.154	127.291	108.457	38.967
2	1	3	25.822	18.287	35.381	48.496	120.634	120.959	87.025	29.225
2	1	3	96.848	90.477	5.9104	84.701	0.8118	1.4612	98.39	4.2863
2	1	3	98.394	71.599	5.4122	88.41	0.1624	6.4944	101.8	2.273
2	2	3	14.852	88.241	7.5594	21.074	181.194	2.1107	82.641	77.446
2	2	3	15.655	70.402	7.5046	19.33	148.722	8.5402	112.678	73.062
2	2	3	19.301	66.474	72.731	73.281	121.121	10.456	23.899	5.845
2	2	3	36.592	96.933	95.744	78.434	91.571	0.8118	2.1107	7.1763
2	2	3	12.985	48.173	5.1814	61.845	100.339	46.76	54.91	11.041
2	2	3	12.896	68.534	6.2957	56.022	59.424	21.107	55.69	21.269
2	2	3	9.93	28.79	12.177	46.729	116.575	86.571	155.704	29.063
2	2	3	11.398	26.177	15.979	49.173	129.564	94.851	148.885	30.394
2	2	3	9.8227	93.801	12.761	39.199	99.852	2.9225	85.402	58.612
2	2	3	21.965	86.943	12.245	39.376	106.184	6.0073	100.176	49.39
2	2	3	29.916	70.187	23.309	17.637	81.18	6.658	90.11	160.412
2	2	3	22.526	88.098	28.427	16.155	101.962	2.273	106.184	160.932
2	2	3	29.86	48.172	10.939	64.412	102.125	35.395	106.671	8.3129
2	2	3	27.932	36.088	13.67	89.455	114.464	79.589	105.372	1.4612
2	2	3	6.9065	55.634	73.074	13.126	132.486	30.037	8.118	122.257
2	2	3	5.0137	77.632	69.862	11.533	106.184	11.365	18.412	128.102
2	2	3	7.295	38.069	12.676	70.813	98.066	63.645	126.479	9.7416
2	2	3	8.1932	39.57	18.537	72.633	96.604	51.955	109.756	11.528

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	3	1	2.2849	85.558	46.47	60.026	32.402	4.1566	35.02	14.401
2	3	1	3.5991	81.257	56.798	94.976	48.276	2.9456	22.78	0.6546
2	3	1	2.5178	57.085	54.198	85.022	36.493	14.401	20.619	4.4185
2	3	1	7.1119	63.108	98.141	18.59	82.805	11.619	0.1636	92.46
2	3	1	5.938	64.229	98.123	22.69	83.787	11.521	0.1636	99.497
2	3	1	5.851	50.274	98.097	31.183	73.641	29.293	0.3273	91.151
2	3	1	12.249	47.75	33.525	71.284	85.587	32.402	57.931	10.964
2	3	1	16.938	45.78	33.103	91.26	101.788	28.474	52.531	2.2911
2	3	1	17.414	91.149	32.932	53.066	90.824	1.1455	57.767	19.801
2	3	1	60.204	88.971	25.987	17.517	16.201	2.6183	88.533	85.914
2	3	1	55.747	68.077	28.702	27.03	26.674	7.2004	70.859	71.841
2	3	1	49.313	70.575	32.345	38.25	36.002	8.1823	65.295	50.239
2	3	1	20.983	69.96	10.326	41.98	101.788	7.5277	109.807	41.566
2	3	1	12.447	74.636	12.074	45.839	107.843	7.0368	105.061	37.999
2	3	1	72.073	66.003	18.513	70.119	5.6294	9.3279	89.024	11.095
2	3	1	46.942	77.206	56.466	83.464	26.674	3.6657	16.07	5.564
2	3	1	7.6656	84.394	55.076	16.924	90.006	4.5821	13.092	127.808
2	3	1	7.8242	70.108	56.762	19.618	91.642	9.3933	14.074	117.989
2	4	1	36.956	90.849	61.688	48.408	50.567	1.6365	17.51	28.082
2	4	1	33.434	81.083	65.268	49.046	56.458	4.4185	7.6914	27.034
2	4	1	34.413	91.69	63.568	53.368	52.923	1.8001	12.666	16.201
2	4	1	1.9924	37.891	6.3446	27.585	21.601	57.113	71.677	71.677
2	4	1	3.5532	42.821	5.9015	26.531	36.33	44.086	64.804	67.586
2	4	1	4.1051	36.382	4.9688	18.03	42.057	59.96	46.639	78.387
2	4	1	34.955	47.948	48.399	56.404	50.73	30.275	46.214	13.681
2	4	1	34.23	59.093	43.711	63.192	58.127	15.874	37.802	9.1642
2	4	1	28.423	82.32	38.09	64.745	62.349	3.2729	56.131	15.546
2	4	1	3.7657	51.586	38.659	63.52	38.784	17.019	56.949	13.255
2	4	1	7.2836	50.207	33.333	36.361	68.568	15.219	70.368	49.912
2	4	1	5.6953	54.313	21.192	41.356	55.313	15.383	108.661	37.835
2	4	1	7.659	52.131	25.409	5.5459	74.296	30.111	79.041	104.406
2	4	1	6.6744	56.088	24.215	5.4228	51.549	21.929	81.005	86.896
2	4	1	26.06	53.737	22.904	5.696	91.642	20.619	76.816	73.641
2	4	1	24.864	55.973	18.755	43.932	92.46	20.947	105.388	32.664
2	4	1	8.2962	50.116	17.701	41.937	83.132	29.293	102.77	38.621
2	4	1	6.179	59.344	19.403	46.955	61.858	15.71	86.242	32.075

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	3	3	62.122	26.536	49.364	27.355	16.723	101.313	32.212	116.9
2	3	3	69.709	25.118	50.118	25.43	15.424	117.874	37.018	117.224
2	3	3	72.712	28.611	14.35	50.339	12.177	103.748	139.143	46.922
2	3	3	45.278	53.587	4.5345	58.101	52.442	38.317	100.014	22.243
2	3	3	44.215	65.728	5.3275	56.933	34.258	19.159	104.885	21.951
2	3	3	14.304	78.686	4.4747	66.849	145.313	8.7675	68.678	16.074
2	3	3	22.146	20.639	12.744	40.984	120.309	134.759	58.287	49.877
2	3	3	79.476	22.619	51.253	44.629	7.6309	134.597	32.634	44.811
2	3	3	74.178	82.961	52.556	21.846	4.2214	4.4162	26.335	109.106
2	3	3	66.836	90.294	53.397	19.042	10.391	2.1107	27.439	122.745
2	3	3	21.182	89.783	12.211	45.071	123.719	2.4354	129.401	42.701
2	3	3	97.198	27.42	12.66	51.379	0.8118	135.084	127.94	23.055
2	3	3	77.027	27.373	10.606	37.873	6.9815	125.829	126.316	73.744
2	3	3	48.884	19.143	13.554	43.138	26.302	123.556	111.12	49.033
2	3	3	38.434	24.155	53.607	48.65	56.826	108.782	26.952	29.712
2	3	3	40.533	70.389	46.048	54.601	49.682	24.029	46.922	26.302
2	3	3	50.473	94.085	3.4071	35.605	33.446	0.8118	58.45	74.199
2	3	3	14.67	49.537	5.0865	43.565	110.73	39.454	61.048	57.151
2	4	3	11.251	56.513	41.157	11.704	124.206	22.406	41.564	129.077
2	4	3	12.488	64.436	41.429	13.692	139.305	15.781	41.759	118.523
2	4	3	12.399	86.517	46.672	74.103	121.446	3.5719	41.24	4.2538
2	4	3	18.102	88.857	47.924	82.82	121.77	2.1107	36.693	2.1107
2	4	3	17.672	44.676	17.924	47.986	112.516	46.273	144.338	42.733
2	4	3	10.749	54.25	29.507	36.01	110.567	25.004	110.405	64.36
2	4	3	9.2124	57.31	35.429	14.747	111.217	20.295	86.051	159.6
2	4	3	5.8939	57.623	64.5	14.6	98.715	21.919	13.638	163.172
2	4	3	32.641	59.577	91.706	31.603	75.011	15.749	4.3837	75.66
2	4	3	31.005	58.319	91.916	27.908	78.258	15.262	2.7601	80.271
2	4	3	26.177	28.369	92.487	49.681	110.08	86.863	1.0066	37.213
2	4	3	21.791	16.66	15.915	47.887	111.217	112.678	171.842	38.512
2	4	3	92.018	36.817	20.84	9.3646	3.5719	70.952	190.189	110.892
2	4	3	85.525	35.581	14.063	10.707	0.6494	78.582	99.04	108.262
2	4	3	40.487	66.034	14.332	14.292	45.948	15.587	119.692	128.265
2	4	3	47.697	62.554	1.6051	14.342	32.829	17.73	46.11	128.59
2	4	3	12.64	32.193	14.078	45.962	76.959	103.099	88.974	41.889
2	4	3	24.767	24.391	12.825	65.489	122.42	115.601	100.176	12.177

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
3	1	1	28.082	99.684	94.518	54.807	75.932	0	0.8182	21.929
3	1	1	27.034	97.942	71.498	55.666	55.64	0	11.783	17.183
3	1	1	16.201	95.695	92.349	61.324	59.24	0.1636	2.1274	8.346
3	1	1	71.677	99.574	28.666	46.421	60.222	0	113.309	36.82
3	1	1	67.586	89.299	11.963	42.778	85.587	0.6546	113.08	34.366
3	1	1	78.387	99.195	29.712	42.165	66.44	0.1636	110.821	37.344
3	1	1	13.681	87.487	24.634	95.432	52.04	3.1093	99.17	2.8474
3	1	1	9.1642	78.398	13.091	93.658	102.77	5.564	98.842	1.4728
3	1	1	15.546	77.483	11.479	90.133	119.953	9.8188	102.606	3.7639
3	1	1	13.255	97.868	33.122	41.872	78.059	1.1455	81.496	43.857
3	1	1	49.912	99.52	43.85	40.849	72.168	0	54.429	51.712
3	1	1	37.835	99.272	48.149	37.676	69.877	0	51.45	61.858
3	1	1	104.406	98.421	39.883	62.511	65.786	0	58.585	33.417
3	1	1	86.896	98.632	35.48	99.861	78.878	0.1636	83.951	0.1636
3	1	1	73.641	98.432	34.207	99.699	81.823	0	87.06	0
3	1	1	32.664	58.633	56.752	99.586	8.1823	18.852	18.656	0
3	1	1	38.621	86.16	60.257	97.212	11.946	5.8913	23.401	0.1636
3	1	1	32.075	71.791	54.108	99.017	21.765	9.8188	28.638	0
3	2	1	22.715	98.849	53.478	91.946	116.516	0.1636	22.911	1.6365
3	2	1	24.444	85.732	50.044	96.3	126.662	4.4185	29.816	1.4728
3	2	1	20.953	99.322	47.495	91.999	141.718	0	36.362	0.9819
3	2	1	94.756	94.864	88.02	96.396	1.3092	1.1455	3.142	1.8001
3	2	1	83.978	88.202	81.125	97.863	4.4185	3.4366	6.0877	0.8182
3	2	1	91.868	96.224	93.792	97.392	1.4728	0.8182	1.8001	1.4728
3	2	1	42.495	94.841	27.198	97.835	56.131	1.1455	94.26	0.6546
3	2	1	42.657	96.162	26.275	98.817	43.694	0.1636	95.406	0.3273
3	2	1	44.913	95.655	25.698	98.712	36.33	0.8182	99.006	0
3	2	1	28.57	95.78	19.125	87.952	91.642	0.9819	146.627	15.383
3	2	1	30.543	77.799	16.563	96.482	86.896	2.6183	121.589	0
3	2	1	35.667	93.503	13.336	97.644	64.313	1.0146	125.026	0.4909
3	2	1	24.304	86.384	25.933	98.132	76.587	4.9094	107.516	0.3273
3	2	1	33.186	82.358	38.438	96.365	63.495	2.2256	75.016	0.3273
3	2	1	90.982	91.637	34.074	91.847	1.3092	2.2911	56.622	1.9638
3	2	1	89.65	79.127	47.582	96.19	5.073	6.9059	41.304	0.4909
3	2	1	45.971	86.913	13.509	96.288	49.749	5.564	137.299	0.4909
3	2	1	33.304	99.535	17.476	94.497	82.151	0.1636	124.633	1.6365

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
3	1	3	44.236	99.395	68.513	99.51	36.369	0.3247	54.163	0
3	1	3	36.393	99.439	62.405	99.475	62.996	0	68.711	0.1624
3	1	3	36.531	97.536	29.154	99.372	82.479	0.1948	133.006	0
3	1	3	41.18	82.592	32.425	99.478	55.657	7.1439	133.785	0
3	1	3	40.308	96.433	53.865	84.371	84.168	0.9742	42.863	1.9483
3	1	3	78.353	97.647	51.548	89.317	10.424	3.2472	45.818	0.1624
3	1	3	83.64	81.36	74.32	99.881	12.859	20.62	19.159	0
3	1	3	50.829	99.272	71.98	87.24	55.04	0.1624	14.937	1.9483
3	1	3	49.401	98.643	65.217	97.487	69.977	0.2922	48.383	0.8118
3	1	3	79.58	99.031	68.205	88.381	25.393	0.3247	44.162	4.5461
3	1	3	78.701	84.66	12.327	99.94	27.926	11.982	113.945	0
3	1	3	48.721	94.035	34.514	99.798	47.896	5.5203	71.926	0
3	1	3	65.289	99.39	20.765	88.319	29.225	0.1624	113.555	0.9742
3	1	3	27.758	98.871	98.697	99.591	105.372	0.6494	0.3572	0
3	1	3	31.344	89.975	94.465	99.818	99.689	5.1955	1.9483	0
3	1	3	27.206	97.995	68.21	85.09	105.404	2.1107	24.841	6.0723
3	1	3	99.876	99.163	99.88	98.148	0	0.4871	0	0.9742
3	1	3	99.074	99.632	99.56	97.651	0.1624	0	0.1624	1.786
3	2	3	75.503	96.853	99.672	99.533	36.531	2.4354	0	0
3	2	3	99.442	99.082	99.896	85.319	0	0.1624	0	8.7675
3	2	3	69.574	83.728	84.273	99.763	42.246	17.373	20.977	0
3	2	3	71.204	86.759	75.08	93.086	34.063	1.786	25.491	0.4871
3	2	3	99.552	99.159	81.507	99.455	0.1624	0.3247	15.911	0.3247
3	2	3	98.644	74.866	76.455	99.917	0.1624	22.893	32.472	0
3	2	3	98.401	99.896	79.177	99.502	1.6236	0	16.691	0.3247
3	2	3	98.843	97.746	79.642	98.474	0.1624	0	20.328	1.4612
3	2	3	48.795	97.965	74.374	84.887	72.25	2.1107	38.642	5.5852
3	2	3	51.201	82.937	53.368	88.578	66.633	5.5203	80.368	6.6568
3	2	3	51.485	98.644	98.734	99.928	83.94	0	0.8118	0
3	2	3	48.494	91.364	79.568	99.712	90.272	2.273	33.511	0
3	2	3	18.465	89.292	76.375	98.858	149.761	0.8118	27.374	0.9742
3	2	3	18.748	90.034	60.137	99.682	154.892	0	63.483	0
3	2	3	42.224	53.429	99.706	95.783	68.549	72.445	0.4871	0.6494
3	2	3	43.282	64.598	99.761	99.577	71.633	55.203	0	0.1624
3	2	3	35.239	99.54	97.612	99.242	98.39	0	2.7601	0.3247
3	2	3	33.055	99.598	85.825	91.536	96.929	0	1.6885	1.2989

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
3	3	1	98.279	99.466	47.282	58.116	1.1455	0.1636	33.384	19.212
3	3	1	98.501	98.64	51.653	52.581	0	0.1636	25.169	23.958
3	3	1	99.471	99.5	50.919	53.99	0	0	26.838	23.565
3	3	1	92.14	44.631	48.287	73.655	2.9456	40.093	28.049	15.874
3	3	1	87.8	41.434	49.646	64.473	10.146	47.49	26.674	13.746
3	3	1	84.73	39.028	49.437	60.766	10.506	49.094	23.598	18.165
3	3	1	13.583	91.332	26.635	20.918	131.899	2.1274	95.733	120.444
3	3	1	13.036	90.249	24.656	18.902	121.917	2.4547	86.078	115.371
3	3	1	13.69	73.728	24.614	21.429	140.409	8.8042	82.151	108.17
3	3	1	31.106	84.888	32.732	98.834	86.078	6.3822	82.151	0.1636
3	3	1	39.711	94.591	28.68	98.92	59.895	1.1455	92.297	0.4909
3	3	1	39.655	95.204	29.268	98.022	65.295	0.3273	89.678	0.3273
3	3	1	16.587	83.03	8.4433	91.195	58.749	9.4915	102.934	2.9456
3	3	1	71.942	41.704	9.5706	94.272	11.128	53.84	106.534	1.4728
3	3	1	50.45	96.641	85.911	96.474	27.493	0.6546	7.855	2.6183
3	3	1	54.628	97.034	79.763	97.761	17.183	0.3273	10.801	0.3273
3	3	1	32.276	96.077	18.84	97.716	68.404	3.9275	115.371	1.1455
3	3	1	45.296	99.949	21.291	98.44	42.548	0	108.498	0.6546
3	4	1	37.545	95.34	7.3483	68.553	57.113	0.8182	7.3483	7.0041
3	4	1	35.629	94.445	8.3594	89.678	60.713	1.4728	8.3594	2.9456
3	4	1	30.397	95.616	10.542	68.591	62.186	0.6546	10.542	7.855
3	4	1	37.13	98.918	36.068	72.633	40.748	0	36.068	21.634
3	4	1	44.512	95.305	33.451	75.205	32.566	5.564	33.451	18.656
3	4	1	46.296	98.922	34.717	80.841	27.002	0.1636	34.717	3.4366
3	4	1	10.5	80.37	10.31	87.681	78.55	3.4366	10.31	4.2548
3	4	1	12.085	93.612	9.6302	90.731	140.572	1.3092	9.6302	2.6183
3	4	1	10.574	95.47	9.8301	89.141	121.753	0.6546	9.8301	3.4366
3	4	1	20.332	99.996	63.748	96.511	112.262	0	63.748	2.4547
3	4	1	19.016	98.777	44.537	88.449	102.443	0	44.537	1.4728
3	4	1	13.097	97.858	36.189	87.944	93.933	0	36.189	1.4728
3	4	1	32.331	98.665	63.988	96.178	62.022	0.1636	63.988	1.4728
3	4	1	34.602	99.114	37.861	95.61	66.44	0.5237	37.861	1.3092
3	4	1	20.895	99.719	53.728	97.429	82.805	0	53.728	1.8001
3	4	1	20.503	97.531	18.645	99.546	77.896	0.1636	18.645	0
3	4	1	18.791	95.347	7.727	36.33	133.045	1.8001	7.727	44.839
3	4	1	11.659	99.237	13.783	44.362	136.318	0.1636	13.783	27.656

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
3	3	3	75.021	96.065	99.803	99.943	17.73	4.8708	0	0
3	3	3	73.384	99.452	97.479	99.777	25.588	0	1.2989	0.1624
3	3	3	65.827	99.592	30.098	98.395	36.921	0	117.062	0.4871
3	3	3	54.809	93.991	29.408	87.747	52.15	4.8708	116.25	0.6494
3	3	3	42.69	99.144	17.446	92.769	76.309	0.3247	128.265	0.8118
3	3	3	55.44	99.19	11.699	99.716	63.321	0.3247	145.15	0
3	3	3	27.433	77.995	99.608	91.331	122.907	8.118	0.4871	1.2664
3	3	3	30.216	99.291	96.578	94.626	126.966	0.1624	2.273	0.4221
3	3	3	54.093	98.307	57.989	99.276	44.454	0.3247	40.655	0.3247
3	3	3	59.856	95.267	55.965	92.931	42.376	1.9483	44.844	1.1365
3	3	3	60.336	96.496	20.651	99.907	39.681	3.2472	136.74	0
3	3	3	31.892	96.532	21.626	96.699	106.671	2.5978	138.623	0
3	3	3	33.186	47.505	58.448	73.197	102.449	63.418	61.697	25.913
3	3	3	30.282	91.368	60.073	97.817	113.49	4.059	60.073	3.0848
3	3	3	62.498	98.192	80.274	90.045	42.376	1.1365	14.288	3.7343
3	3	3	61.132	80.314	99.304	99.67	45.136	4.8708	0.6494	0.3247
3	3	3	24.047	98.081	49.502	99.924	99.04	1.4612	41.727	0
3	3	3	22.589	75.512	46.535	94.963	100.858	8.1505	45.169	0
3	4	3	20.492	98.597	97.785	96.891	116.997	0.6494	0.4871	0.3247
3	4	3	44.949	76.133	80.466	94.12	76.732	7.4686	3.9291	1.9483
3	4	3	41.134	98.971	98.436	78.776	83.161	0.1624	0.6494	5.5203
3	4	3	44.491	98.001	97.596	80.782	50.656	0.1624	0.6494	7.7933
3	4	3	40.667	37.079	98.845	99.984	61.762	93.714	0.3247	0
3	4	3	40.483	40.24	38.244	99.976	67.38	90.792	63.645	0
3	4	3	33.659	99.059	36.158	70.545	92.221	0.8118	85.726	8.9298
3	4	3	34.007	80.088	34.143	87.66	79.622	10.878	81.018	3.7343
3	4	3	64.605	99.565	44.284	41.809	32.31	0	71.731	60.755
3	4	3	97.487	98.554	52.257	37.506	0	0.6494	55.203	85.077
3	4	3	69.334	99.249	45.677	95.395	31.011	0.6494	51.014	0.4871
3	4	3	97.133	98.927	55.13	99.721	1.786	0.1624	37.83	0.1624
3	4	3	79.097	98.894	35.861	99.376	8.9298	0.3247	113.815	0.4871
3	4	3	92.583	98.762	22.609	91.193	3.8967	0.3247	107.483	0.6494
3	4	3	92.636	98.628	25.088	49.709	4.7085	0.0974	116.575	45.916
3	4	3	61.605	97.328	32.689	43.563	39.356	0.9742	102.32	55.04
3	4	3	66.345	98.67	99.161	32.702	47.214	1.4612	0	86.051
3	4	3	27.659	98.3	99.206	28.851	156.645	0	0.1624	106.346

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
4	1	1	3.1793	88.122	4.4087	88.963	50.403	2.4547	63.331	2.6183
4	1	1	6.2434	81.836	3.5144	97.146	81.66	3.1093	59.076	0.3273
4	1	1	12.969	88.573	3.406	93.714	104.57	1.6365	56.294	1.6365
4	1	1	1.6264	28.348	5.21	85.324	23.892	81.169	66.931	1.9638
4	1	1	3.0213	35.264	46.664	21.02	47.294	64.902	39.275	109.48
4	1	1	4.88	29.108	45.638	20.69	41.73	81.987	43.694	116.222
4	1	1	26.748	37.536	45.228	19.516	90.169	58.422	42.221	115.534
4	1	1	33.285	37.209	38.892	19.339	77.274	58.945	57.996	107.679
4	1	1	34.655	39.086	3.9725	38.558	74.197	54.658	65.786	53.218
4	1	1	3.8175	39.529	2.2671	39.554	57.604	51.876	62.84	49.094
4	1	1	3.14	38.505	2.274	39.696	48.276	54.822	65.459	42.581
4	1	1	3.2825	38.329	2.6699	39.424	47.948	57.113	67.095	50.436
4	1	1	5.3358	51.972	3.2785	41.068	73.15	18.034	49.421	41.566
4	1	1	12.185	50.175	3.4106	43.353	78.223	18.492	49.421	35.806
4	1	1	8.6457	49.966	6.0341	42.384	80.35	17.674	54.331	37.671
4	1	1	18.718	30.855	34.665	45.794	95.733	96.29	44.021	26.674
4	1	1	19.704	27.029	32.99	42.463	87.453	106.37	47.294	36.657
4	1	1	18.129	28.962	41.304	42.59	99.333	102.443	42.221	36.166
4	2	1	15.935	35.676	6.5394	41.827	90.66	60.222	83.951	43.53
4	2	1	13.793	38.272	7.2476	41.702	101.134	51.221	80.678	45.33
4	2	1	14.047	37.531	10.894	41.745	102.77	53.84	138.609	45.821
4	2	1	8.9539	44.068	8.4375	50.791	83.623	32.729	95.897	21.634
4	2	1	8.1326	46.341	7.6428	46.867	89.678	27.984	107.843	30.929
4	2	1	5.7257	46.397	8.4012	47.428	59.895	32.729	107.843	30.602
4	2	1	19.02	47.861	8.2572	73.417	120.117	23.401	83.132	8.346
4	2	1	14.651	47.804	12.301	54.497	105.225	21.274	99.497	19.638
4	2	1	16.796	49.854	13.924	50.299	116.025	23.172	103.916	23.074
4	2	1	11.318	42.312	3.2361	41.101	78.878	43.039	68.404	57.996
4	2	1	5.0302	44.691	2.3547	38.47	60.058	36.33	50.894	60.386
4	2	1	5.397	36.747	2.358	41.338	60.549	61.302	40.748	51.549
4	2	1	6.8994	44.445	3.7241	26.044	58.258	39.21	58.913	99.366
4	2	1	14.742	54.517	5.2288	22.249	62.349	27.984	90.333	111.607
4	2	1	18.259	34.61	5.1278	56.378	113.571	58.815	86.078	14.041
4	2	1	14.779	42.036	4.0706	50.843	126.499	44.021	63.331	17.674
4	2	1	12.582	39.47	53.883	95.039	120.28	51.221	26.838	0.4909
4	2	1	22.974	38.245	41.656	91.725	122.244	54.331	43.039	1.1455

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
4	1	3	87.191	25.656	24.419	55.842	3.0848	90.597	117.711	21.107
4	1	3	54.576	19.927	21.747	56.041	44.649	114.464	131.544	15.424
4	1	3	70.03	48.575	50.686	10.265	11.365	30.524	22.113	121.121
4	1	3	88.784	53.052	44.337	16.497	3.7343	16.398	38.155	127.453
4	1	3	23.866	62.572	13.892	30.459	134.434	18.834	136.058	80.856
4	1	3	20.189	49.719	12.886	37.533	134.759	28.575	135.084	77.771
4	1	3	96.553	39.926	52.763	69.453	0.1624	48.871	21.464	15.262
4	1	3	98.308	51.378	45.296	65.745	0	31.336	37.343	9.4819
4	1	3	72.981	48.712	34.338	44.498	9.0922	36.206	74.751	32.407
4	1	3	83.484	56.835	28.064	51.743	6.0073	16.885	95.468	24.549
4	1	3	36.732	6.6011	29.079	38.018	64.619	101.638	101.962	68.841
4	1	3	18.038	4.8445	24.465	11.063	108.294	99.202	127.615	142.715
4	1	3	20.829	15.509	16.387	10.906	126.154	132.811	125.537	91.409
4	1	3	28.804	15.921	30.547	14.221	107.807	134.922	85.239	107.158
4	1	3	17.336	11.319	25.359	48.636	148.722	121.283	121.933	33.771
4	1	3	14.181	19.967	16.827	47.696	139.792	153.755	126.804	33.933
4	1	3	17.488	10.657	54.198	13.958	126.966	102.612	19.97	101.313
4	1	3	20.751	6.5054	51.761	3.9369	138.818	91.409	23.575	68.841
4	2	3	43.758	28.212	62.798	67.738	50.656	92.87	10.618	13.703
4	2	3	39.552	31.139	61.96	71.497	67.217	83.94	12.664	8.3453
4	2	3	16.788	74.867	3.035	57.839	166.582	6.6568	74.361	14.418
4	2	3	19.156	60.681	16.648	61.156	168.53	6.3321	103.748	14.937
4	2	3	13.041	74.491	11.332	69.525	127.291	5.0656	120.471	9.5793
4	2	3	16.686	44.905	9.8826	79.259	150.346	42.701	120.634	3.5719
4	2	3	5.8974	50.917	22.372	71.15	96.604	33.122	100.014	8.8974
4	2	3	7.847	74.365	22.957	75.579	130.375	9.2545	114.302	4.8708
4	2	3	47.035	88.201	87.001	60.95	32.959	3.2472	3.4096	27.764
4	2	3	50.601	58.753	77.293	39.775	35.07	16.269	8.5077	58.937
4	2	3	5.6658	81.276	20.718	18.761	104.235	3.8967	100.664	96.929
4	2	3	4.1444	88.823	15.131	18.13	108.619	2.3055	134.434	101.638
4	2	3	2.051	67.337	7.9884	38.613	58.612	11.69	121.77	73.062
4	2	3	1.0816	60.845	5.1025	23.06	34.096	12.826	87.35	102.125
4	2	3	13.489	75.012	14.061	91.087	157.814	4.8708	142.065	2.7601
4	2	3	5.5651	72.849	14.492	67.703	113.165	5.4878	162.685	15.749
4	2	3	36.786	86.44	13.905	58.901	81.018	2.7601	118.686	18.996
4	2	3	31.016	88.553	10.587	53.705	91.247	1.5262	141.903	19.97

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
4	3	1	28.523	39.944	50.915	21.04	100.315	50.894	38.457	115.862	4	3	3	50.164	24.077	29.557	57.584	45.948	126.479	99.527	8.0856
4	3	1	25.508	39.972	56.889	21.528	111.116	49.454	17.936	112.752	4	3	3	51.846	22.486	28.36	79.615	45.461	119.432	107.45	8.6051
4	3	1	25.864	39.981	54.142	21.68	111.934	52.04	20.947	111.771	4	3	3	19.593	82.637	36.578	53.128	124.206	4.3837	68.581	28.088
4	3	1	5.1864	45.789	6.2584	95.918	69.877	33.384	101.297	1.1455	4	3	3	21.861	77.368	46.041	65.022	131.674	5.7476	44.162	13.638
4	3	1	2.5117	44.902	5.9593	59.181	39.112	32.402	99.497	17.837	4	3	3	14.652	82.981	24.968	60.547	136.545	3.2472	129.239	14.612
4	3	1	6.996	45.404	6.7418	60.024	77.568	30.929	104.734	14.401	4	3	3	79.198	70.968	6.7862	57.533	6.4944	6.3321	81.18	19.321
4	3	1	68.15	48.846	12.805	67.339	18.492	24.383	64.477	10.146	4	3	3	66.699	82.32	14.302	37.56	15.749	7.3062	120.796	69.003
4	3	1	73.624	46.053	11.807	59.18	5.7931	33.548	62.186	15.055	4	3	3	54.038	63.238	11.104	37.743	30.426	12.502	112.841	71.828
4	3	1	69.584	45.905	12.074	56.136	10.146	34.038	63.331	17.183	4	3	3	11.42	79.599	7.2618	55.597	167.881	7.7933	99.365	18.022
4	3	1	18.339	54.133	5.659	17.689	84.278	17.837	56.785	98.679	4	3	3	10.785	75.835	7.7993	57.945	165.445	8.6051	113.652	11.852
4	3	1	23.205	46.336	3.4598	19.38	86.242	29.784	61.367	98.842	4	3	3	22.225	58.645	7.4107	57.718	131.35	19.808	80.206	16.756
4	3	1	17.868	49.558	3.6095	17.691	94.26	23.074	59.567	105.061	4	3	3	26.817	77.149	68.535	34.664	123.069	9.0922	8.2804	78.582
4	3	1	12.164	50.755	22.958	24.806	76.423	24.056	123.88	96.879	4	3	3	22.821	42.372	71.986	29.005	119.984	55.073	8.66051	104.56
4	3	1	18.664	50.238	24.575	26.163	102.115	26.38	118.807	95.406	4	3	3	4.5444	46.508	54.148	51.352	84.752	44.324	23.055	30.686
4	3	1	51.401	17.953	31.103	14.142	24.711	79.532	98.842	111.607	4	3	3	8.4509	32.215	49.859	14.991	86.538	78.582	31.336	99.202
4	3	1	38.16	18.793	10.039	14.2	49.094	89.187	90.006	113.734	4	3	3	8.6308	63.565	10.489	16.52	86.051	20.457	109.918	104.56
4	3	1	23.815	45.087	9.1482	92.346	108.007	42.875	97.37	2.4547	4	3	3	25.45	82.868	22.816	91.495	89.136	5.1955	110.405	1.2989
4	3	1	26.664	89.513	9.5898	94.208	104.243	2.4547	100.643	0.6546	4	3	3	30.046	79.741	20.419	74.959	80.693	7.5985	141.773	8.3453
4	4	1	0.5481	45.208	56.798	28.843	13.91	41.239	21.438	90.987	4	4	3	31.981	18.624	51.788	7.5107	107.645	167.069	26.14	131.35
4	4	1	2.3673	46.101	58.39	26.995	43.857	36.33	21.11	103.588	4	4	3	29.375	16.122	54.232	9.0759	115.114	177.622	25.783	126.154
4	4	1	7.5964	45.461	52.812	29.877	69.059	38.948	22.092	92.133	4	4	3	23.964	90.404	60.877	30.299	118.198	3.2472	24.192	86.701
4	4	1	3.487	44.373	68.983	32.199	50.894	40.257	11.652	77.896	4	4	3	16.222	79.668	46.922	20.115	122.42	10.553	46.922	129.401
4	4	1	8.1435	46.681	65.006	32.232	70.859	34.366	15.546	77.568	4	4	3	10.24	15.154	45.287	90.477	156.191	159.113	46.792	1.2989
4	4	1	1.1894	45.727	68.355	33.579	22.583	35.02	12.11	75.277	4	4	3	14.294	13.163	42.059	76.176	168.368	153.593	58.969	7.1439
4	4	1	4.4397	35.492	6.5359	43.094	39.766	76.521	99.497	38.13	4	4	3	11.427	45.912	48.258	39.039	158.789	44.649	35.395	63.97
4	4	1	2.8597	37.517	9.1254	47.157	28.965	69.844	116.025	29.456	4	4	3	18.314	50.046	39.084	36.969	155.541	26.952	68.549	66.503
4	4	1	3.1981	35.82	11.563	47.58	28.965	76.587	122.899	27.493	4	4	3	1.4595	41.133	15.933	39.686	45.623	56.079	142.553	58.125
4	4	1	48.219	47.059	5.5943	21.965	37.148	33.875	82.314	97.042	4	4	3	1.5158	40.395	16.822	36.039	46.435	62.834	131.674	76.374
4	4	1	49.264	48.954	6.1843	26.493	42.974	29.947	93.115	85.751	4	4	3	15.711	52.755	18.156	58.615	106.996	31.498	105.21	19.159
4	4	1	45.887	49.543	9.4189	25.993	41.73	29.456	86.242	88.009	4	4	3	7.833	60.062	29.971	53.298	121.933	18.347	81.343	34.583
4	4	1	6.7532	87.751	3.4081	17.223	90.169	5.073	54.167	92.133	4	4	3	56.555	37.236	10.293	9.4222	20.133	53.741	119.335	84.427
4	4	1	8.8616	92.696	3.6087	24.158	97.697	2.9456	59.076	81.987	4	4	3	28.701	39.003	7.3255	9.2373	82.999	54.878	154.892	87.837
4	4	1	7.364	97.152	42.541	36.947	97.533	0.3273	52.367	60.713	4	4	3	53.575	59.275	2.7118	11.768	22.893	12.989	72.413	143.689
4	4	1	24.215	17.803	45.241	17.621	85.587	99.563	48.276	92.624	4	4	3	48.427	86.337	4.9229	12.323	36.077	2.273	92.221	138.169
4	4	1	23.342	14.108	17.708	75.493	79.369	91.642	83.787	11.292	4	4	3	2.7389	47.519	53.054	12.997	76.959	42.538	22.99	126.154
4	4	1	22.846	9.5919	21.665	69.551	75.932	95.733	92.133	11.292	4	4	3	5.1362	44.337	56.445	9.4062	120.309	44	22.243	110.73

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
5	1	1	22.141	44.124	9.9328	48.095	125.517	40.912	63.986	23.892
5	1	1	15.158	47.912	9.6165	48.254	125.353	26.674	63.658	27.165
5	1	1	11.971	46.802	10.12	48.15	118.644	30.602	68.568	31.584
5	1	1	28.057	41.31	37.139	57.794	59.731	43.694	51.385	13.746
5	1	1	22.876	43.138	38.182	52.568	63.822	40.912	46.148	23.467
5	1	1	10.045	46.207	37.415	54.93	66.44	34.202	51.876	20.03
5	1	1	16.099	51.701	42.609	51.887	94.751	17.51	29.227	27.493
5	1	1	15.439	52.381	42.674	55.055	83.787	21.929	24.58	18.918
5	1	1	16.508	75.963	42.785	59.594	88.86	4.9094	27.493	16.234
5	1	1	9.3045	54.689	9.9074	13.432	99.006	25.365	81.987	110.789
5	1	1	11.048	35.13	14.858	11.478	95.733	58.749	106.37	115.043
5	1	1	10.315	25.573	8.3799	12.186	91.642	88.533	77.732	112.425
5	1	1	5.0269	10.416	12.675	16.067	80.187	130.099	80.187	105.225
5	1	1	5.3734	11.275	8.0842	15.353	72.495	143.191	63.495	95.242
5	1	1	65.819	13.771	37.076	20.768	14.434	147.118	32.729	100.806
5	1	1	96.928	59.369	87.2	16.691	0.4909	9.6551	2.4547	110.298
5	1	1	68.882	59.79	2.2522	83.395	8.1823	10.31	49.912	2.1274
5	1	1	85.681	80.386	2.4845	81.658	2.1274	4.7457	55.803	1.6365
5	2	1	15.508	88.208	1.1521	32.202	130.59	3.4366	31.911	67.455
5	2	1	13.377	85.281	1.5331	32.05	129.281	2.9456	32.729	71.023
5	2	1	12.072	14.756	1.5762	33.365	122.408	110.952	34.202	59.24
5	2	1	5.0837	15.598	27.556	34.941	81.987	105.388	96.551	36.853
5	2	1	4.8795	16.793	26.624	52.724	80.678	117.007	89.024	20.619
5	2	1	5.0441	51.962	20.77	56.751	86.569	20.783	126.662	19.965
5	2	1	10.008	54.558	20.67	48.15	114.716	24.58	132.554	29.325
5	2	1	13.743	53.718	20.982	48.86	84.605	28.311	131.899	30.438
5	2	1	10.415	51.95	39.892	47.873	102.606	23.729	33.875	29.62
5	2	1	3.0088	51.792	38.206	26.468	46.476	20.979	42.712	100.152
5	2	1	1.928	51.3	38.449	27.3	28.147	19.048	40.781	99.006
5	2	1	2.5703	50.076	6.0324	29.606	44.185	22.583	84.933	81.496
5	2	1	18.144	52.053	7.3024	47.059	121.098	20.947	82.478	37.966
5	2	1	13.104	50.442	6.128	57.955	116.189	23.401	89.187	20.619
5	2	1	26.956	39.867	5.2215	92.034	101.788	50.894	62.349	2.9456
5	2	1	21.869	40.136	5.0555	86.938	102.443	52.203	69.713	3.9275
5	2	1	26.625	43.751	5.1131	13.998	80.678	40.29	67.422	70.532
5	2	1	14.014	40.831	39.777	16.349	116.68	44.348	37.311	71.514

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
5	1	3	6.6612	79.604	7.6649	41.941	85.889	9.2545	126.479	56.014
5	1	3	6.8973	97.777	10.844	43.299	83.453	0.6494	120.634	56.826
5	1	3	4.4521	42.963	18.893	66.975	75.985	32.797	93.357	15.424
5	1	3	5.5923	48.563	25.838	56.68	100.339	24.029	86.863	18.866
5	1	3	22.3855	39.446	21.529	42.509	104.235	40.752	122.745	44.649
5	1	3	35.685	52.92	23.081	37.594	81.992	20.457	124.043	58.774
5	1	3	18.484	81.305	57.519	30.554	87.999	7.7933	20.295	70.172
5	1	3	18.099	74.586	56.736	24.148	107.645	9.0922	18.347	63.97
5	1	3	6.6678	91.354	52.616	46.131	81.667	3.4096	29.712	45.299
5	1	3	9.0105	79.483	53.525	69.553	127.778	4.059	25.653	7.6309
5	1	3	15.726	20.706	51.544	38.436	136.708	78.42	25.166	67.055
5	1	3	17.958	43.35	40.785	26.999	145.313	33.446	43.837	107.483
5	1	3	17.521	26.676	32.138	59.647	112.678	57.313	65.269	16.074
5	1	3	20.555	50.178	7.9789	72.477	127.453	18.996	84.59	8.6051
5	1	3	20.19	57.926	9.9056	41.167	98.878	22.406	94.494	45.299
5	1	3	17.449	68.125	8.1638	30.938	95.468	18.834	67.704	72.9
5	1	3	62.015	78.278	59.674	61.894	12.664	10.066	20.295	12.502
5	1	3	52.742	40.232	65.085	79.571	24.419	27.114	11.041	5.1955
5	2	3	13.99	73.073	49.077	40.175	124.206	10.066	30.686	65.431
5	2	3	19.531	71.757	55.792	39.263	155.541	10.391	18.022	62.509
5	2	3	14.686	35.979	13.085	41.394	151.482	52.118	148.722	44.974
5	2	3	11.892	37.081	10.214	31.402	138.169	52.442	136.708	80.531
5	2	3	18.196	46.663	14.45	56.861	121.933	23.38	111.217	17.21
5	2	3	19.73	81.247	18.56	63.753	118.848	3.8967	136.415	11.69
5	2	3	20.295	26.472	9.1815	41.689	81.862	67.055	87.025	57.313
5	2	3	32.592	36.381	16.272	31.858	63.808	56.826	97.092	86.376
5	2	3	20.934	15.828	34.501	20.97	126.479	74.848	78.095	122.745
5	2	3	15.069	19.561	34.954	17.477	148.885	66.081	79.719	138.818
5	2	3	3.9354	10.044	37.206	46.251	89.136	77.446	66.405	42.766
5	2	3	4.6738	11.869	30.706	48.37	99.365	74.523	86.213	33.609
5	2	3	5.7424	20.77	61.04	20.559	92.87	76.472	13.963	106.346
5	2	3	5.8117	26.84	61.223	30.699	114.627	72.25	12.826	82.317
5	2	3	12.189	35.28	14.397	55.715	137.682	44	147.099	21.756
5	2	3	7.6357	43.645	10.991	50.024	112.191	34.096	146.774	30.361
5	2	3	12.057	31.206	9.2456	59.894	140.929	48.871	135.571	19.321
5	2	3	6.7497	22.436	9.0047	60.544	112.516	63.97	128.265	16.723

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
5	3	1	16.063	46.711	22.065	20.339	93.769	37.475	102.115	97.861	5	3	3	24.636	49.473	22.562	9.3342	69.003	20.133	103.261	151.158
5	3	1	9.1363	45.977	20.87	17.316	75.277	38.293	106.534	106.861	5	3	3	15.17	48.943	15.876	27.766	150.346	22.893	96.28	82.641
5	3	1	9.7737	46.358	18.469	17.462	86.405	36.853	111.607	108.17	5	3	3	20.301	24.391	14.171	26.185	143.202	93.195	98.878	85.889
5	3	1	15.368	48.445	30.335	57.48	121.426	37.475	61.073	14.237	5	3	3	19.715	15.171	21.585	19.907	154.567	111.542	100.014	128.427
5	3	1	14.281	48.823	27.265	63.008	125.19	29.129	69.877	15.546	5	3	3	24.366	6.2518	11.385	26.665	130.863	85.889	94.331	108.457
5	3	1	13.737	50.625	29.605	59.079	124.208	28.965	60.713	16.037	5	3	3	37.562	5.2184	5.6821	51.968	75.011	70.627	62.184	28.121
5	3	1	27.571	12.892	12.826	61.531	103.425	122.08	132.717	11.946	5	3	3	35.12	74.519	2.4964	51.767	78.94	8.6051	50.169	25.328
5	3	1	30.932	13.005	11.437	63.463	89.515	117.662	128.79	15.055	5	3	3	27.031	56.659	2.4242	31.778	110.243	13.638	48.221	82.317
5	3	1	28.691	14.484	12.079	59	95.897	121.589	132.39	19.801	5	3	3	17.828	14.283	47.463	36.3	131.025	87.837	31.888	77.771
5	3	1	16.234	57.279	40.169	43.086	95.897	16.365	48.112	47.523	5	3	3	21.744	14.768	45.966	82.642	117.841	86.701	34.453	2.7601
5	3	1	24.803	53.338	34.418	47.991	88.205	19.343	66.277	36.657	5	3	3	16.867	62.68	41.228	94.454	99.365	22.243	62.834	1.6236
5	3	1	23.101	53.716	11.702	46.835	93.769	21.274	92.297	38.948	5	3	3	33.885	72.246	34.555	29.728	87.74	8.2804	77.608	99.365
5	3	1	27.036	32.736	5.2745	32.444	91.315	69.877	62.186	78.223	5	3	3	43.783	58.359	16.587	38.891	45.169	14.45	128.102	56.339
5	3	1	19.677	33.661	16.532	43.29	103.425	65.459	109.97	42.417	5	3	3	41.54	59.686	11.247	54.685	47.766	17.21	111.704	23.055
5	3	1	28.329	32.101	34.267	56.699	81.66	66.768	62.84	18.656	5	3	3	41.308	80.598	12.073	52.224	44	4.3837	139.143	32.472
5	3	1	11.908	27.257	32.564	53.055	83.623	75.932	72.823	23.892	5	3	3	38.91	79.351	9.0034	97.984	49.845	5.3579	112.516	0.4871
5	3	1	30.928	38.999	43.357	17.126	75.441	55.476	33.548	121.098	5	3	3	18.263	41.51	9.599	94.17	121.933	26.465	92.708	0.8118
5	3	1	29.568	39.041	45.474	12.384	74.786	54.003	30.438	112.098	5	3	3	27.167	48.406	22.835	80.449	111.282	21.951	75.985	3.9291
5	4	1	16.66	40.593	34.095	41.778	81.496	45.657	56.294	41.894	5	4	3	13.733	26.368	96.68	86.074	115.114	64.782	0	4.059
5	4	1	31.716	42.123	36.013	42.312	52.531	44.185	44.185	36.493	5	4	3	12.135	46.335	93.774	82.34	125.18	28.088	1.9483	5.3579
5	4	1	18.759	42.325	37.557	43.413	73.805	43.857	43.595	36.33	5	4	3	18.175	46.116	2.3022	71.004	116.283	21.269	51.631	13.476
5	4	1	3.7855	40.71	13.541	47.514	51.876	45.166	88.86	24.874	5	4	3	10.819	28.781	3.0621	59.679	133.785	52.28	58.612	15.814
5	4	1	6.2886	41.957	15.42	50.232	87.387	42.712	88.205	25.889	5	4	3	3.5461	14.629	11.368	23.599	87.837	120.796	139.305	109.593
5	4	1	5.761	39.901	12.13	46.123	78.714	45.33	82.674	28.474	5	4	3	5.4776	16.674	9.6058	16.934	107.158	122.907	139.792	121.121
5	4	1	9.3022	45.604	5.6516	38.687	88.042	32.729	80.023	44.348	5	4	3	21.025	45.689	65.834	51.058	123.881	48.546	11.852	25.913
5	4	1	11.653	49.394	7.1535	38.1	92.788	26.543	87.878	47.13	5	4	3	19.686	43.042	68.852	49.552	117.549	51.144	13.963	28.9
5	4	1	9.9127	45.862	7.6834	39.209	85.096	33.548	88.696	49.421	5	4	3	2.222	58.05	4.5089	54.759	56.826	30.037	75.011	22.568
5	4	1	3.1004	48.295	13.985	34.927	60.713	23.892	93.933	57.996	5	4	3	4.0815	85.878	10.351	65.356	107.158	3.8967	145.15	13.151
5	4	1	3.3647	43.983	12.457	31.653	55.313	34.857	87.06	70.041	5	4	3	30.477	56.132	11.31	25.496	84.915	35.557	133.947	111.055
5	4	1	2.6598	40.134	14.081	30.407	34.693	41.403	94.915	73.15	5	4	3	33.042	67.779	5.1316	27.676	72.413	16.885	82.641	120.147
5	4	1	3.09	62.91	1.7979	34.304	58.095	11.619	24.056	54.494	5	4	3	4.0688	67.87	16.559	64.285	87.837	11.69	128.427	13.801
5	4	1	5.2308	64.345	1.3456	34.046	83.623	9.6551	19.638	59.404	5	4	3	12.458	82.669	28.441	50.53	103.489	6.6568	90.272	26.302
5	4	1	6.9506	5.8015	1.3081	30.072	97.697	84.769	18.328	86.405	5	4	3	20.179	25.636	31.667	54.997	144.533	102.774	81.83	21.919
5	4	1	5.9839	5.763	8.6417	36.91	66.44	86.733	102.934	61.793	5	4	3	16.001	26.306	56.234	56.798	146.449	104.885	17.6	29.225
5	4	1	15.06	5.6286	3.4274	76.033	95.079	83.623	42.712	2.9456	5	4	3	31.425	55.158	56.463	14.642	81.602	27.601	17.535	108.944
5	4	1	8.1039	43.006	22.721	72.876	89.515	33.057	79.532	5.073	5	4	3	35.669	56.464	2.6469	18.479	67.542	21.269	53.904	100.501

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
6	1	1	10.271	26.382	45.33	38.493	112.098	87.387	106.37	61.367
6	1	1	8.4687	21.908	36.69	40.578	100.479	97.042	119.462	46.312
6	1	1	8.3959	23.846	46.672	39.459	99.988	98.842	90.66	52.04
6	1	1	52.35	36.627	27.329	19.089	21.438	63.986	82.478	114.553
6	1	1	53.371	32.425	29.129	20.723	22.42	73.805	61.695	113.931
6	1	1	55.378	33.59	28.802	19.685	21.11	66.768	58.422	119.953
6	1	1	2.4061	73.255	93.279	27.749	28.638	6.8732	60.386	80.023
6	1	1	0.7168	71.575	92.788	26.66	9.9824	5.4003	50.076	71.841
6	1	1	4.5977	8.2133	101.395	26.575	85.587	98.679	62.349	71.677
6	1	1	4.7403	6.2607	45.166	45.583	81.332	92.951	50.076	36.166
6	1	1	78.441	7.5964	49.585	46.187	5.2367	73.968	81.005	30.275
6	1	1	85.946	7.2448	47.687	47.101	1.9638	74.786	99.824	29.947
6	1	1	40.178	8.2419	2.782	47.966	51.221	77.896	43.694	32.238
6	1	1	42.374	37.733	10.31	45.153	46.148	49.389	64.477	39.93
6	1	1	26.964	36.508	3.2729	45.682	82.805	63.658	81.496	41.043
6	1	1	19.609	54.545	6.3168	11.46	78.387	14.728	65.688	60.386
6	1	1	1.334	53.863	19.965	11.312	20.947	21.34	54.822	68.241
6	1	1	1.2675	40.703	18.983	13.709	28.147	38.948	39.439	65.622
6	2	1	3.3916	55.636	84.52	20.495	60.713	14.27	4.2548	111.934
6	2	1	7.3118	60.03	73.748	20.436	101.297	10.473	6.5459	114.716
6	2	1	4.094	60.794	69.477	21.031	68.895	7.7568	6.3822	107.843
6	2	1	3.9539	61.551	1.4336	45.734	69.877	16.037	30.602	40.028
6	2	1	3.5945	63.367	1.8638	43.506	70.368	13.255	34.529	48.112
6	2	1	3.8002	48.087	2.0439	43.138	68.241	29.129	37.639	50.894
6	2	1	9.0932	42.409	56.337	36.87	102.115	42.254	24.547	66.277
6	2	1	12.931	64.818	56.022	38.321	101.134	11.455	16.201	61.695
6	2	1	12.737	47.417	53.972	37.835	104.734	31.747	23.565	64.313
6	2	1	6.2967	51.551	22.614	23.091	89.678	28.311	122.408	84.933
6	2	1	10.834	59.127	15.761	24.773	123.226	15.219	112.262	87.06
6	2	1	11.974	59.327	18.811	25.354	121.262	15.874	115.371	86.078
6	2	1	8.2993	57.514	70.551	16.029	108.17	20.129	7.5277	69.386
6	2	1	7.1941	45.249	60.326	17.973	90.497	41.37	13.746	71.35
6	2	1	7.3831	54.931	62.318	23.46	90.66	26.02	12.175	75.605
6	2	1	5.2752	43.622	14.305	23.532	90.66	44.839	117.171	78.55
6	2	1	3.9189	53.951	23.642	52.647	70.532	21.11	117.007	22.256
6	2	1	5.6917	61.642	14.241	52.134	97.042	16.528	113.243	25.856

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
6	1	3	5.4718	93.035	32.753	52.942	56.501	0.9742	85.564	23.672
6	1	3	4.7844	76.353	34.009	41.706	54.553	7.9557	73.549	51.955
6	1	3	64.619	5.3561	7.3851	56.213	13.963	64.132	69.555	23.347
6	1	3	64.344	7.7633	12.933	65.351	9.4169	88.324	111.704	10.716
6	1	3	88.703	32.06	7.3237	52.113	4.059	85.564	111.379	24.516
6	1	3	14.062	36.076	13.657	52.448	117.159	64.49	127.615	29.387
6	1	3	9.9067	33.887	19.026	32.308	94.981	70.14	99.527	67.737
6	1	3	8.8715	28.952	19.512	33.672	115.114	98.748	78.258	62.184
6	1	3	51.455	63.498	14.373	52.53	21.594	15.262	113.328	25.978
6	1	3	49.431	66.55	16.282	53.015	29.225	13.184	120.342	25.004
6	1	3	47.01	56.332	10.578	93.036	38.317	16.074	80.531	0.9742
6	1	3	39.428	62.469	16.562	77.269	51.955	15.781	97.579	3.8967
6	1	3	48.647	37.745	35.686	57.3	30.621	57.183	74.848	24.516
6	1	3	36.291	38.314	23.948	83.699	61.892	57.768	88.486	5.3579
6	1	3	18.273	5.7133	15.561	66.907	105.697	103.261	86.051	9.5143
6	1	3	12.82	4.7065	6.2142	85.409	112.516	99.04	87.025	5.3579
6	1	3	7.5431	47.151	42.015	38.146	106.573	29.777	51.631	52.118
6	1	3	10.48	50.363	24.131	40.701	106.346	24.841	103.424	51.468
6	2	3	6.4846	53.985	57.38	17.219	104.073	25.328	15.911	105.697
6	2	3	4.7938	88.126	66.365	18.066	82.479	3.5719	16.398	88.649
6	2	3	4.6616	87.138	15.003	82.309	70.789	2.273	115.438	6.9815
6	2	3	7.9089	42.473	10.498	90.938	70.302	48.708	104.885	2.5978
6	2	3	10.234	40.699	44.826	41.703	88.324	51.955	38.317	44.974
6	2	3	39.343	43.86	32.449	33.321	50.527	50.494	65.918	72.413
6	2	3	29.862	61.231	24.04	30.314	81.83	13.476	121.608	97.254
6	2	3	15.451	63.265	10.177	25.986	124.855	13.314	95.468	117.062
6	2	3	22.551	60.279	48.37	59.02	75.498	15.424	23.964	14.06
6	2	3	9.0224	61.225	63.605	80.457	66.243	12.664	10.196	4.7085
6	2	3	12.442	59.984	55.244	61.088	92.221	14.612	22.568	18.704
6	2	3	14.796	60.103	58.049	76.945	122.257	15.587	22.081	7.3062
6	2	3	12.192	54.303	10.183	14.954	126.316	13.833	115.763	119.497
6	2	3	27.566	55.407	6.6348	13.308	99.527	13.021	111.055	128.265
6	2	3	24.667	63.779	20.294	10.328	101.443	9.904	91.409	103.261
6	2	3	26.927	93.65	22.316	11.362	112.711	3.4096	89.948	108.294
6	2	3	26.503	58.252	57.106	24.729	105.859	49.163	28.575	113.003
6	2	3	66.826	33.769	68.172	20.934	13.314	70.172	13.866	125.667

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
6	3	1	7.7879	43.048	6.3195	50.697	103.588	44.839	59.567	17.347	6	3	3	63.67	28.042	19.979	40.935	27.471	88.324	93.195	56.989
6	3	1	6.5473	54.077	6.7012	51.246	101.624	23.401	67.095	22.321	6	3	3	43.034	26.788	13.764	36.906	37.895	95.338	116.575	67.867
6	3	1	4.9548	43.054	5.0959	42.366	102.115	47.13	73.15	40.912	6	3	3	39.345	45.221	50.157	26.48	43.707	35.395	34.745	105.697
6	3	1	1.1668	49.101	11.715	53.629	20.456	30.962	102.77	19.638	6	3	3	26.878	72.277	38.655	25.928	107.158	8.118	51.955	90.5
6	3	1	2.3777	48.837	7.4198	45.768	41.894	30.504	79.859	38.457	6	3	3	18.282	25.603	37.322	17.403	132.486	101.638	56.534	128.102
6	3	1	2.6621	48.941	4.6089	40.594	47.294	31.747	64.149	43.53	6	3	3	37.924	27.232	59.956	13.214	57.573	92.708	26.14	104.073
6	3	1	4.3872	33.866	34.147	64.309	57.767	61.367	66.44	12.273	6	3	3	37.742	55.767	41.178	40.668	54.228	22.73	52.085	45.948
6	3	1	4.2915	36.603	39.029	55.104	59.731	49.912	51.385	14.957	6	3	3	40.875	54.521	45.007	49.46	45.493	23.867	42.051	24.029
6	3	1	4.6165	40.125	43.355	54.734	63.331	47.948	37.475	16.201	6	3	3	50.093	54.122	27.056	10.449	31.563	20.652	96.604	107.807
6	3	1	16.323	57.915	3.1078	42.85	142.372	10.637	43.203	35.904	6	3	3	7.9523	48.997	27.62	37.888	95.143	31.985	96.832	49.13
6	3	1	17.488	59.589	1.3712	39.677	129.608	11.488	21.929	45.003	6	3	3	8.6427	56.906	37.56	31.85	94.494	35.232	61.859	68.516
6	3	1	2.7473	55.779	1.8476	40.508	36.984	13.386	28.638	43.203	6	3	3	74.795	66.208	43.677	27.417	18.314	16.398	61.372	75.563
6	3	1	1.6264	62.206	9.3233	31.099	32.238	10.997	88.86	73.477	6	3	3	24.427	70.2	10.042	19.563	87.35	10.391	117.874	115.276
6	3	1	2.3143	66.918	7.5244	32.544	38.784	9.1642	64.804	65.786	6	3	3	16.874	15.905	9.7433	22.687	101.508	142.553	90.922	119.173
6	3	1	1.4443	41.621	2.1601	70.023	21.601	44.119	40.421	7.8223	6	3	3	12.263	16.683	25.233	29.394	100.664	133.947	107.645	91.734
6	3	1	3.4989	38.716	2.8693	83.268	46.803	41.566	51.385	3.6002	6	3	3	26.912	17.112	31.388	44.947	86.895	128.427	89.785	31.823
6	3	1	9.6571	61.186	35.114	66.651	98.352	8.8369	65.295	8.8369	6	3	3	34.532	50.753	42.801	46.292	63.548	36.401	56.307	33.284
6	3	1	15.959	54.048	30.148	70.651	112.098	18.165	78.878	10.964	6	3	3	33.045	47.917	46.903	38.25	65.269	30.329	38.967	58.969
6	4	1	29.216	40.143	42.081	15.489	65.786	45.33	40.748	82.641	6	4	3	36.021	46.404	50.439	39.418	73.062	26.919	28.251	56.372
6	4	1	33.011	41.363	44.071	13.302	55.313	36.69	37.311	80.35	6	4	3	38.834	47.329	40.752	43.911	62.639	29.874	56.664	40.265
6	4	1	34.375	39.256	45.331	18.639	48.439	46.672	32.402	85.096	6	4	3	38.869	52.873	38.66	22.752	66.405	23.899	53.741	117.874
6	4	1	10.166	53.095	11.344	51.245	91.478	27.329	96.715	20.194	6	4	3	15.321	44.071	57.932	22.189	133.947	41.727	26.01	118.361
6	4	1	11.286	50.388	6.5876	57.017	90.169	29.129	77.896	11.455	6	4	3	14.155	54.772	27.254	6.3586	153.268	17.697	53.579	111.866
6	4	1	25.058	49.237	5.3886	57.747	69.222	28.802	61.04	11.619	6	4	3	12.078	46.693	27.213	7.7164	157.327	34.42	58.612	106.508
6	4	1	26.159	27.762	17.991	43.462	65.622	93.279	113.898	38.457	6	4	3	29.782	56.893	51.529	16.55	117.711	44.032	27.991	115.276
6	4	1	26.101	25.48	26.53	41.932	72.986	92.788	93.606	47.294	6	4	3	23.381	68.687	56.392	20.259	136.87	16.106	28.348	107.97
6	4	1	5.4812	24.761	26.452	40.706	67.422	101.395	90.006	45.985	6	4	3	22.686	69.257	71.833	41.706	119.822	8.7675	10.391	36.401
6	4	1	6.4902	42.704	16.947	9.0841	80.187	45.166	109.48	77.078	6	4	3	11.527	60.373	10.009	53.607	112.029	28.933	62.022	26.237
6	4	1	6.6343	40.152	15.129	7.393	77.078	49.585	113.08	72.823	6	4	3	7.2339	44.714	3.8862	20.152	98.228	39.811	88.162	131.999
6	4	1	5.449	42.245	27.854	5.1532	68.732	47.687	86.405	58.258	6	4	3	8.9476	46.257	65.982	12.636	79.232	37.343	20.457	112.353
6	4	1	30.241	89.493	74.72	5.3599	72.659	2.782	4.7457	49.749	6	4	3	20.628	50.499	57.995	97.65	94.981	57.346	12.924	0.4871
6	4	1	30.999	65.733	75.324	3.2754	63.822	10.31	6.7095	37.639	6	4	3	29.773	65.312	63.134	90.809	74.036	16.463	12.339	2.1107
6	4	1	31.914	78.738	37.326	52.137	85.914	3.2729	63.168	18.983	6	4	3	25.269	33.576	19.19	29.107	100.761	78.647	108.132	109.431
6	4	1	28.681	76.711	42.905	54.832	89.842	6.3168	45.494	15.285	6	4	3	22.124	25.809	12.68	30.736	129.401	119.335	110.243	98.553
6	4	1	2.2783	50.079	13.593	36.499	36.82	19.965	87.387	42.188	6	4	3	17.887	58.102	7.4855	71.252	117.874	16.398	114.951	32.894
6	4	1	6.3383	52.901	5.9286	32.688	63.331	18.983	70.041	66.31	6	4	3	16.404	49.165	30.318	78.682	112.353	32.797	89.201	7.4686

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
7	1	1	3.5197	35.926	43.496	39.693	28.474	56.131	34.857	36.657	7	1	3	47.747	51.358	19.64	68.592	33.122	33.446	91.441	10.553
7	1	1	4.3435	35.976	49.465	42.026	34.529	54.069	31.911	40.093	7	1	3	53.434	68.391	11.036	76.378	24.841	13.151	119.173	6.3321
7	1	1	23.212	35.804	46.914	57.638	65.786	56.622	37.311	17.183	7	1	3	6.9886	33.788	90.671	61.704	95.468	76.309	1.786	15.1
7	1	1	19.599	62.335	4.0536	61.182	71.023	16.692	44.675	12.11	7	1	3	9.9642	41.508	44.467	70.819	107.807	56.826	35.395	9.2545
7	1	1	14.762	58.35	2.484	60.224	65.622	13.583	29.947	13.157	7	1	3	27.576	60.346	17.132	60.127	89.136	20.782	121.283	12.989
7	1	1	1.9059	33.82	26.222	42.333	26.674	52.203	90.169	28.147	7	1	3	31.688	52.686	20.634	67.884	85.402	28.575	115.925	11.917
7	1	1	1.6457	30.986	29.609	90.357	27.493	59.731	77.568	2.4547	7	1	3	27.454	37.289	10.853	52.863	101.313	63.645	145.475	24.354
7	1	1	1.8882	34.746	6.6675	59.84	32.566	52.694	26.183	12.437	7	1	3	73.902	39.523	9.9059	40.049	6.8191	53.579	132.973	51.598
7	1	1	1.769	18.319	5.5383	54.381	21.601	72.495	36.33	18.165	7	1	3	63.637	74.332	14.88	52.895	11.041	11.69	123.069	27.309
7	1	1	1.8846	14.137	6.6579	55.581	23.074	76.75	54.167	14.074	7	1	3	41.658	93.215	7.9226	71.538	47.572	0.9742	114.464	11.56
7	1	1	2.6778	13.453	18.405	39.76	25.365	71.677	71.023	44.839	7	1	3	41.339	99.68	10.501	57.415	51.468	0	134.467	18.542
7	1	1	11.164	47.042	39.229	33.668	87.715	18.983	59.895	65.786	7	1	3	41.481	99.913	8.2044	72.85	52.605	0	139.468	10.391
7	1	1	14.696	49.289	37.191	19.481	112.098	22.911	61.858	101.624	7	1	3	41.834	32.001	2.4896	47.764	57.151	89.298	50.656	37.668
7	1	1	14.642	51.065	4.3349	24.653	108.334	19.474	37.639	87.551	7	1	3	36.301	26.731	4.985	55.079	63.645	103.261	80.206	24.549
7	1	1	3.6161	29.795	1.8453	33.775	36.493	73.968	27.329	76.259	7	1	3	12.495	38.599	5.7896	57.923	109.918	68.191	71.763	17.86
7	1	1	8.9232	30.65	8.9255	36.443	60.386	73.805	41.239	64.968	7	1	3	11.1	22.06	6.8162	55.307	100.988	123.232	86.051	21.464
7	1	1	12.186	35.555	9.2081	30.856	81.66	66.604	53.512	76.259	7	1	3	38.783	22.574	10.464	93.588	53.904	112.191	69.815	0.9742
7	1	1	16.59	47.234	11.253	38.379	95.242	28.507	59.895	61.04	7	1	3	28.164	20.284	3.8002	93.193	75.985	92.708	66.405	0.6494
7	2	1	16.658	44.851	21.616	41.981	92.951	33.548	75.277	35.02	7	2	3	5.3544	54.035	21.18	21.283	86.8633	35.395	84.103	87.025
7	2	1	18.751	46.499	3.7967	42.134	90.006	28.998	45.003	38.784	7	2	3	9.1345	43.608	22.818	12.948	130.7	48.708	93.52	102.287
7	2	1	1.6863	39.856	0.8173	41.427	20.947	43.53	14.237	43.366	7	2	3	12.518	64.68	5.625	84.927	117.549	12.697	83.453	3.4096
7	2	1	7.8914	38.279	11.299	44.888	47.457	54.167	73.805	40.421	7	2	3	12.794	76.786	5.137	61.602	122.257	7.6309	88.974	15.1
7	2	1	7.4102	39.049	16.968	30.115	45.657	50.239	75.768	60.386	7	2	3	2.5068	71.167	20.355	52.544	70.952	6.2671	109.106	31.855
7	2	1	23.547	21.405	14.912	29.849	53.676	64.313	96.388	56.753	7	2	3	6.4806	61.815	9.2089	87.859	70.952	16.561	103.099	4.5461
7	2	1	27.783	20.274	30.362	3.0613	46.803	65.786	84.114	36.002	7	2	3	3.8492	97.459	34.048	56.122	91.084	0.3247	76.05	17.892
7	2	1	24.875	21.352	6.9686	2.1299	52.367	64.149	58.095	19.638	7	2	3	4.4065	94.748	29.686	64.529	102.612	0.4871	86.895	12.339
7	2	1	29.073	52.992	6.8136	27.817	38.784	12.11	53.512	72.692	7	2	3	19.385	88.77	23.933	65.229	96.929	6.6568	122.907	13.314
7	2	1	42.739	51.361	43.355	26.278	24.547	13.419	44.021	81.66	7	2	3	14.528	97.54	9.3083	53.442	102.612	0.1624	112.353	26.919
7	2	1	43.647	51.858	36.931	8.7794	20.947	14.565	56.622	68.568	7	2	3	20.913	54.889	48.391	62.612	106.996	19.483	29.874	12.989
7	2	1	36.422	37.439	34.781	47.115	51.549	48.308	67.75	28.311	7	2	3	9.5241	65.01	47.559	53.035	94.494	9.0922	36.206	24.841
7	2	1	37.158	41.626	39.907	36.004	49.258	39.766	47.13	52.531	7	2	3	32.237	53.603	18.343	53.675	97.416	19.159	132.161	20.977
7	2	1	39.611	68.037	38.864	45.638	43.039	8.6733	44.021	31.42	7	2	3	32.318	48.35	19.454	92.636	96.28	33.933	142.065	0.3247
7	2	1	41.159	51.222	32.273	19.222	45.657	29.947	47.457	75.114	7	2	3	27.651	81.477	7.0533	95.05	108.457	4.5786	58.937	1.1365
7	2	1	40.859	61.859	34.975	39.521	46.476	15.874	47.294	37.148	7	2	3	34.907	86.849	3.7142	47.248	91.247	4.7409	79.557	34.583
7	2	1	23.221	38.814	15.517	48.234	82.641	52.694	77.405	21.274	7	2	3	18.957	89.03	7.4632	52.835	115.276	2.7601	95.306	21.432
7	2	1	28.1	38.123	14.48	43.706	75.016	50.567	90.006	27.984	7	2	3	12.24	96.274	8.4487	94.249	96.767	0.6494	108.944	0.6494

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
7	3	1									7	3	3	13.528	94.797	12.087	73.627	106.346	2.4354	115.763	11.852
7	3	1									7	3	3	12.998	96.202	12.648	93.645	105.859	0.1624	117.062	1.1365
7	3	1									7	3	3	14.801	28.303	43.346	74.443	122.745	93.682	45.818	7.014
7	3	1									7	3	3	74.12	31.076	49.661	94.346	14.45	84.005	28.413	0.8443
7	3	1									7	3	3	84.607	48.37	23.751	70.222	8.9298	39.746	95.63	26.789
7	3	1									7	3	3	30.611	49.091	21.079	38.234	101.151	36.531	106.508	69.166
7	3	1									7	3	3	34.475	50.283	22.666	39.049	82.804	25.685	124.206	64.782
7	3	1									7	3	3	53.47	48.553	25.005	37.642	24.841	29.712	103.911	52.767
7	3	1									7	3	3	73.118	26.818	32.548	38.981	12.015	114.464	81.732	57.313
7	3	1									7	3	3	24.63	27.068	30.578	30.211	113.003	111.736	84.752	78.745
7	3	1									7	3	3	11.486	33.738	9.6289	69.497	93.195	78.323	102.32	10.748
7	3	1									7	3	3	16.919	29.222	11.186	81.196	104.073	99.04	130.051	5.6826
7	3	1									7	3	3	18.726	38.755	15.942	66.681	125.992	71.374	121.933	15.392
7	3	1									7	3	3	43.595	47.82	36.388	49.741	49.845	38.967	51.825	28.575
7	3	1									7	3	3	37.211	54.186	43.223	61.488	71.114	27.471	40.59	21.659
7	3	1									7	3	3	38.525	47.244	39.092	27.136	74.036	30.361	49.845	102.449
7	3	1									7	3	3	28.933	47.675	16.812	29.254	76.472	41.012	106.671	104.268
7	3	1									7	3	3	40.219	55.939	16.81	46.458	69.003	23.023	92.87	35.589
7	4	1									7	4	3	39.592	63.944	35.497	44.86	64.457	10.878	59.911	36.661
7	4	1									7	4	3	10.783	71.155	27.182	39.472	137.844	13.476	88.811	66.795
7	4	1									7	4	3	16.233	63.743	15.223	50.154	152.781	33.544	128.752	30.037
7	4	1									7	4	3	5.1304	93.476	12.44	95.705	82.154	1.6236	145.962	1.2989
7	4	1									7	4	3	76.607	54.849	35.926	70.176	11.365	20.62	59.911	31.92
7	4	1									7	4	3	60.016	48.206	35.208	27.565	17.86	41.305	59.262	103.748
7	4	1									7	4	3	17.698	46.56	7.1355	34.193	133.46	30.848	100.176	73.549
7	4	1									7	4	3	19.574	42.494	12.591	25.673	132.973	47.734	105.047	94.007
7	4	1									7	4	3	61.229	42.702	47.1	34.162	21.919	49.845	37.181	74.199
7	4	1									7	4	3	24.152	52.765	59.271	11.605	127.778	27.439	14.418	109.269
7	4	1									7	4	3	24.917	59.109	34.788	97.16	127.778	19.646	62.184	1.4612
7	4	1									7	4	3	35.15	45.015	38.313	70.674	75.173	48.611	50.754	29.225
7	4	1									7	4	3	35.185	25.678	24.56	29.684	76.147	105.21	100.501	95.468
7	4	1									7	4	3	25.72	38.061	35.918	22.897	90.76	61.372	73.03	112.353
7	4	1									7	4	3	29.48	63.863	26.396	41.495	77.446	10.229	77.771	49.228
7	4	1									7	4	3	30.945	92.24	41.961	34.626	65.431	0.8118	50.819	70.042
7	4	1									7	4	3	38.605	36.26	22.318	18.346	64.782	64.652	91.734	124.693
7	4	1									7	4	3	34.731	20.708	24.087	14.106	72.088	116.25	93.033	136.545

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
1	1	2	5.5984	57.162	18.286	35.713	48.708	15.587	82.154	58.937
1	1	2	4.4995	59.203	24.235	34.589	39.454	16.074	80.856	54.553
1	1	2	3.0469	96.992	52.587	33.73	31.823	0.9742	28.575	62.671
1	1	2	2.8774	88.774	26.399	60.931	22.568	9.0922	106.833	38.122
1	1	2	3.0327	73.547	8.8707	55.428	23.218	6.9815	72.575	43.123
1	1	2	2.6768	79.986	8.8007	61.778	25.166	4.3837	68.191	11.722
1	1	2	5.3526	43.525	19.616	61.917	31.823	30.037	67.542	13.833
1	1	2	14.287	43.395	16.313	60.918	40.752	33.284	74.036	29.485
1	1	2	17.895	43.519	15.158	18.918	44.324	31.336	80.888	76.309
1	1	2	19.274	45.215	13.007	16.823	46.468	31.823	111.055	75.822
1	1	2	55.867	86.201	12.981	61.07	18.022	2.7601	113.328	20.782
1	1	2	56.83	86.341	14.003	62.263	21.107	1.6236	125.18	18.054
1	1	2	51.845	91.379	20.599	58.256	21.756	0.6494	81.992	21.432
1	1	2	3.9202	71.161	21.031	59.224	38.317	4.3837	87.675	25.296
1	1	2	4.5921	36.457	22.709	19.863	43.026	43.026	86.376	100.339
1	1	2	7.4642	31.613	21.486	18.913	43.513	56.826	83.778	104.235
1	1	2	18.779	31.519	19.049	19.833	70.302	56.014	98.715	99.04
1	1	2	21.838	35.03	12.852	19.511	71.601	52.767	131.999	99.689
1	2	2	47.62	35.584	2.8013	56.172	23.899	41.564	34.745	18.347
1	2	2	33.245	38.068	3.088	56.191	50.332	40.428	31.823	18.217
1	2	2	2.2337	72.115	3.3936	51.084	19.808	4.3188	37.668	29.387
1	2	2	0.9717	78.023	76.661	61.017	12.502	2.5978	6.6568	32.18
1	2	2	29.506	3.872	67.368	65.332	46.597	36.531	10.878	17.178
1	2	2	15.654	3.8959	59.9111	50.378	57.151	43.026	17.957	24.906
1	2	2	7.2879	34.718	50.245	44.426	54.144	49.52	21.139	34.485
1	2	2	4.6332	35.09	21.447	93.444	40.265	45.006	94.819	3.2472
1	2	2	69.817	56.518	23.889	62.731	9.2545	12.502	92.545	16.95
1	2	2	76.134	48.217	23.295	61.978	8.2804	25.491	96.929	26.27
1	2	2	7.0127	4.8392	19.712	51.549	65.269	35.395	98.878	14.775
1	2	2	5.3873	4.0057	20.827	58.794	53.417	33.609	98.553	13.606
1	2	2	19.587	69.048	2.0105	62.832	56.826	6.6568	39.129	9.839
1	2	2	33.36	89.223	1.8377	57.301	43.026	1.4612	29.55	12.339
1	2	2	49.511	67.03	7.3582	79.231	20.133	7.6309	63.645	8.2804
1	2	2	48.256	68.663	8.5065	80.078	20.457	5.845	73.387	10.618
1	2	2	15.79	54.079	10.06	69.866	75.173	10.553	79.232	18.282
1	2	2	15.657	60.589	12.396	69.08	75.173	13.379	90.11	21.042

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
1	1	4	47.317	47.791	20.995	32.289	29.582	35.557	93.957	68.029
1	1	4	49.554	28.482	27.137	29.537	32.472	87.35	73.809	75.822
1	1	4	7.2786	31.92	23.445	24.208	81.992	82.641	101.313	96.604
1	1	4	14.674	48.1	27.14	49.191	70.464	25.88	91.247	31.173
1	1	4	4.1361	98.47	11.888	45.816	72.088	0.1624	77.771	41.564
1	1	4	10.233	94.706	16.321	33.592	60.236	2.273	112.678	65.107
1	1	4	26.011	50.554	4.9546	35.571	60.236	34.908	70.464	55.235
1	1	4	19.415	60.587	2.4685	32.324	67.38	17.535	20.457	61.21
1	1	4	23.2	64.927	33.829	33.941	65.107	12.859	50.169	52.28
1	1	4	31.454	28.979	30.227	33.916	64.619	84.915	57.638	53.092
1	1	4	13.369	53.635	28.752	26.01	89.785	29.225	58.612	84.915
1	1	4	13.191	53.007	95.449	26.136	90.597	25.166	0.9742	80.693
1	1	4	13.495	54.224	95.655	38.32	91.247	29.874	1.9483	52.702
1	1	4	16.247	54.125	83.084	7.9274	112.353	17.21	8.9298	55.365
1	1	4	17.77	99.166	28.254	35.636	112.029	0	114.691	52.605
1	1	4	13.586	83.823	21.752	35.485	118.198	1.2989	131.674	60.593
1	1	4	16.813	25.07	16.575	33.255	98.066	99.04	149.047	66.081
1	1	4	30.546	24.311	45.852	40.704	65.918	105.534	49.033	52.572
1	2	4	63.76	55.583	44.019	35.173	18.834	25.231	48.578	57.476
1	2	4	24.936	63.588	44.395	29.377	97.903	19.321	51.631	75.985
1	2	4	30.965	92.555	58.904	49.881	86.538	2.1107	18.639	40.428
1	2	4	27.365	98.286	57.632	45.981	108.294	0.3247	22.243	47.572
1	2	4	38.841	67.424	13.98	74.359	48.741	12.664	103.911	9.5468
1	2	4	35.724	67.046	8.5778	93.723	67.25	13.508	111.542	1.6236
1	2	4	27.695	87.902	35.672	37.525	87.188	3.4096	69.166	64.457
1	2	4	25.599	90.854	38.607	33.69	85.564	3.0848	73.874	71.926
1	2	4	26.718	34.778	41.74	29.814	83.291	69.653	49.195	79.589
1	2	4	18.442	30.297	38.214	41.529	114.789	81.83	64.944	60.236
1	2	4	20.745	29.66	17.878	28.908	121.933	84.103	110.567	97.254
1	2	4	18.705	65.777	8.7191	78.608	135.733	9.4819	101.151	9.9365
1	2	4	28.802	73.294	9.341	97.644	71.926	6.3321	92.253	0.6494
1	2	4	40.003	82.892	40.174	95.17	46.597	3.2472	60.885	4.3837
1	2	4	41.656	82.878	32.09	18.962	39.616	5.6177	81.635	95.046
1	2	4	64.321	90.303	9.0919	11.516	12.177	2.5004	108.554	98.553
1	2	4	32.751	48.988	8.6364	28.139	81.343	44.519	121.608	87.512
1	2	4	36.562	78.551	4.636	25.935	73.225	7.4686	94.656	100.826

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
1	3	2	59.544	2.7491	26.524	54.054	11.528	24.679	70.042	19.159	1	3	4	76.718	74.843	5.1669	43.674	7.1763	4.8708	93.033	31.336
1	3	2	60.863	2.792	16.916	41.335	10.716	23.218	64.944	34.128	1	3	4	58.1	75.82	7.3049	52.789	17.73	12.274	79.719	18.184
1	3	2	78.784	6.7654	4.324	37.761	8.4427	50.169	48.708	36.369	1	3	4	10.672	35.295	8.1788	51.752	76.472	79.719	86.863	29.225
1	3	2	90.786	6.4694	2.3531	58.687	3.2472	52.118	27.601	10.391	1	3	4	7.2717	29.969	5.1048	41.953	104.398	99.04	98.878	36.726
1	3	2	75.555	3.0588	2.5523	58.553	4.5461	18.671	29.225	9.5793	1	3	4	3.6219	64.463	4.6794	40.623	63.613	15.1	95.143	56.177
1	3	2	62.626	0.1121	25.466	62.259	11.69	2.273	84.915	12.826	1	3	4	7.6446	82.063	8.0819	36.259	116.088	2.9225	83.583	65.431
1	3	2	67.806	3.1636	50.192	36.724	7.3062	37.992	33.024	44.649	1	3	4	43.484	85.644	36.644	97.585	51.631	5.8774	66.081	0.9742
1	3	2	87.142	2.758	37.28	32.864	2.9225	33.933	61.502	48.871	1	3	4	16.607	98.88	34.815	98.328	119.66	0	65.918	0.3247
1	3	2	94.321	2.624	34.304	23.679	0.9742	32.634	63.645	66.243	1	3	4	56.06	58.73	34.257	99.702	17.145	26.952	57.963	0.1624
1	3	2	86.641	72.578	15.167	36.652	2.4354	15.587	64.619	51.144	1	3	4	56.737	47.595	4.6294	92.825	17.665	41.175	71.439	0.8443
1	3	2	18.653	71.951	15.973	43.175	65.594	20.62	100.664	41.921	1	3	4	42.233	60.424	7.1852	54.917	40.2	17.697	84.427	31.336
1	3	2	22.558	76.692	4.2581	55.239	68.354	9.6442	70.302	19.646	1	3	4	47.402	56.845	8.3485	74.392	40.265	21.789	89.461	9.904
1	3	2	9.3019	77.903	3.9981	52.719	65.594	9.7092	68.029	24.516	1	3	4	12.463	49.763	24.282	62.756	125.018	32.18	88.162	11.852
1	3	2	10.436	30.852	3.7328	1.5653	80.856	45.786	68.516	18.834	1	3	4	15.096	70.454	27.993	52.165	117.062	16.561	77.381	35.557
1	3	2	39.886	31.949	3.2792	54.228	41.24	43.675	63.645	20.782	1	3	4	19.187	78.612	26.765	45.236	117.062	9.7416	82.804	35.395
1	3	2	23.347	30.193	41.839	60.444	58.774	44.974	37.44	13.086	1	3	4	17.611	70.447	22.63	57.496	116.9	9.7416	115.114	18.314
1	3	2	24.851	37.625	39.882	40.728	67.217	45.786	41.402	45.461	1	3	4	23.843	97.423	31.64	53.558	106.021	0.6494	100.014	17.86
1	3	2	25.426	37.487	38.798	36.737	62.346	46.11	39.778	55.3	1	3	4	8.7612	99.601	30.172	51.36	91.896	0	111.444	27.114
1	4	2	48.76	12.879	8.123	38.425	22.568	79.719	60.56	58.287	1	4	4	9.3531	50.052	50.165	88.874	93.682	46.922	45.006	2.1107
1	4	2	52.035	10.367	11.908	43.636	15.587	69.166	85.402	40.98	1	4	4	60.334	78.533	42.618	84.955	17.21	11.982	57.638	4.8708
1	4	2	3.3832	42.738	8.2957	61.494	22.406	31.173	95.63	13.801	1	4	4	76.579	17.744	33.821	93.39	8.118	128.265	75.011	1.1365
1	4	2	4.5713	41.027	7.2989	54.067	33.122	34.745	68.841	19.808	1	4	4	58.07	16.575	38.98	66.294	30.686	121.283	68.191	8.8324
1	4	2	2.1254	73.513	39.92	67.806	61.21	19.288	59.749	23.218	1	4	4	40.022	83.556	41.602	55.219	50.656	6.4944	65.594	40.103
1	4	2	10.315	72.172	23.729	61.982	79.881	14.483	81.505	25.231	1	4	4	50.658	61.587	16.892	34.478	28.738	17.86	69.977	76.504
1	4	2	5.3726	97.687	37.565	92.601	50.332	0.4871	42.279	1.6236	1	4	4	6.1442	96.108	19.237	98.959	88.486	0.3247	130.083	1.4612
1	4	2	5.0005	97.892	25.483	74.326	49.845	0.8118	57.8	22.666	1	4	4	6.8745	98.158	19.179	98.628	100.339	0	136.383	0.1624
1	4	2	29.982	6.4413	1.8971	52.89	45.948	59.099	44.487	21.756	1	4	4	2.619	45.111	40.541	18.614	55.852	44.584	56.014	140.442
1	4	2	33.116	7.0619	0.7993	70.908	44.974	65.431	23.38	8.4427	1	4	4	1.4993	46.79	53.13	12.328	43.837	40.752	29.874	161.062
1	4	2	31.381	14.317	12.556	13.497	52.442	103.943	76.472	99.04	1	4	4	31.192	93.955	48.53	23.009	92.383	0.3247	44.162	71.439
1	4	2	28.147	13.361	6.6744	15.168	58.774	114.139	70.302	99.689	1	4	4	6.4588	94.744	40.043	28.661	118.198	1.0066	61.372	65.594
1	4	2	25.539	41.338	20.481	34.347	56.826	30.361	78.258	48.871	1	4	4	10.821	52.783	49.425	42.717	129.564	22.893	46.305	61.535
1	4	2	9.6375	38.695	34.325	50.402	48.935	35.557	44.552	25.815	1	4	4	40.13	47.367	56.239	49.569	49.682	32.797	33.739	44.974
1	4	2	13.702	52.954	50.588	42.632	58.774	12.826	27.147	46.922	1	4	4	45.67	60.769	9.4962	52.901	42.051	19.873	114.951	36.304
1	4	2	16.94	55.92	53.512	44.183	68.354	12.989	16.723	42.701	1	4	4	46.47	53.02	14.586	25.895	38.967	27.601	121.283	88.486
1	4	2	2.9112	9.5396	6.4088	14.213	53.254	95.793	42.376	55.69	1	4	4	37.552	65.314	8.3573	45.992	76.504	8.6051	141.741	44.811
1	4	2	5.2242	8.8946	5.9433	37.954	53.579	92.058	53.579	39.941	1	4	4	22.596	66.27	11.899	49.079	129.564	9.5793	124.206	36.239

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	1	2	37.772	42.978	6.5288	76.636	36.044	48.383	61.859	8.2804
2	1	2	48.036	61.012	4.1158	91.905	24.192	14.612	46.273	2.5978
2	1	2	48.336	91.216	9.7869	99.433	31.336	1.6236	63.97	0
2	1	2	30.527	61.04	4.8217	97.103	63.483	19.483	48.383	1.786
2	1	2	3.0218	70.746	29.84	54.631	31.173	25.491	62.996	21.756
2	1	2	4.6101	67.557	36.473	61.777	39.778	28.413	48.871	16.561
2	1	2	1.7322	32.683	5.0753	94.063	20.782	84.915	87.025	0.4871
2	1	2	1.6558	30.954	5.8622	92.797	18.834	85.239	91.409	5.4878
2	1	2	9.4724	50.501	61.932	52.475	81.18	15.749	19.159	20.945
2	1	2	13.288	55.173	64.078	43.996	96.604	19.159	16.885	38.057
2	1	2	27.44	61.248	61.909	56.433	97.092	16.561	13.801	21.432
2	1	2	30.53	52.233	56.312	51.552	90.76	22.243	26.952	26.465
2	1	2	30.442	39.635	13.605	15.982	65.464	48.383	102.287	102.449
2	1	2	34.512	42.38	15.402	21.036	50.981	48.871	106.508	100.826
2	1	2	47.982	57.64	8.0717	44.37	46.435	21.919	89.461	45.299
2	1	2	36.318	50.177	8.125	54.529	60.171	26.952	91.734	30.848
2	1	2	18.774	94.658	8.9136	44.807	85.889	1.1365	90.597	38.642
2	1	2	21.173	63.659	17.088	44.247	75.011	41.305	80.206	39.454
2	2	2	35.939	51.94	17.03	95.052	53.287	20.62	75.335	0.7144
2	2	2	33.703	53.201	24.859	95.963	50.332	24.192	89.623	0.4871
2	2	2	33.853	40.85	17.423	77.876	53.969	34.291	89.948	22.113
2	2	2	32.85	40.666	12.861	98.512	58.645	35.557	88.649	0.1624
2	2	2	22.659	32.12	17.922	98.553	91.409	59.586	89.785	0.3247
2	2	2	26.625	31.833	14.552	35.634	82.057	65.269	86.538	69.977
2	2	2	19.385	19.283	8.4248	32.562	81.343	100.826	68.191	75.822
2	2	2	29.452	38.096	7.8744	31.385	67.542	54.553	67.867	73.712
2	2	2	26.124	32.58	8.7698	49.216	82.966	69.003	75.011	30.361
2	2	2	17.131	31.318	2.6375	57.668	86.538	81.667	44.974	27.439
2	2	2	21.76	31.346	2.7775	54.964	84.427	64.457	41.24	31.498
2	2	2	25.236	21.352	6.7355	53.224	77.771	78.582	58.612	24.776
2	2	2	20.923	48.678	8.249	62.121	85.239	26.789	62.509	14.125
2	2	2	5.4596	42.957	10.312	61.031	61.697	37.181	70.952	18.671
2	2	2	2.6669	62.274	35.559	72.476	34.583	14.125	50.104	10.196
2	2	2	2.6616	62.232	31.342	68.346	35.232	15.424	58.45	13.638
2	2	2	10.68	59.685	28.051	94.527	69.003	13.963	63.97	0.8118
2	2	2	12.839	60.914	64.005	97.878	69.977	19.061	20.782	0.3247

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	1	4	26.614	34.819	39.118	66.631	75.335	66.243	40.428	12.177
2	1	4	26.874	36.552	30.518	58.565	73.874	62.834	67.217	14.125
2	1	4	12.016	65.867	2.3615	47.965	92.383	15.911	61.859	34.908
2	1	4	13.545	55.769	13.125	50.996	86.538	23.38	55.495	32.342
2	1	4	53.806	60.864	11.21	46.175	23.38	23.705	85.726	33.284
2	1	4	58.198	62.839	6.8801	46.822	26.108	19.808	86.376	31.108
2	1	4	43.036	68.882	16.212	44.123	27.764	15.1	106.833	33.771
2	1	4	38.326	78.704	16.072	49.228	44.811	7.2088	91.084	23.38
2	1	4	25.588	69.663	14.314	62.811	81.992	9.9365	80.726	10.391
2	1	4	28.356	80.87	18.673	70.841	79.946	4.7085	122.745	8.7675
2	1	4	7.1495	71.953	14.314	27.135	84.59	33.381	111.542	95.955
2	1	4	4.7608	98.968	14.751	23.075	55.365	0	106.346	97.254
2	1	4	27.046	68.92	11.724	34.797	77.446	8.7675	107.97	60.073
2	1	4	14.739	74.932	21.613	51.086	91.084	7.4686	104.235	22.081
2	1	4	29.958	20.871	20.748	53.482	87.837	108.944	98.39	15.587
2	1	4	29.808	20.409	19.659	72.144	81.018	118.848	104.073	7.9557
2	1	4	10.515	56.187	2.6773	70.468	94.007	22.893	53.904	10.878
2	1	4	31.812	64.908	3.3297	49.22	58.774	19.646	54.228	24.289
2	2	4	40.561	88.135	1.3791	47.926	51.144	3.7343	19.97	30.848
2	2	4	55.21	75.776	3.3913	48.632	37.992	9.5793	36.693	33.609
2	2	4	42.109	51.412	17.149	56.322	47.117	24.354	105.372	16.723
2	2	4	51.061	42.697	15.832	64.296	33.771	37.992	102.612	13.638
2	2	4	51.851	94.917	49.222	85.838	33.122	0.1624	47.961	3.4096
2	2	4	36.53	93.783	48.61	15.554	53.741	0.1624	42.863	74.361
2	2	4	43.151	95.777	20.849	12.127	51.631	0.9742	90.11	77.608
2	2	4	42.076	89.809	26.714	43.027	38.642	1.786	80.693	42.214
2	2	4	17.878	47.982	29.867	26.382	128.265	26.465	70.627	88.162
2	2	4	22.162	53.509	13.066	59.518	116.412	20.133	90.76	14.483
2	2	4	10.425	40.506	24.342	50.459	72.575	60.073	89.331	27.764
2	2	4	19.536	45.655	22.605	36.586	80.92	39.941	92.87	68.841
2	2	4	18.917	98.687	19.594	31.22	86.376	0.1624	118.523	88.486
2	2	4	10.602	96.995	21.731	24.017	74.523	0.9742	114.951	91.896
2	2	4	25.984	53.703	16.805	26.371	91.084	20.457	112.678	82.641
2	2	4	21.947	55.366	17.07	34.194	129.401	28.575	111.379	52.93
2	2	4	24.397	96.54	68.386	48.806	129.564	0.1624	25.036	23.412
2	2	4	31.301	96.396	60.235	55.821	111.704	0.6494	21.984	18.477

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	3	2	3.5116	58.818	63.044	59.9	48.708	13.963	18.022	12.859
2	3	2	4.6408	61.603	64.199	57.39	58.125	12.956	16.074	18.671
2	3	2	8.2006	27.5	69.479	42.566	81.992	92.221	10.911	41.24
2	3	2	8.7142	33.949	46.835	66.321	84.427	68.354	42.214	15.489
2	3	2	21.63	56.944	43.253	68.4	82.934	25.004	46.435	13.963
2	3	2	32.834	62.671	32.951	63.519	77.121	14.775	77.446	23.964
2	3	2	6.2756	57.674	39.926	48.509	72.737	13.963	56.501	30.848
2	3	2	12.684	60.719	42.178	41.857	97.416	12.502	50.656	40.59
2	3	2	3.1417	68.453	38.403	37.936	39.941	30.524	65.107	52.767
2	3	2	3.7944	98.765	95.739	43.14	52.605	0.1624	1.6236	36.206
2	3	2	9.3846	45.896	95.527	47.229	78.42	37.668	0.9742	34.745
2	3	2	11.036	37.543	22.153	47.937	82.804	56.177	90.597	42.214
2	3	2	43.958	43.408	19.153	44.455	39.454	37.018	94.494	38.512
2	3	2	46.491	59.574	18.585	45.36	36.239	13.151	92.87	35.037
2	3	2	6.4915	48.389	3.7987	48.606	75.822	25.328	39.291	25.004
2	3	2	6.3969	46.479	3.2006	48.968	70.627	32.31	45.299	23.705
2	3	2	4.8405	50.025	19.996	23.93	65.431	31.985	118.848	105.047
2	3	2	7.0815	55.261	18.75	26.876	79.07	20.945	109.106	95.306
2	4	2	1.9615	95.799	26.457	70.972	43.675	1.4612	81.505	8.9623
2	4	2	3.4636	92.582	26.708	91.692	68.191	2.273	81.667	2.1107
2	4	2	19.359	40.52	22.81	93.001	78.095	42.766	84.915	1.6236
2	4	2	14.047	46.04	26.883	77.449	79.07	27.114	79.394	14.418
2	4	2	34.23	55.789	42.426	97.973	61.372	18.412	35.654	0.1624
2	4	2	21.331	57.741	64.965	97.991	83.453	16.885	11.365	0.4871
2	4	2	11.635	30.45	37.225	89.629	78.907	53.417	42.701	2.7601
2	4	2	15.69	60.406	48.222	89.508	76.309	11.852	26.952	1.786
2	4	2	54.686	66.214	62.129	1.4108	44.682	6.1697	17.21	34.096
2	4	2	95.842	64.584	68.394	1.8268	1.1365	12.339	16.885	41.727
2	4	2	87.593	90.733	21.417	49.282	6.0073	4.3838	75.173	23.38
2	4	2	4.2923	64.201	12.887	44.75	51.793	19.808	74.686	36.531
2	4	2	2.7747	12.698	19.976	12.562	44.162	104.723	105.534	86.051
2	4	2	37.485	21.824	24.968	15.069	49.845	112.841	96.669	87.837
2	4	2	45.595	53.358	53.173	39.99	36.856	22.146	35.07	36.531
2	4	2	1.8288	46.74	55.347	31.234	40.915	27.829	27.829	59.586
2	4	2	1.3332	39.67	18.367	54.895	23.218	50.819	119.465	25.004
2	4	2	9.9437	39.683	25.006	46.28	92.221	49.195	112.029	39.941

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
2	3	4	11.677	44.364	32.043	41.866	84.103	31.173	71.569	39.291
2	3	4	40.925	36.657	24.087	36.944	39.973	51.306	89.785	50.981
2	3	4	41.483	41.344	7.289	11.853	37.018	46.597	98.715	86.084
2	3	4	20.776	49.745	4.1186	15.32	104.073	33.771	57.313	95.468
2	3	4	18.271	43.51	10.922	62.806	89.785	46.76	84.265	11.365
2	3	4	9.0628	56.991	10.823	89.29	124.855	24.224	78.582	1.786
2	3	4	4.0072	39.121	49.894	27.672	83.616	40.428	33.122	83.129
2	3	4	21.815	42.879	40.41	32.966	82.641	38.479	47.247	84.427
2	3	4	28.514	60.516	15.914	50.67	86.538	11.398	91.247	32.342
2	3	4	30.611	48.755	15.045	45.627	86.538	22.893	94.331	43.74
2	3	4	25.153	64.3	58.021	40.018	97.254	16.074	37.181	55.69
2	3	4	24.864	56.712	55.299	35.498	105.534	23.867	29.355	56.826
2	3	4	16.827	65.089	23.102	40.822	113.165	18.347	103.294	40.103
2	3	4	16.604	75.874	30.109	36.201	125.18	11.041	86.538	48.871
2	3	4	1.8139	62.849	22.932	42.21	45.299	14.45	98.066	42.376
2	3	4	6.959	71.26	14.18	66.022	76.959	6.9815	99.202	16.074
2	3	4	5.5629	58.979	67.669	25.659	77.608	22.73	17.373	90.792
2	3	4	2.2321	81.305	58.424	16.782	38.804	13.963	21.919	116.25
2	4	4	20.178	25.569	78.955	24.735	112.029	112.516	10.553	93.195
2	4	4	23.07	23.265	51.487	18.251	126.804	115.601	42.538	113.815
2	4	4	28.908	39.281	44.386	16.799	74.199	63.97	56.014	101.313
2	4	4	24.817	45.747	39.026	86.006	81.992	48.871	75.985	5.3579
2	4	4	11.66	98.53	36.778	92.938	116.25	0.6494	73.062	1.2989
2	4	4	9.6246	95.869	49.495	69.469	103.911	0.8118	57.053	7.7933
2	4	4	46.251	83.708	24.955	33.921	43.35	6.4944	114.663	79.232
2	4	4	47.486	68.664	22.142	35.18	34.583	15.911	134.11	58.287
2	4	4	53.625	87.257	36.801	38.861	24.809	2.4354	89.785	52.442
2	4	4	60.387	95.838	17.481	58.106	26.789	0.6494	117.549	26.302
2	4	4	68.824	97.809	5.9829	58.577	13.151	0.9742	78.258	16.885
2	4	4	68.349	96.347	6.543	71.908	10.229	0.4871	73.419	24.874
2	4	4	39.244	95.705	4.6604	89.557	78.095	0.1624	73.225	4.059
2	4	4	32.35	82.306	25.547	59.682	79.719	4.3837	114.789	20.782
2	4	4	5.8026	92.036	25.278	75.882	94.007	1.2989	97.806	7.1114
2	4	4	9.9561	15.617	15.609	44.435	152.911	106.833	130.051	37.505
2	4	4	19.095	72.73	15.275	46.249	100.014	13.314	125.505	34.745
2	4	4	17.172	63.191	15.311	49.799	121.965	15.262	118.523	31.011

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
3	1	2	37.213	99.816	10.323	99.987	59.586	0	150.508	0
3	1	2	39.421	99.911	13.962	97.769	52.28	0	166.907	0
3	1	2	30.106	74.777	48.527	97.53	82.317	12.502	33.446	0.8118
3	1	2	28.465	90.818	56.68	79.311	96.929	3.8967	24.841	11.365
3	1	2	37.422	37.602	24.617	50.163	53.579	68.029	87.512	41.24
3	1	2	48.259	42.586	28.971	43.231	41.564	50.494	76.959	47.117
3	1	2	98.883	96.423	13.225	99.443	0.4871	0.6494	140.442	0
3	1	2	98.056	97.839	18.768	99.642	0.3247	0.3247	141.091	0
3	1	2	77.512	71.919	42.043	93.941	20.23	21.302	67.282	0.1624
3	1	2	65.268	97.848	56.799	99.956	20.782	0.1624	32.797	0
3	1	2	66.986	97.225	57.493	92.963	9.904	0.4871	34.583	3.7343
3	1	2	63.698	47.971	93.334	97.091	20.133	69.653	1.1365	0
3	1	2	13.175	44.221	48.903	99.557	104.787	51.176	35.687	0
3	1	2	23.996	41.614	49.466	99.669	88.324	52.28	36.726	0.1624
3	1	2	18.316	36.97	18.633	99.957	137.357	79.719	116.737	0
3	1	2	19.687	58.099	8.7373	98.842	130.375	18.119	121.283	0.4871
3	1	2	47.474	59.436	33.312	99.934	26.952	16.561	102.125	0
3	1	2	14.769	61.822	28.429	99.914	64.944	20.62	96.28	0
3	2	2	46.153	96.922	3.3079	95.488	31.66	0.8118	57.151	1.4612
3	2	2	52.987	80.33	8.925	98.257	23.38	17.86	93.357	0.3247
3	2	2	57.604	31.85	40.07	99.94	28.575	65.107	38.869	0
3	2	2	54.386	26.204	51.642	90.085	26.952	76.959	24.581	0.6494
3	2	2	18.818	8.0611	10.617	54.344	105.21	59.749	89.948	19.483
3	2	2	17.65	11.105	24.144	44.725	133.136	66.081	69.977	34.096
3	2	2	29.573	53.086	41.711	92.996	80.368	22.081	45.461	1.4612
3	2	2	28.901	60.705	45.958	96.943	79.881	21.659	43.35	1.4612
3	2	2	31.695	89.603	6.423	76.961	74.686	4.8708	59.424	5.845
3	2	2	53.512	71.586	10.841	73.786	31.628	46.37	78.095	6.8191
3	2	2	60.448	98.393	43.025	94.791	21.042	0.3247	32.147	2.273
3	2	2	59.291	97.995	53.91	97.185	18.022	0	18.834	0.4871
3	2	2	54.771	99.28	43.379	94.188	27.277	0	53.904	3.0848
3	2	2	56.791	98.173	43.873	77.739	21.042	0.8118	54.034	25.458
3	2	2	59.622	92.626	29.228	96.066	18.347	4.0915	62.509	0.9742
3	2	2	61.163	92.752	30.599	86.969	29.679	3.4096	60.398	14.97
3	2	2	9.6728	14.218	29.163	98.69	92.058	92.87	58.125	0.8118
3	2	2	10.951	13.333	1.913	79.993	96.604	108.294	32.31	25.166
3	1	4	93.952	35.149	19.463	55.04	4.3837	108.424	77.284	22.795
3	1	4	78.486	75.199	19.855	56.803	13.476	12.404	75.985	17.73
3	1	4	61.549	55.782	46.444	98.43	27.601	29.55	54.391	0.8118
3	1	4	41.639	57.001	67.849	78.195	45.948	24.354	35.07	15.749
3	1	4	74.375	99.215	64.563	94.021	7.5335	0	49.682	4.8708
3	1	4	76.561	95.362	48.737	74.037	15.424	2.4354	56.664	23.38
3	1	4	98.802	65.6	31.281	80.343	0.1624	36.693	91.734	10.586
3	1	4	99.572	65.246	38.545	95.847	0	28.023	72.413	0.6494
3	1	4	99.402	68.288	45.236	81.345	1.2989	27.601	67.217	3.0848
3	1	4	99.85	61.326	26.373	82.963	0	54.91	79.557	1.786
3	1	4	99.118	79.296	31.185	95.888	0.6494	16.009	71.439	0
3	1	4	77.182	89.428	34.9	99.787	24.354	13.638	50.332	0
3	1	4	78.131	99.823	90.27	99.91	16.398	0	2.7601	0
3	1	4	97.896	50.119	98.468	99.514	1.6236	38.967	0.1624	0
3	1	4	97.517	57.038	90.167	99.036	1.1365	35.589	1.786	0.4871
3	1	4	98.193	74.614	71.473	99.554	0.4871	17.697	26.465	0.1624
3	1	4	99.306	99.814	71.733	81.071	0.1624	0	28.9	3.7343
3	1	4	97.197	99.844	72.055	85.325	0.1624	0	40.915	12.826
3	2	4	62.129	98.583	99.626	68.536	35.687	0	0	16.885
3	2	4	66.508	99.927	98.992	81.677	27.439	0	0.1624	11.463
3	2	4	99.698	99.936	98.126	99.165	0	0	0.9742	0.1624
3	2	4	92.168	98.656	18.271	71.683	4.059	0.8118	126.479	34.908
3	2	4	93.247	28.633	15.241	99.227	4.5461	118.036	126.641	0
3	2	4	97.778	25.004	20.389	98.059	1.9483	112.353	77.933	0.1624
3	2	4	68.039	30.98	17.46	99.811	32.472	90.078	78.095	0
3	2	4	87.188	68.848	31.374	99.994	5.1955	24.711	91.896	0
3	2	4	97.057	65.733	99.461	99.874	0	34.096	0	0
3	2	4	99.86	99.919	97.557	96.267	0	0	0	0.2922
3	2	4	61.406	98.929	66.43	99.696	41.824	0	15.749	0
3	2	4	95.216	85.802	73.373	99.588	3.8967	7.3062	7.9881	0
3	2	4	96.183	95.247	94.418	99.838	2.4354	0.6494	1.4612	0
3	2	4	77.34	95.14	64.459	99.92	12.145	0	13.054	0
3	2	4	86.248	98.048	37.088	99.877	5.6501	0.3247	39.616	0
3	2	4	77.308	99.917	12.747	99.748	19.646	0	113.652	0.1624
3	2	4	99.094	99.791	46.989	99.804	0.1624	0	37.765	0
3	2	4	62.385	99.769	58.085	96.353	34.193	0	26.14	1.2989

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
3	3	2	40.794	96.327	2.4094	91.105	51.468	1.4612	39.616	1.9483
3	3	2	34.389	89.825	3.6044	71.317	72.25	2.4354	45.786	13.963
3	3	2	20.945	24.045	89.839	30.602	132.161	87.09	6.8191	80.856
3	3	2	11.464	17.287	96.6	29.036	121.056	106.021	1.2989	80.693
3	3	2	20.671	13.858	1.8958	95.749	100.826	106.996	43.837	0.1624
3	3	2	18.11	81.494	1.7023	94.069	113.652	13.638	40.265	1.2989
3	3	2	40.802	75.989	4.7616	30.578	40.623	19.97	76.959	51.631
3	3	2	44.344	80.637	4.147	18.943	34.908	11.105	69.815	69.815
3	3	2	60.36	94.669	13.136	48.903	31.173	0.2598	115.438	26.952
3	3	2	60.688	80.645	14.435	34.82	28.088	6.6568	116.088	56.826
3	3	2	45.791	93.391	7.3554	94.208	29.225	1.2989	72.9	0.9742
3	3	2	51.275	95.422	5.6121	91.59	28.121	0.1624	68.354	4.2214
3	3	2	55.622	63.711	65.117	95.559	15.1	14.06	15.1	1.2989
3	3	2	53.743	52.296	48.059	91.742	16.398	23.218	39.616	1.2989
3	3	2	85.229	95.692	76.538	31.757	14.288	0.1624	9.4819	54.715
3	3	2	69.667	96.385	77.057	28.072	34.42	0.4871	6.9815	77.933
3	3	2	98.396	93.126	98.623	97.195	1.1365	1.3963	0.3897	0.6494
3	3	2	98.557	15.827	94.775	93.732	0.6494	111.866	1.1365	1.4937
3	4	2	65.579	32.647	6.894	57.477	11.528	65.269	59.424	19.646
3	4	2	66.359	24.046	71.082	61.831	9.5793	96.28	21.107	14.937
3	4	2	98.784	97.189	7.1583	95.622	0.8118	0.6494	71.763	1.2989
3	4	2	98.634	98.252	13.494	96.552	0	0.1624	90.272	0.9742
3	4	2	74.728	38.2	20.27	57.971	24.387	66.73	105.697	21.789
3	4	2	93.379	34.073	10.355	51.892	3.8967	89.136	92.545	34.42
3	4	2	79.67	48.776	14.087	83.569	5.4228	32.862	113.003	6.6568
3	4	2	98.31	52.502	13.32	51.478	0	23.542	113.977	43.35
3	4	2	47.376	36.788	89.535	97.244	29.452	55.852	2.1107	1.2989
3	4	2	37.214	26.16	89.898	98.125	52.93	81.7	2.9225	0.9742
3	4	2	44.565	25.148	42.822	41.886	48.124	101.67	53.092	37.57
3	4	2	39.79	23.96	42.581	70.977	60.106	95.63	51.696	12.664
3	4	2	89.807	14.551	52.886	96.603	2.7601	80.693	38.674	0.9742
3	4	2	37.139	10.818	62.902	76.664	45.136	69.166	20.782	9.7741
3	4	2	34.848	6.6706	59.467	94.872	72.9	55.365	29.387	1.2989
3	4	2	19.909	4.825	40.155	94.336	119.497	44.487	72.413	1.2989
3	4	2	74.07	6.491	44.332	99.895	10.066	76.959	39.356	0
3	4	2	65.262	4.132	47.957	97.279	14.937	60.885	35.07	0

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
3	3	4	90.236	99.727	45.935	99.79	4.059	0	81.18	0
3	3	4	98.783	99.336	45.695	96.105	1.2989	0.8118	77.284	0
3	3	4	79.733	99.934	31.638	99.046	15.424	0	104.073	0
3	3	4	93.369	95.298	24.717	98.962	4.3513	0.3247	115.276	0
3	3	4	86.342	99.803	93.084	97.165	5.3579	0	4.5461	0
3	3	4	13.864	94.502	62.252	97.321	93.195	1.6236	51.696	0
3	3	4	23.032	99.793	50.122	99.42	77.154	0.3247	36.304	0.1624
3	3	4	26.336	99.914	66.96	97.64	87.382	0	21.432	0.8118
3	3	4	99.959	96.032	39.872	99.838	0	0	59.749	0
3	3	4	99.516	95.806	45.314	88.79	0	0	53.774	3.4096
3	3	4	99.71	53.784	23.759	99.348	0.1624	27.277	110.892	0
3	3	4	39.041	48.154	13.024	99.822	50.624	35.395	85.564	0
3	3	4	45.645	96.294	60.79	98.017	60.723	0.8118	33.414	3.7343
3	3	4	94.297	95.888	55.054	97.832	9.5793	2.5978	41.921	0
3	3	4	80.479	99.913	27.224	80.006	10.391	0	116.575	7.9557
3	3	4	38.008	98.512	31.703	96.182	66.73	0.9742	101.638	1.1365
3	3	4	36.12	99.904	50.48	97.607	71.439	0	36.044	0.1948
3	3	4	40.242	95.653	38.662	99.912	59.424	3.6369	58.287	0
3	4	4	58.773	87.215	29.971	99.25	23.218	8.118	84.622	0
3	4	4	54.177	51.545	54.288	97.246	30.037	55.203	28.9	0
3	4	4	54.544	96.3	99.816	69.205	32.147	0.1624	0	33.284
3	4	4	94.711	99.902	98.311	96.044	3.8967	0	0	0
3	4	4	99.896	96.328	99.014	99.755	0	0	0	0
3	4	4	84.713	96.826	98.869	99.585	9.4169	0	0	0
3	4	4	99.459	48.882	97.983	98.477	0.4546	62.671	0	0
3	4	4	55.522	54.345	98.731	93.584	24.516	63.97	0	3.8967
3	4	4	55.855	62.533	77.886	99.889	28.738	40.59	23.055	0
3	4	4	30.218	44.959	85.801	99.707	96.929	77.121	6.2346	0
3	4	4	26.774	49.521	72.652	99.471	108.294	46.5	18.022	0
3	4	4	98.892	42.517	79.523	99.683	0	71.926	8.7999	0
3	4	4	92.8	47.132	72.554	99.815	8.4427	104.365	18.509	0
3	4	4	98.989	42.352	86.685	99.429	0.1624	76.959	13.151	0
3	4	4	22.73	99.775	87.067	99.971	101.151	0	8.6051	0
3	4	4	17.84	98.497	99.806	96.804	100.176	0.9742	0	2.4354
3	4	4	42.52	78.472	73.325	98.066	46.273	14.223	19.808	0.9742
3	4	4	48.368	60.707	89.635	97.854	41.889	31.173	5.3579	0.6494

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
4	1	2	42.277	99.773	18.885	42.608	57.8	0	66.243	44.162
4	1	2	14.586	98.044	48.094	37.85	87.188	0	42.246	50.721
4	1	2	26.091	99.657	36.893	54.044	104.787	0	73.225	27.926
4	1	2	4.9079	98.752	99.547	53.144	70.789	0.3247	0	32.732
4	1	2	67.297	98.97	25.782	29.026	12.989	0	82.154	80.044
4	1	2	99.771	99.303	49.782	27.242	0	0	33.446	86.213
4	1	2	99.909	49.714	29.311	64.621	0	35.395	91.409	11.105
4	1	2	11.393	60.22	37.026	81.362	76.634	26.465	80.693	5.0332
4	1	2	29.503	97.257	46.542	92.779	65.301	1.2989	46.597	1.6236
4	1	2	28.357	99.348	16.506	94.436	67.867	0.1624	126.479	1.9483
4	1	2	25.808	65.679	15.62	38.806	70.789	21.756	118.523	71.439
4	1	2	32.537	62.48	23.617	58.217	76.991	27.277	94.331	24.679
4	1	2	24.137	58.44	10.695	77.757	78.42	27.439	102.612	6.8191
4	1	2	18.443	62.296	6.8595	77.157	81.505	21.269	70.302	5.293
4	1	2	15.547	93.788	12.652	91.359	82.479	2.4354	88.974	3.4096
4	1	2	8.6848	96.268	18.296	96.961	87.123	0.3247	101.962	1.6236
4	1	2	8.4758	29.084	39.394	10.784	87.025	104.723	46.435	93.195
4	1	2	8.3931	30.445	47.473	11.971	91.084	99.527	39.941	97.579
4	2	2	13.781	22.505	57.015	23.383	76.634	98.228	33.122	105.697
4	2	2	48.016	20.191	21.239	23.588	37.668	98.066	89.948	104.56
4	2	2	53.295	21.698	19.971	25.457	31.043	96.767	80.206	104.885
4	2	2	54.263	19.946	16.786	23.679	29.355	95.793	80.661	99.365
4	2	2	60.263	89.716	2.1246	26.123	20.782	2.9225	35.492	90.435
4	2	2	21.875	92.887	69.571	23.759	117.387	2.1107	13.638	108.457
4	2	2	23.642	88.943	83.321	43.913	109.269	3.7343	7.4686	29.874
4	2	2	30.29	85.198	96.572	40.853	93.844	3.5719	1.2989	41.532
4	2	2	71.522	90.973	67.838	59.917	9.5793	0.1624	11.852	18.834
4	2	2	75.809	96.394	70.802	60.279	9.5793	1.1365	8.118	13.963
4	2	2	56.456	97.729	85.719	61.469	20.945	0.4871	4.5461	12.664
4	2	2	62.463	96.804	95.713	19.785	22.893	0.6494	0.6494	92.383
4	2	2	12.1	97.64	94.345	18.127	102.449	0.6494	0.8118	80.044
4	2	2	10.64	88.467	92.909	98.161	103.911	2.4354	1.1365	0.3247
4	2	2	11.196	93.168	22.07	99.17	97.416	1.1365	89.136	0
4	2	2	18.143	96.844	20.249	60.773	102.807	0.4871	102.125	22.568
4	2	2	24.517	96.517	22.954	49.828	101.8	0.8118	101.313	28.413
4	2	2	19.126	94.686	52.64	47.493	112.029	0.9742	42.376	28.413

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
4	1	4	50.245	27.392	3.3672	30.947	37.895	76.472	48.871	85.402
4	1	4	19.764	28.572	6.0603	33.933	76.147	78.258	47.896	78.582
4	1	4	20.193	33.428	15.428	44.075	96.28	43.837	79.07	45.299
4	1	4	16.872	46.483	4.4331	38.563	99.689	29.809	52.28	54.813
4	1	4	25.298	37.34	16.08	62.65	79.881	42.863	107.483	12.664
4	1	4	26.136	38.969	17.301	61.642	69.815	45.948	109.106	11.365
4	1	4	18.901	41.979	17.258	69.66	78.582	28.478	112.029	12.664
4	1	4	11.796	56.093	21.223	84.412	116.25	25.815	101.475	3.5719
4	1	4	14.215	29.234	47.021	57.417	111.866	63.645	31.011	17.21
4	1	4	11.111	27.898	50.099	56.005	74.523	68.841	39.778	18.184
4	1	4	19.925	51.27	16.011	59.61	71.439	22.243	92.545	23.25
4	1	4	5.5154	48.807	12.825	52.442	74.361	26.789	114.951	18.347
4	1	4	10.175	71.752	9.8346	32.68	116.25	16.723	85.889	79.719
4	1	4	36.777	93.196	42.836	24.782	56.664	1.2989	44.324	110.892
4	1	4	28.837	53.291	41.847	70.329	67.217	21.009	49.812	9.4819
4	1	4	32.904	66.582	18.75	67.506	71.276	13.638	100.501	14.58
4	1	4	34.8	74.232	17.35	34.846	52.605	4.3837	103.261	61.859
4	1	4	47.662	83.068	13.436	39.082	33.154	4.2214	106.508	48.221
4	2	4	46.441	8.4005	18.043	34.442	37.538	67.38	99.202	53.417
4	2	4	36.628	13.021	1.7144	48.403	46.273	72.575	30.524	28.9
4	2	4	11.579	43.279	2.3199	47.806	116.088	36.369	37.018	27.439
4	2	4	10.782	43.211	3.4616	52.06	109.756	39.616	42.214	30.199
4	2	4	10.61	51.047	10.031	5.0687	93.195	19.84	91.896	74.523
4	2	4	5.6113	53.361	12.056	8.8743	64.782	17.535	100.664	91.084
4	2	4	38.225	69.273	14.486	38.976	41.24	18.087	119.335	52.93
4	2	4	45.829	69.251	11.709	49.054	26.627	16.723	99.852	27.601
4	2	4	1.4433	73.241	43.432	37.496	28.575	8.7675	35.882	50.332
4	2	4	1.8988	92.781	41.083	40.695	39.778	2.9225	44.974	46.922
4	2	4	21.71	15.858	5.019	27.702	90.727	112.353	72.413	85.239
4	2	4	20.968	21.552	6.8621	32.452	86.538	109.593	77.771	80.368
4	2	4	46.211	13.591	7.0949	10.33	33.609	87.999	77.608	102.449
4	2	4	42.395	20.076	18.311	15.035	40.103	100.664	101.638	107.158
4	2	4	35.163	51.694	15.511	10.836	67.704	21.919	102.774	119.497
4	2	4	32.03	43.898	48.277	11.413	74.264	39.454	23.542	120.471
4	2	4	10.131	30.889	29.784	10.524	110.405	69.653	60.398	118.686
4	2	4	18.511	38.696	47.401	51.704	99.04	50.949	28.575	28.738

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
4	3	2	19.793	97.597	50.604	87.93	109.269	0.6494	41.402	1.4612
4	3	2	5.4543	76.003	46.381	72.886	75.335	13.476	47.247	5.6826
4	3	2	21.492	77.64	41.207	59.829	119.822	12.177	58.612	19.808
4	3	2	22.7	65.558	34.106	66.781	119.984	19.97	72.9	12.989
4	3	2	24.5	43.188	45.153	32.82	112.191	56.989	49.682	80.531
4	3	2	20.656	45.169	42.892	32.828	112.353	50.007	49.423	78.972
4	3	2	24.674	54.9	96.263	87.551	89.785	40.46	0.9742	3.2472
4	3	2	27.965	91.241	86.544	92.41	75.985	3.2472	4.5461	1.6236
4	3	2	36.676	76.589	3.6201	28.486	64.782	8.7675	59.749	65.983
4	3	2	23.123	65.501	5.6209	32.002	80.206	19.321	70.952	59.424
4	3	2	27.198	67.553	58.866	60.65	68.289	18.022	19.646	14.612
4	3	2	37.571	61.864	68.353	52.408	60.69	22.893	10.391	22.406
4	3	2	25.828	56.603	20.496	90.483	103.034	29.225	90.272	2.7601
4	3	2	27.833	87.08	21.743	78.399	97.741	5.0332	97.903	7.7933
4	3	2	28.535	77.453	5.0406	20.124	96.799	7.7933	61.697	89.298
4	3	2	28.678	94.047	4.8567	21.281	94.819	1.4612	64.295	91.409
4	3	2	17.659	96.876	1.3215	36.245	73.062	1.2989	28.088	64.132
4	3	2	18.48	94.532	2.6258	33.413	97.254	2.1107	47.734	71.114
4	4	2	11.979	31.785	31.587	52.446	94.494	66.081	67.38	25.004
4	4	2	28.033	25.559	60.751	73.966	77.933	73.712	16.398	5.0332
4	4	2	39.049	25.051	92.778	31.331	75.498	53.254	4.059	63.483
4	4	2	28.959	18.069	75.432	29.129	98.878	56.664	11.365	64.457
4	4	2	12.011	58.222	98.107	12.376	100.826	20.003	0	84.59
4	4	2	9.7613	71.723	98.66	11.596	114.789	8.9298	0.6494	69.328
4	4	2	7.5784	51.292	59.032	32.005	117.874	24.029	17.697	56.826
4	4	2	6.1856	52.919	58.85	31.825	106.833	26.01	20.782	68.354
4	4	2	47.71	97.755	57.063	17.709	54.553	0.9742	27.277	115.114
4	4	2	19.809	97.518	60.601	15.632	97.579	0.9742	15.944	117.549
4	4	2	17.614	84.419	7.9472	19.498	67.542	5.5203	62.509	93.682
4	4	2	13.381	58.195	12.399	14.436	62.509	31.336	93.52	81.505
4	4	2	8.0185	56.167	96.831	28.321	67.867	39.129	0.8118	83.94
4	4	2	57.719	41.453	89.861	31.438	18.022	62.671	3.0848	93.52
4	4	2	57.601	29.596	28.596	5.1557	19.84	100.988	78.907	57.638
4	4	2	51.691	27.301	17.048	3.9093	28.251	103.261	67.217	52.93
4	4	2	63.837	98.805	31.28	11.124	20.003	0	73.874	63.645
4	4	2	60.762	97.934	54.91	10.213	22.406	0.3247	26.075	58.287

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
4	3	4	2.7323	4.2893	2.4462	53.392	51.631	69.815	41.564	28.251
4	3	4	4.8174	5.4414	2.1005	54.816	86.376	72.088	37.992	24.029
4	3	4	42.709	30.987	1.4177	36.263	66.243	79.557	23.38	58.45
4	3	4	23.295	31.34	56.627	33.273	98.878	73.387	19.321	63.97
4	3	4	2.1203	54.265	61.482	32.363	46.11	20.62	11.852	71.763
4	3	4	3.9088	55.161	65.68	55.151	76.472	21.269	16.885	31.011
4	3	4	12.134	70.756	37.609	56.716	112.191	8.6051	85.402	23.705
4	3	4	19.301	41.684	18.776	55.346	109.918	39.291	108.944	20.945
4	3	4	54.115	48.831	25.865	13.83	28.738	24.192	103.911	93.195
4	3	4	54.403	95.979	19.074	13.513	32.505	0.9742	105.859	86.213
4	3	4	49.378	97.288	25.749	11.603	45.461	0	89.298	81.18
4	3	4	35.672	46.001	31.076	73.212	66.081	40.071	71.926	9.904
4	3	4	41.941	42.175	21.383	64.084	65.594	38.317	102.449	23.542
4	3	4	61.435	99.75	14.007	81.174	31.985	0	114.789	8.118
4	3	4	6.195	99.635	52.909	64.968	73.874	0	29.55	12.015
4	3	4	8.1306	68.413	46.765	41.877	88.486	14.937	44.649	45.299
4	3	4	12.008	46.825	42.202	32.569	146.124	41.077	42.701	64.782
4	3	4	24.234	93.294	49.929	54.143	152.132	0.8118	26.789	18.347
4	4	4	23.314	79.093	10.706	66.433	118.848	8.118	119.822	9.0922
4	4	4	25.123	94.163	5.6686	3.5595	123.719	0.7144	80.693	43.837
4	4	4	99.919	93.855	54.443	10.718	0	1.6236	34.193	69.653
4	4	4	99.848	34.345	61.815	23.324	0	65.756	24.419	92.708
4	4	4	56.523	80.867	27.373	25.144	42.538	5.845	111.217	96.929
4	4	4	80.863	62.859	23.105	16.899	13.963	14.612	125.05	106.671
4	4	4	21.1	55.946	6.5562	21.035	115.081	26.205	51.631	118.523
4	4	4	20.16	72.017	7.8513	99.012	93.844	9.7416	57.313	0.1624
4	4	4	6.1529	70.9	58.143	99.476	77.478	12.177	26.627	0
4	4	4	7.5545	93.098	61.087	12.365	103.424	2.5978	20.457	86.213
4	4	4	79.576	98.853	25.65	13.835	6.6568	0.1624	117.062	101.962
4	4	4	55.992	51.378	13.7	21.333	25.491	28.9	123.719	110.632
4	4	4	5.4	28.811	51.472	21.873	91.896	78.42	39.778	109.756
4	4	4	6.7106	38.896	60.631	96.808	94.494	62.996	18.184	0.4871
4	4	4	24.53	13.845	25.325	51.453	89.136	105.697	53.092	47.734
4	4	4	18.327	14.441	2.5241	52.491	91.409	130.375	45.136	33.284
4	4	4	19.287	50.339	11.732	28.823	100.176	31.985	125.505	79.07
4	4	4	10.644	72.866	15.562	28.863	110.892	12.015	137.844	82.641

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
5	1	2	39.682	91.724	15.526	54.079	58.45	2.5978	113.977	23.38
5	1	2	41.749	96.891	8.5395	59.08	48.026	0.3247	83.129	14.125
5	1	2	11.924	26.894	7.1289	69.8	111.866	53.904	73.062	11.203
5	1	2	13.599	75.248	37.78	73.868	104.593	10.553	74.361	17.21
5	1	2	23.849	63.121	57.685	93.178	78.355	14.84	21.919	2.1107
5	1	2	23.013	45.995	59.769	57.85	80.693	44.649	22.893	14.742
5	1	2	6.3847	48.287	11.016	24.902	68.516	31.823	107.158	112.516
5	1	2	6.182	53.494	44.651	25.808	65.594	26.465	46.273	105.534
5	1	2	30.292	41.895	44.578	25.22	76.959	54.78	42.376	106.736
5	1	2	29.216	38.517	13.835	50.648	76.212	54.715	147.423	29.712
5	1	2	16.197	97.325	14.029	60.431	96.117	0.4871	121.608	20.1
5	1	2	18.63	97.572	26.538	55.634	90.597	0	96.767	18.184
5	1	2	28.637	94.633	2.3123	57.23	98.878	0.9742	44.162	19.873
5	1	2	62.166	82.462	2.552	27.82	10.716	5.2605	44.649	87.999
5	1	2	68.497	99.04	26.82	27.213	7.6309	0	102.937	86.538
5	1	2	45.875	98.056	32.655	30.695	33.933	0.1624	72.575	78.258
5	1	2	9.0394	57.02	12.814	10.374	85.402	17.21	81.505	108.782
5	1	2	10.455	60.896	14.094	10.977	89.948	12.664	77.933	127.778
5	2	2	15.708	74.604	9.9777	78.059	74.523	6.8191	59.099	5.6826
5	2	2	8.5296	43.992	8.3604	72.454	86.376	41.272	60.236	10.716
5	2	2	14.363	49.773	13.047	58.635	81.667	29.582	62.184	18.184
5	2	2	12.815	50.731	5.2676	60.925	83.778	24.192	32.147	9.904
5	2	2	36.256	60.992	4.044	70.698	60.236	15.911	41.24	8.4427
5	2	2	38.733	66.481	4.3539	63.547	57.151	11.041	43.188	11.852
5	2	2	33.876	36.467	2.0381	39.478	62.509	61.697	29.225	51.371
5	2	2	43.655	37.195	11.077	48.347	33.122	57.8	69.977	33.122
5	2	2	44.447	86.004	8.0471	59.283	29.55	5.5203	67.217	25.685
5	2	2	9.7083	54.306	18.758	54.295	74.848	28.608	64.619	22.081
5	2	2	27.504	48.683	20.106	56.879	74.036	28.088	85.239	14.158
5	2	2	21.166	51.235	2.1477	62.828	108.619	21.204	18.022	13.638
5	2	2	17.064	57.009	2.1725	46.744	113.977	19.873	33.122	31.173
5	2	2	22.662	56.684	11.893	42.929	100.826	21.919	84.85	41.402
5	2	2	23.118	96.995	14.129	41.225	95.63	0	95.468	52.085
5	2	2	17.4	93.223	5.2816	67.378	76.309	0.6494	71.926	12.664
5	2	2	17.444	29.016	17.374	63.841	77.608	89.461	101.962	13.801
5	2	2	4.3123	33.005	14.186	58.686	56.826	76.797	94.981	15.846

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
5	1	4	11.641	57.636	15.967	21.854	80.531	31.173	102.774	106.021
5	1	4	18.097	47.147	19.267	26.795	127.453	40.103	102.449	92.545
5	1	4	19.596	42.028	18.547	31.726	119.173	45.786	102.612	66.081
5	1	4	24.005	44.202	4.0673	32.299	98.878	36.531	61.21	59.586
5	1	4	1.9326	44.59	6.2399	39.417	44.811	41.402	73.062	36.693
5	1	4	7.3037	29.44	6.46	39.54	62.346	66.568	81.667	40.428
5	1	4	9.3045	28.953	12.405	17.115	78.907	75.822	110.08	124.693
5	1	4	5.9195	53.771	14.159	16.817	65.107	20.945	117.874	123.069
5	1	4	10.71	49.276	8.2736	11.235	113.717	28.251	91.084	89.136
5	1	4	14.791	61.883	6.056	14.89	84.265	12.989	77.446	83.616
5	1	4	11.054	62.134	7.8607	17.75	83.94	12.826	84.915	95.955
5	1	4	11.926	44.515	10.823	16.461	119.335	33.511	106.184	98.715
5	1	4	11.772	47.364	42.65	33.018	109.593	33.446	42.701	62.346
5	1	4	51.049	44.596	45.527	30.765	21.756	41.564	31.985	74.848
5	1	4	53.042	56.094	21.66	17.928	22.081	19.061	98.553	87.188
5	1	4	39.386	54.623	20.334	23.085	48.708	19.97	100.534	89.298
5	1	4	40.581	76.95	4.8869	34.897	54.066	4.3837	98.878	70.14
5	1	4	42.325	60.076	2.6248	33.943	52.93	19.483	58.125	69.003
5	2	4	38.583	56.994	3.6229	23.357	55.56	21.367	62.996	75.66
5	2	4	82.695	9.8054	2.6086	22.729	7.3062	90.435	62.996	88.324
5	2	4	65.296	9.981	2.0678	21.348	15.587	87.675	40.59	97.903
5	2	4	27.801	95.979	2.1756	26.203	114.951	0.6494	45.299	86.213
5	2	4	31.013	89.098	3.8106	45.928	107.32	5.1955	54.228	39.941
5	2	4	7.0515	8.5755	3.7589	53.668	86.213	121.446	59.099	21.984
5	2	4	7.5282	11.967	9.0468	86.413	92.545	129.726	80.596	3.0848
5	2	4	8.4466	69.609	23.257	60.692	78.907	10.066	125.505	16.398
5	2	4	60.112	79.203	5.714	41.867	18.671	5.4553	89.298	37.992
5	2	4	49.77	96.884	10.102	44.929	28.413	0.3247	122.745	27.926
5	2	4	51.454	85.47	15.205	91.299	26.465	3.7343	110.405	2.1107
5	2	4	40.254	36.189	13.837	71.392	60.236	82.154	108.782	6.6568
5	2	4	38.521	46.841	13.131	39.533	52.118	50.819	111.379	40.558
5	2	4	34.663	57.543	14.214	39.126	65.269	19.256	114.627	42.376
5	2	4	22.165	54.536	17.49	53.629	81.505	13.476	104.755	22.406
5	2	4	22.311	17.632	3.44	69.893	82.479	112.841	67.38	10.424
5	2	4	7.4472	23.484	3.1009	10.121	83.778	104.073	57.963	96.604
5	2	4	5.7899	26.803	3.0398	8.1559	73.062	108.132	51.631	86.051

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
5	3	2	8.5658	29.09	14.397	55.214	79.849	84.915	91.571	23.867	5	3	4	6.074	37.477	6.4052	50.494	76.472	74.036	77.284	24.516
5	3	2	17.148	40.646	17.588	51.92	77.121	57.638	93.877	31.985	5	3	4	8.139	18.289	14.198	39.822	97.416	108.782	111.379	39.291
5	3	2	16.164	73.407	15.98	76.375	78.42	9.5793	91.247	10.229	5	3	4	7.7927	21.38	17.997	33.479	100.501	109.918	111.542	61.21
5	3	2	13.511	62.469	44.158	64.599	93.033	16.398	51.306	15.587	5	3	4	6.5024	65.775	33.143	19.468	87.675	9.5793	70.627	102.612
5	3	2	17.311	67.186	45.397	33.381	88.974	10.553	45.136	65.269	5	3	4	3.9007	58.09	31.656	38.091	49.358	10.066	79.557	51.793
5	3	2	8.3069	67.572	48.115	16.278	77.901	16.074	38.317	111.866	5	3	4	5.8845	28.57	27.695	27.931	75.498	84.265	87.512	80.531
5	3	2	10.451	83.876	48.506	16.262	76.309	4.8708	41.24	114.139	5	3	4	35.194	30.258	4.2847	10.565	63.158	87.869	67.867	89.785
5	3	2	8.2189	75.13	7.5444	37.539	73.225	5.6826	67.704	64.327	5	3	4	17.78	33.726	3.4469	18.09	91.247	59.262	59.099	96.767
5	3	2	19.777	70.157	5.4695	35.217	95.63	12.372	57.638	74.036	5	3	4	1.3852	39.944	16.23	39.365	29.712	44.811	102.612	51.468
5	3	2	20.783	58.18	6.1579	50.718	93.844	21.269	58.774	22.893	5	3	4	1.4108	75.882	14.172	43.358	30.199	8.118	110.243	47.409
5	3	2	18.286	53.417	25.088	57.599	97.903	23.575	92.383	9.4169	5	3	4	29.727	55.421	16.034	14.384	77.706	15.911	111.542	76.309
5	3	2	19.264	53.579	19.733	45.095	86.376	24.094	94.656	38.317	5	3	4	32.557	49.991	7.9254	17.243	72.25	21.594	98.715	87.188
5	3	2	20.478	59.508	17.064	55.903	86.376	17.048	104.56	21.432	5	3	4	10.055	46.039	6.2333	16.297	96.767	30.848	105.697	103.586
5	3	2	22.076	60.114	7.8792	64.956	83.778	15.846	72.088	10.878	5	3	4	22.352	86.611	31.817	19.082	104.56	3.8967	75.173	103.911
5	3	2	18.748	77.902	8.0281	53.986	127.94	8.735	69.49	28.413	5	3	4	63.199	80.181	32.822	19.33	25.491	7.9557	67.867	90.597
5	3	2	21.391	86.517	13.181	57.538	108.944	3.0848	96.604	24.744	5	3	4	30.952	43.585	21.405	13.836	88.324	39.454	103.424	93.682
5	3	2	25.163	58.648	10.427	55.21	96.929	18.542	92.221	30.264	5	3	4	16.17	48.499	25.881	28.337	112.516	23.38	84.752	90.11
5	3	2	22.891	58.67	8.8489	76.968	80.206	17.373	105.534	6.8191	5	3	4	13.842	45.512	18.698	19.106	94.819	36.369	108.944	112.029
5	4	2	20.984	63.864	11.212	42.764	94.819	12.437	117.387	40.428	5	4	4	28.687	48.236	4.0343	23.343	129.856	28.738	67.704	101.638
5	4	2	21.766	12.515	4.3139	55.462	110.73	90.272	76.797	19.808	5	4	4	42.907	45.154	6.8326	23.594	60.82	34.096	95.793	95.468
5	4	2	9.826	47.181	3.8629	40.787	86.376	46.11	70.627	44.487	5	4	4	11.658	48.54	10.532	51.079	101.475	28.738	102.612	26.4
5	4	2	7.1071	41.729	3.976	46.996	80.856	54.066	60.885	25.978	5	4	4	6.9151	79.074	15.996	54.002	122.095	8.2804	106.021	31.336
5	4	2	63.711	33.513	5.4114	48.128	13.314	73.225	76.959	29.712	5	4	4	10.344	49.466	25.522	32.263	151.158	37.181	62.834	84.59
5	4	2	72.988	29.86	10.574	41.569	11.69	74.361	93.033	38.869	5	4	4	13.945	94.705	27.394	46.297	152.781	1.4612	69.815	30.199
5	4	2	27.9	28.222	11.202	47.389	80.401	75.498	90.272	28.738	5	4	4	68.565	88.662	32.226	67.048	14.612	1.1365	61.048	10.066
5	4	2	31.191	36.595	13.233	38.595	60.918	61.048	96.604	39.908	5	4	4	54.155	77.55	12.835	82.722	41.402	8.118	133.785	3.5395
5	4	2	60.11	37.531	86.716	41.001	18.184	62.996	2.273	40.46	5	4	4	17.689	49.782	16.084	52.568	117.874	35.752	132.811	23.867
5	4	2	64.822	36.376	74.265	16.752	13.314	71.114	8.3453	120.634	5	4	4	19.184	63.104	42.715	60.388	130.181	21.919	46.273	18.022
5	4	2	54.542	55.855	92.657	18.145	23.705	19.808	0.8118	120.309	5	4	4	99.296	83.033	39.325	48.789	0	6.9815	64.132	44.162
5	4	2	53.858	52.636	12.556	18.04	25.653	22.763	119.66	122.095	5	4	4	99.328	97.42	9.6337	50.826	0.4871	0.3247	70.464	29.517
5	4	2	29.254	52.782	14.009	9.1046	83.616	26.14	123.232	85.726	5	4	4	10.882	91.659	42.529	31.738	134.272	1.2989	58.937	93.033
5	4	2	30.317	61.789	18.079	6.9995	74.199	28.835	110.892	76.309	5	4	4	16.77	16.503	31.536	27.096	123.069	111.217	84.265	101.962
5	4	2	20.526	58.076	5.1124	48.618	119.335	42.051	50.169	26.14	5	4	4	92.317	12.671	13.639	27.681	1.8509	108.944	111.704	101.8
5	4	2	16.588	92.996	14.613	59.492	116.575	2.1107	89.298	13.638	5	4	4	97.945	97.903	14.061	15.908	0.3247	0.1624	112.841	106.346
5	4	2	73.664	92.105	4.3402	49.049	7.6309	0.8118	46.273	28.738	5	4	4	22.29	97.634	33.491	20.136	88.649	0.4871	97.579	92.545
5	4	2	16.848	93.886	1.7766	55.234	107.32	1.6236	45.786	31.823	5	4	4	28.839	26.826	32.516	22.459	98.715	106.996	96.767	94.819

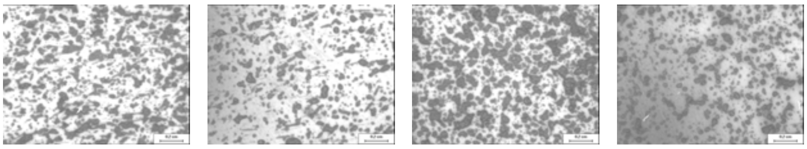
T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
6	1	2	10.161	73.63	1.5151	65.951	101.151	7.7933	40.265	82.317
6	1	2	20.878	59.01	1.2246	110.892	108.165	17.21	32.472	79.07
6	1	2	25.498	61.649	4.4072	102.774	103.911	15.911	46.11	12.21
6	1	2	10.559	69.877	1.491	72.023	116.737	12.015	25.653	16.593
6	1	2	14.11	65.523	1.1176	76.797	105.892	21.172	23.218	15.197
6	1	2	11.911	42.971	1.2523	50.332	97.416	48.059	29.387	8.2804
6	1	2	11.068	43.172	7.7521	43.707	96.604	47.247	73.225	6.0073
6	1	2	25.431	46.227	16.443	31.855	111.217	47.572	106.021	5.0332
6	1	2	22.623	46.083	0.6501	35.752	136.545	45.136	17.048	70.464
6	1	2	22.05	48.911	0.8997	90.435	139.468	25.491	15.1	93.682
6	1	2	4.1363	48.963	91.112	103.748	56.664	24.354	4.059	95.306
6	1	2	9.7796	49.756	80.793	105.859	62.087	23.705	10.229	66.73
6	1	2	26.043	32.95	29.509	40.655	102.06	67.217	73.744	66.893
6	1	2	30.68	36.252	40.067	32.797	107.158	55.462	54.521	70.789
6	1	2	26.21	36	39.758	35.914	103.034	57.963	54.618	94.007
6	1	2	12.499	31.204	33.788	53.644	91.734	76.472	64.132	98.553
6	1	2	6.8466	31.342	22.646	65.431	86.213	76.309	83.453	102.612
6	1	2	21.015	31.803	19.515	61.372	97.157	74.946	81.992	93.033
6	2	2	18.505	51.78	7.726	15.423	109.269	23.218	68.191	97.773
6	2	2	16.23	52.622	6.8311	17.2	125.342	25.101	67.704	100.826
6	2	2	17.143	53.922	6.043	25.324	111.704	23.542	64.295	61.697
6	2	2	3.6014	37.962	3.56	27.48	58.287	56.339	57.313	65.724
6	2	2	3.0329	40.005	3.6277	28.794	50.332	47.02	59.586	69.977
6	2	2	3.2052	88.908	2.5667	21.068	51.631	2.9225	40.265	92.383
6	2	2	5.5885	91.442	2.728	26.767	70.789	1.1365	40.752	84.265
6	2	2	3.7705	60.04	31.542	46.705	60.236	14.288	60.073	25.004
6	2	2	5.2615	60.888	27.474	47.995	68.678	13.801	64.132	24.192
6	2	2	13.923	50.524	15.369	92.926	104.56	26.952	76.797	0.8118
6	2	2	19.346	45.324	22.835	92.918	126.641	37.992	78.745	0.4871
6	2	2	14.996	38.669	30.086	95.511	54.391	43.837	68.256	1.4612
6	2	2	30.772	42.179	6.6835	56.306	56.989	44.324	69.003	21.756
6	2	2	26.223	69.578	7.4746	49.862	68.516	12.015	78.745	27.764
6	2	2	31.601	60.653	6.7063	75.472	58.287	12.859	70.464	4.3837
6	2	2	27.732	58.358	5.4916	70.046	62.217	12.989	77.446	8.2804
6	2	2	45.044	53.515	5.3396	25.11	42.441	19.905	83.616	70.464
6	2	2	44.342	50.161	5.3495	30.362	37.181	19.938	78.745	66.6

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
6	1	4	16.072	84.741	28.292	32.189	93.52	7.3062	81.83	63.321
6	1	4	12.934	78.696	26.608	31.231	94.007	8.6051	90.11	64.944
6	1	4	40.355	99.673	29.364	33.327	40.752	0.1624	79.232	54.715
6	1	4	37.803	98.598	50.943	32.865	45.461	0.3247	20.945	67.737
6	1	4	7.4315	33.272	47.203	27.519	80.044	73.225	30.199	74.523
6	1	4	10.883	31.226	43.259	29.277	88.486	82.804	31.823	70.14
6	1	4	10.543	28.301	44.145	44.05	69.653	84.265	31.985	33.284
6	1	4	11.098	66.146	47.938	45.601	84.752	25.653	23.542	24.516
6	1	4	41.452	80.643	48.676	13.173	33.122	9.4169	25.004	90.435
6	1	4	39.116	94.115	18.761	11.609	31.985	1.786	93.844	78.42
6	1	4	2.5304	96.694	17.876	17.346	46.273	0.9742	96.767	94.981
6	1	4	1.9062	95.743	13.987	17.471	37.83	0.9742	103.911	89.785
6	1	4	20.629	97.956	17.59	10.801	90.76	0.8118	113.977	112.029
6	1	4	11.321	89.157	12.393	7.0764	89.136	4.2214	102.612	84.427
6	1	4	27.601	56.887	22.452	10.21	78.258	37.343	104.398	98.878
6	1	4	29.541	37.574	17.989	7.5578	73.874	70.789	107.32	80.856
6	1	4	29.861	97.14	4.2127	30.423	65.756	0.3247	61.535	69.653
6	1	4	12.697	94.652	10.238	27.656	89.785	1.1365	66.405	70.952
6	2	4	53.255	50.307	21.915	49.581	25.004	52.605	113.977	29.225
6	2	4	69.453	56.537	21.086	50.159	9.904	39.778	119.497	31.173
6	2	4	20.689	65.588	18.219	50.218	120.309	14.775	116.412	29.55
6	2	4	13.967	89.992	26.517	86.873	131.999	3.4096	101.475	1.786
6	2	4	8.3721	93.187	41.754	90.506	96.604	1.9483	72.088	3.5719
6	2	4	10.109	99.806	42.08	33.025	89.136	0	54.131	66.568
6	2	4	33.772	99.576	40.452	24.579	78.258	0	57.313	70.14
6	2	4	44.24	66.141	22.041	66.639	52.994	18.184	122.745	10.229
6	2	4	44.411	69.862	18.099	81.739	41.24	14.775	142.715	5.7151
6	2	4	35.695	35.137	39.83	34.352	63.158	78.745	67.867	77.121
6	2	4	51.647	28.652	48.435	54.636	30.199	95.955	55.527	28.933
6	2	4	51.368	27.614	50.176	6.5567	28.64	90.597	49.358	106.508
6	2	4	27.657	87.862	95.267	17.69	100.014	4.2214	1.2989	92.058
6	2	4	23.072	47.392	87.207	91.957	112.516	64.295	2.7601	1.2989
6	2	4	27.783	94.749	27.651	77.104	97.903	1.1365	78.128	5.5203
6	2	4	2.5251	77.029	24.44	36.878	67.704	14.288	80.044	47.734
6	2	4	5.3473	44.041	49.229	37.11	96.604	37.992	37.83	51.793
6	2	4	6.5006	42.393	44.103	38.682	106.996	50.981	43.026	40.265

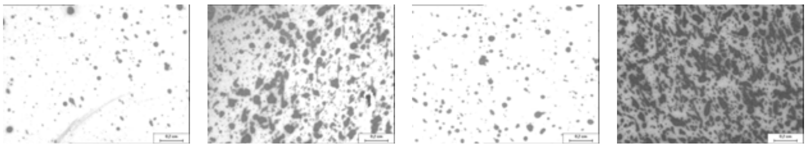
T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
6	3	2	6.9049	26.17	8.6602	27.095	96.929	74.848	77.608	74.881	6	3	4	31.305	44.527	80.393	47.168	103.586	49.682	7.4686	35.719
6	3	2	4.6903	29.817	10.951	18.196	77.608	67.704	93.033	79.232	6	3	4	33.537	41.723	85.011	45.061	88.389	51.793	3.2472	43.513
6	3	2	27.653	39.787	11.768	15.391	88.811	44.292	108.294	75.498	6	3	4	30.248	97.177	13.607	85.824	92.708	0	121.608	4.8708
6	3	2	28.907	33.231	15.066	49.688	84.752	63.808	105.534	22.73	6	3	4	5.6483	94.193	10.576	77.112	85.564	1.2989	133.136	5.9749
6	3	2	28.682	33.495	38.762	47.927	86.051	59.099	69.295	34.583	6	3	4	7.5657	28.885	24.738	43.318	91.409	88.162	108.944	39.096
6	3	2	29.679	63.148	65.278	60.98	79.394	12.534	16.885	16.236	6	3	4	15.55	37.328	7.5756	47.737	136.87	67.867	86.213	27.764
6	3	2	5.3183	22.056	60.911	76.097	90.76	78.258	18.996	26.952	6	3	4	10.718	98.578	16.644	56.665	103.586	0.1624	126.154	29.225
6	3	2	11.021	27.165	34.914	76.96	71.763	62.346	84.135	31.888	6	3	4	23.263	99.053	12.732	36.188	103.261	0	124.368	63.158
6	3	2	44.703	39.822	31.071	95.887	52.442	35.557	86.441	1.786	6	3	4	17.97	99.127	37.68	68.79	122.42	0.3247	69.328	8.7675
6	3	2	39.629	27.756	31.77	13.341	65.756	70.14	66.081	109.593	6	3	4	25.502	98.3	39.25	59.57	99.527	0.1624	56.501	14.288
6	3	2	30.375	29.606	26.398	11.514	94.331	71.601	65.918	104.235	6	3	4	31.465	30.964	6.6104	38.781	76.18	81.343	86.376	57.963
6	3	2	39.834	53.938	40.596	68.493	69.166	51.371	46.11	21.691	6	3	4	5.9662	61.976	6.8651	36.925	94.981	32.797	76.472	62.996
6	3	2	18.199	91.879	5.0487	65.618	82.641	2.1107	65.756	25.393	6	3	4	17.481	62.42	40.405	56.562	71.926	14.288	57.8	17.892
6	3	2	19.914	66.471	68.516	60.836	94.007	11.852	13.638	32.699	6	3	4	2.3605	69.607	32.636	51.21	52.93	12.177	71.926	25.491
6	3	2	23.459	63.533	60.289	41.205	81.667	17.113	22.049	46.273	6	3	4	9.5351	79.483	2.5835	49.128	111.542	7.7933	52.767	31.206
6	3	2	31.136	44.302	72.913	36.267	66.73	39.454	8.4427	53.579	6	3	4	18.871	87.99	4.165	34.408	114.139	4.059	75.011	64.749
6	3	2	20.605	49.027	11.853	38.315	101.962	29.063	101.475	47.214	6	3	4	11.747	76.418	26.152	92.646	119.822	9.7416	87.999	3.0848
6	3	2	20.419	33.982	3.348	8.8773	105.047	56.664	44.811	82.641	6	3	4	6.8735	62.864	34.218	78.214	80.856	21.919	71.601	5.4878
6	4	2	40.166	36.816	32.056	7.6989	50.656	52.93	65.951	90.922	6	4	4	7.4602	92.652	47.319	47.934	78.258	1.9483	43.188	28.088
6	4	2	5.6575	37.885	11.151	8.3259	62.834	50.007	110.892	87.999	6	4	4	10.02	89.58	43.81	47.487	76.472	2.273	46.597	32.927
6	4	2	26.141	33.87	9.2109	63.805	84.265	75.628	102.774	11.722	6	4	4	9.8394	96.522	41.839	64.284	82.804	0.4871	44	16.561
6	4	2	34.284	41.54	26.544	62.689	69.49	48.773	72.023	10.716	6	4	4	11.752	92.968	15.655	47.985	77.771	1.6236	114.627	27.439
6	4	2	45.323	41.817	21.177	55.875	43.837	47.929	76.797	14.612	6	4	4	38.626	95.246	1.891	32.91	49.682	1.4612	37.505	43.707
6	4	2	43.763	9.2634	5.9839	58.553	39.908	76.309	50.332	14.45	6	4	4	40.001	82.832	1.2513	35.506	41.24	5.845	39.129	31.66
6	4	2	46.049	8.0958	42.809	79.573	33.771	78.095	43.707	6.4944	6	4	4	5.5413	48.006	14.91	50.486	105.372	36.044	94.169	34.908
6	4	2	6.5635	63.496	50.143	86.585	107.158	13.541	31.855	3.2472	6	4	4	9.5518	75.378	6.4517	67.35	123.232	5.845	61.048	13.151
6	4	2	6.3441	58.295	43.386	32.969	91.084	19.256	35.752	72.121	6	4	4	16.653	44.173	8.2082	40.196	96.604	47.247	74.361	49.195
6	4	2	7.1639	85.218	12.518	28.693	97.579	4.2214	90.435	91.474	6	4	4	21.882	43.712	24.627	45.07	90.435	51.631	84.915	30.361
6	4	2	18.525	79.637	13.265	46.935	107.32	6.1697	103.748	46.597	6	4	4	15.549	57.316	37.116	21.875	98.715	20.457	43.188	77.933
6	4	2	16.967	83.908	18.099	9.8701	112.353	4.2214	105.859	103.261	6	4	4	43.791	51.162	43.19	18.093	39.161	28.251	39.454	92.058
6	4	2	17.689	26.93	41.909	11.567	113.165	67.704	40.655	105.047	6	4	4	46.334	97.693	33.889	25.57	31.043	0.8118	63.645	75.335
6	4	2	17.843	33.929	44.257	13.335	112.353	54.975	32.797	105.534	6	4	4	48.192	97.343	26.778	43.036	32.797	0.8118	81.667	36.856
6	4	2	39.526	30.389	46.016	21.129	68.516	71.861	35.914	92.708	6	4	4	18.367	79.986	16.596	49.139	70.952	4.8708	87.837	33.771
6	4	2	35.397	30.564	32.231	20.291	76.147	67.704	53.644	75.822	6	4	4	16.056	71.993	28.677	44.88	69.977	16.074	67.704	42.538
6	4	2	28.929	35.663	27.712	17.439	83.681	55.073	65.431	72.413	6	4	4	11.847	91.491	12.568	5.174	127.291	2.9225	108.619	72.25
6	4	2	47.196	47.502	3.6485	12.155	28.9	28.413	61.372	72.9	6	4	4	16.332	88.714	11.017	5.0056	125.829	4.2214	88.974	74.523

T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
7	1	2	34.437	91.439	16.887	36.012	84.427	3.2472	114.951	49.52	7	1	4	9.097	28.318	28.192	54.381	97.254	70.952	61.177	16.398
7	1	2	20.805	64.337	4.0625	32.301	95.793	9.0922	75.011	61.372	7	1	4	7.1469	30.053	31.03	55.069	78.42	72.802	54.066	22.73
7	1	2	30.008	65.429	3.7622	54.21	80.856	6.8191	82.966	23.867	7	1	4	15.893	27.927	41.278	17.597	86.051	83.453	45.299	102.287
7	1	2	23.72	58.874	4.1236	64.819	87.837	16.885	82.154	17.892	7	1	4	6.427	28.686	36.249	18.646	61.21	77.608	60.398	113.977
7	1	2	23.635	85.938	28.73	46.986	114.302	4.3837	77.608	55.852	7	1	4	12.799	28.861	87.745	53.865	98.066	81.505	4.2214	21.756
7	1	2	22.533	85.524	28.561	50.36	114.464	2.7601	85.4002	29.063	7	1	4	8.7302	31.435	69.093	39.715	77.121	69.653	16.463	44.649
7	1	2	28.614	75.798	16.332	52.881	83.453	5.3579	90.922	17.535	7	1	4	7.5949	22.705	41.249	66.433	75.011	97.416	45.071	9.904
7	1	2	36.107	24.785	30.155	58.07	73.549	77.608	60.723	15.164	7	1	4	1.4128	22.164	42.903	79.387	26.627	105.21	49.52	6.8841
7	1	2	37.228	24.265	8.087	14.077	65.594	80.693	83.129	89.136	7	1	4	5.2816	30.093	46.224	38.577	36.693	75.173	32.959	52.767
7	1	2	43.913	68.305	7.8401	78.876	53.254	10.716	95.306	4.7085	7	1	4	26.552	32.761	41.695	41.861	87.188	60.236	45.948	40.265
7	1	2	19.905	43.772	7.7856	62.405	95.63	49.682	76.959	11.203	7	1	4	24.936	59.974	19.719	18.831	87.188	16.074	119.335	92.545
7	1	2	27.527	24.337	80.095	52.225	93.033	87.188	6.1697	23.607	7	1	4	14.542	56.882	12.792	14.712	96.442	16.918	107.32	90.597
7	1	2	27.341	89.431	81.055	50.667	92.221	3.5719	6.0073	26.465	7	1	4	13.25	41.252	24.461	26.416	98.553	42.474	79.719	95.468
7	1	2	23.24	83.729	61.051	50.231	102.449	3.4096	15.262	28.088	7	1	4	14.244	43.446	34.425	28.605	82.641	32.797	56.339	88.422
7	1	2	21.565	74.668	17.612	95.125	93.844	7.9557	81.18	0.6494	7	1	4	14.552	61.239	27.093	47.76	90.597	12.274	90.922	33.771
7	1	2	21.642	70.022	8.2343	96.165	81.667	11.203	64.132	1.6236	7	1	4	17.646	79.13	24.387	48.922	104.56	4.7085	83.453	25.166
7	1	2	0.7797	51.115	13.165	42.813	14.937	22.081	78.745	36.044	7	1	4	24.606	38.5	88.322	59.2	99.689	61.729	2.273	11.268
7	1	2	0.7683	47.462	12.126	40.317	4.5461	27.926	77.771	44.324	7	1	4	16.837	38.059	82.461	63.181	84.427	57.67	4.8708	9.0922
7	2	2	46.166	93.371	8.6848	77.496	26.789	1.9483	70.789	4.7085	7	2	4	22	70.354	17.321	60.122	118.361	11.365	134.434	25.491
7	2	2	46.311	56.956	8.0484	85.54	26.497	24.192	64.782	4.059	7	2	4	7.5441	78.243	28.253	27.927	103.099	3.8967	106.963	105.859
7	2	2	43.561	75.466	8.2797	43.678	38.382	11.528	97.579	32.472	7	2	4	34.105	72.766	40.87	79.16	80.856	12.859	38.642	8.9298
7	2	2	19.76	77.603	5.1187	46.432	106.671	6.9815	67.38	26.627	7	2	4	34.433	74.866	39.475	55.472	76.309	7.4361	46.922	26.627
7	2	2	24.566	63.129	96.502	46.093	110.99	18.184	1.1365	29.387	7	2	4	29.787	90.595	54.322	85.058	96.604	4.059	31.758	4.3837
7	2	2	49.835	71.636	90.343	50.835	37.31	9.4169	3.0848	17.373	7	2	4	24.374	94.918	59.297	67.624	118.686	0.6494	26.789	15.1
7	2	2	49.377	83.113	31.153	49.282	43.513	5.5203	70.952	23.542	7	2	4	15.728	96.064	4.6046	58.196	134.759	0.4871	51.793	31.498
7	2	2	44.434	44.83	21.812	50.928	44.682	40.395	99.04	28.738	7	2	4	8.6947	88.588	4.1957	56.168	109.756	2.4354	60.073	19.938
7	2	2	19.874	37.498	20.631	71.06	85.564	59.099	98.553	6.8191	7	2	4	56.517	91.022	59.413	97.84	20.62	1.9483	26.789	0.6494
7	2	2	20.127	37.982	4.74	71.563	84.103	56.664	50.819	6.3321	7	2	4	64.609	98.077	68.564	98.698	14.288	0.1624	29.063	0.1624
7	2	2	4.8412	39.737	7.069	11.298	34.745	68.841	70.14	85.239	7	2	4	94.434	50.105	38.541	99.543	1.6236	31.985	60.073	0
7	2	2	2.6811	96.471	56.83	33.348	29.387	1.4612	71.763	56.989	7	2	4	88.626	42.108	46.738	99.19	4.059	52.93	48.221	0.1624
7	2	2	2.6296	81.075	15.283	11.352	27.926	4.3837	112.516	76.147	7	2	4	26.303	27.677	4.966	96.447	106.996	115.438	59.424	0.3247
7	2	2	2.6294	6.9503	14.79	12.667	28.738	91.896	101.8	82.804	7	2	4	30.767	35.164	6.8281	94.858	96.28	70.367	99.04	1.1365
7	2	2	2.7625	10.318	17.985	81.226	30.686	101.151	91.084	8.5077	7	2	4	56.417	96.956	27.283	96.395	25.166	0	98.066	1.1365
7	2	2	12.032	58.079	21.325	94.296	67.38	17.373	84.915	0.9742	7	2	4	40.982	98.26	40.17	93.144	49.455	0.4871	61.859	2.9225
7	2	2	17.88	53.649	3.5111	50.677	74.069	26.14	37.83	21.594	7	2	4	38.127	45.653	84.995	76.34	46.792	38.707	4.8708	6.9815
7	2	2	3.5372	60.668	6.2363	79.21	32.959	13.314	54.228	4.8708	7	2	4	40.002	49.875	88.98	59.546	46.76	29.615	4.5461	18.671

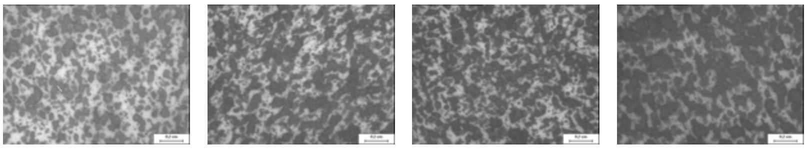
T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN	T	R	A	2LowerA	2UpperA	4LowerA	4UpperA	2LowerN	2UpperN	4LowerN	4UpperN
7	3	2	4.1655	60.253	7.637	33.864	37.505	14.612	66.405	67.055	7	3	4	20.479	69.137	27.585	65.076	89.461	7.3062	93.52	14.612
7	3	2	6.0121	73.441	34.569	33.455	49.845	4.8708	69.815	61.21	7	3	4	12.889	88.766	18.814	58.838	97.254	2.7601	119.01	20.295
7	3	2	22.261	71.227	31.27	39.082	98.001	6.3321	87.35	45.623	7	3	4	61.407	92.347	24.299	64.747	15.424	2.4354	110.567	15.619
7	3	2	25.29	36.92	33.066	20.932	94.819	43.35	73.712	79.557	7	3	4	69.039	98.447	25.822	64.345	13.119	0.1624	108.294	12.339
7	3	2	30.445	38.435	10.238	20.844	74.751	37.992	76.147	76.147	7	3	4	7.7823	51.027	94.01	56.462	108.619	32.147	1.9483	23.218
7	3	2	24.862	44.312	52.6	56.052	88.194	33.609	21.594	16.723	7	3	4	4.1949	43.488	20.994	52.862	95.793	48.383	105.534	29.712
7	3	2	20.047	47.968	58.829	49.627	75.985	32.472	16.561	26.302	7	3	4	3.3213	48.635	8.0015	68.027	54.391	32.31	114.789	13.314
7	3	2	28.911	24.858	3.5473	42.654	72.088	75.173	56.501	39.161	7	3	4	5.7556	53.26	7.2443	57.253	65.594	24.192	96.28	18.671
7	3	2	1.0996	84.52	5.7062	69.753	18.509	6.8191	69.003	6.8191	7	3	4	35.153	90.582	7.0706	94.863	61.535	1.2989	93.033	0.8118
7	3	2	8.0339	45.564	6.7335	65.362	106.833	29.874	70.627	7.6309	7	3	4	36.977	91.135	8.1291	91.276	64.132	2.4354	114.302	1.786
7	3	2	6.98	97.952	19.559	58.286	60.788	0.1624	136.708	11.852	7	3	4	38.279	51.901	16.907	26.798	51.306	27.439	129.077	79.232
7	3	2	8.5656	45.537	23.865	59.31	63.321	36.693	120.796	9.7416	7	3	4	26.187	81.164	21.735	24.646	85.726	4.7085	112.191	90.435
7	3	2	22.359	51.031	31.391	67.655	115.925	23.38	68.354	11.69	7	3	4	14.403	41.954	24.941	88.709	92.221	48.838	86.213	3.4096
7	3	2	15.846	57.082	32.016	98.149	109.269	15.749	78.258	0.3247	7	3	4	14.734	42.439	26.504	70.166	100.664	49.617	76.634	12.502
7	3	2	19.725	50.158	17.134	94.691	108.782	23.218	71.601	2.1107	7	3	4	6.5366	91.957	20.016	37.32	81.992	1.1365	88.811	52.442
7	3	2	19.62	39.605	25.431	53.873	108.327	39.941	74.199	19.678	7	3	4	14.977	96.397	10.855	53.37	133.785	0.6819	118.198	24.516
7	3	2	3.6952	48.77	11.55	49.288	44.811	21.432	62.184	23.705	7	3	4	11.229	70.528	10.823	95.426	88.649	12.015	123.069	1.2989
7	3	2	3.7558	48.517	8.2559	52.564	44.974	23.055	54.391	19.97	7	3	4	14.701	60.611	2.6814	87.166	109.269	20.198	45.136	5.5203
7	4	2	6.2703	24.289	22.176	54.84	66.568	78.907	133.46	22.081	7	4	4	43.127	49.963	5.3632	26.629	41.889	30.426	86.538	87.675
7	4	2	15.729	17.669	18.262	59.873	66.373	97.903	130.7	27.439	7	4	4	39.544	59.521	52.342	26.309	57.476	12.989	19.646	91.084
7	4	2	14.428	90.452	7.6989	54.165	114.302	2.1107	84.265	27.926	7	4	4	12.671	25.761	56.984	14.901	119.335	90.792	13.119	111.704
7	4	2	12.875	95.532	12.491	50.646	114.789	0.3247	119.01	31.238	7	4	4	25.18	23.587	39.803	14.819	95.793	89.948	54.066	107.32
7	4	2	13.313	8.1476	10.734	66.82	111.055	58.937	87.675	12.339	7	4	4	12.426	37.866	10.338	30.379	100.176	43.545	112.191	74.036
7	4	2	55.975	18.596	10.013	66.991	18.834	76.797	118.036	15.1	7	4	4	6.8895	42.69	9.39	26.401	72.088	38.447	93.357	87.188
7	4	2	51.089	78.538	13.111	60.066	23.867	7.3062	92.383	12.826	7	4	4	4.0184	79.134	10.116	13.597	67.055	12.989	110.08	117.874
7	4	2	51.282	59.187	8.1217	56.002	26.14	15.262	73.549	14.158	7	4	4	5.0355	49.09	13.932	11.624	58.45	25.978	119.173	113.977
7	4	2	33.604	49.096	38.196	37.193	72.9	24.841	55.04	74.686	7	4	4	38.847	67.869	45.571	16.895	41.889	18.671	32.472	105.372
7	4	2	29.983	36.083	31.653	31.124	93.195	61.372	61.697	81.31	7	4	4	29.251	80.154	46.07	26.485	72.023	6.1697	27.277	101.962
7	4	2	27.617	36.843	17.8	66.573	103.261	58.287	91.409	10.553	7	4	4	44.645	67.416	21.464	32.669	35.297	12.502	74.036	76.797
7	4	2	4.5188	30.823	17.8	60.334	55.203	59.424	92.383	13.801	7	4	4	37.923	63.099	23.269	31.269	53.611	12.08	64.619	74.686
7	4	2	9.2297	39.347	38.356	55.006	75.985	48.221	63.808	21.919	7	4	4	18.608	53.653	66.822	25.355	121.933	19.029	14.937	78.095
7	4	2	15.275	40.712	16.816	47.958	101.183	49.682	94.981	34.258	7	4	4	12.667	58.409	50.042	30.069	106.833	19.646	43.026	68.711
7	4	2	31.263	31.421	58.624	45.24	76.634	72.9	28.738	37.018	7	4	4	38.21	19.491	50.866	7.6499	45.623	106.671	29.063	84.915
7	4	2	68.893	30.953	56.385	53.314	13.963	72.575	30.296	29.712	7	4	4	41.722	19.635	32.727	10.836	30.524	101.962	80.206	113.328
7	4	2	24.576	9.6028	57.506	63.054	108.457	82.966	16.398	18.022	7	4	4	17.19	58.154	37.746	49.965	73.387	18.704	59.911	24.516
7	4	2	38.754	8.4611	52.183	57.426	50.494	93.033	19.646	15.911	7	4	4	2.0759	49.111	43.535	39.458	31.985	29.387	40.59	52.767



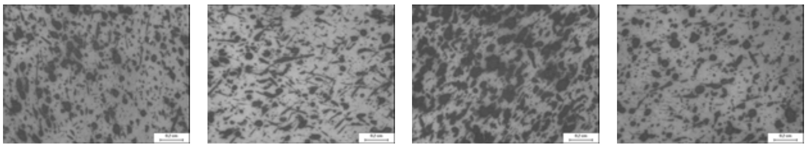
1CuZ - 4th wire/upper leaf-side



1CuZ - 4th wire/lower leaf-side

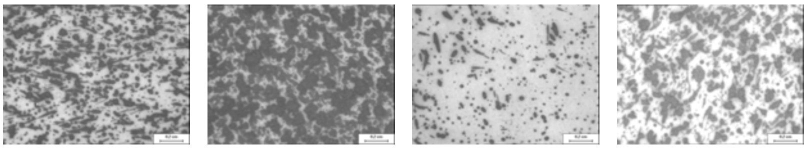


1CuZ - 2nd wire/upper leaf-side

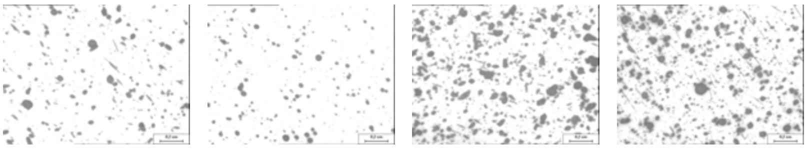


1CuZ - 2nd wire/lower leaf-side

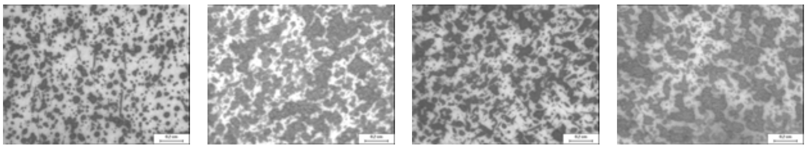
Figure AppF1: *Spray coverage for 1CuZ treatment (water application rate 400 L ha^{-1}) on WSP-s on different heights and leaf-sides.*



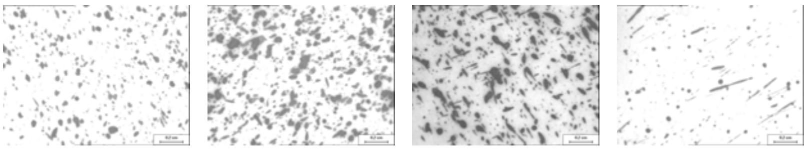
2CuZU - 4^{th} wire/upper leaf-side



2CuZU - 4^{th} wire/lower leaf-side

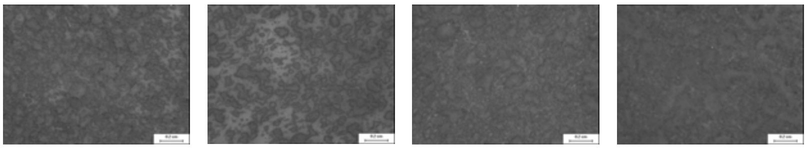


2CuZU - 2^{nd} wire/upper leaf-side

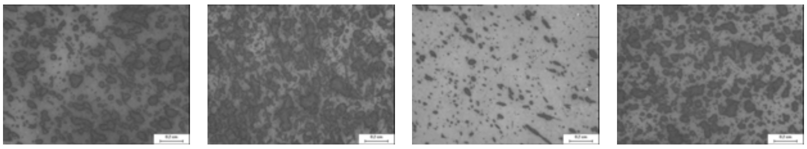


2CuZU - 2^{nd} wire/lower leaf-side

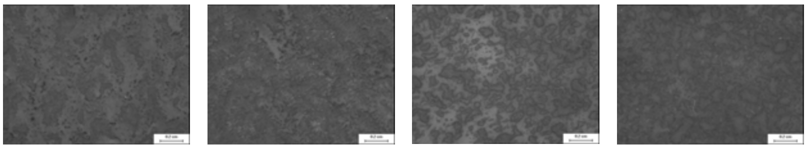
Figure AppF2: *Spray coverage for 2CuZU treatment (water application rate 400 L ha^{-1}) on WSP-s on different heights and leaf-sides.*



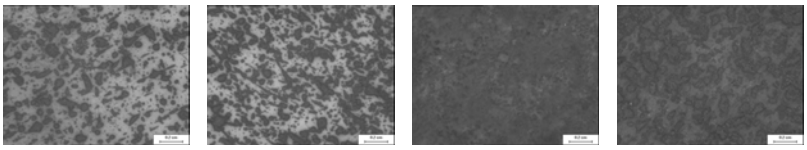
3CuZU - 4^{th} wire/upper leaf-side



3CuZU - 4^{th} wire/lower leaf-side

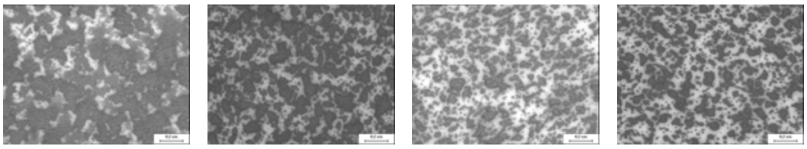


3CuZU - 2^{nd} wire/upper leaf-side

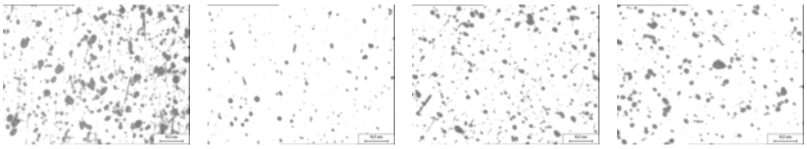


3CuZU - 2^{nd} wire/lower leaf-side

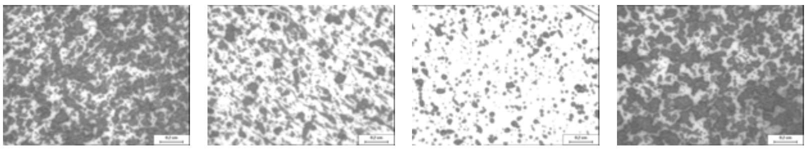
Figure AppF3: *Spray coverage for 3CuZU treatment (water application rate 1000 L ha^{-1}) on WSP-s on different heights and leaf-sides.*



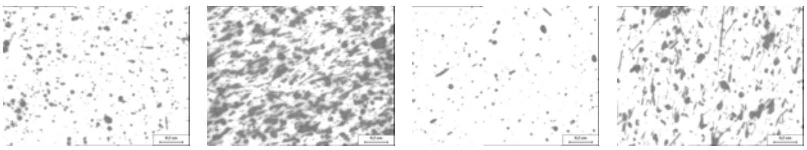
4Cha - 4th wire/upper leaf-side



4Cha - 4th wire/lower leaf-side

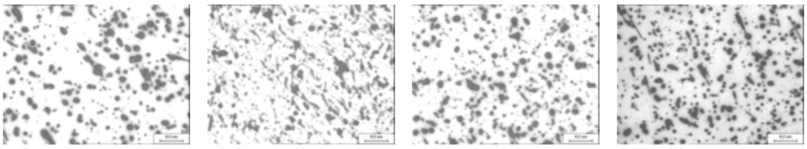


4Cha - 2nd wire/upper leaf-side

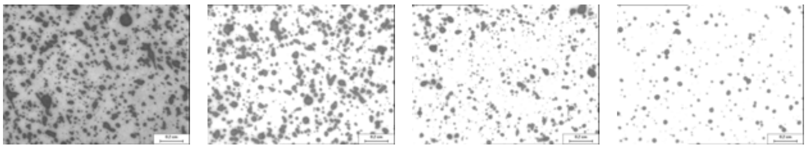


4Cha - 2nd wire/lower leaf-side

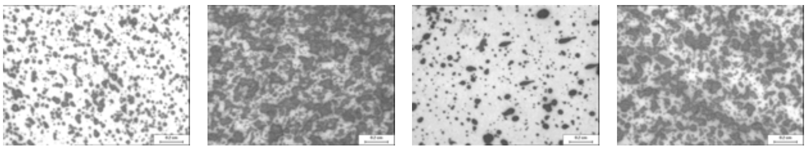
Figure AppF4: *Spray coverage for 4Cha treatment (water application rate 400 L ha^{-1}) on WSP-s on different heights and leaf-sides.*



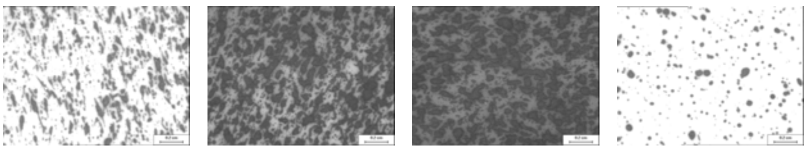
5Koc - 4th wire/upper leaf-side



5Koc - 4th wire/lower leaf-side

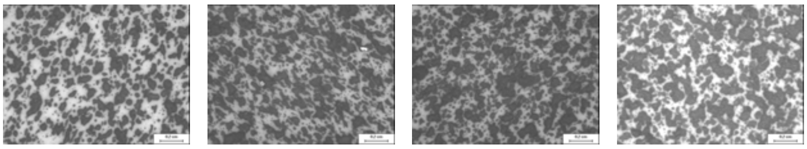


5Koc - 2nd wire/upper leaf-side

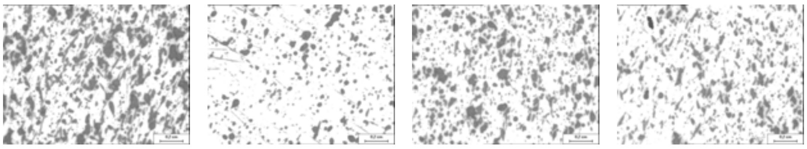


5Koc - 2nd wire/lower leaf-side

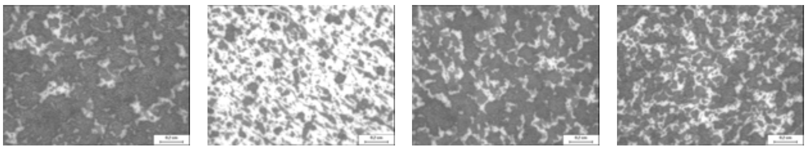
Figure AppF5: *Spray coverage for 5Koc treatment (water application rate 400 L ha^{-1}) on WSP-s on different heights and leaf-sides.*



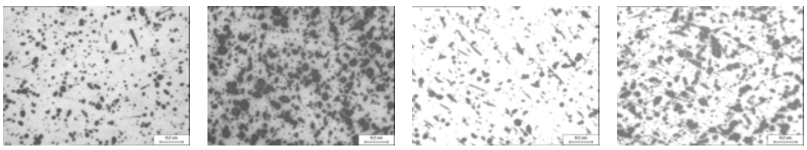
6Cha - 4th wire/upper leaf-side



6Cha - 4th wire/lower leaf-side

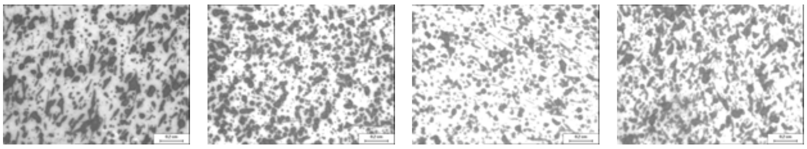


6Cha - 2nd wire/upper leaf-side

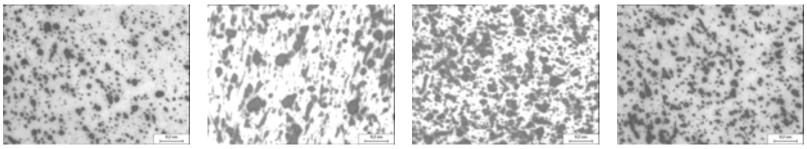


6Cha - 2nd wire/lower leaf-side

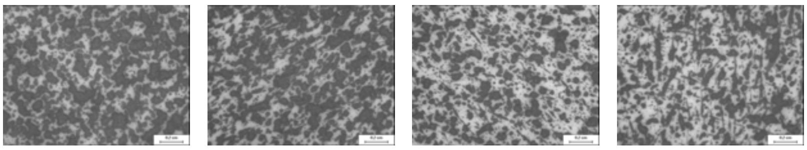
Figure AppF6: *Spray coverage for 6Cha treatment (water application rate 400 L* ha^{-1}*) on WSP-s on different heights and leaf-sides.*



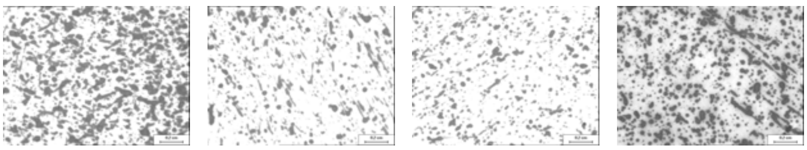
7Koc - 4th wire/upper leaf-side



7Koc - 4th wire/lower leaf-side



7Koc - 2nd wire/upper leaf-side



7Koc - 2nd wire/lower leaf-side

Figure AppF7: *Spray coverage for 7Koc treatment (water application rate 400 L* ha^{-1}*) on WSP-s on different heights and leaf-sides.*

Appendix G

Comparison of copper ion deposit on vine leaves and filter papers

Table AppG: *Comparison of copper ion deposit on vine leaves and filter papers.*

Legend:
Tcode - treatment code (see table App1)

VL (after - before) - 3Tcode - the values for the copper ion deposit on vine leaves in µg Cu cm^{-2} before each application were subtracted from the values obtained after each application. 3CuZU treatment was excluded (high application rate of water).

FP (2nd and 4th wire) - 3Tcode - the values for the filter paper in µg Cu cm^{-2} were obtained by summation of two measurements (lower and upper leaf side for one and the same leaf, and separately for 2nd and 4th wire). 3CuZU treatment was excluded (high application rate of water).

Tcode	Replication	Application date	VL(after-before)-3TCode µg Cu cm^{-2}	FP(2nd and 4th wire)-3TCode µg Cu cm^{-2}
7	3	4	1.08	2.39
7	3	4	1.08	2.18
5	4	4	1.4	2.48
5	4	4	1.4	2.56
5	3	4	1.59	3.2
5	3	4	1.59	1.54
2	4	3	1.6	3.25
2	4	3	1.6	3.03
7	4	3	1.62	4.88
7	4	3	1.62	5.08
5	4	1	1.88	2.52
5	4	1	1.88	2.44
5	4	3	1.9	3.63
5	4	3	1.9	2.9
7	4	1	2.18	2.82
7	4	1	2.18	2.7
5	1	1	2.32	2.82
5	1	1	2.32	1.8
6	4	4	2.33	3.63
6	4	4	2.33	3.33
5	1	4	2.48	2.92
5	1	4	2.48	2.9
2	3	3	2.49	3.46
2	3	3	2.49	3.63
5	2	1	2.52	2
5	2	1	2.52	2.09
6	3	4	2.61	3.2
6	3	4	2.61	3.29
5	3	1	2.62	2.35
5	3	1	2.62	2.48
6	4	3	2.65	3.67
6	4	3	2.65	3.97
2	3	4	2.67	2.94
2	3	4	2.67	4.06
4	4	3	2.7	4.19
4	4	3	2.7	2.99
4	4	4	2.88	3.46
4	4	4	2.88	2.99
4	3	4	3	3.72
4	3	4	3	3.59
1	4	2	3.01	3.41
1	4	2	3.01	5.81
4	2	3	3.08	3.72
4	2	3	3.08	3.85
6	1	4	3.23	3.24
6	1	4	3.23	3.76
5	3	3	3.28	2.87
5	3	3	3.28	3.12
6	4	1	3.32	3.46
6	4	1	3.32	2.82
1	3	3	3.36	4.19

Tcode	Replication	Application date	VL(after-before)-3Tcode	FP(2nd and 4th wire)-3Tcode
1	3	3	3.36	3.16
5	2	4	3.37	3.16
5	2	4	3.37	2.87
5	2	3	3.38	3.07
5	2	3	3.38	2.65
5	3	2	3.39	2.3
5	3	2	3.39	1.96
1	4	3	3.41	4.02
2	2	3	3.41	3.55
1	4	3	3.41	4.05
2	2	3	3.41	3.42
2	3	2	3.45	2.65
2	3	2	3.45	3.41
6	2	1	3.51	2.95
6	2	1	3.51	3.33
5	2	2	3.52	2.43
5	2	2	3.52	2.26
2	4	4	3.59	3.93
2	4	4	3.59	3.42
7	4	4	3.62	4.32
7	4	4	3.62	3.16
1	4	4	3.63	5.3
1	4	4	3.63	3.38
6	3	3	3.65	3.93
6	3	3	3.65	3.17
2	2	2	3.68	3.42
4	4	2	3.68	3.46
2	2	2	3.68	4.23
4	4	2	3.68	3.76
4	3	3	3.79	4.57
4	3	3	3.79	4.32
6	3	1	3.81	2.52
6	3	1	3.81	2.91
4	1	2	3.87	4.11
4	1	2	3.87	4.48
4	3	2	4.02	3.21
4	3	2	4.02	5.13
7	3	3	4.09	4.36
7	3	3	4.09	2.65
2	4	2	4.13	3.03
2	4	2	4.13	3.67
1	3	4	4.16	5.17
1	3	4	4.16	3.79
4	2	2	4.18	6.11
4	2	2	4.18	5.08
2	1	4	4.2	3.64
2	1	4	4.2	3.33
1	3	2	4.24	3.59
1	3	2	4.24	3.03
2	2	4	4.33	3.93
2	2	4	4.33	3.76
5	1	3	4.38	3.5

Tcode	Replication	Application date	VL(after-before)-3Tcode	FP(2^{nd} and 4^{th} wire)-3Tcode
5	1	3	4.38	3.97
5	1	2	4.45	2.57
5	1	2	4.45	3.72
6	2	3	4.51	4.95
6	2	3	4.51	3.38
5	4	2	4.52	3.07
5	4	2	4.52	2.87
6	3	2	4.59	2.99
6	3	2	4.59	3.12
1	1	4	4.68	5.09
1	1	4	4.68	4.49
7	1	4	4.79	3.12
7	1	4	4.79	3.56
6	1	1	4.82	2.94
6	1	1	4.82	3.04
6	1	2	4.96	3.29
6	1	2	4.96	3.24
7	2	1	5.03	3.89
7	2	1	5.03	3.03
7	2	3	5.04	2.95
7	2	3	5.04	4.32
7	2	4	5.08	4.7
7	2	4	5.08	5.05
2	3	1	5.26	4.3
2	3	1	5.26	3.28
6	2	4	5.29	4.45
6	2	4	5.29	3.51
1	4	1	5.32	3.39
1	4	1	5.32	3.9
1	2	2	5.33	2.78
1	2	2	5.33	4.36
7	3	1	5.36	3.33
7	3	1	5.36	3.59
6	4	2	5.48	3.24
6	4	2	5.48	3.12
7	1	1	5.51	3.54
2	1	3	5.51	2.65
7	1	1	5.51	3.64
2	1	3	5.51	2.99
4	1	4	5.6	5.13
4	1	4	5.6	4.75
1	1	2	5.65	4.45
1	1	2	5.65	3.68
4	2	4	5.75	3.84
4	2	4	5.75	4.53
2	4	1	5.79	2.65
2	4	1	5.79	4.19
1	2	3	5.91	3.55
1	2	3	5.91	4.53
7	3	2	6.01	3.8
7	3	2	6.01	3.93
4	4	1	6.16	4.11

Tcode	Replication	Application date	VL(after-before)-3TCode	FP(2nd and 4th wire)-3TCode
4	4	1	6.16	4.45
2	1	2	6.22	4.83
2	1	2	6.22	3.72
7	2	2	6.28	3.76
7	2	2	6.28	4.26
7	4	2	6.31	3.11
7	4	2	6.31	4.14
1	3	1	6.46	3.54
1	3	1	6.46	3.49
6	1	3	6.48	3.29
6	1	3	6.48	3.95
6	2	2	6.73	4.49
6	2	2	6.73	3.76
1	2	4	6.9	4.65
1	2	4	6.9	6.03
1	1	3	6.94	2.99
1	1	3	6.94	3.54
2	2	1	6.96	3.54
2	2	1	6.96	3.44
4	3	1	7.05	5.13
4	3	1	7.05	6.41
4	1	3	7.16	4.51
4	1	3	7.16	4.06
7	1	3	7.84	4.62
7	1	3	7.84	4.44
7	1	2	7.93	3.68
7	1	2	7.93	3.29
1	1	1	8.36	3.8
1	1	1	8.36	4.36
4	2	1	8.76	4.75
4	2	1	8.76	5
1	2	1	8.99	3.49
1	2	1	8.99	4.31
2	1	1	9.05	3.46
2	1	1	9.05	4.42
4	1	1	9.21	4
4	1	1	9.21	5.23

Errata