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DEVELOPING A COPPER AND ZINC FOLIAR FERTILIZING SYSTEM ON WINTER WHEAT BASED ON PRECESION SOIL AND PLANT EXAMINATIONS (*TRITICUM AESTIVUM* L.)

Author:
Eszter Forró-Rózsa
PhD candidate

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PHD DISSERTATION THESES

SZÉCHENYI ISTVÁN UNIVERSITY
FACULTY OF AGRICULTURAL AND FOOD SCIENCES

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PLANT, ANIMAL AND FOOD SCIENCES

GOTTLIEB HABERLANDT
PLANT SCIENCES DOCTORAL PROGRAMME

Doctoral School and Programme Leader:
Prof. Dr. Vince Ördög DSc

Consultant:
Prof. Dr. Pál Szakál CSc
University professor, Canditate of Agricultural

Dr. Zsuzsanna Pecze
Head of Department, IKR Agrár Ltd.

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1. INTRODUCTION

Agricultural production is realized amidst more and more difficult conditions all over the world. The population of the world has skyrocketed from 3 billion to 7 billion since the year 1950. Based on the forecast of the United Nations this tendency will slightly weaken in the upcoming 40 years, still, the number could possibly reach as much as 9.3 billion by 2050. The need for food, water as well as energy is continuously increasing in the developing countries. The farming areas required to satisfy the growing demands are constantly decreasing. The greatest challenges of the agricultural production are preserving biodiversity and also ensuring a livable environment since agricultural as well as technological research and the latest advancements must not destroy biodiversity. Apart from the quantitative demand, people are paying more attention to the quality of food products they consume.

Quality food products can only be produced from healthy and well sustained raw materials. That takes necessary the essential microelements. That are indispensable in the life of our cultivated plants. That group of elements contain primarily metal ions, thus their main role being positively charged is to interact with the negatively charged parts of the molecules in the living organisms. The two most important essential microelements of the winter wheat (*Triticum aestivum* L.) are copper and zinc. Both are vital for reaching an adequate quality and quantity of the product.

1.1. The aims of the research

The effects of copper and zinc compounds were examined on winter wheat (*Triticum aestivum* L.) grown in calcareous chernozem soil in the years of 2011, 2012, and 2013.

Our aim was to:

- to produce quality foodstuff with optimal chemical contents taking into consideration the conditions of sustainable farming

- to achieve an amount of yield that corresponds with the country’s average and also its quality is suitable for the food industry.
- to improve the qualitative parameters of winter wheat applying copper foliar fertilizer as well as to define the exact amount of fertilizer to be used for the result.
- to prove that by using zinc foliar fertilizer the yield of winter wheat can be significantly increased.
- to develop a method for replenishing essential microelements which could be applied in the practices of farmers.
- to check the precision of applying chemicals regarding place and time using precision soil and plant analysis.

2. MATERIAL AND METHODS

I conducted my examination in the Faculty of Agricultural and Food Sciences at the University of West Hungary - which is the legal predecessor of the Faculty of Agricultural and Food Sciences at the Széchenyi István University - in the Department of Water and Environmental Science under the expert direction of Dr. Pál Szakál as well as Dr. Zsuzsanna Pecze in the Technological Development Department of the IKR Agrár Ltd.

The experiments on winter wheat (*Triticum aestivum* L.) were carried out in the calcareous chernozem soil of Regöly, Tolna county, over a time period of three years (2011, 2012, 2013). Comparative tests with different doses of copper and zinc (0.1; 0.3; 0.5; 1.0 and 2.0 kg/ha) were carried out with the application of ecologically approved copper-saccharose and basic zinc-carbonate complexes by using precision technology.

2.1. Selection of test areas, planning parcels, and applications

When selecting test areas we relied on the results of the precision soil analyses executed in a density of 3 ha. In the selection process, supplementary GPS-supported mechanical samplings were carried out using a diagonal sampling method at a density of 1 ha and a depth of 0-30cm complying with the rules of crop land soil sampling. To draw the sampling maps the sample area was measured by a **Trimble GeoXT GPS**, then the coordinates of the area were transferred into an internally developed **ArcGIS** system and dividing the areas the net-sampling plans were prepared in *shp format. Those *shp files were imported into the field devices and based on the plans we proceeded diagonally while taking samples. An average sample represented 1 ha-t, and was composed of 20-25 partial samples. The samples were further analyzed in the laboratory of sYnlab Umweltinstitut Ungarn Ltd, in Mosonmagyaróvár. The results of the soil analyses were examined with 3RP System program both per field and per sampling area as well. The relatively flat areas selected had a lack of copper and zinc, low humus content and were rich in phosphor and lime. Having selected the fields plots had to be marked within them, thus considering the factors of soil analyses and relief the test plots were defined with a **Trimble GeoXT GPS** using *shp format with the help of boundary files prepared in advance then they were assigned to the field boundaries stored in the database of our server. Planning the plots the working width of the sprayer also had to be taken into consideration (self-propelled, GPS-controlled **DAMMANN DT 2000 H Plus**) which was 24 m, therefore, the widths of all plots were adjusted to that.

Plots were treated:

- in strip-design with 4 replications,
- during the vegetation period in two phenological phases at the time of shooting and flowering,
- we applied the same copper and zinc doses in all the three years: 0.1; 0.3; 0.5; 1.0; 2.0 kg/ha,
- the amount of sprayed foliar fertilizer was 8 l/ha with the given density on all plots.

The pre-made foliar fertilizer at the right density was injected into the sprayer through the blending container on the side accompanied by continuous water injection. The applications were executed based on the predefined boundaries of the plots which were previously fed into the on-board computer in *shp format. Sprayings were precisely recorded by the sprayer thus they could be used in the analyses.

2.2. Materials used in the experiments

In the course of our experiments **copper-saccharose complex** and foliar fertilizer containing **basic zinc-carbonate** microelements were applied. All the materials were recycled substances, produced from industrial waste, and approved to be used in ecological farming.

The **copper-saccharose complex**, which was developed by Dr. Kálmán Burger academic at the University of Szeged, was stabilized by Dr. Pál Szakál in the Department of Chemistry at the University of West Hungary and the Faculty of Agricultural and Food Sciences and he also managed to provide its agricultural application.

The **basic zinc-carbonate** is obtained from acidic zinc-chloride, or zinc sulphide which is intermediate products in the pharmaceutical production.

2.3. Weather conditions

The average annual temperature was similar in the breeding seasons all through the three years, although it was a few degrees higher compared to the previous years. It was 8.44°C in the farming year of 2010-2011, 8.96°C in the farming year of 2011-2012, and 9.43°C in the farming year of 2012-2013.

The precipitation was also fairly varied. The farming year of 2010-2011 was stricken with drought as the year 2011 was excessively dry characterized by an extremely low amount of rainfall in the breeding season (164 mm). As for precipitation, the farming year of 2011-2012 could also be considered dry (452 mm) since there was only 2mm of rain in March. As opposed to the two preceding years, there was significant rainfall in the spring of the last experimental year (568 mm).

2.4. Harvest, yield measurement and plant analysis

Harvesting was executed by a GPS-controlled **New Holland CR 9070** harvester equipped with a yield meter system and an **IntelliView** monitor. Therefore, the exact data regarding the yield of each parcel were available. In order to verify the results, the quantity of yield was checked in each plot with the help of a weighing scale. The digital data obtained were marked on a map using the **New Holland PFS** software then they were exported into analytical software developed by us. Since the yield meter records data second by second when harvesting, the received figures were fairly dense. Due to the fact that our parcels were less than 1 ha in size, no analyses could be executed applying such mass of data. Thus, they had to be averaged after which the received yields were interpolated again using the spline method and our internally developed system based on **ArcGIS**. These were then analyzed and marked on a map.At the harvest, samples were taken from all the treated and control parcels which then were examined in the laboratory of the mill in Komárom applying a **FOSS Infratec 1241** grain analyzer.

2.5. Statistical examinations

Statistical analyses were done using traditional methods because this way not only the final results are visible, but also the ones throughout the process. The only tool we employed for the calculations was Excel 10.0. The effects of copper and zinc applications were analyzed separately. Two-factor variance analysis was used to depict the effect of treatments with different doses (6 = control+5 different applications, 4 replications in 3 years) at a probability level of 95%. During the variance analysis using an F-test it was proven that the treatments have a real effect on the factors examined, then with the help of the significant differential values (LSD) we could determine what doses of the applications are effective. These analyses were carried out with the help of the average of the four measured data in all the three years. To prove the general efficiency of the applications these measurements were executed on the average of the data gained during the three-year period as there was a significant alteration in the examined data of the different years due to the differing environmental and climatic conditions.

3. RESULTS AND CONCLUSIONS

3.1. The effect of the applications on the yield in the year 2011

Based on the statistical analysis of the treatments it was learnt that the yield of the winter wheat was increased by all the treatments except for the copper-saccharose and the zinc-carbonate complexes in the doses of 0.1 and 0.3 kg/ha. Significant alteration was only discovered in the case of applying zinc at the doses of 0.5 kg/ha (LSD=0.35) Maximum yields were achieved by zinc-carbonate treatments at the doses of 1.0 kg/ha and 2 kg/ha. These resulted in yields such as 7.06 t/ha and 7.2 t/ha.

Regarding copper treatments the maximum yield was 6.29 t/ha in the year of 2011 which was achieved by applying copper-saccharose complex at the doses of 1 kg/ha. It can be established that the effect of the zinc-carbonate applications was more favorable on the yield than the effect of the copper-saccharose applications. Using the approximate values gained from the average of the four replications we could determine the growth in percent on the treated areas. The yield applying zinc foliar fertilizer at the doses of 1.0 kg/ha and 2.0 kg/ha was increased by 20%.

3.2. The effect of the treatments on the raw protein content in the year 2011

The results have proven that the raw protein content was significantly improved by applying copper compared to the control areas. Serious change was achieved by applying copper-saccharose at the doses of 0.3 kg/ha (LSD=0.34) The most excessive growth as for the raw protein content was measured when applying copper at the doses of 1.0 kg/ha and 2.0 kg/ha resulting in 14.05 m% and 14.95 m% (LSD=0.34). A noticeable increase of the raw protein content using zinc treatments could be detected at the doses of 0.5 kg/ha. While the raw protein content in the control parcel was extremely low with 12.86 m%. Winter wheat is classified and valued at a higher price based on its raw protein content by most traders. Therefore, even as little as 1% increase in the amount of raw protein could result in significant increase in the profit. Applying copper-saccharose can contribute to a 10% growth in the raw protein content.

3.3. The effect of the treatments on the gluten content in the year 2011

Based on the final results, it can be stated that similarly to the changes in the raw protein content, the most significant increase was caused by the copper treatment. It is known that the amount of gluten content changes together with the amount of raw protein content. The doses of copper over 0.3 kg/ha resulted in an excessive increase in the gluten content (LSD=1.08). Excessive increase could already be proven from the amount of 0.3 kg/ha regarding the doses of copper, while in the case of zinc foliar fertilizer such change could be detected above the doses of 0.5 kg/ha. The maximum growth in gluten content was achieved by the application of copper-saccharose complex in a doses of 2.0 kg/ha (33.98 m%). All the applications resulted in some increase compared to the control parcels.

3.4. The effect of the applications on the Zeleny-number in the year 2011

As the Zeleny-number (sedimentation index) the effects of the applications on it was also examined in all the three years in question. It was found that all copper applications substantially increased the Zeleny index, while the applications of zinc foliar fertilizer only resulted in a growth of a few percent. Considerable rise can also be detected when applying copper and zinc at the doses of 0.3 kg/ha (LSD=2.00)

While the increased doses of copper resulted in 30-40% growth in the Zeleny-number, the increased doses of zinc did not cause significant rise over 0.5 kg/ha. Based on the counted averages, applied doses over 0.3 kg/ha resulted in only two percent rise of the sedimentation index.

3.5. The effect of the applications on the yield in the year of 2012

Based on the yield results of the experiments of 2012, it is shown that while the applications of zinc at the doses of 0.1 kg/ha caused increase in yields, the treatments with copper-saccharose complex at the doses of 0.1 kg/ha and 0.3 kg/ha resulted in decreased yields. Significant increase was achieved by applying zinc-carbonate from the doses of 0.3 kg/ha, while in the case of copper treatments from the doses of 0.5 kg/ha (LSD=0.21). Similarly to the subsequent year, the application of zinc at all doses proved to be more effective regarding yields rather than the application of copper. Alike all the other parameters and the previous year, results were depicted in a yield map. The result of the effect of each specific application was calculated based on the average of applications with four replications. Compared to the control plots 12% of yield increase was achieved with applications of zinc foliar fertilizer at the doses of 1.0 kg/ha and 2.0 kg/ha in the rather dry farming year of 2010-2011.

3.6. The effect of the treatments on the raw protein content in the year of 2012

The results of the raw protein content examinations proved that the copper applications were the more effective ones among the treatments executed in the year of 2012. Excessive growth was achieved by using copper-saccharose at the doses from as much as 0.1 kg/ha while in the case of zinc applications, similarly to the previous year, significant changes in the increase of the raw protein content were only detected at the doses of 0.5 kg/ha compared to the control areas (LSD=0.47). The maximum increase of the raw protein content was achieved by applying copper-saccharose foliar fertilizer at the doses of 2.0 kg/ha.

The increase of the raw protein content was defined in percent based on the averages of the applications. It can be stated that the application of copper at a doses as little as 0.1 kg/ha resulted in 5% growth regarding the raw protein content while applying the same amount of zinc-carbonate decreased the raw protein content compared to the control plots.

3.7. The effect of the treatments on the gluten content in the year of 2012

When evaluating the gluten content it was found that applying the doses as little as 0.1 kg/ha of both zinc and copper will lead to some increase compared to the control areas. Significant increase was detected at the doses of 0.3 kg/ha regarding copper treatments and 0.5 kg/ha in the case of zinc applications. On the other hand, when applying zinc at a doses higher than 1 kg/ha some decrease was observed as for the gluten content. The increase of the gluten content was not moving together with the raw protein content in this farming year. This requires some further big-scale examinations as each of the raw protein fractions has to be examined separately.Similarly to the zinc-carbonate, some decrease was detected after applying copper-saccharose at the doses of 0.5 kg/ha and then a doses of 1.0 kg/ha. However, further increase in the doses resulted again in some growth of the gluten content. This also requires some further examinations regarding specific protein fractions.

3.8. The effect of the applications on the Zeleny-number in the year of 2012

It was established that copper treatments excessively increased the Zeleny-number similarly to the experiments in the previous year. Considerable rise can be detected when applying copper and zinc at the doses of 0.5 kg/ha (LSD=3.73) compared to the control areas. The Zeleny-number maximum was 57.57 ml which was achieved by applying copper at the doses of 2.0 kg/ha. The increase of the Zeleny-number defined in percent was analyzed based on the averages. It can be stated that copper applications at the doses of 2.0 kg/ha resulted in 32% growth while the application of zinc brought about only 15% increase compared to the control plots.

3.9. The effect of the applications on the yield in the year of 2013

Evaluating the results of yields, zinc applications seem to be more effective similarly to the previous two years. Serious increase was achieved in yields by applying zinc at the doses of 0.5 kg/ha (LSD=0.26) As for the copper, there was only some small growth measured in the yield in the farming year of 2013 compared to the control areas. Our results were greatly influenced by the precipitation conditions. There was significant precipitation in the vegetation period in spring. The yields of the control plot (6.88 t/ha) were even higher than the results of the treated areas in the previous two drought-stricken years. The increase of yields was calculated in percentage based on the averages of treatments. The results - similarly to the ones of the two previous farming years - prove that applying zinc foliar fertilizer at the doses of 1.0 kg/ha and 2.0 kg/ha leads to an increase of 15-16%, namely more than 1 t/ha in yields.

3.10. The effect of the treatments on the raw protein content in the year of 2013

Similarly to the two preceding years, the copper applications from the doses of as much as 0.3 kg/ha resulted in a serious growth regarding the raw protein content while applying zinc foliar fertilizer caused a more modest increase in the raw protein content compared to the control plots (LSD=0.23). Excessive increase was measured when applying zinc foliar fertilizer at the doses of 0.5 kg/ha or more. The maximum increase of raw protein content was achieved by applying copper-saccharose at the doses of 2.0 kg/ha. In the vegetation period with much precipitation, copper treatments could only result in a 6-7% increase regarding the raw protein content at its best while the application of zinc-carbonate caused an increase of as little as 3%.

3.11. The effect of the treatments on the gluten content in the year of 2013

Similarly to the results of the preceding two years, significant increase of gluten content was detected due to the application of copper at the doses of 0.5 kg/ha or more (LSD=0.80). The application of zinc also resulted in increasing gluten content, yet the amount was insignificant compared to the control areas. It can be stated that in this year, similarly to the preceding experimental year, the gluten content was changing in correlation with the raw protein content due to the treatments. Having examined the average gluten content, it was clear to see that the application of copper increased the amounts with 10% while the zinc-carbonate treatments caused barely 5% growth compared to the control plots.

3.12. The effect of the applications on the Zeleny-number in the year of 2013

During the examinations it was observed that the applications of copper caused greater increase regarding the Zeleny-number similarly to the previous two years. Significant increase was detected when applying copper-saccharose at the doses of 0.3 kg/ha and also the application of zinc-carbonate at the doses of 0.5 kg/ha (LSD=1.15). The Zeleny-number maximum was 32.75 ml which was achieved by applying copper at the doses of 2.0 kg/ha. Applying a doses of 2.0 kg/ha copper resulted in a 16% increase regarding the Zeleny-number while the application of zinc-carbonate at the same doses only caused 11% growth.

3.13. The effect of the applications as the average of the three years

3.13.1. The effect of copper applications

As a result of the different environmental effects of the years, the Zeleny-number significantly rose - almost doubled - in 2012 compared to 2011 and 2013, while the gluten and raw protein content was much higher in the year of 2013 compared to the previous years. The applications starting at the doses of 0.5 kg/ha proved to be improving the yields significantly (LSD=0.22). The yield function (y_{11}=-0.23x_1^2+0.77x_1+5.96) reached a peak with the application of 1.67 kg/ha copper.

Having examined the average of raw protein content during the three-year period it was found that as a result of the applications from the doses of 0.5 kg/ha it increases (LSD= 0.22) significantly. The fitted regression curve (y_{14}=-0.60x_1^2+1.80x_1+12.81) reached a peak with the application of 1.50 kg/ha copper.

Based on the examination of all the three years it can be stated that the applications from the doses of 0.3 kg/ha increased the gluten content significantly (LSD= 1.38). The fitted regression curve (y_{12}=-2.49x_1^2+6,.88x_1+28.63) reached a peak with the application of 1.38 kg/ha copper-saccharose.

Regarding the Zeleny-number, the applications below the doses of 0.3 kg/ha show some decrease, above the doses of 0.5 kg/ha they increased (LSD= 2.91)the parameter in focus excessively. The Zeleny-number function (y_{13}=-4.56x_1^2+13.83x_1+31.25) reached a peak with the application of 1.52 kg/ha copper.

3.13.2. The effect of zinc applications

Based on the average of the three years, the applications from the doses of 0.5 kg/ha increased the yield (LSD= 0.37) significantly. The yield function (y_{21}=-0.46x_2^2+1.46x_2+6.00) reached a peak with the application of 1.59 kg/ha zinc.

The applications from the doses of 0.5 kg/ha increased the gluten content significantly (LSD= 0.45). The fitted regression curve (y_{24}=-0.49x_2^2+1.51x_2+12.50) reached a peak with the application of 1.54 kg/ha zinc.

Having examined the gluten content it was found that the applications from the doses of 0.5 kg/ha increased the amounts significantly (LSD= 1.33). The yield function (y_{22}=-1.45x_2^2+4.31x_2+28.47) reached a peak with the application of 1.33 kg/ha zinc-carbonate foliar fertilizer.

Evaluating the Zeleny-number it was found that similarly to the copper treatments, the applications below the doses of 0.3 kg/ha show some decrease, yet above the doses of 0.5 kg/ha they increased (LSD= 2.97)the parameter in focus excessively. The Zeleny-number (y_{23}=-$2.55x_2^2+7.61x_2+31.04$) reached a peak with the application of 1.49 kg/ha zinc.

4. CONCLUSIONS AND RECOMMENDATIONS

In the course of our experiments it was found that the effectiveness of applications were detected in the case of copper and also zinc in each of the three years. Compared to the control areas, all applications over the doses of 0.5 kg/ha resulted in significant increase. It was also estimated that the applications of Zn increased yields more substantially, while other quality parameters showed improvement due to some Cu treatments. It can be stated that the effects of both substances are the most significant at the amount of 1.4-1.6 kg/ha, the choice between them is determined by the result variable (e.g. yield) wished to be increased the most. All in all, in the case of the decision about Cu and Zn applications, it is based on not only the quality of the soil but also the price and accessibility. Using any of them will definitely increase the amount of wheat produced and improves the quality of the produce, in other words the value of it.

Based on the result analysis of my examinations the following statements and recommendations can be defined:

If the aim is to execute such treatments that improve quantity parameters (yield) it is recommended:

- to apply **basic zinc-carbonate** foliar fertilizer in two phenological phases when shooting and flowering in areas poor in zinc and copper in both dry warmer years lacking precipitation and also in the case of colder, rainier weather in order to increase **yield**. The optimal amount to apply: **1.5-1.6 kg/ha.**

If the aim is to execute such treatments that improve quality parameters (raw protein, gluten, Zeleny-number) it is recommended:

- to apply **copper-saccharose complex** foliar fertilizer at an optimum amount of **1.5 kg/ha** when shooting and flowering in areas poor in zinc and copper in both dry warmer years lacking precipitation and also in the case of colder weather with more rain in order to increase the **raw protein content**.

- to apply **copper-saccharose complex** foliar fertilizer in two phenological phases when shooting and flowering in areas poor in zinc and copper in both dry warmer years lacking precipitation and also in the case of colder weather in order to increase the **gluten content**. The optimal amount to apply: **1.5 kg/ha**,

- It is recommended to apply **copper-saccharose complex** at the doses of **1.5 kg/ha** in two phenological phases (shooting and flowering) to increase the **Zeleny-number** in soil lacking zinc and copper in both rainy and dry years.

5. NEW SCIENTIFIC RESULTS

1. Applying copper (copper-saccharose complex) and zinc (basic zinc-carbonate) foliar fertilizers at the doses of at least 0.5 kg/ha in soil which lacks more (relative) zinc (0.5-0.8 gm/kg) than copper (0.8-1.49 mg/kg) twice in the vegetation period (when shooting and flowering) has a beneficial effect on the yield, protein and gluten content of the wheat.

2. In the case of calcareous chernozem soil poor in copper and zinc, the copper-saccharose foliar fertilizer at the doses of 1.5 kg/ha is more effective on the raw protein content than the application of zinc-carbonate at the doses of 1.5 kg/ha.

3. Applying copper-saccharose complex foliar fertilizer (1.38 kg/ha) has a more favorable effect on the gluten content than the application of zinc-carbonate (1.49 kg/ha). Both applications from the doses of 0.5 kg/ha greatly improve the gluten content.

4. Yield increase can be achieved more effectively by applying additional zinc-carbonate foliar fertilizer (1.33 kg/ha) than applying copper-saccharose complex (1.67 kg/ha). Thus taking into consideration the results from all the three years and the given soil composition, the optimal amount of zinc to apply is the doses of 1.5-1.6 kg/ha.

6. LIST OF PUBLICATIONS

LIST OF PUBLICATIONS CONCERNING THE SUBJECT MATTER OF THE DISSERTATION:

Scientific communications abroad in foreign language, proof-read periodicals:

- **Forró-Rózsa Eszter**- Szakál Pál- Csatai Rózsa: The qualitative and quantitative impact of copper and zinc applications on winter wheat cultivation African Journal of Plant Science 2017.11.9. 351-361. Szeptember 2017.

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- **Forró-Rózsa Eszter:** Réz a talajban (szakirodalmi összefoglaló) Acta Agronomica Óváriensis, 2014.56.1. 97-108.

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- **Rózsa Eszter**- Pecze Zsuzsanna- Nagy Lajos- Szakál Pál: Mikroelem visszapótlás hatása az őszi búza minőségére Kémia, Környezettudomány, Fenntarthatóság Kémiai Intézet Tudományos Ülése, Sopron, 2013.08.29. 105-110.

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- Sződi Szilvia - Rozsnyay Zsuzsanna - **Rózsa Eszter** - Turóczy György: Susceptibility of sour cherry cultivars to isolates of Monilia laxa(Ehrenbergh) saccardo et Voglino. International Journal of Horticultural Science, 2008.14.1-2. 83-87.

- Sződi Szilvia – **Rózsa Eszter** – Rozsnyay Zsuzsanna – Turóczi György: Különböző meggyfajták érzékenysége Monilinia laxa (Aderhold et Ruhland) Honey/Monilia laxa(Ehrenbergh) Saccardoet Voglino izolátumokkal szemben XII. Növénynemesítési Napok. 2006. 164.

- Sződi Szilvia – **Rózsa Eszter** – Rozsnyay Zsuzsanna – Turóczi György: Monilinia laxa (Aderhold et Ruhland) Honey/Monilia laxa (Ehrenbergh) Saccardo et Voglino izolátumok agresszivitásának vizsgálata meggyfajtákon 52. Növényvédelmi Tudományos Napok. 2006.45.

- Sződi Szilvia – **Rózsa Eszter** – Rozsnyay Zsuzsanna – Turóczi György: Különböző meggyfajták érzékenysége Monilinia laxa (Aderhold et Ruhland) Honey/Monilia laxa (Ehrenbergh) Saccardo et Voglino izolátumokkal szemben XIII. Növénynemesítési Tudományos Napok. 2007. 181.