University of West-Hungary,
Faculty of Agricultural and Food Sciences
Institute of Environmental Sciences
Institute of Company Economics and Management

Head of Doctoral School
Dr. Neményi, Miklós

Theme consultants:
Dr. habil. Salamon, Lajos
Dr. habil. Szakál, Pál

ECONOMIC INVESTIGATION OF COPPER MICRO-ELEMENT TREATMENT IN WINTER WHEAT

Written by

RÉDER, ORSOLYA

Mosonmagyaróvár
2010

1. OBJECTIVES

Winter wheat is one of the most important cultivated plants in Hungary. In the market-oriented agricultural circumstances decreasing yields and fluctuating quality cause considerable problems to the producers. The objective of the research was to increase and stabilise yields with suitable fertilisation, and as a result to improve profitability.

During the research the effect of copper micro element fertilisers was in the focus, due to the fact that in the past years and decades some essential elements like copper were not supplied sufficiently. In case the soil is deficient in micro elements, one should expect the decrease of yields and decline in content values. Winter wheat fertilisation investigations have been carried out for three years with using copper-amine complex, copper-carbohydrate complex and copper ion-exchanged synthesised zeolite with the objective of defining the best yield-increasing copper micro element fertiliser, the optimal application time. The effect of copper complex fertilisers on yields was also put in numerical form.

In market economic circumstances production should not only focus on excellent quality and high yields; farmers should also produce a reasonable profit with the production. For that reason revenues and expenditures were nominalised and profit level was also defined. It is hard to give exact numbers for the profit originating from higher quality – especially in case of basically good quality winter

wheat –, therefore in order to illustrate the usefulness of micro element supply in winter wheat, economic analysis concentrated on the definition of profit increase originating from yield increase.

Last but not least the objective of the research was to elaborate concrete recommendations to producers on how to manage profitable winter wheat production. Recommendations are based on the comparisons of yields and economic analysis.

2. MATERIAL AND METHOD

A considerable part of soils is copper-defective in Hungary. Based on the investigations it can be stated that due to blocked transport processes, the wheat plant can show signs of copper-defectiveness even if soils contain a sufficient amount of copper. Copper deficiency affects both quality and volume of the produce; therefore the symptoms of deficiency should be taken care of. Considering these facts, three different types of copper micro element fertilisation treatments were used in winter wheat, in two phenologic phases (at tillering and flowering).

Fertilisers were produced at the Department of Chemistry of the University of West-Hungary Faculty of Agricultural and Food Sciences. Fertilisers include:

- copper-amine complex,
- copper-carbohydrate complex and
- copper ion-exchanged zeolite.

Copper in the fertilisers originate from industrial copper waste. Copper was mixed with amine in order to produce copper-amine complex and with carbohydrate containing materials to produce copper-carbohydrate complex fertilisers. Zeolon type synthesised zeolite was used to produce copper ion-exchanged zeolite, with replacing natrium ion with copper-tetramin-ion and resulting 2,4 volume per cent copper content. A great advantage of this type of copper is that copper ion is supplied to the plant leave and at the same

time ammonium ion– which is an important material for plant feeding reasons – remains in a cationic location.

Research has been carried out between 2005 and 2007 on Danube alluvial soil using copper-amine and copper-carbohydrate complex compounds and copper ion-exchanged zeolite in two phonological phases, during tillering and flowering. The average soil composition is illustrated in the following table.

Average soil composition (2005-2007 Darnózseli)

pH		K_A	$CaCO_3$ m/m%	Humus m/m%	Al-soluble			nKCl	EDTA-soluble			
H_2O	KCl				P_2O_5	K_2O	Na	Mg	Zn	Cu	Mn	Fe
					mg/kg							
7,63	7,49	34	9,7	1,68	259	121	56	112	0,8	0,9	18	17

(Source: own measuring)

In every year and in case of all three fertilisers treatments included 0,1, 0,3, 0,5, 1,0 and 2 kg/ha copper dose supply at tillering and also at flowering. In all cases untreated control areas were also included in the research. Copper fertilisers were applied with high-pressure sprayers, at 0,6 dm^3/plot rate. Trial plots were 10 m^2 in size, designed in random blocks and in four repeating, with MV Emese winter wheat variety. Harvesting was performed by a plot combine; produce harvested from the plots was weighed.

The measured volumes were analysed with statistical methods (variance analysis and regression calculation).

In order to analyse the yield effect of the different copper treatments, one-factor variance analysis was performed. Two-factor variance analysis was also used to investigate the effects of copper doses and micro-element fertilisers. The production function was defined to illustrate yields. In order to define the three most useful copper rates and micro-element fertilisers, regression analysis was performed for the average yields of the three years.

Economic calculations included a two-factor variance analysis to investigate the effectiveness of copper doses and micro-element fertilisers in each year separately and for the average of the three years. Besides, production and also profit functions were defined to find the fertiliser and the dose which result the highest profit.

Calculations were performed with using the Microsoft EXCEL 7.0 programme.

3. RESULTS AND EVALUATION OF RESULTS

3.1. Effect of treatments on yields

During the research it was experienced that winter wheat yields increased in all three treatments (copper-amine complex, copper-carbohydrate complex and copper-amine ion exchanged synthesised zeolite) and in case of both phonological phases (tillering and flowering), by selecting the suitable dose. Yields on the control plots were around or under the county average. In case of treatments yields were more than one t/ha higher than the county average in all three years.

At tillering 0,5 kg/ha and higher rate treatments were significantly more effective compared to the control yields. At flowering middle rate copper doses (0,3-1,0 kg/ha) resulted statistically provable higher yields, compared to the control yields.

From the three copper micro element fertilisers in both phonological phases the copper-amine ion-exchanged synthesised zeolite was the most effective treatment to increase yields. Among the copper leaf fertilisers significant differences could not be proved.

In case of the copper ion-exchanged zeolite treatment that resulted the highest yield, at tillering yields can be estimated with the $y = -0,2979x^2+1,0478x+4,1345$ equation. The maximum yield was 5,06 t/ha with 1,76 kg/ha copper supply. At the same time copper treatment at flowering resulted a quadratic regression curve with y = -

$0,5776x^2+1,7004x+4,0667$ equation for the average yield of the three years. The maximum 5,32 t/ha yield corresponds to 1,47 kg/ha copper dose, resulting more than 30 % increase of the yield. Comparing the phonological phases, copper supply at flowering turned to be more effective. In this case higher yields were reached with less copper supply, saving input material.

3.2. Economic calculations

Based on the incomings, costs and the calculated profit it can be stated that profit increased considerably in all three years, for all three copper micro element fertilisers supplied in suitable doses. The increase was considerable at tillering-time applications: the maximum increase at copper-amine complex treatment was 38 %, at copper-carbohydrate complex treatment 23 % and at the copper-amine ion-exchanged synthesised zeolite treatment the increase reached 45 %. When treatments were applied at flowering, these rates were even higher: 47 %, 47 % and 53 % respectively.

During the three consecutive years the economic circumstances changed considerably. In 2006 production costs have not changed drastically compared to the previous year, and also the average sales price only slightly increased. In contrast to this, in 2007 costs increased by 15-20 % and sales price doubled compared to the previous year. For that reason economic calculations mainly refer to average price values for the three years, in order to balance the

economic fluctuation, besides the effects of variation originating from agricultural production.

Similar to yield investigations, economic calculations also proved the most favourable effects of copper-amine ion-exchanged zeolite treatments, for both phonological phase applications. Significant differences among the copper micro element fertilisers could not be proved, except for the copper-carbohydrate complex treatment and the copper-amine ion-exchanged zeolite treatments, applied at tillering. Similar to yield investigations, the highest three copper rates (0,5 kg/ha copper dose and above) applied at tillering and the three medium rates (0,3 – 1,0 kg/ha) applied at flowering proved to be significantly more effective, compared to the control.

Considerable economic differences cannot be proved concerning the two phenological phases. Investigating the three-years average and the maximum yield from the production function, profit increased by more than 1,5 times in both cases. Yield increase was lower at tillering-time treatments, but with applications at flowering the extra costs of supplementary application decreased the profit. Research results show that investigating the most effective copper-amine ion-exchanged synthesised zeolite, the highest profits can be reached with 1,56 kg/ha copper dose at tillering and the maximum profit at flowering application is reached with 1,35 kg/ha copper dose.

Investigation results prove the favourable effects of copper micro element fertilisation, based on both natural and value indicators. The results of the analysis indicate that copper-amine ion-exchanged

synthesised zeolite treatments in winter wheat can be recommended, as such applications increase both yields and profit considerably. Considering phenological phases input material savings and higher yield increasing effect are in favour of applications at flowering; treatments at tillering are favourable due to work organisation reasons, as fertilising can be performed along with plant protection work phases.

4. NEW AND NOVEL SCIENTIFIC RESULTS

Investigation results prove the favourable effects of copper micro element fertilisation, based on both natural and value indicators; the following new and novel scientific results summarise the findings:

1. The **yield increasing effect** could be proved for all copper micro element fertilisers (copper-amine complex, copper-carbohydrate complex and copper-amine ion-exchanged synthesised zeolite) and for both phenological phases (tillering and flowering), applied in winter wheat. Applying the suitable doses yields increased considerably in all cases; however, significant differences – compared to the control plots – could not be proved in all cases.
2. Investigation results proved that concerning **the three copper micro element fertilisers**, applied during both phenological phases, the **copper-amine ion-exchanged synthesised zeolite had the most effective yield increasing effect**.

   The more favourable time of application was also defined. Concerning the phenological phases, **treatments at flowering** turned out to be the most effective, reaching higher yields with less copper amount, in an input material saving way.
3. **Production function** was defined, for the copper-amine ion-exchanged synthesised zeolite treatment resulting the highest yield, applied at flowering resulted a quadratic regression curve for the average yield of the three years. The maximum resulting more than 30 % yield increase compared to the control.

4. It was demonstrated that the **copper micro element fertiliser** applied as a supplement to the regular plant nutrition **has a profit increasing effect**. As a result of the suitable dose of all three copper micro element fertilisers in all research years, profit increased considerably by 25-60 %.

   The most useful copper leaf fertiliser was defined, based on economic viewpoints: economic calculations indicate **that copper-amine ion-exchanged synthesised zeolite was the most favourable treatment** from all three copper micro-element fertilisers, applied both at tillering and flowering.

5. Concerning the most favourable copper-amine ion-exchanged synthesised zeolite, applications performed at different phenological phases were compared from economic viewpoints. Based on the economic calculations, research results do not indicate significant differences concerning treatments applied at different phenological phases. Analysing the average of the three years, profit increased by more than one and a half times. Profit was the highest with 1,56 kg/ha copper dose applied at tillering, and with 1,35 kg/ha copper dose applied at flowering.

5. LIST OF PUBLICATIONS

5.1. Publications in the topic of the dissertation

REVIEWED STUDIES IN HUNGARIAN LANGUAGE:

Réder O. - Csatai R. - Szakál P. (2008): Az őszi búza mangán-komplexes kezelésének gazdasági vizsgálata (Acta Agronomica Óváriensis, 2008. Vol. 50. No. 1. 115-122. o.)

Réder O.- Csatai R.-Szakál P. (2005): Az őszi búza rét-tetramin-hidroxid komplexes kezelésének gazdasági vizsgálata (Acta Agronomica Óváriensis, 2005. Vol. 47. No. 1. 173-179.o.)

Halasi T.-Tóásó Gy.- **Réder O**. (2005): A búza minősége és cink-mikroelem tartalma közötti összefüggés (Acta Agronomica Óváriensis, 2005. Vol. 47. No. 1. 189-193.o.)

Réder O. (2005): Az őszi búza rét-szénhidrát komplexes kezelésének gazdasági vizsgálata (Gazdálkodás, 2005. L. évf. 16.sz.104-108.o.)

REVIEWED STUDIES IN FOREIGN LANGUAGE:

Szakál, P.- Schmidt, R.- Barkóczi, M.- Kalocsai, R. - Beke, D. - **Réder, O**. (2006): N-containing copper complexes in wheat production (Cereal Research Communications, 2006. Vol 34. No. 1. 681-684.o.)

PRESENTATIONS:

Réder O. – Csatai R. – Salamon L. (2009): Az őszi búza rézmikroelem trágyás kezelésének gazdasági vizsgálata. PhD Hallgatók és Doktorok a Gazdálkodásban Tudományos Konferencia. Mosonmagyaróvár, 2009. október 16.

Réder O. (2006): Gazdasági vizsgálat a búza réz-komplexekkel történő kezelésénél. Óvári Tudományos Napok, Mosonmagyaróvár, 2006. október 5.

Réder O.- Csatai R.- Szakál P. (2005): Az őszi búza rét-tetramin-hidroxid komplexes kezelésének gazdasági vizsgálata. Melléktermékek mezőgazdasági újrahasznosításának szerepe a környezetgazdálkodásban Konferencia. Mosonmagyaróvár, 2005. szeptember 22.

Halasi T. - Tóásó Gy. - **Réder O.** (2005): A búza minősége és cink-mikroelem tartalma közötti összefüggés. Melléktermékek mezőgazdasági újrahasznosításának szerepe a környezetgazdálkodásban Konferencia. Mosonmagyaróvár, 2005. szeptember 22.

Réder O. (2005): Az őszi búza réz-szénhidrát komplexes kezelésének gazdasági vizsgálata. PhD Hallgatók a Gazdálkodásban Tudományos Konferencia. Mosonmagyaróvár, 2005. október 14.

Réder O. (2004): Melléktermékek mezőgazdasági újrahasznosításának szerepe a környezetgazdálkodásban. "AZ EURÓPAI UNIÓBAN" Nemzetközi Konferencia. Mosonmagyaróvár, 2004. május 6-7.

5.2. Other publications

STUDIES IN HUNGARIAN LANGUAGE:

Réder O. - Csatai R. (2008): Burgonya cink-amin komplexes kezelésének gazdasági vizsgálata (Acta Agronomica Óváriensis, 2008. Vol. 50. No. 1. 109-114. o.)

Csatai R. - **Réder O**. (2006): A nyugat-dunántúli régió állattenyésztő üzemei a 2000-es években (X. Agrárökonómiai Tudományos Napok Kiadványa, Gyöngyös, 2006)

PRESENTATIONS:

Csatai R. – **Réder O.** (2009): Hatékonyságmérés komplex mutatóval mezőgazdasági vállalkozásoknál. PhD Hallgatók és Doktorok a Gazdálkodásban Tudományos Konferencia. Mosonmagyaróvár, 2009. október 16.

Réder O. - Csatai R. (2008): Burgonya cink-amin komplexes kezelésének gazdasági vizsgálata (Mikroelemek tápanyagkörforgalma és újrahasznosítása Nemzetközi Konferencia. Mosonmagyaróvár, 2008. március 14)