EFFECT OF CHEMICAL FERTILIZERS ON GRAIN QUALITY OF WINTER WHEAT IN PRELUVOSOIL CONDITIONS

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Abstract

In this paper, we analyses the influence of potassium fertilizers in long time application on different NP background on wheat backing quality – Crişana variety – taking into acount – crude protein, moist gluten, falling number and deformation index. Balanced fertilization in the preluvosoil conditions with optimum potassium management may lead to maximize wheat yield and quality. The long term field experiment was carried out at the Agricultural and Development Research Station Oradea – Romania, begining with 1974 to ascertain the effect of potassium application on wheat in a crop rotation. Four different level of potassium (K) were applied on four NP backgrounds. Due to application of different levels of K there is a significant variation in the protein and moist gluten content. The best performance of the crop parameters was recorded when 80 kg/ha was applied a different NP backgrounds.

Keywords: Winter wheat, chemical fertilizers, potassium, background, backing quality.

INTRODUCTION

The Romanian grain wheat yield was the target in the last few years, of speculations about their technological skills (Stefănescu and Tianu, 2001, Burlacu, 2007, Ciobanu, 2007b, Marinciu and Saulescu, 2008). These speculations were fueled by a number of issues that characterize the production of wheat in Romania: higher quality variations from one crop to another, especially the quality parameters that reflect the enzyme activity (index fall, the index of deformation) (Cakmak, 2002, 2003). Although variations in quality of Romanian wheat crop has been claimed, because lack of suitability of the new Romanian varieties to new climatic conditions, but number of studies have shown that the main causes for this situation are inadequate technology requirements, especially wheat and unbalanced fertilization (Hera et al., 1986, Ciobanu, 2007a, Tabără, 2008, Şemun, 2010).

Wheat quality, expecially protein content and breadmaking quality is influenced by type of soil, climate conditions, nitrogen fertilization, plant protection and genotype (Pepó, 2002; Tanács et al., 2004; Szentpétery et al., 2004, Csathó, 2007). The mineral fertilization can increase the protein content with 26 - 42% comparative to non fertilization (control) (Brucher and Moroy, 1988). Recent research on backgrounds spectrum on different varieties of wheat (Wagner and Tabără, 2007; Şandor et al. 2010) highlights the dependence of hectoliter mass (hm/kg/l), moist gluten, falling index and Zeleny index (gluten index), the rates of NPK fertilizer and other agrophytotechnical factors (Győri and Sipos, 2006). In the case of using unbalanced fertilization the influence on the quality much stronger (Albert, 2001, Noordwijk and Cadisch, 2002).

MATERIAL AND METHOD

Experimental site

The research data was obtained at the Agricultural Research and Development Station Oradea in the long term field experiments with fertilizers, using a unique design in the all the research network of Research Institute from Fundulea.

The investigation has been carried out beginning with the autumn of 1974 in Oradea, in a flat plain area on the third terrace of the Crisul Repede River, whose geographical coordinates are: $21^{0}56$ ' Eastern longitude, $47^{0}03$ ' Northern latitude and 136 m altitude.

Long term NPK fertilizers application determine a differentiated evolution of preluvosoil chemical properties in function of fertilizers rates applied this having a strong influence an wheat yield and it's quality.

The experiment was designed as a completely randomized block with four replications. All plots were seeded at a rate of approximately 550 seeds/m², using Crişana variety (created at Agricultural Research and Development Station Oradea), classified in A2 (B1) valuable group, being appreciated like an ameliorative one. It is recommended to be cultivating in hill zone from Crişana, Maramureş, Transylvania and Bucovina counties and in western Romania plain zone. All trials were taken up with sowing of seeds at the end of October and harvesting at the beginning of July. The total amount of N was applied in split: ¹/₂ at sowing and ¹/₂ in spring at the beginning of stem elongation of the crop. The phosphorus and potassium rates were given at sowing.

Field experiment with potassium fertilizers was set up in 1974 using a crop rotation: pea – winter wheat – maize – sunflower.

We have organized field experiments involving two experimental factors:

A factor – K fertilization

a₁ K0; a₂ - K₄₀; a₃- K80, a₄- K₁₂₀

B factor – NP fertilization

b: NP rates: b_1 - N_0P_0 ; b_2 - $N_{80}P_{40}$; b_3 - $N_{80}P_{80}$; b_4 - $N_{160}P_{80}$.

(N was apllied like ammonium nitrate, in spring, P was aplied like superphosphate and K like KCl in autumn).

The crop rotation used in the field experiments was sunflower - wheat - corn - wheat.

The experiment maintenance imposed the following crop measures: chemical fertilization, using Nitrogen-based fertilizers in accordance with doses assessed for each experimental variant; weed control was performed using RIVAL and STAR control products; no treatments were done to control crop diseases. Harvesting was done at full plant maturity and was performed mechanically for each experimental field. In the field experiment the influence of fertilizers applied on wheat kernels yield was determined and a statistical interpretation of the yield differences obtained between different treatements was made.

For each experimental variant, plant samples were taken in order to perform biometrical measurements as well as grain samples to test physical characteristics and to determine the main bread and milling characteristics.

The determination of physical properties was done an order to assess TGW (thousand grain weight) and HM (hectoliter mass); these were separately determined for each variant. Milling quality analysis for grain yields were performed at A.R.D.S. Oradea this unit having the most modern and updated equipments to determine the main quality characteristics of wheat grains for milling processes.

Sampling and analytical method

All samples were taken to the laboratory and used for routine soil chemical analysis. pH was determined in water suspension.

The harvested grain was subjected to quality analysis is in triplicate. Grain samples from three replications were evaluated for quality characteristics. Determination of test weight and grain moisture was determined by standards. Grain protein content of seeds was determined by Kjeldahl method.

RESULTS AND DISCUSSION

Crude protein content (%)

The grain protein content of wheat is a critical factor in breadmaking. High protein content of wheat is associated with good breadmaking characteristics. The protein content of grain wheat depends on NP background existing and on rates of K applied taking values between 8.4 and 13.4%.

Lower values was registered in the case of backgrounds N_0P_0 were protein content are taking values between 8.41 - 8.57 and highest values 12.82 - 13.41 in the case of $N_{160}P_{80}$ background.

The values of protein grain wheat content are increasing with 0.1 - 0.6% following the potassium rates applied (Figure 1).



Fig. 1. The influence of KxNP fertilizers on crude protein of winter wheat yield, Oradea 2008-2010

Moist gluten

The analysis of the obtained results (Figure 2) allowed us to conclude, that nitrogen doses positively influenced the accumulation of average content of moist gluten.

In the lake of potassium the moist gluten are taking values between 21 and 31,3% when rates of nitrogen applied are increasing from 0 to 160 kg N/ha.

The effect of potassium fertilization is slight in the case of N_0P_0 and $N_{80}P_{40}$ backgrounds, when is registered 0.3 - 1% increase of most gluten value because of potassium rates. In the case of $N_{80}P_{80}$ and $N_{160}P_{80}$ backgrounds moist gluten values are increasing to 3 - 4% when is applied 80 kg potassium.



Fig. 2. The influence of KxNP fertilizers on moist gluten content (%) of winter wheat yield, Oradea 2008-2010

Falling number (FN)

Falling number (FN) is a test more recently introduced into country elevators and mills. It givens an indication of the amount of sprout damage that has occurred within a wheat sample. Generally, a falling number value of 350 seconds or longer indicates a low enzyme activity and very sound wheat quality. As the amount of enzyme activity increases, the falling number decreases. Values below 200 seconds indicate high levels of enzyme activity.

When it rains just before harvest, grain may start to germinate (or sprout) in the head. The germination causes an increase in alpha amylase, an enzyme that breaks down starch. There are also increases in enzymes that break down proteins. Of these, the starch degrading enzyme has a greater effect on reducing the quality of flour, and of products made from the flour. The longer the grain sprout, the greater the amount of the alpha amylase formed. If badly sprouted grain is milled, the flour can cause product problems.

Falling number characterized the activity of amidine from wheat grain on alpha-amylase activity witch influenced the quality of wheat bread, optimal value being between 180 and 260 sec.

The analysis of the obtained results show that the lowest values of FN (146 – 149 sec.) was registered in the case of N_0P_0 background. Potassium application in this case determines a slight decrease of FN values.

The best value of FN was registered in the case of $N_{80}P_{80}$ and $N_{160}P_{80}$ backgrounds when potassium application determines an increase of these values with 1 - 6 sec (Figure 3).



Fig. 3. The influence of KxNP fertilizers on falling number of winter wheat yield, Oradea 2008-2010

Deformation index (DI)

The higher values of DI (mm), 15.8 - 16.7 mm indicating low value bakery was registered in the case of N₀P₀ background and the lowest values (6 - 8 mm) in the case of N₁₆₀P₈₀ background.

The potassium applied on different background had a slight positive influence on deformation index (Figure 4).



Fig. 4. The influence of KxNP fertilizers on deformation index of winter wheat yield, Oradea 2008-2010

CONCLUSIONS

The chemical fertilizers is favoring the synthesis of the carbon hydrates and is contributing to the resistance to drought and disease of the plants and this is positively correlated with protein content, moist gluten, falling number and deformation index.

Long term balanced NPK fertilization maintain the potential preluvosoil fertility at a level that allows obtaining high wheat yields and good breadmaking quality.

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