INFLUENCE OF NPK FERTILIZERS UPON WINTER WHEAT GRAIN QUALITY

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Abstract: *The most efficient way of improving food resources of humanity is to increase agricultural production per hectare in arable terrains by introducing new varieties and qualified hybrids and by improving crop technology. Wheat contains a large quantity of starch (65 – 70 %), the main component of grain, and also, some sugars (maltose, sucrose). All these have an important energetic role. The wheat contain almost the entire types of amino acids, nevertheless lysine, methionine, threonine and tyrosine are find in insufficient quantities for human requirement. The research takes place in experimental field from U.S.A.M.V.B. Didactic Station from Timisoara and after that in the research lab of Soil Science and Plant Nutrition Department from Agricultural Faculty. The experiments are stationary type, with wheat – maize – sun flower rotation. Each plot is sub-dived in four repetitions, linear, with size of 10 x 3 m (30 m^2). The variety used for this experiment is Alex variety. The fertilizers used are: 20.20.0 complex mineral fertilizers, N 28 liquid foliar fertilizers Nitrophoska 13.42.0 micro granulated fertilizers. Raw protein content from wheat grain was determined by Kjeldahl method, as Kjeldahl nitrogen multiplied with 6.25. The amino acids were assayed using ion-exchange chromatography after hydrolizing with 6 M HCl for 24h at 110°C. Methionine and cystine were analyzed by using formic acid protection prior to acid hydrolysis. The higher values for raw protein were founded in the case of maximum dose of nitrogen fertilizers. The increase of phosphorus and potash fertilizers doses influence in an insignificant manner the nitrogen content of grains. The raw protein content from wheat grain is significant in the case of fertilized wheat; the lowest content in raw protein was found in the case of unfertilized wheat. The increase of mineral fertilizers dose has a major role in the variation of histidine content. The content of isoleucine depend in a less important manner by the fertilizers doses. The arginine content from wheat grain is found in connection with fertiliser dose. The metionine content from wheat grain is undersized; the use of mineral fertilizers has an insignificant impact.*

Key words: *fertilization, wheat, raw protein, amino acids*

INTRODUCTION

Amino acid composition is an important feature in determining the nutritional value of wheat grain for human and animal diets. From all agricultural crops, wheat represents the most important cultivated species. The wheat contain almost the entire types of amino acids, nevertheless lysine, methionine, threonine and tyrosine are find in insufficient quantities for human requirement.

Wheat contains a large quantity of starch (65 – 70 %), the main component of grain, and also, some sugars (maltose, sucrose). All these have an important energetic role.

Nitrogen fertilizer whether applied to the soil (DUBETZ, 1972; FAJERSON, 1961; SOLSULSKI et al., 1963) or to the plant (FINNEY et al., 1957; KOLDERUP, 1974) can be used in to increase the protein content of wheat (*Triticum aestivum* L.) and changes in amino acid composition are associated with increased grain protein.

The grain protein content and amino acid composition of wheat also vary genotype and environment, including rate and time of nitrogen fertilization, water availability and

temperature during grain filling (RAO et al., 1993; LOPEZ BELLIDO et al.,1988; RHARRABTI et al., 2001).

MATERIAL AND METHODS

A serie of wheat samples, Alex, fertilized with different fertilizers was studied, in pedoclimatical conditions from USAMVB Timisoara. The samples were obtained from field plots receiving foliar fertilization:

- Nitrophoska 13.42.0 (13%N, 42% P_2O_5,) – 20kg/ha,
- Granulated 20.20.0. (20%N, 20% P_2O_5,) – 150kg/ha,
- N28 liquid (28%N,) – 20L/ha,

The wheat samples were finely ground and dried for 24 hours at 60°C . Raw protein content from wheat grain was determined by Kjeldahl method, as Kjeldahl nitrogen multiplied with 6.25.

The amino acids were assayed using ion-exchange chromatography after hydrolizing with 6 M HCl for 24h at 110°C. Methionine was analyzed by using formic acid protection prior to acid hydrolysis. Trypthophan was determined by the alkaline hydrolysis method

The chromatographic conditions are: DIONEX ICS-3000 Amino Analyzer, AMINOPAC PA10 Analytical Column (2x250 mm, P/N 055406), AMINOPAC PA10 Analytical Guard Column (2x50 mm, P/N 055407), Mobile phase: E1: water, E2: NaOH 250 mM, E3: NaAc 1 M, Reference electrode: pH/Ag/AgCl, Flush volume: 250 µL, Flow rate: 0,25 mL/min, Column temperature 30^0C

The minimum detection levels of standard was 5 ng/L for each of the amino acids and have been established based on signal to noise ratios of 3:1. The linear dynamic range of the detector response was checked. The average correlation coefficient was between 0,9884-0,994.

The values obtained are expressed as per cent of a given amino acid in the whole grain. All values are expressed on the basis of the moisture free samples. The original samples contained 13 to 14% moisture.

RESULTS AND DISCUSSIONS

Of all nutrients, the increase of wheat production is mostly influenced by nitrogen, followed by phosphorus and potassium. Besides the direct effect, most cases show the positive effect of interaction between them, especially between nitrogen and phosphorus. Nitrogen is the nutrient involved in production components formation, having a favorable effect on plant roots and brotherhood. However, it increases grains number/ear, grain weight and improve their content in protein substances.

In the experimentation, total nitrogen content of wheat grain varies between 1.98% and 2.68% for the application of Nitrophoska 13.42.0 + 20.20.0. + N 28 liquid, growth was 40.6%. Raw protein has values between 12.41% and 16.49% Nitrophoska 13.42.0+20.20.0.+ N 28 liquid, while the starch content decreases from 60.16% in untreated variant to 57.96%.

Table 1

Influence of chemical fertilizers on total nitrogen content in total nitrogen, raw protein and starch (%) of whole wheat, crop year 2010-2011

Variant	Nt%	PB%	A%
Control variant	1,98	12,41	60,16
Nitrophoska 13.42.0	2,25	14,05	59,39
Nitrophoska 13.42.0+ 20.20.0.	2,55	15,92	58,37
Nitrophoska 13.42.0+20.20.0.+ N 28 liquid	2,68	16,49	57,96

The highest values are determined in the case of the maximum dose of nitrogen fertilizer, phosphate fertilizer but increasing the dose of potassium influenced only slightly in grain nitrogen content. Also, starch content values are higher in the untreated variant The maximum decrease from control variant, with 2.2 units, can be observed in the application of the maximum dose of nitrogen fertilizer on, the lowest content in phosphorus and potassium pre fertilizing trial.

Results from some studies indicate that the proportions of certain amino acids in wheat protein may depend upon the total nitrogen content of the wheat. Lysine, in particular, has been found in greater concentration in wheats of low protein content than in high protein samples. (SIMMONDS D.H., 1962; PRICE S.A., 1950)

Although phosphorus has no such a big influence as the nitrogen on protein content, it supports the effect of nitrogen, resulting in better assimilation and metabolisation of absorbed nitrogen forms. Application of nitrogen fertilizers gave the best results on the pre fertilizing trial with the lowest dose of phosphorus and potassium. Between nitrogen and potassium is an antagonistic action, application of high doses of potassium fertilizers can decrease potassium content of wheat grain.ter assimilation and metabolism of nitrogen forms absorbed.

Nitrogen is often the most limiting factor in crop production. Hence, application of fertilizer nitrogen results in higher biomass yields and protein yield and concentration in plant tissue is commonly increased. Nitrogen often affects aminoacid composition of protein and in turn its nutritional quality. These years of experience in application of high doses of phosphorus and potassium indicated a decrease of raw protein content. This can be explained by the fact that while potassium and phosphorus are necessary for plant growth and p rotein biosynthesis, these intensely stimulate the synthesis and carbohydrate movement from the other organs to seeds, than nitrogen substances synthesis. Foliar applications of nitrogen and fertilization late in the growing season tended to have a greater effect on increasing grain protein concentration than on increasing grain yield (ALTMAN et al., 1983).

Table 2

Influence of chemical fertilizers on amino acid content in wheat grain (%) averages 2010 - 2011

Variant	Arginine	Histidine	Isoleu-cine	Leucine	Lysine	Methio nine	Phenylal anine	Trypto-phan	Valine
Control variant	3,3	1,4	2,7	3,5	2,2	0,2	3,3	0,3	2,6
Nitrophoska 13.42.0	3,8	1,8	3,0	4,1	2,4	0,3	3,6	0,2	2,9
Nitrophoska 13.42.0+ 20.20.0.	4,6	2,5	3,4	4,8	2,2	0,5	4,2	0,5	3,3
Nitrophoska 13.42.0+ 20.20.0.+ N 28 liquid	4,9	2,6	3,6	5,1	2,0	0,5	4,4	0,4	3,5

In order for human body to be able to synthesize and use in the most effective protein, is required to find that all the amino acids in proportions. Absence or insufficient presence of any amino acid will decrease in proportion to the effectiveness of others. The nine essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine. Other known amino acids are alanine, arginine, aspartic acid, ornithine, cysteine, cystine, proline, glutamic acid, serine, glutamine, glycine. Wheat is containing ten essential amino acids .Protein substances found at the periphery of the grain, so the flour from center of the grain is low in protein. The wheat grain protein substances are formed by gliedina (40-50%), gluteina (30-40%), globulin (6-10%) and albumin (3-5%). Gluteine and gliedine form gluten, which imprint bread quality.

The lowest amounts of amino acids were determined for methionine and tryptophan, the highest being for arginine, leucine and phenylalanine. Of common fertilizers, the nitrogen fertilzers causes significant changes in protein content and composition changes.

As shown in Table 2 amino acid content increases as the dose of nitrogen fertilizer increases, regardless of pre fertilization with phosphorus and potassium. The exception is lysine content of which is negatively influenced by increasing the dose of nitrogen fertilizer.

Conditions of nitrogen and potassium-phosphorus nutrition of plants have a substantial effect on the amino-acid composition of protein substances in wheat. With a nitrate source of nitrogen, the content of the aromatic amino acids tryptophan and tyrosine are substantially increased in wheat while given ammonia nutrition the cystine content is higher. When wheat is inadequately supplied with the total tryptophan content in the wheat grain drops. Thus, normal phosphorus nutrition is vitally important for tryptophan synthesis in wheat. (POLTAVSKAYA I. A., 1965)

Phosphorus does not affect the same extent as the nitrogen the content of amino acids. However, phosphorus support the effect of nitrogen and especially reduces the negative influence of high doses of nitrogen on the amount of amino acid metabolism resulting in better forms of nitrogen absorbed. Application of potassium fertilizers increases the production of protein per unit area and improves its quality by increasing the content of essential amino acids. The total amino acid composition of the grain was mainly dependent on N content of grain. Phosphorus and potassium affected the amino acid composition of wheat grain only indirectly through their effects on nitrogen concentration. In wheat increasing grain N% was accompanied by a decrease in the amount of lysine, threonine, methionine, cystine and an increase in glutamic acid, proline, phenylalanine, and serine contents. (WILFRIED H EPPENDORFER, 1978)

Changes in amino acid composition of wheat grain protein that occurred as a results of nitrogen fertilization generally agree with other studies (ABROL et al., 1971; KOLDERUP 1974; LARSEN and DISSING, 1966).

KOLDERUP (1974) showed that increased levels of nitrate fertilizers resulted in changes in the amino acid composition of protein from wheat grain. BENZIAN and LANE (1979) analyzed the relationship between nitrogen supply, grain yield, and grain protein concentration for wheat. They found that a greater nitrogen supply increased grain protein concentration linearly while grain yield response to added nitrogen had a diminishing return relationship. They also found that when nitrogen was very limiting, small nitrogen additions resulted in greater grain yield with decreased protein concentration caused by dilution of the plant nitrogen. However, at higher levels of nitrogen, which are far more common, grain and protein yields usually increased while the grain protein concentration increased as well.

Of the three amino acids shown in Figure 1, we observed that the increase rate of mineral fertilizers affect in the utmost levels of histidine, 97.2%, while the content is influenced to the extent isoleucine: the smallest, at the rate of 87,67%. All three response curves have an upward trend.

Figure 2 present the increasing trend of levels of arginine on the extent of increasing doses of fertilizers; they influence the amount of arginine in wheat grain at a rate of 98.0%. Response curve of the lysine content of the application of fertilizers is a downward trend, the correlation coefficient with the lowest namely 0.9. Methionine content of the wheat grain is low, application of fertilizers modifying it in a proportion of 93.33%.

Response curves of the contents of phenylalanine and valine have an upward trend, with very close values of correlation coefficients : 0.9689 for phenylalanine and 0.9908 for valine figure 3. Tryptophan is found in small quantities in wheat grain, its content is modified by fertilization with increasing doses of mineral fertilizers at a rate of 50%.

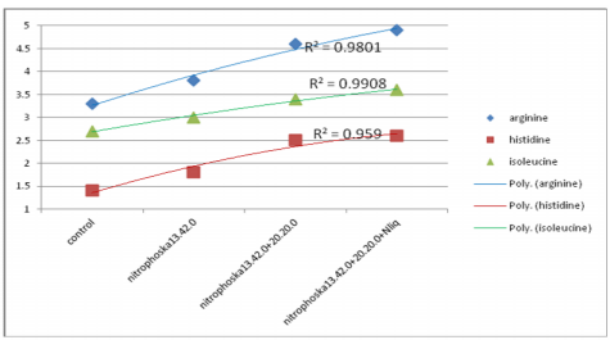

Figure 1. Correlation between mineral fertilizer and arginine, histidine and isoleucine content of winter wheat grains

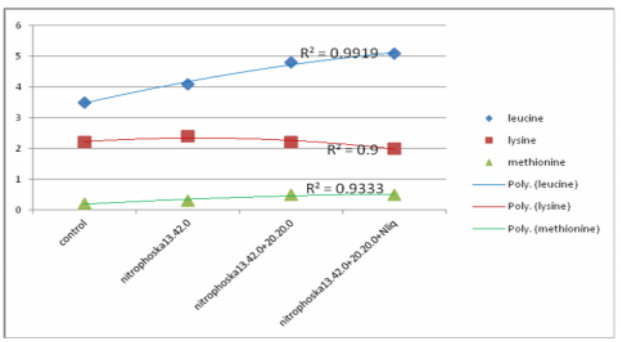

Figure 2. Correlation between mineral fertilizer and leucine, lysine and methionine content of winter wheat grains

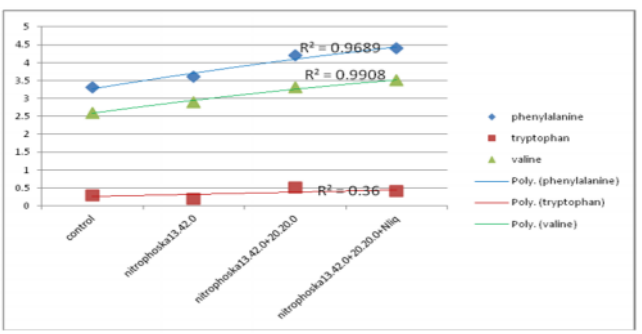

Figure 3. Correlation between mineral fertilizer and phenylalanine, triptophan and valine content of winter wheat grains

CONCLUSIONS

1. The raw protein content from wheat grain is significant in the case of fertilized wheat; the lowest content in raw protein was found in the case of unfertilized wheat.
2. The higher values for raw protein were founded in the case of maximum dose of nitrogen fertilizers. The increase of phosphorus and potash fertilizers doses influence in an insignificant manner the nitrogen content of grains.

3. The increase of mineral fertilizers dose has a major role in the variation of histidine content. The content of isoleucine depend in a less important manner by the fertilizers doses.
4. The arginine content from wheat grain is found in connection with fertiliser dose. The metionine content from wheat grain is undersized; the use of mineral fertilizers has an insignificant impact.

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