FOLIAR FERTILIZATION INFLUENCE ON MAIZE GRAIN PROTEIN CONTENT AND AMINO ACID COMPOSITION

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Abstract: *The importance of cereal grains to the nutrition of millions of people around the world is widely recognized. Because they make up such a large part of diets, cereal grains cannot be considered only as a source of energy, as they provide significant amounts of protein as well. It is also recognized that cereal grains have a low protein concentration and that protein quality is limited by deficiencies in some essential amino acids, mainly lysine. Much less appreciated is the fact that some cereal grains contain an excess of certain essential amino acids that influence the efficiency of protein utilization. Maize, after wheat and rice, it is the most important cereal grain in the world, providing nutrients for humans and animals. The nutritional quality of maize is determined by the amino acid makeup of its protein. Maize is deficient in two essential amino acids: lysine and tryptophan. For a balanced nutrition is important not only the amount of amino acids taken over, but the ratio between them, because the disproportion in feed of amino acids composition leads to a complex disorder of protein metabolism. In this paper the protein content and amino acid composition of maize grain was determined. Maize (Zea mays L.) was grown in a series of field plots which received nitrogen only and various rata of applied nitrogen, phosphorus, potassium and microelements as foliar fertilizers. Total N in the maize grain was determined by a Kjeldahl method and protein content by calculation (N x 6.25). Amino acid composition, after subjecting samples to conditions which would hydrolyze protein, was determined by ion chromatographic method developed in the Organic Sustainable Agriculture and Food Safety-ADSA, PLATFORM laboratory. The results obtained indicated that grain yield increase have resulted in lower protein concentration except when the yield increase resulted from nitrogen fertilizer application. Raw protein content of maize grain was ranged between 7.0% and 10.0%. Higher nitrogen application rates alter the amino acid balance thereby reducing the nutritional value.*

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

INTRODUCTION

The importance of cereal grains to the nutrition of millions of people around the world is widely recognized. After the wheat and rice, maize is the most important cereal grain in the world, providing nutrients for humans and animals. In industrialized countries, a larger proportion of the grain is used as livestock feed and as industrial raw material for food and nonfood uses. In developing countries is used mainly as human food, although its use as animal feed is increasing. Corn constitutes an important source of carbohydrates, protein, vitamin B and minerals. The nutritional quality of maize is determined by the amino acid makeup of its protein (BERGNER H., 1994).

Amino acids are important to animal and human body proper functioning. Amino acids role includes repairing muscles, organs, skin, ligaments and glands. Out of the many amino acids, humans require anly 20 different kind. Yet of the 20 amino acids, only 12 (nonessential amino acids) can be produced within the body, whereas the other eight (essensial amino acids) – isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine – must be obtained from the diet (PARSONS C.M., Y. ZHANG AND M. ARABA, 1998).

Is recognized that cereal grains have a low protein concentration and that protein quality is limited by deficiencies in some essential amino acids. Corn is deficient in two essential amino acids: lysine and triptophan. Less apreciated is the fact that some cereal grains contein an excess of certain essential amino acids that influence the efficiency of protein utilization. The classic example is maize (STEIN, H.H.. 2003).

Fertilization has a significant influence upon protein yield on surface unit and its quality. Fertilizers trough sortiments, doses and application periods determines protein and amino acids quantity in plants. Although the genetic potential is decisive for the protein content in plants, protein quantity and ratio of certain amino acids may be influenced by the fertilization.

MATERIAL AND METHOD

A series of corn samples, hybrid ZP 434, fertilized with different fertilizers was studied, in pedoclimatical conditions from USAMVB Timisoara. The samples were obtained from field plots receiving foliar fertilization:

- Cropmax (0,2%N, 0,4% P_2O_5, 0,02%K_2O) – 3L/ha,
- Bionat (7,5%N, 0,003% P_2O_5, 0,8%K_2O) – 4 L/ha,
- Bionex (0,042%N, 0,013%P_2O_5, 0,137%K_2O) – 3L/ha,
- Fertitel (6,6%N, 6,0%P_2O_5, 4,1%K_2O) – 2 L/ha
- Phomak (30% P_2O_5, 20% K_2O) – 4 L/ha.

The corn samples were finely ground and dried for 24 hours at 60°C . Raw protein content from corn 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. Trypthophan was determined by the alkaline hydrolysis method (SONG G.L., LI D.F., PIAO X.S., CHI F., WANG T.J. , 2003).

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 (RADULOV ISIDORA ET.AL., 2009).

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

The protein content of the corn grain analyzed is presented in table 1. The raw protein content of corn grain was ranged between 7.01% in control sample and 9.31% in plot fertilized with Fertitel fertilizer. Unlike the other fertilizers, in Phomak case, which contain only phosphorus and potassium, the raw protein content is lower (8%). Fertilizers with only phosphorus and potassium influence tha amount of raw protein in the grain of maize to a smaller extent and when applied in larger quantities they entail its decrease.

All of the 18 amino acids were found to be present in corn in significant amount. Compared to control we determined rises of amino acid content in all fertilizing plots. Among

applied fertilizers Fertitel stands, in this fertilizing plot being determined the highest value of total amino acid content.

Table 1

Raw protein content of corn grain after foliar fertilization

Nr.crt.	Sample	Raw protein %
1	Control	7,01
2	Cropmax	8,43
3	Bionex	8,50
4	Fertitel	9,31
5	Bionat	8,10
6	Phomak	8,00

Table 2

Amino acid content of corn fertilized with foliar fertilizers (%)

AA	Control	Cropmax	Bionex	Fertitel	Bionat	Phomak
Alanine	0,60	0,69	0,62	0,71	0,63	0,65
Arginine	0,42	0,46	0,48	0,45	0,46	0,45
Aspartic acid	0,61	0,63	0,66	0,69	0,64	0,64
Cystine	0,14	0,28	0,22	0,26	0,23	0,19
Glutamic acid	1,15	1,30	1,42	1,53	1,45	1,40
Glycine	0,23	0,24	0,24	0,39	0,25	0,28
Histidine	0,15	0,17	0,22	0,31	0,21	0,20
Isoleucine	0,25	0,26	0,28	0,32	0,33	0,30
Leucine	0,70	0,80	0,91	1,03	0,98	0,95
Lysine	0,13	0,13	0,15	0,22	0,14	0,10
Methionine	0,11	0,15	0,11	0,13	0,14	0,11
Phenylalanine	0,30	0,35	0,42	0,40	0,37	0,38
Proline	0,55	0,67	0,71	0,80	0,73	0,70
Serine	0,28	0,30	0,33	0,36	0,30	0,29
Threonine	0,30	0,30	0,29	0,33	0,34	0,30
Tryptophan	0,025	0,026	0,028	0,031	0,028	0,031
Tyrosine	0,28	0,34	0,37	0,40	0,35	0,36
Valine	0,42	0,43	0,50	0,49	0,51	0,45
Total	6,65	7,53	7,96	8,85	8,09	7,78

The highest content in cystine and methionine was determined in Cropmax fertilized variant. Of all the fertilizers used Cropmax has the highest sulfur content, which would explain the increased intake of these sulfur amino acids to its application. Bionex fertilization resulted in obtaining the highest content of arginine and phenylalanine, while applying Bionat considerably increased the amount of valine. Applying Phomak resulted in amino acid content positive changes compared to the control, but maximum values were not recorded.

Of all the nutrients, nitrogen is the main factor determining the variation of protein content, and major changes in its composition. Phosphorus does not influence the protein quality in a larger extent like nitrogen, but contribute to its effect causing a better assimilation and metabolism of absorbed nitrogen forms. Unlike phosphorus, potassium helps to increase the essential amino acid content.All applied fertilizers contain nitrogen, phosphorus and potassium in different quantities, with secondary macronutrients and some micronutrients, except Phomak fertilizer which is a type 0: 30:20.

As it shown in figure 1, alanine, arginine and aspartic acid content in corn grain decreases as the raw protein content increases. Cystine, cysteine and glutamic acid content remains relatively constant as the percentage of crude protein increases, small differences occurring between different types of fertilization.As we observe in figure 1c both the leucine and histidine content increases proportional to the protein percentage increased in corn grain; isoleucine content remaining relatively constant.

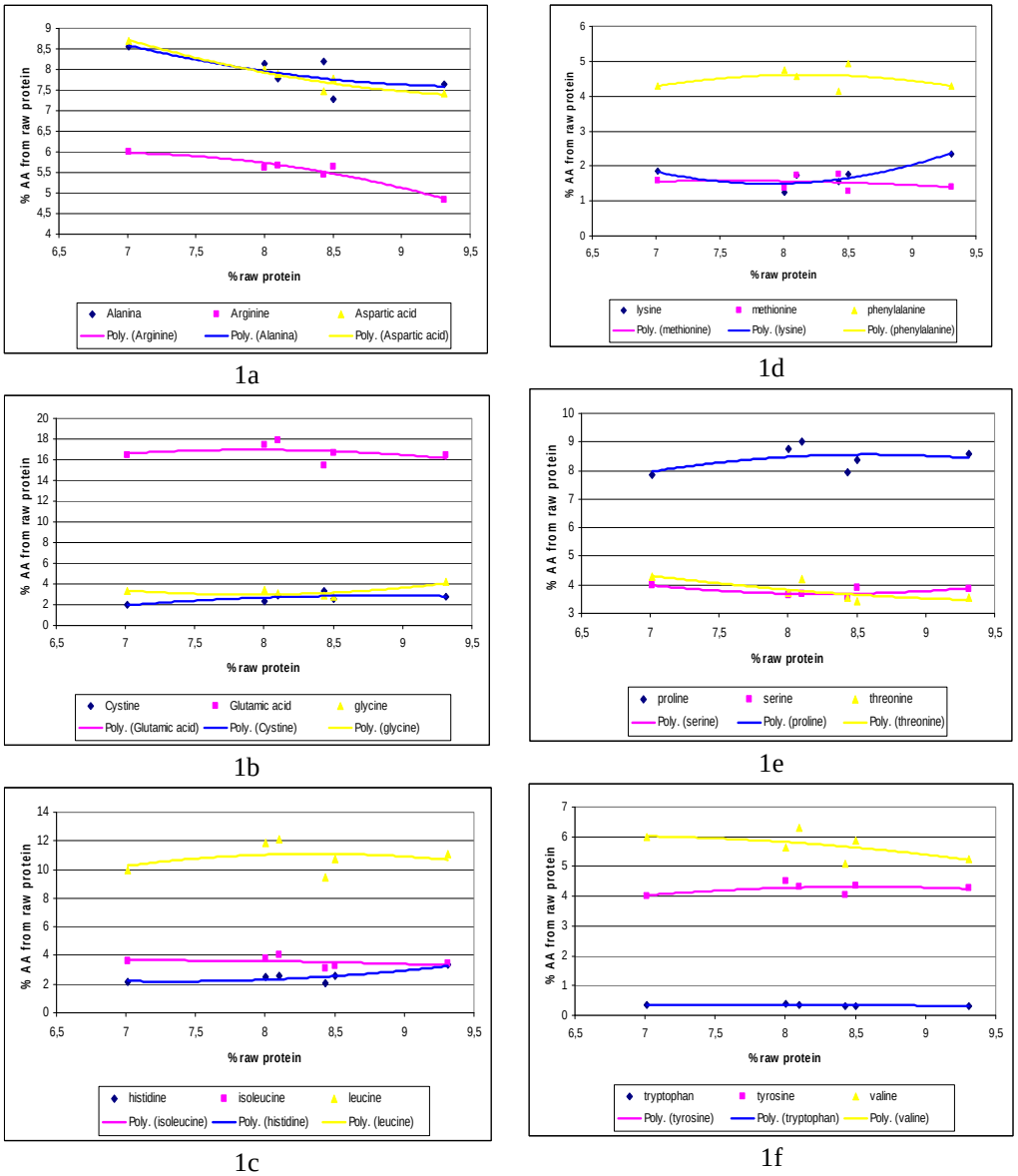

Fig.1. Relation between protein content of maize and amino acid per cent in the total protein

The percentage of certain amino acids in the corn grains remaines relatively constant as the raw protein content increases, its the case of: methionine and serine. Phenylalanine, valine and threonine content has a decreasing tendency, while lysine, proline and tyrosine content is greater with the increase of total protein.

CONCLUSIONS

1. Corn fertilization with foliar fertilizers containing different nitrogen, phosphorus and potassium dose reveals that the highest protein content, 9.31%, was determined in the plot treated with Fertitel, wich means a rise of 32,8% compared to the control.

2. Lowest protein content, 8%, was obtained in the plot fertilized with Phomak, fetilizer which containes only phosphorus and potassium.
3. Higest total amino acid content, 8,85%, was determined in plot fertilized with Fertitel, followed by Bionat with 8,09%.
4. The content of certain amino acids in the total proteins became greater as the percentage of total protein in corn increase, its the case of: leucine, histidine, methionine, lisine, proline, serin and tyrosine.
5. Fertilization with foliar fertilizers containing different N,P,K quantities not only increased the protein content of corn, but it also affected the relative proportion of the various amino acids in the raw protein of corn.

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