CHANGING THE QUALITY OF MAIZE GRAIN AFTER APPLYING MICRO-GRANULAR FERTILIZERS

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Abstract. *The main objective of the research is to track how the localized application of micro granular chemical fertilizers with seeding, under different types of fertilizers, influences the variation in the raw protein, amino acid, hectolitre weight and fat composition of the maize grain. Corn constitutes an important source of carbohydrates, proteins, vitamins and minerals. The research was run in an experimental field from B.U.A.S.M.V. "King Michael I of Romania" in Timisoara Didactic Station from Timisoara and after that in the research laboratory of the Soil Science Department from the Faculty of Agriculture. The experiments are of the stationary type, with wheat – maize – sunflower rotation. Each plot is sub-divided in four replicates, linear, with the size of 10 x 3 m (30 m^2). The hybrid used for this experiment is MAS 44 A. The fertilizers used are: Crop Starter 18.40.0 micro-granular fertilizers, 20.20.0 complex mineral fertilizers, N 28 liquid foliar fertilizers. Crop quality is appreciated not only by morphology and technology but by the content of biochemical compounds (carbohydrates, proteins, essential amino acids, minerals, vitamins, and fats). Currently, researchers are focused on improving production and quality of maize grain.*
Keywords: *quality indicators, corn, micro-granulates, variants.*

INTRODUCTION

Corn (Zea mays L) is one of the most valuable crop plants, due to its high productivity and to its multiple uses in human nutrition, in animal husbandry and in industry.

The grains (which contain on average 10% proteins, 7% non-nitrogenous extractive substances, 4% fat, 2% cellulose, 1% ashes, 13% water), are used predominantly as concentrated feed for all categories of animals. Having high productive potential, maize consumes large quantities of nutriments. For every 1000 kg grains + secondary yield, maize consumes: 18-28 kg nitrogen, 9-14 kg P2O5 and 24-36 kg K2O.

Nitrogen is considered an element of growth par excellence. The increase in size and weight of the cells and of the plant as a whole cannot be conceived without the biosynthesis of protein substances, which cannot take place without nitrogen.

Corn is a big consumer of nitrogen that absorbs the greatest part of nitrogen in its first period of vegetation. That is why, in our research, the micro-granular fertilizer was applied locally. Corn must be well supplied with nitrogen at the end of its vegetation, too, in order to increase the protein content of its grains. Hence, our research included the foliar treatment with liquid nitrogen-based fertilizer.

MATERIAL AND METHOD

A series of wheat samples were studied, which had been fertilized with different fertilizers, in the soil and climate conditions from BUASVM Timisoara. The samples were obtained from field plots treated with foliar fertilizers:

V1- not fertilized - control

V2- Crop Starter 18.40.0 (NPK 18% N, 40%) - 20kg/ha.

V3- Crop Starter 18.40.0 (NPK 18% N, 40%) - 20kg/ha + Granulated 20.20.0. (20% N, 20% P 2O5) - 150kg/ha.
V4- - Crop Starter 18.40.0 (NPK 18% N, 40%) - 20kg/ha + Granulated 20.20.0. (20% N, 20% P 2O5) - 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 maize grain was determined by Kjeldahl method, as Kjeldahl nitrogen multiplied with 6.25.

The amino acids were determined using ion-exchange chromatography after hydrolysing with 6 M HCl for 24h at 110°C. Methionine and cysteine were analysed by using formic acid protection prior to acid hydrolysis.

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. 9606-0.8959.

RESULTS AND DISCUSSIONS

Micro-granular fertilizers influence the vegetative development of plants, encouraging the formation of taller, vigorous plants, with large dark green leaves. In what the nutritional value is concerned, protein is the most important of substances, its quantity and quality determining flour quality.

Nitrogen contributes to plant growth, being the determining element of yield quantity, but also of yield quality, especially in what the presence of proteins and essential amino acids is concerned .

Table 1

Table of the average values in the three replicates.

Fertilization variants	N content	Fats	Starch	MH kg/hl	Protein %
V1	0	10.95	70.15	83.08	9.575
V2	18	11.4	71.4	83.58	11.23
V3	38	11.63	71.48	83.98	11.45
V4	66	11.85	72.2	84.85	11.83

The starch content in grains ranged from 70.15 % - in the control variant (V1) to 11.85% - in the variant fertilized with 66Kg N (V4), namely the variant where all three types of chemical fertilizers were used. It is worth noting that the highest values of the starch content were determined where the localized fertilizers containing nitrogen and phosphorus were applied.

Consider a growth model in relation to one factor (the cumulated nitrogen in the fertilizers), of the Mitscherlich function type:

$$y = a(1 - e^{-b(x+x_0)}), \quad (1)$$

where y – represents the dependent variable;
x - the independent variable;
a – the maximum expected;
b – growth rate;
x_0 – doses of fertilizers in the soil.

In order to determine the constants, we will use the method of linearization, relation (1) and we obtain:

$$-\ln\left(1 - \frac{y}{a}\right) = bx + bx_0. \quad (2)$$

In the regression line (2), b is the coefficient of x, a is determined as the maximum expected, and x_0 is determined from relation bx_0 as the free term in (2).

In all fertilization variants there is obvious increase of the fat content in the corn ears as compared to the control variant.

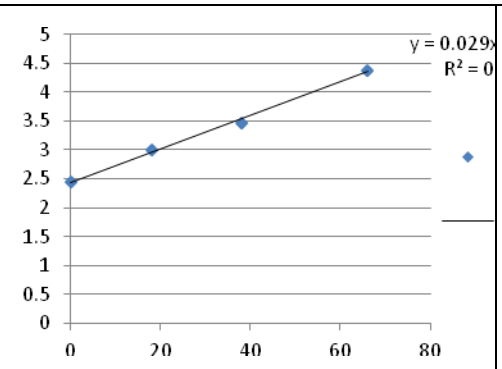

Figure 1. Regression points and line given by relation (2) for fats

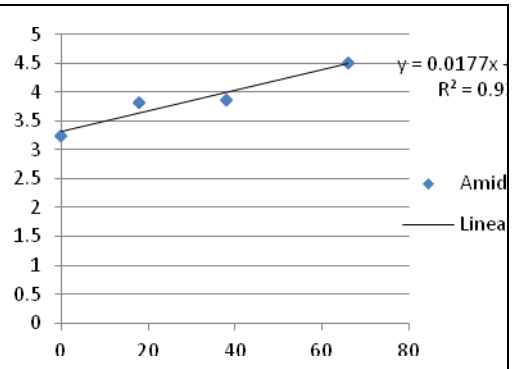

Figure 2. Regression points and line given by relation (2) for starch

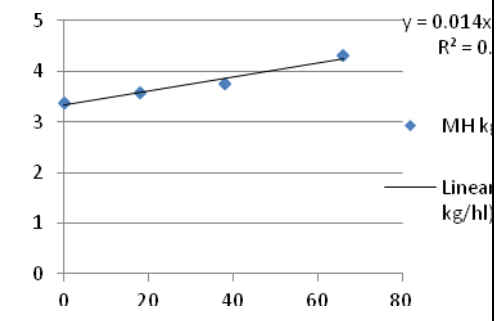

Figure 3. Regression points and line given by relation (2) for MH

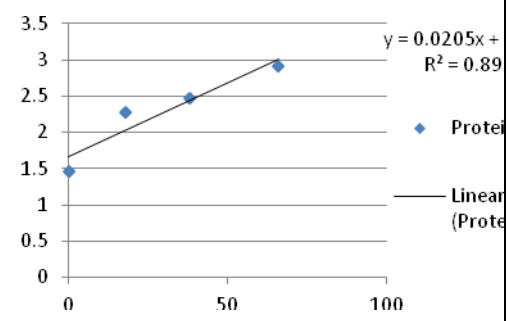

Figure 4. Regression points and line given by relation (2) for protein

After the statistical analysis of the starch content, the smallest values of the starch content were determined in the control variant.

As it is easy to notice in Figure 3, application of 66kg/N a.s./ha determined an increase of the hectolitre weight in the variants with complete fertilization with the three types of chemical fertilizers (V4) .

Phosphorus enhances the formation, transport and deposition of carbohydrates, while nitrogen plays an important part in protein formation.

Thus, after determining the coefficients of the model given by the Mitscherlich function, the following constant values are obtained, for each case, corresponding to the quality indices under research:

$a = 12, \quad b = 0.029$ and $x_0 = 83.9$.
$a = 73, \quad b = 0.017$ and $x_0 = 195.35$.
$a = 86, \quad b = 0.014$ and $x_0 = 237.64$.
$a = 12.5, b = 0.02$ and $x_0 = 82.8$.

When we represent graphically in the same system of coordinates both the experimental data (averages) and the theoretical curves given by the Mitscherlich function, we will obtain the following figures:

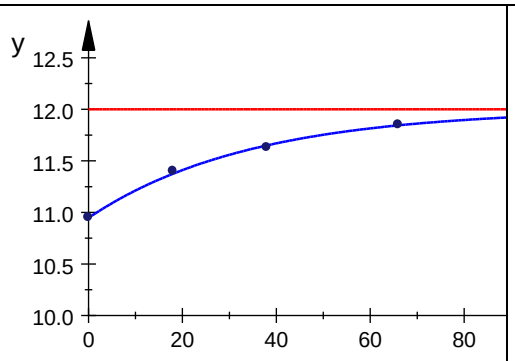

Figure 5. Experimental data and theoretical curve given by (1) for fats

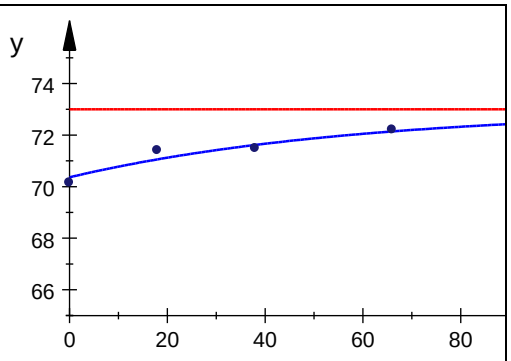

Figure 6. Experimental data and theoretical curve given by (1) for starch

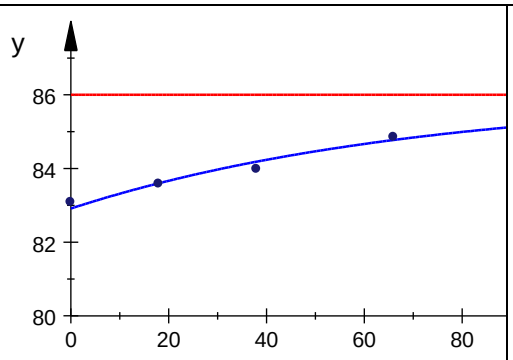

Figure 7. Experimental data and theoretical curve given by (1) for MH

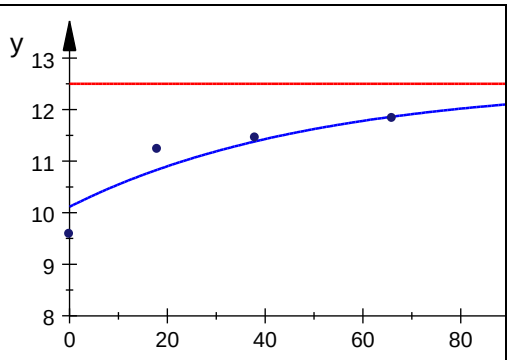

Figure 8. Experimental data and theoretical curve given by (1) for protein

Each figure shows good concordance between the experimental data and the theoretical curves. Thus, the curves determined as above will make a prediction about the evolution of the fat, starch, MH and protein contents, by using functions of the Mitscherlich type. Therefore, depending on our aim, we will be able to decide on the total quantity of nitrogen required. Nevertheless, it is worth noting that the present paper does not deal with obtaining the technical maximum from an economic point of view.

CONCLUSIONS

Each figure shows good concordance between the experimental data and the theoretical curves.

The raw protein content from maize grain is significant in the case of fertilized maize (V4); the lowest content in raw protein was found in the case of unfertilized maize (V1).

The highest raw protein values were found in the case of maximum dose of nitrogen fertilizers (V4).

Effective complex mineral fertilization is significantly distinct from the first dose of micro-granular fertilizer and maximum yield the highest dose (with granular and foliar fertilizer), proving that the soil responds positively to application of mineral elements from the first vegetation phenophase of plants but in optimal climate conditions.

Micro granulated fertilizers applied (V4) to allow a reduction of noticeable contribution in the field of chemicals that allow building soil reserves.

The statistical analysis of the starch content revealed that the smallest values of the starch content were in the control variant (V1).

In all fertilization variants there is obvious increase of the fat content in the corn ears when compared to the control variant.

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