THE INFLUENCE OF FERTILIZATION, SOIL AND CLIMATE ON THE YIELD OF GRAIN MAIZE CROPS

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Abstract: *Our studies and research aimed at assessing the influence of the fertilization system and of soil and climate conditions on the yield of grain maize crops. The experimenting conditions are specific for Banat Plain, and the soil on which the tests were run, slightly gleyzed cambic chernosem, is located within Timişoara Didactic Station. We tested the influence of a conventional fertilization system based on complex fertilizers and ammonium nitrate, as well as the influence of a leaf fertilization system. We observed the differentiated way in which the grain maize crop used the nutrients made available by the two fertilization systems. The indicators evaluated were quantitative (yield) and qualitative (protein content, fats content and starch content). Multivariate statistical analysis highlighted that the variants were placed into three groups in relation with the quantitative indicator, as a result of differentiated use of available resources. In the case of mineral fertilization of soil, with different doses of nitrogen on different PK combinations, the correlation between variables is very significantly positive, r = 0.924; r^2 = 0.854; p < 5%. Protein is also in significant correlation with the fertilization level, r = 0.886, r^2 = 0.785, p < 5%, while the contents of fats and starch are negatively correlated, with a low degree of significance.*

Key words: *fertilization system, mineral and foliar fertilizers, maize, yield, quality*

INTRODUCTION

Researchers are constantly trying to achieve harmonization of fertilizing agricultural technologies, regarding the type of fertilizer and fertilization methods, Kraus 2000, Hera et al. 2001, Dumitru 2002, Rusu et al. 2002.

Fertilization strategies are meant to supply the necessary nutriments for crops challenged by changing soil, climate, technical and economical conditions. Therefore, designing more efficient technologies and covering the food demand is an important goal (11, 12).

Soil and climate conditions play an important role in planning agricultural systems and achieving balanced fertilization systems for obtaining large quantities of high quality agricultural yields while preserving soil fertility, Ţărău et al. 2002.

Some studies aim at optimizing crop fertilization from a technical point of view anad from an economical point of view, as well, Sala and Boldea 2011, Boldea and Sala 2012.

Due to its importance in agriculture, food industry and energy, and also because of its prevalence among crop plants, maize has permanently kept the attention of researchers for testing new technological elements, optimizing technology and improving quality, Bahr et al. 2006, Orosz et al. 2008, Law-Ogbomo 2009.

In the specific context of agricultural systems where we developed our research, the necessary nutrients are provided by mineral fertilization; the complex interaction among the soil and climate conditions, fertilization system and biologic material playing a key part in the quantity and quality of agricultural yield.

This paper presents the results of our research regarding the influence of the fertilization system and of soil and climate conditions on the quantity and quality of the yield for grain maize crop.

MATERIAL AND METHOD

We ran our experiments at Timişoara Didactic Station, where the soil and climate conditions were specific for Banat Plain.

The soil in the experimental field is a slightly gleyzed cambic chernozem, with neutral reaction (pH = 7.04), good humus supply (H = 3,4), high base saturation (V > 87%), poor supply of mobile phosphorus (P_{AL} = 23 ppm) and good supply of potassium (K_{AL} = 187 ppm).

In terms of climate, the area is characterized by average multiannual precipitations of 603.3 mm and average temperatures 10.9°C. During our experiment, the rainfall regime fell generally within the multiannual average limits, but with certain irregularities regarding their distribution decades. We recorded strong deficit of precipitation between August and November 2011, and again between July 2012 and September 2012.

To provide the necessary nutrients for the crop, we used mineral fertilizers of the type NPK (S) complex with Zinc [15/15/15(+3+Zn)] and ammonium nitrate (33.5% N). We also tested the effect of three leaf fertilizers (Biocomplex 900, Fertitel and Megafol) applied in two phenophases, namely four leaves and 6-8 leaves respectively (code BBCH 13 – 15 and 17 - 32).

Crop structure consisted of wheat, maize and sunflower, our experiments focusing on grain maize crop. The cultivated hybrid was *DKC 5143*, a productive hybrid, recommended for the west of Romania.

The area of the experiment covered a 30 mp plot and the experiments were organized in randomized blocks, in four repetitions. The fertilizers were applied manually, thus ensuring even distribution.

Harvest was performed manually, at physiological maturity as ears, for each experimental variant. Subsequently, morphological and biometric determinations and quality analyses were conducted in the laboratory.

The results we obtained were processed through adequate statistic analyses, variance analysis and linkage distance for getting the influence that fertilization variants have over the yield.

RESULTS AND DISCUSSIONS

Table 1 presents the results we obtained regarding the influence that mineral fertilizers applied on the soil and on the leaves have on the quantity and quality of grain maize crops. Because of the water deficit, the fertilizers were not used to the full biologic potential of the hybrid, of the soil and technology involved.

The average yield in the experimenting period (2011 – 2012) vacillated between 2415 – 5820 ± 387.93 kg/ha; these values were smaller than expected, because they are below the potential of the hybrid and of the area, in what the soil and climate are concerned.

In the variants with soil mineral fertilization, the correlation between the variables (fertilization / yield) is very significantly positive, $r = 0.924$; $r^2 = 0.854$; $p < 5\%$. The protein content also presents significant positive correlation with the doses of fertilizers, $r = 0.886$, $r^2 = 0.785$, $p < 5\%$. The fat and starch contents are negatively correlated with the fertilization level, with low significance.

The yield increase given by the mineral fertilizers applied on the soil was differentiated depending on the type and dose of fertilizer.

When applied alone, nitrogen generated yield increase between 1145 kg and 2910 kg, as compared to the yield ensured by the natural soil fertility, as shown in Figure 1.

Table 1

Experimental data on maize yield, hybrid *DKC 5143*
under the conditions at Timişoara Didactic Station, average values 2011 - 2012

Parameters / Variant	Yield (kg / ha)	Protein (%)	Fats (%)	Starch (%)
PK0N0	2415 ± 387.93	7.9 ± 0.28	4.1 ± 0.04	71.4 ± 0.14
PK0N100	3560 ± 387.93	9.5 ± 0.28	4.4 ± 0.04	71.2 ± 0.14
PK0N200	5325 ± 387.93	9.7 ± 0.28	4.4 ± 0.04	71.1 ± 0.14
PK50N200	5370 ± 387.93	9.4 ± 0.28	4.0 ± 0.04	71.8 ± 0.14
PK100N200	5780 ± 387.93	10.6 ± 0.28	4.2 ± 0.04	70.4 ± 0.14
PK150N200	5820 ± 387.93	10.6 ± 0.28	4.1 ± 0.04	70.6 ± 0.14
Biocomplex 900	3720 ± 387.93	9.6 ± 0.28	4.3 ± 0.04	71.5 ± 0.14
Fertitel	4566 ± 387.93	9.5 ± 0.28	4.1 ± 0.04	71.3 ± 0.14
Megafol	3810 ± 387.93	8.7 ± 0.28	4.2 ± 0.04	70.8 ± 0.14

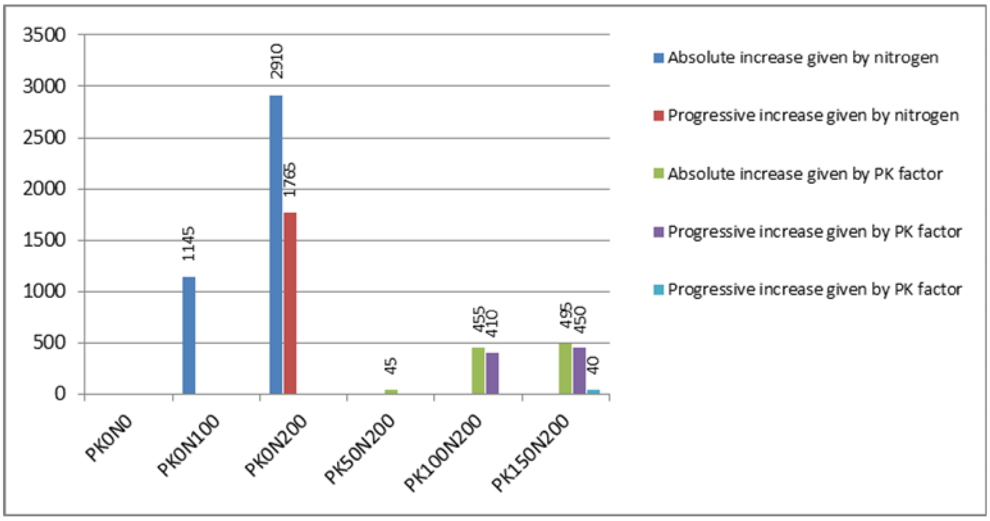

Fig. 1. Yield increase determined by nitrogen and PK combination.

Phosphorus and potassium determined yield increase between 45 and 495 kg/ha, considering as reference the yield obtained for variant N_{200}, nitrogen fertilization level with which phosphorus and potassium were associated. The contribution of phosphorus and potassium was much smaller than that of nitrogen; this can be explained on the one hand by the smaller plant demand, and on the other hand by lower soil bioavailability due to water deficit.

Leaf fertilization gave yields of 3700 to 4500 kg/ha, which classify it as medium to high fertilization with nitrogen alone, or medium complex fertilization (NPK).

Variant distribution through cluster analysis shows three variant groupings: the control, with the lowest yield (2415 kg/ha), a group of three variants (PK_0N_{100}, Biocomplex 900 and Megafol) with yields between 3000 and 4000 kg/ha and a group that includes five variants with yields bigger than 4000 kg/ha (variant Fertitel with 4566 kg yield on a separate position within the group and variants PK_0N_{200}, PK_{50} N_{200}, $PK_{100}N_{200}$, $PK_{150}N_{200}$ with yields bigger than 5000 kg/ha), Figure 2.

This analysis and grouping of variants is helpful in assessing the technical efficiency of fertilization and the way in which the fertilizers are used by the plants in the experimenting period, under specific conditions of soil and climate.

In addition, multiple correlation analysis of the variables, through geometric spatial representation, reveals that yield and protein are associated and correlated with large doses of fertilizers, while fat content is associated and correlated with small fertilizer doses. Starch is positioned in the middle, as shown in Figure 3.

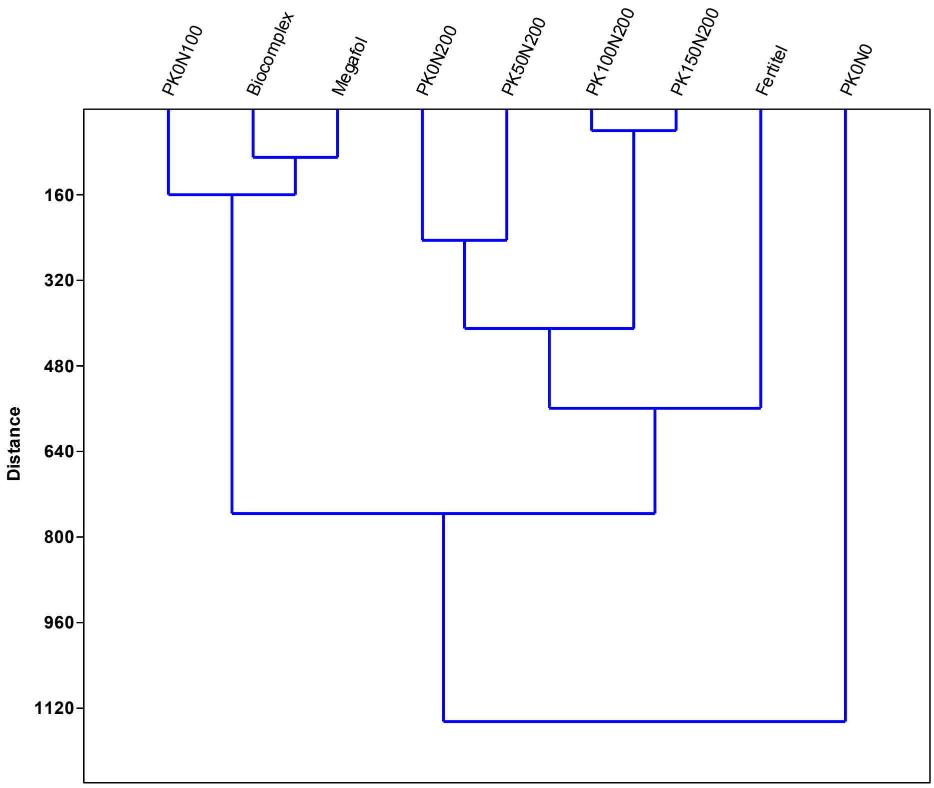

Fig. 2. Grouping of variants based on Euclidean distance, (cluster analysis).

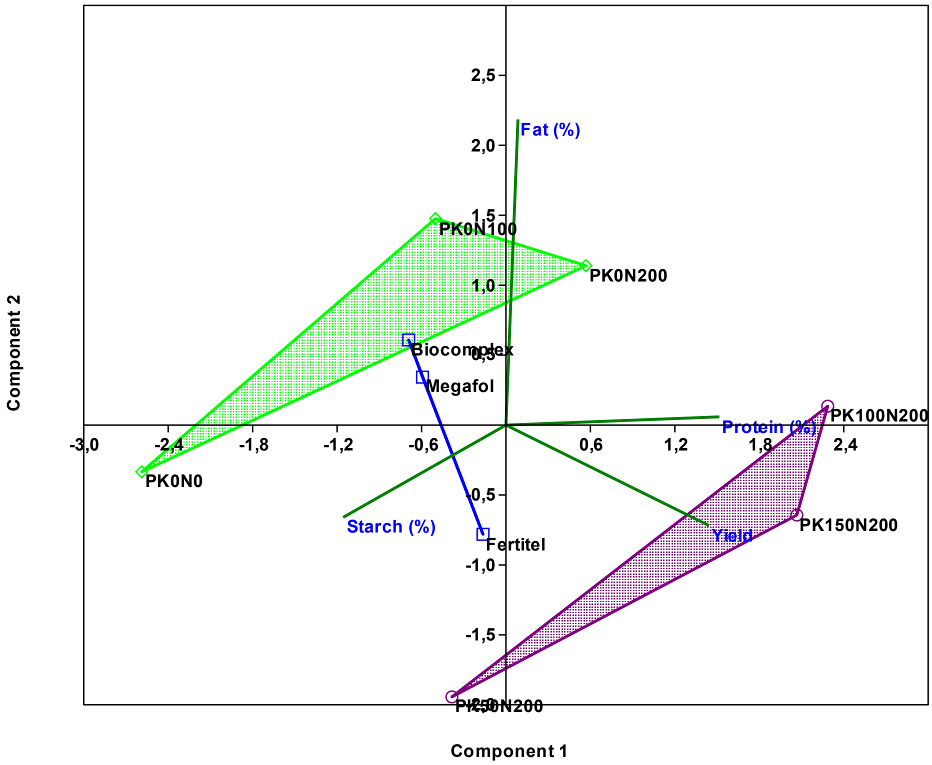

Fig. 3. Spatial disposition of the variables based on multiple correlations.

CONCLUSIONS

Supporting productivity of the grain maize crop by mineral fertilization applied on soil and on leaves resulted in yields between 3560 and 5820 kg/ha; by comparison, natural soil fertility gave a yield of 2415 kg/ha.

The yield increases generated by simple nitrogen fertilizers ranged from 1145 kg/ha to 2910 kg/ha and the PK complex determined increases between 45 kg/ha and 495 kg/ha.

It is worth noting that the great water deficit between July and September diminished the effect of fertilizers applied on the soil.

Leaf fertilization, applied on the background of natural soil fertility (i.e. in the absence of soil fertilizers), led to a yield which was similar to the one obtained when applying 100 to 150 kg N active substance, but with significantly smaller costs.

Multivariate analysis and Euclidean distribution reveal three groupings of variants, depending on the yield level, which makes it easier to choose the appropriate fertilization system in accordance with the objective pursued.

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