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THE EFFECT OF NITROGEN FERTILIZATION ON YIELD OF MAIZE

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Abstract

During two-year period (2005 and 2007), the effects of different nitrogen rates (PKN_{30}, PKN_{60}, PKN_{120} and PKN_{180}) on the grain yield maize of different FAO maturity groups (ZP 434, ZP 578 and ZP 677) was examined. The research ws carried out by field micro experiments in agroecological conditions of the central Sumadija (Raca Kragujevacka) on eutric cambisol. Experiments were conducted using split plot design wih four repetition .

The results show significant differences in grain yield of maize between the examined nitrogen rates and hybrids in the years of research. In the year with favorable weather conditions (2005) during the vegetative period, the increased nitrogen nutrition had a stronger effect on grain yield, compared to 2007, when there were adverse weather conditions.

Keywords: *nitrogen, hybrid, maize, grain yield.*

Introduction

In Serbia, maize is a major crop, necessary for domestic use and a strategic export product as well. It is grown on an area of 1.17 to 1.27 million hectares; with a total annual production varying from 3.9 (in 2007) to 7.2 (in 2010) million tones and an average grain yield from 3.25 to 5.89 t ha^{-1} (*Republic Institute for Statistics, Republic of Serbia*, 2011). Considering maize production in Serbia is very important, special attention should be paid to its further development.

Improvement of maize production involves problem solving, especially in the field of cropping practices. In this context, nitrogen nutrition and hybrid selection have an important place. Due to rising prices and current costs of applying nitrogen fertilizers, the fertilizing system should be revised, in particular the amount of active ingredient per hectare. Moreover, the importance of this issue should be also taken into consideration from the aspect of environmental control.

On the other hand, nitrogen nutrition and hybrid selection must be examined and studied according to climatic conditions of a region (thermal conditions, precipitation amount, and distribution), soil type, etc. Regardless of regional character of such studies, they are fully justified even though there is a lot of information related to this issue (*Binder et al.,* 2000; *Blažić,* 2006; *Dinnes et al.,* 2002; *Hojka,* 2004; *Latković,* 2010; *Matei et al.,* 2009; *Živanović et al.,* 2007).

The objective of this study was to determine an optimal nitrogen rate for the examined hybrids, choosing the top-yielding ones for the agro ecological conditions of central Šumadija and eutric cambisol.

Materials and methods

The research of the effect of nitrogen rates on the grain yield of maize hybrids with different length of vegetation period was carried out in the vicinity of Rača Kragujevačka (village of Miraševac) in 2005 and 2007. The experiments were carried out on eutric cambisol, characterized by the following important chemical properties: pH (KCl) - 5.58; humus content - 2.73%, total nitrogen content - 0.16%; P_20_5 - 4.30 mg per 100 g of soil and K_2O - 18.90 mg per 100 g soil. pH was determined by a pHmeter with a glass electrode, humus content by the Kotzman method, total nitrogen content by the Kjeldahl method while the content of P_20_5 and K_2O were determined by the AL method (Egner-Rhiem). The field micro trial was set up using a split-plot design with four repetitions. The main plot and a subplot surface were 201.6 m^2 and 16.8 m^2 (6.0 m x 2.8 m), respectively. The surface of the plot for billing grain yield was 8.4 m^2.

Two important elements for maize production were studied in this research, in the following variants:

1. Nitrogen rates (A): $P_{90}K_{60}N_{30}$ kg ha^{-1} (phon); $P_{90}K_{60}N_{60}$ kg ha^{-1}; $P_{90}K_{60}N_{120}$ kg ha^{-1}; $P_{90}K_{60}N_{180}$ kg ha^{-1};
2. Hybrids (B): ZPSC 434 (FAO 400), ZPSC 578 (FAO 500) and ZPSC 677 (FAO 600)

Standard cropping practices were applied. The harvest was carried out manually in the late September or early October depending on the year. Water content of maize hybrids had been determined by drying in an oven at 105^0C before the yield of dry grains (with 14% water) per hectare was calculated. The data were analyzed and tested using the analysis of variance and the LSD test.

Meteorological conditions

Table 1. Average monthly temperatures and precipitation for maize in the 2005 and 2007 growing seasons (Raca, Mirasevic)

Meteorological factor	Year	Month						Average
		IV	V	VI	VII	VIII	IX	
Temperature (^{0}C)	2005	12,1	16,5	19,1	22,0	20,5	18,1	18,1
	2007	12,8	18,3	22,5	24,1	23,4	16,3	19,6
Precipitation (mm)	2005	69,0	71,0	52,0	86,0	118,0	112,0	508,0
	2007	3,0	119,0	26,0	11,0	83,0	52,0	294,0

Monthly air temperatures and precipitation for the 2005 and 2007 growing seasons are presented in Table 1. The weather conditions for maize production in these two years were very different. The average temperature in 2007 was higher by 1.5^0 C and the amount of precipitation lower by 214.0 mm compared to the 2005 growing season. This difference was most pronounced in the summer months (June, July, August) when maize reacts strongly on adverse environmental conditions.

Results and discussion

This paper studies the effect of nitrogen rates on the grain yield of maize hybrids with different length of vegetation period. Table 2 shows that the average yield of dry maize grain (with 14% water) achieved over the two-year research was 9.2 t ha^{-1}. Weather conditions during the years of the research strongly affected the grain yields. Compared to 2005, when there were optimal conditions for maize growth and development, in 2007 the grain yield was lower by 41.6% due to dry weather.

Table 2. Effect of nitrogen fertilization on the grain yield of maize hybrids (t ha^{-1})

Nitrogen fertilization (A)	Hybrid (B)	Year		Average	Index (%)
		2005.	2007.		
PKN_{fon}	ZP 434	9,68	6,38	8,03	100,0
	ZP 578	10,73	6,57	8,65	107,7
	ZP 677	10,32	6,79	8,56	106,6
	Prosek	10,24	6,58	8,41	100,0
PKN_{60}	ZP 434	10,78	6,88	8,83	100,0
	ZP 578	11,14	6,99	9,07	102,7
	ZP 677	11,83	7,22	9,53	107,9
	Prosek	11,25	7,03	9,14	108,7
PKN_{120}	ZP 434	12,06	6,57	9,32	100,0
	ZP 578	12,36	6,88	9,62	103,2
	ZP 677	13,08	7,35	10,22	109,7
	Prosek	12,50	6,93	9,72	115,6
PKN_{180}	ZP 434	12,45	6,15	9,30	100,0
	ZP 578	12,60	6,59	9,60	103,2
	ZP 677	12,62	7,20	9,91	106,6
	Prosek	12,56	6,65	9,60	114,1
Prosek hibrida	ZP 434	11,24	6,50	8,87	100,0
	ZP 578	11,71	6,76	9,24	104,2
	ZP 677	11,96	7,14	9,55	107,7
The total average		11,64	6,80	9,22	-
Index (%)		100,0	58,4	-	-

LSD	2005. godina				2007. godina			
	A	B	B x A	A x B	A	B	B x A	A x B
0,05	0,52	0,44	0,87	0,88	0,61	0,33	0,66	0,81
0,01	0,74	0,59	1,18	1,21	0,88	0,45	0,90	1,14

The biennial average with increasing of nitrogen rates up to 120 kg ha^{-1} shows that grain yield first increased, and then decreased. On average, this increase for the hybrids and years varied from 8.7% (N_{60}) to 15.6% (N_{120}). Thereby, these results confirm some previous research (*Blagojević and Vesković*, 1985; *Videnović et al*., 2007), which showed that it was the nitrogen rate of 120 kg ha^{-1} that had the biggest effect on the grain yield of maize on eutric cambisol in Šumadija (*Blagojević*, 1985). When it comes to the nitrogen rates and years, on average, the highest grain yield (9.55 t ha^{-1}) was determined for ZP 677 hybrid. Then comes ZP 578 hybrid (9.24 t ha^{-1}), while the lowest grain yield (8.87 t ha^{-1}) had ZP 434 hybrid. As for the years, the effect of nitrogen fertilization on grain yield had a different character and intensity.

Grain yield in the 2005 growing season: The average yield in this year was 11.64 t ha^{-1}. The lowest yield was achieved by the phon ($P_{90}K_{60}N_{30}$) and amounted to 10.24 t ha^{-1}. With increasing of nitrogen rates from 60, and 120 to 180 kg ha^{-1}, grain yield also increased by 1.01, 2.26, and 2.32 t ha$^{-1.}$ All the differences in grain yield using different nitrogen rates are statistically highly significant, except for the differences occurred with using 120 and 180 kg N ha^{-1}. Lengthening of vegetation period of the examined hybrids led to higher yields. The highest grain yield was achieved by ZP 677 hybrid (11.96 t ha^{-1}), lower yield by ZP 578 (11.71 t ha^{-1}), and the lowest by ZP 434 hybrid (11.24 t ha^{-1}). All the differences in grain yields of maize hybrids were statistically significant and highly significant, except for the differences between the grain yields of ZP 578 and ZP 677 hybrids.

Grain yield in the 2007 growing season: The average yield in this year was 6.80 t ha^{-1}. The lowest grain yield (6.58 t ha^{-1}) was achieved by the phon, and the highest (7.03 t ha^{-1}) by the variant with 60 kg N ha$^{-1.}$ The differences in grain yields achieved by using different nitrogen rates are not statistically significant. The grain yield of ZP 677 hybrid was

statistically significant and highly significant compared to the yield of ZP 578 and ZP 443 hybrids. Between ZP 578 and ZP 434, there were no statistically significant differences in grain yields. A x B and B x A interactions had no statistically significant effect on grain yield of maize in this year of research.

Conclusion

Based on the results of the two-year research on the effect of nitrogen rates on the grain yield of maize hybrids of different FAO maturity groups from central Sumadija, it can be concluded that:

- Grain yield mostly depended on weather conditions during the vegetation period. Compared to the 2005 growing season that had favorable weather conditions, grain yield in the 2007 growing season was lower by 41.6% due to dry weather.
  When it comes to the hybrids and years, on average, the increased nitrogen rates of 60 and 120 kg ha^{-1} resulted in an increase in grain yield by 8.7 to 15.6% compared to the phon ($P_{90}K_{60}N_{30}$) variant.
- As for the nitrogen rates and years, on average, the hybrids with longer vegetation period (ZP 578 and ZP 677) had higher grain yields by 4.2 and 7.7% compared to the early vegetation hybrid (ZP 434).

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