

YIELDING OF TWO TYPES OF MAIZE CULTIVARS GROWN ON CCM IN CONDITIONS OF ZERO NITROGEN FERTILIZATION

Summary

Field studies were carried out in the Didactic and Experimental Farm in Swadzim near Poznań in the years 2004-2007. The objective of the studies was the investigation of the reaction of two types of maize cultivars to zero mineral fertilization and in consequence to the energetic value of the maize raw material grown on CCM in comparison with mineral fertilization. In the experimental studies, a more useful hybrid for the application in ecological agriculture has shown to be the cultivar LG 2244 „stay-green” type in comparison with the hybrid Anjou 258. The LG 2244 cultivar possessed a more favorable content of organic compounds in the cobs and a higher concentration of net energy. Furthermore, in LG 2244, the differences between the two applied fertilization variants were smaller than in Anjou 258 which was more sensitive to nitrogen fertilization.

PLONOWANIE DWÓCH TYPÓW ODMIAN KUKURYDZY UPRAWIANEJ NA CCM W WARUNKACH ZEROWEGO NAWOŻENIA AZOTEM

Streszczenie

Badania polowe wykonano w Zakładzie Dydaktyczno-Doświadczalnym w Swadzimiu, koło Poznania w latach 2004-2007. Celem badań było poznanie reakcji dwóch typów odmian kukurydzy na zerowe nawożenie mineralne, a w konsekwencji na wartość energetyczną surowca kukurydzy uprawianej na CCM, w stosunku do nawożenia mineralnego. Bardziej przydatnym mieszańcem do zastosowania w rolnictwie ekologicznym w przeprowadzonych badaniach była odmiana LG 2244 „typ stay-green” w stosunku do Anjou 258. Mieszańiec ten posiadał korzystniejszą zawartość związków organicznych w kolbie, oraz większą koncentrację energii netto. Ponadto w przypadku tego mieszańca różnice w/w cechach pomiędzy dwoma wariantami nawożenia były mniejsze, niż przy uprawie odmiany Anjou 258, bardziej reagującej na nawożenie azotowe.

1. Introduction

During the past several years, an increasing interest of Polish farmers has been observed in the ecological forms of agriculture. The specificity of the ecological cultivation of plants (no pesticides and no fertilizers) consists in the fact that the selection of the adequate cultivar for growing may have a deciding importance for the quantity and quality of the obtained product [10]. It is assumed that cultivars designed for ecological agriculture should be more resistant to pathogens, they should be characterized by quicker initial growth and they should possess a better ability to uptake nutritive components from the soil [2]. The above presented problem is not a new one, but it is continuously actual because both in Polish and in foreign literature, there are still only few reports dealing with it.

Therefore, the presented studies have been undertaken to investigate the reaction of two types of maize cultivars to a zero mineral fertilization and in consequence to the energetic value of maize raw material grown on CCM as compared with the mineral fertilization recommended by IUNG [4] in Puławy as the best one for this species.

2. Methodics

Field studies were carried out in the Didactic and Experimental Farm in Swadzim near Poznań in the years 2004-2007. Results obtained in the year 2006 were disqualified because of a dominating drought. The experiment

was established as a 2-factorial one. The first degree factor included two cultivars: Anjou 258 and LG 2244 „stay-green” type. The second degree factor included two variants of nitrogen fertilization: 0 kg N ha⁻¹ and 120 kg N ha⁻¹. Maize was grown in the second year after manure.

Analyses of organic component content in maize cobs were carried out in the Department of Soil and Plant Cultivation, University of Natural Sciences in Poznań, according to the following methods: total protein was determined by the examination of nitrogen content in a sample using Kjeldahl's method and the result was multiplied by coefficient 6.25; fat was studied by Soxhlet's method; crude fibre was identified by the hydrolysis of the remaining components contained in the cob; ash was determined by dry combustion method; while nitrogen-free extracts were calculated by extraction of the remaining contents from the total 100% sum.

Evaluation of the energetic value of cobs was done by Kellner's method by calculating oat units which were converted into net energy accepting that one oat unit = 7.6 MJ of net energy for pigs [3]. This permitted to determine the net energy concentration, the energy yield and the yield of digestible protein. On the other hand, the yield of protein was calculated by the multiplication of the proportional content of protein in the cobs by their yield.

The experiment was carried out on grey-brown soil of light loamy sands shallowly lying on light loam belonging to a good rye complex. Nutrient resources of soil and its acidity are shown in table 1.

Thermal and moisture conditions during vegetation in the experimental years were favourable for the growth and development of maize, Rainfall sum in the period Apr.-Sept. was 301.0 mm in 2004, 305.4 mm in 2005, and 332.9 mm in 2007. Taking into consideration in a complex way both the air temperature and the atmospheric precipitations,

one can state that the hydrothermal coefficients in the experimental years (the sum of rainfalls and their distribution) were favourable for the growth and development of maize. Insignificant moisture deficits in the soil were found in the period of maize sowing (April 2004, Apr. 2005 and Apr. 2007) and in June 2005 (table 2).

Table 1. Soil condition at Swadzim

Specification	Years		
	2004	2005	2007
N-NH ₄ [mg 100 g ⁻¹ dry mass of soil]	0.13	0.12	0.14
N-NO ₃ [mg 100 g ⁻¹ dry mass of soil]	0.45	0.31	0.32
P [mg P ₂ O ₅ · 100 g ⁻¹ of soil]	12.5	16.4	19.0
P [mg P · 100 g ⁻¹ of soil]	5.5	7.2	8.3
K [mg K ₂ O · 100 g ⁻¹ of soil]	14.6	20.7	20.5
K [mg K · 100 g ⁻¹ of soil]	12.1	17.2	17.1
Mg [mg Mg · 100 g ⁻¹ of soil]	9.5	5.6	7.3
pH [in 1n KCl]	5.87	5.55	6.22

Table 2. Weather condition at Swadzim

Years	IV	V	VI	VII	VIII	IX	X	IV-IX
Temperature in °C								
2004	9.7	12.9	16.1	18.2	20.1	14.2	10.4	14.5
2005	9.4	13.3	16.5	19.9	17.3	16.0	10.5	14.7
2007	10.8	15.2	19.3	18.9	19.2	13.7	8.5	15.1
Rainfall in mm								
2004	19.4	49.8	51.3	49.4	53.6	32.3	45.2	301.0
2005	14.5	74.3	19.1	97.4	60.7	34.4	5.0	305.4
2007	9.3	77.0	59.6	87.0	48.1	33.4	18.5	332.9
The hydrothermal coefficient of protection in water according to Sielianinow ¹⁾								
2004	0.66	1.24	1.06	0.87	0.86	0.76	1.40	0.97
2005	0.49	1.80	0.48	1.57	1.13	0.71	0.15	0.89
2007	0.28	1.63	1.02	1.48	0.81	0.81	0.70	0.96

1. according to Molga (1986)

Interpretation of hydrothermal coefficient

0,00-0,50 –drought,

0,51-1,00 –halfdrought (moisture for plants majority insufficient),

1,01-2,00) – relative moisture (moisture for plants majority sufficient),

> 2,01– large moisture (moisture for plants majority excessive).

Table 3. Content of nutritional components in ears (2004-2007)

Specification		In dry mass in %				
		Total protein	Crude fibre	Ash	Crude fat	N-free extract
Cultivars	Anjou 258	8.79	7.33	1.39	3.78	78.69
	LG 2244	8.85	6.86	1.39	4.68	78.19
	LSD _{0.05}	n.s.	0.311	n.s.	0.603	n.s.
Dose of N in kg ha ⁻¹	0	8.27	7.04	1.51	3.91	79.25
	120	9.38	7.16	1.27	4.55	77.63
	LSD _{0.05}	1.512	0.018	0.058	0.139	1.498

n.s. – non significant differences

Table 4. Net energy concentration, net energy yield, protein yield and digestible protein yield in ears (2004-2007)

Specification		Net energy concentration	Net energy yield	Digestible Protein yield	Protein yield
		MJ kg ⁻¹ sm – dm	GJ ha ⁻¹	dt ha ⁻¹	dt ha ⁻¹
Variety	Anjou 258	9.65	106.20	7.30	961.55
	LG 2244	9.85	101.61	6.98	919.65
	LSD _{0.05}	0.007	n.s.	n.s.	n.s.
Dose N in kg ha ⁻¹	0	9.79	98.23	6.28	826.41
	120	9.81	109.58	8.01	1054.79
	LSD _{0.05}	n.s.	n.s.	1.151	56.125

n.s. – non significant differences.

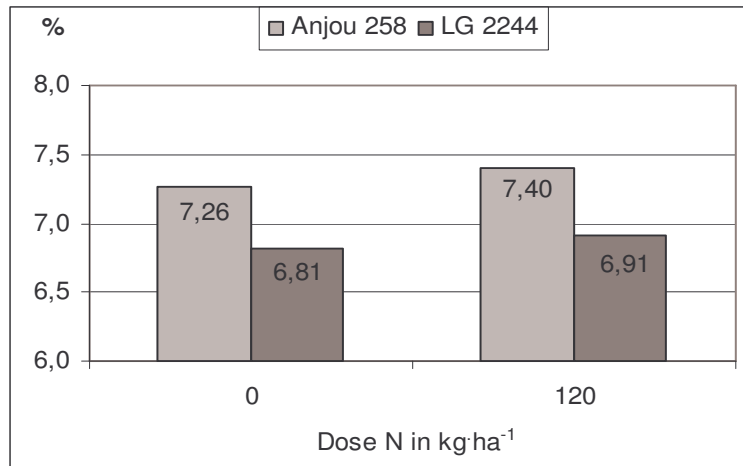


Fig. 1. Content of crude fibre in maize cob depending on the cultivar type and on the quantity of nitrogen fertilization (2004-2007)

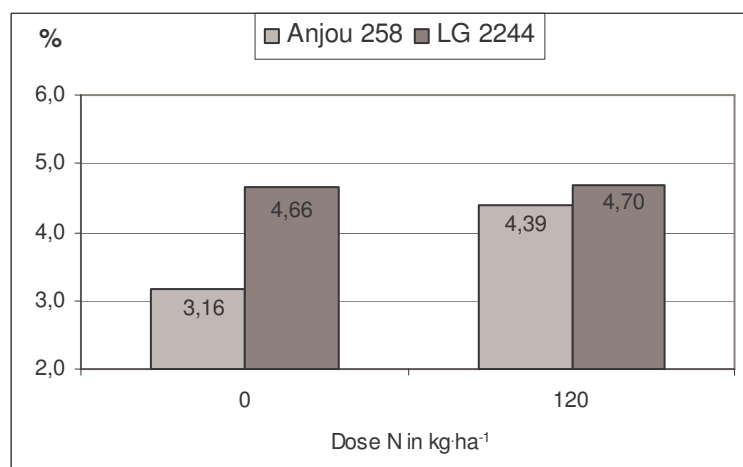


Fig. 2. Content of crude fat in maize cob depending on the cultivar type and on the quantity of nitrogen fertilization (2004-2007)

3. Results and discussion

On the average, in the period of 3 years of studies, no effect was found to be exerted by the cultivar type on the content of total protein, ash and nitrogen-free extracts in maize cobs (table 3). Cultivar type determined only the percentage of crude fibre and crude fat content in the cob dry matter (table 3). A smaller content of crude fibre by 0.47 point % and a greater content of crude fat by 0.9 point % was found in the cobs of the LG 2244 „stay-green” type, as compared with the hybrid Anjou 258. Borowiecki [1], Machul and Borowiecki [6] and Michalski [7] also indicated the existence of differences in the chemical composition in the cobs of maize cultivars.

Nitrogen fertilization level modified in a significant way the proportional content in the cob dry matter of total protein, crude fibre, ash, crude fat and nitrogenfree extracts (table 3). The application of 120 kg N ha⁻¹ caused an increase in the cob dry matter of total protein by 1.11 point %, crude fibre by 0.12 point %, crude fat by 0.64 point %, nitrogenfree extracts by 1.62 point %. On the other hand, it reduced ash by 0.24 point %, in comparison with the objects where no nitrogen fertilization was applied.

In case of the content of crude fibre and crude fat in the cob, it was shown that there took place an interrelation of

cultivar type and nitrogen fertilization level (fig. 1 and fig. 2). The application of 120 kg N ha⁻¹ caused a significant increase of crude fibre content and crude fat content in the cobs of the two maize types in comparison with the object of 0 kg N ha⁻¹. However, independent of the nitrogen fertilization level, the hybrid Anjou 258 had a higher content of crude fibre and a lower content of crude fat in the cobs, as compared with the cultivar LG 2244 „stay-green” type (fig. 1 and fig. 2).

The energetic value of maize cobs expressed by the yield of net energy depended in a significant way on the requested experimental factors (table 4). The net energy concentration depended exclusively on the cultivar type (table 4). A higher value of this feature was reached by the cultivar LG 2244 „stay-green” type, in comparison with the hybrid Anjou 258. This difference amounted to 0.2 MJ kg⁻¹. On the average, in the period of 3 years of studies, the yield of digestible protein and the yield of protein depended only on the nitrogen fertilization level (table 4). Maize grown on CCM and fertilized with nitrogen in the dose of 120 kg N ha⁻¹ brought a yield increase of digestible protein by 1.73 dt ha⁻¹ and protein increase by 228.38 dt ha⁻¹ in comparison with the object without N fertilization (0 kg N ha⁻¹) – table 4. Fertilization with nitrogen constitutes a differentiating factor in maize cobs, In our studies, with the increase of

N fertilization level, there increased the protein content in cobs. Similar results were obtained among others by Kruczek [5] and by Perry and Olson [9].

4. Conclusions

1. A more favourable chemical composition of the cultivar LG 2244 „stay-green” type in comparison with the hybrid Anjou 258 has decided that this cultivar is more suitable for growing on CCM.
2. Application of 120 kg N \cdot ha⁻¹ increased the content of total protein, crude fibre, crude fat, nitrogen-free extracts and it decreased the content of ash in the dry matter of cobs, as compared with objects with zero nitrogen fertilization.
3. The highest yield of digestible protein and protein was obtained with the dose of 120 kg N \cdot ha⁻¹, as compared with the dose of 0 kg N \cdot ha⁻¹.
4. In case of the hybrid of „stay-green” type, the differences in the content of nutritive components in maize cob evoked by two variants of nitrogen fertilization were smaller than in the growing of Anjou 258 cultivar which is more sensitive to nitrogen fertilization.

The cultivar of „stay-green” type is a hybrid more suitable for application in ecological agriculture.

5. References

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