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Examination of the Water and Nutrient Utilization of Maize Hybrids on Chernozem Soil

L. G. Karancsi

Abstract**—**The research was set up on chernozem soil at the Látókép AGTC MÉK research area of the University of Debrecen in Hungary. We examined the yield, the yield production per 1kg NPK fertilizer and the water and nutrient utilization of hybrid PR37N01 and PR37M81 in 2013. We found that PR37N01 produced the most yield at the level of N_{120}+P (17,476kg ha^{-1}) while PR37M81 reached the highest yield at level N_{150}+PK (16,754kg ha^{-1}). Studies related to yield production per 1kg NPK indicated that the best results were achieved at level N_{30}+PK compared to the control treatment. Yield production per 1kg NPK was17.6kg kg^{-1} by P37N01 and 44.2kg kg^{-1} by PR37M81. By comparing the water utilization of hybrids we found that the worst water utilization results were reached in the control treatment (PR37N01: 26.2kg mm^{-1}, PR37M81: 19.5kg mm^{-1}). The best water utilization values were produced at level N_{120}+PK in the case of hybrid PR37N01 (32.1kg mm^{-1}) and at N_{150}+PK in the case of hybrid PR37M81 (30.8kg mm^{-1}). We established the values of the nutrient reaction and the fertilizer optimum of hybrids. We discovered a strong relationship between the amount of fertilizer applied and the yield produced (r^2= 0.8228–0.9515). The best nutrient response was induced by hybrid PR37N01, while the weakest results were reached by hybrid PR37M81.

Keywords**—**Hybrid, maize, nutrient, yield, water utilization.

I. Introduction

MAIZE occupies the largest area of cultivation in Hungary which varies between 1.1 and 1.2 million hectares [1]. One of the most important yet most difficult tasks in plant production is to determine optimum fertilizer doses as several other factors have to be taken into account, such as the hybrid's fertilizer utilization, its fertilizer response and the effect of the growing year [2]. Various weather conditions pose great risk to production. Low yields do not always result from lack of rain. High yields are produced along favorable conditions of precipitation [3]. According to [4], it is basically water supply that determines the yield increasing effect of fertilizers. Nitrogen uptake of corn during the vegetation period is usually altered by irrigation and the crop year [5]. The amount of nutrients needed has to be determined based on the estimated yield and nutrient supply of the soil [6]. As stated by [7], when considering the development of cultivated plants and its water supply, it was rather the amount of rainfall than its distribution that matters. According to [8] the relationship between the year, fertilization and yield of maize hybrids is strong. While in drought years fertilization did not have a yield enhancing effect, it increased it by 40% to 50% in optimal years. Reference [9] verified that yield enhancing effects of a permanent and one-sided fertilization process showed up in a decreasing degree due to the relative lack of phosphorus and potassium. The effectiveness of fertilization declined over time. Unbalanced fertilization methods not only failed to increase yield but also generated significant soil acidity. The application of the fertilizers of their own or combined along with PK resulted in more increased yield production [10].

L. G. Karancsi is with Institute of Crop Science, Faculty of Agricultural and Food Sciences and Environmental Management, Centre for Agricultural and Applied Economic Sciences, University of Debrecen, H-4032 Hungary (e-mail: karancsi@agr.unideb.hu).

II. Materials and Methods

The research was set up on chernozem soil with lime patches at the Látókép AGTC KIT research area of the University of Debrecen. The research area is located in Eastern-Hungary on the area of the aeolain loess of the Hajdúság. Tilth of the research area is around 80 to 90 cm, is of good agricultural condition, medium hard and loamy with medium humus content. Features of water supply of the soil are favorable. The long-time experiment was set up in 1983. We examined Pioneer maize hybrids (PR37N01 and PR37M81), as a small parcel research in four repetitions. Our pre-crop was winter wheat. The fertilization covered six levels of treatments shown in Table II. 50% of the nitrogen and 100% of phosphorus and potassium were applied in the autumn in the complex form of Kemira Optima 10:15:18. The residual 50% of nitrogen was applied during the spring in the form of a 34% ammonium nitrate on each parcel.

By comparing rainfall data, we established that the amount of rainfall in the first half of 2012 (332.7mm) exceeded the 30-year average of that of the same period (220.2mm). Rainfall levels in April 2012 (48.0mm) and May (68.7mm) were also lower than the long term average (42.4mm and 58.8mm). Precipitation values in June (30.8mm), July (15.6mm) and August (32.2 mm) was lower than that of the 30-year average (June: 79.5mm, July: 65.7mm, August: 60.7mm). After comparing temperature data, we found that average temperature in the first half of 2012 (21.3°C) exceeded the 30-year average (17.2°C). Temperature measured in April (12.0°C), May (16.6°C), and July 2013 (21.2°C) was also higher compared to the long term average (Table III).

TABLE I
EXPERIMENTAL SOIL DATA

Soil layes (cm)	pH value	Soil physical structure	$CaCO_3$ %	Humus content %	Total N %	NO_3+NO_2 ppm	P_2O_5 ppm	K_2O ppm
							AL soluble	
0-25	6.46	43.0	0.0	2.76	0.150	6.20	133.4	239.8
25-50	6.36	44.6	0.0	2.16	0.120	1.74	48.0	173.6
50-75	6.58	47.6	0.0	1.52	0.086	0.60	40.4	123.0
75-100	7.27	46.6	10.2	0.90	0.083	1.92	39.8	93.6
100-130	7.36	45.4	12.7	0.59	0.078	1.78	31.6	78.0

TABLE II
APPLIED FERTILIZER DOSES (DEBRECEN, 2013)

Treatment	N	P_2O_5	K_2O
	kg ha^{-1}		
Control	0.0	0.0	0.0
1	30.0	22.5	26.5
2	60.0	45.0	53.0
3	90.0	67.5	79.5
4	120.0	90.0	106.0
5	150.0	112.5	132.5

TABLE III
SOME IMPORTANT METEOROLOGICAL DATA (DEBRECEN, 2013)

	Precipitation (mm)		Temperature (ºC)	
	2012-2013	30 year's average	2012-2013	30 year's average
October - March	332,7	220,2	3,6	2,9
April	48,0	42,4	12,0	10,7
May	68,7	58,8	16,6	15,8
June	30,8	79,5	19,6	18,7
July	15,6	65,7	21,2	20,3
August	32,2	60,7	21,5	19,6
September	47,6	38,0	14,0	15,8
Total	575,6	565,3	15,5	14,8

III. RESULTS AND DISCUSSION

Yield results indicated that the non-fertilized stocks produced the lowest yields in the case of both hybrids (PR37N01: 14,250kg ha^{-1}, PR37M81: 10,630kg ha^{-1}). By increasing the fertilizer doses, we experienced yield growth up to level N_{120}+PK for hybrid PR37N01 and up to level N_{150}+PK for PR37M81. Hybrid PR37N01 produced the highest yield at level N_{120}+PK (17,476kg ha^{-1}) while PR37M81 reached its maximum at level N_{150}+PK (16,754kg ha^{-1}). The application of maximum fertilizer doses resulted in yield decrease in the case of hybrid PR37N01 (17,127kg ha^{-1}) compared to the results measured at level N_{120}+PK (17,476kg ha^{-1}). We experienced significant differences between the yields measured in the control treatment and at level N_{30}+PK, N_{60}+PK, N_{90}+PK and N_{120}+PK. In the case of hybrid PR37N01, we noticed significant differences between the control level and all the other levels, between level N_{30}+PK and N_{120}+PK, N_{150}+PK and between level N_{60}+PK and N_{120}+PK, N_{150}+PK. As for PR37M81, we experienced significant differences between the non-fertilized stock and all the other fertilizer levels, and between the levels of N_{150}+PK and N_{30}+PK, N_{60}+PK, N_{90}+PK and N_{120}+PK (Fig. 1).

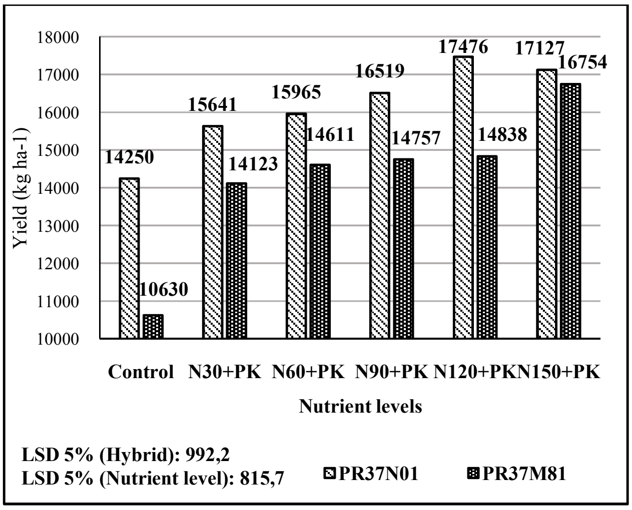

Fig. 1 The average yield of the hybrids on the different nutrient levels (Debrecen, 2013)

We also determined the yield production per 1kg NPK. We found that the highest yield increase was measured at level N_{30}+PK compared to the control treatment. This increase was 17.6kg kg^{-1} in the case of PR37N01 and 44.2kg kg^{-1} in the case of PR37M81. We experienced yield decrease at level N_{150}+PK for hybrid PR37N01(4.4kg kg^{-1}) while hybrid PR37M81 produced an increased yield at the same level compared to the results measured at level N_{120}+PK (24.3kg kg^{-1}) (Fig. 2).

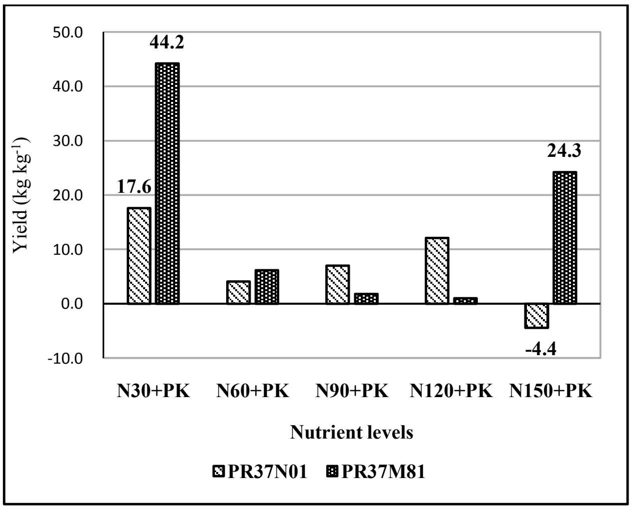

Fig. 2 Development of the yield growth per each kg applied NPK fertilizer active substance (Debrecen, 2013)

We calculated the water utilization of hybrids. We came to the conclusion that the worst results were recorded in the control treatment for both hybrids (PR37N01: 26.2kg mm^{-1} and PR37M81: 19.5kg mm^{-1}). There was a slight improvement due to fertilization, i.e. increased yield per unit value of precipitation. PR37N01 achieved the best results at level N_{120}+PK (32.1kg mm^{-1}) while PR37M81 reached the best values at level N_{150}+PK (30.8kg mm^{-1}). The water utilization of hybrid PR37N01 passed that of hybrid PR37M81 at all nutrient levels (Fig. 3).

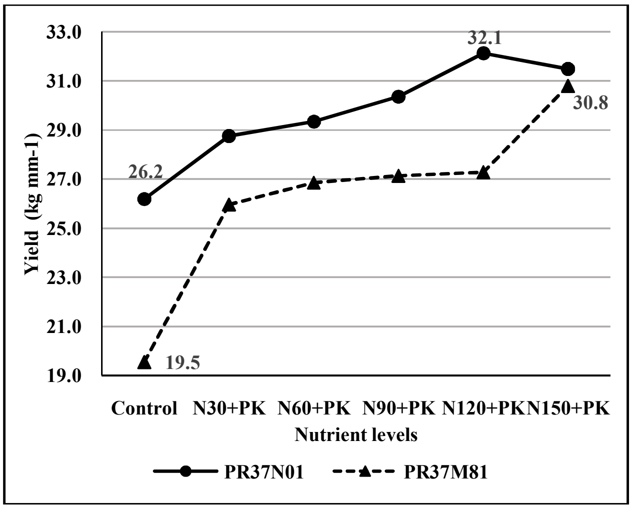

Fig. 3 The water utilization of the different genotype maize hybrids on the different nutrient-levels (Debrecen, 2013)

Fig. 4 represents the nutrient utilization ability and fertilizer optimum of hybrids. We used regression analysis and parabolic curve fitting to calculate the optimum fertilizer doses of the corn hybrids examined. We found that there was a significant relationship between the amount of fertilizer applied and the yield produced (0.8228–0.9515). The best results regarding nutrient response were achieved by hybrid PR37N01 while PR37M81 turned out to be the weakest one. Both hybrids were accompanied by high fertilizer doses (PR37N01: 150kg N+PK, PR37M81: 150kg N+PK).

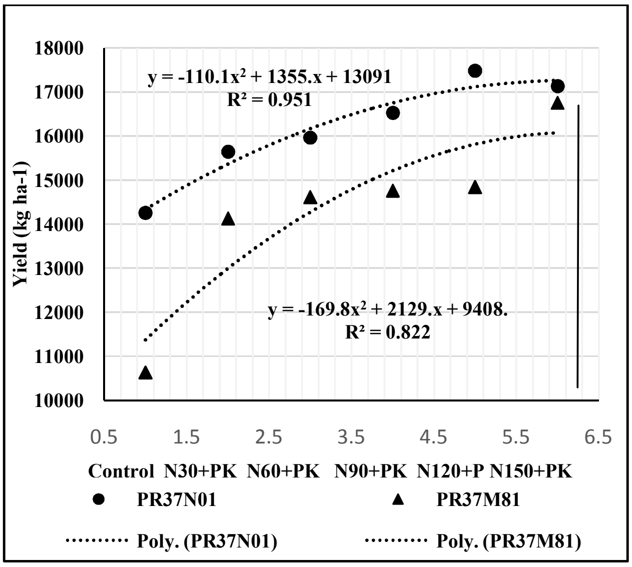

Fig. 4 Nutrient response of maize hybrids with regression analysis (Debrecen, 2013)

IV. Conclusion

The research was set up on chernozem soil at the Látókép AGTC MÉK research area of the University of Debrecen in Hungary. We examined the yield production, the yield production per 1kg NPK fertilizer and the water and nutrient utilization of hybrid PR37N01 and PR37M81 in 2013. After examining the yield we found that yield production of hybrid PR37N01 varied between 14,250kg ha^{-1}–17,476kg ha^{-1} while that of hybrid PR37M81 was between 10,630kg ha^{-1} and 16,754kg ha^{-1} at different nutrient levels. The highest yield results were achieved by PR37N01 at level N_{120}+PK (17,476kg ha^{-1}) and at level N_{150}+PK in the case of hybrid PR37M81 (16,754kg ha^{-1}). We examined the amount of yield per 1 kg NPK and concluded that the highest yield increase was achieved at level N_{30}+PK compared to the control treatment in the case of both corn hybrids. Yield achieved per 1kg NPK was 17.6kg kg^{-1} in the case of PR37N01 and 44.2kg kg^{-1} in the case of PR37M81. Comparing the water utilization results of corn hybrids showed that the lowest values were measured in the control stocks in the case of both hybrids (PR37N01: 26.2kg mm^{-1}, PR37M81: 19.5kg mm^{-1}). The best water utilization results were measured at level N_{120}+PK for hybrid PR37N01 (32.1kg mm^{-1}) and at level N_{150}+PK in the case of hybrid PR37M81 (30.8kg mm^{-1}). We determined the nutrient response and the fertilizer optimum of hybrids. Hybrid PR37N01 performed the best results, while PR37M81 was the weakest hybrid when considering nutrient response. We determined high optimum fertilizer values in the case of both hybrids (150kg N+PK).

References

[1] J. Nagy, A. Megyes. *„A kukorica termesztés kritikus agrotechnikai elemei"* Agrofórum: a növényvédők és növénytermesztők havilapja, 2009. 20. Extra 32. 36-40.

[2] J. Nagy, *"Kukoricatermesztés"* Akadémiai Kiadó, Budapest. 2007. 230.

[3] J. Nagy, *„A vízellátáshatása a korai (FAO 300-399) éréscsoportba tartozó kukorica hibridek termésére öntözés nélküli termesztésben"*Növénytermelés. 2006. 55. 1-2. 103-112.
[4] P. Pepó." *"A kukorica (Zea mays L.) termése és növénydőlése szárazés csapadékos évjáratban csernozjom talajon",*Növénytermelés. 2009. 58. 3. 4. 53-66.
[5] J Nagy,V. A. Széles, IN: Harcsa Marietta (Szerk.).*„Az öntözésés a műtrágyázás hatásának értékelése a kukorica (Zea mays L.) nitrogen dinamikájára klorofill-mérősegítségével"* V. Növénytermesztési Tudományos Nap. Gazdálkodás- Klímaváltozás- Társadalom. 2009. 161-164.
[6] L. Radics, "*Szántóföldi növénytermesztés*" Szaktudás Kiadó Ház Rt. Budapest. 2009.
[7] B. Gyulai, E.Sebestyén*„Adalékok a kukorica trágyázásához"* Agrárágazat. 2011. 12. 4. 40-42 p.
[8] M. Sárvári, B. Boros. *„A kukorica hibridspecifikus trágyázása és optimális tőszáma"* Agrofórum: a növényvédők és növénytermesztők havilapja. 2009. 20.27. 40-45.
[9] T. Árendás, J. Sarkadi, D.Molnár, *"Műtrágyahatások kukorica-őszibúza bikultúrában erdőmaradványos csernozjom talajon"* Növénytermelés. 1998. 47.1. 45-56.
[10] S. Huang, W. Zhang, X.Yu, Q. Huang. *„Effect of long-term fertilization on corn productivity and its sustainability in an Ultisol of southern China"*Agriculture, Ecosystems and Environment.2010. 138. 44-50 p.

Lajos Gábor Karancsi Place of birth: Berettyóújfalu, Hungary Date of birth: 16. 09. 1984.Education: Agricultural Engineer, Faculty of University of Debrecen, Debrecen, Hungary, 2009
Job: PhD student. Institute of Crop Science, Faculty of Agricultural and Food Sciences and Environmental Management, Centre for Agricultural and Applied Economic Sciences, University of Debrecen. Main publications: L. G. Karancsi, "Examination of Nutrient and Water Utilization of Different Maize Genotypes on ChernozemSoi" *In: Saji, B.-Parvinder, S.S. (eds.) 2nd International Multi-conference on Agricultural, Chemical, Biological and Ecosystems (IMACBE'13).* „2nd International conference on agriculture and environment systems" Pattaya, Thaiföld. 251-254. ISBN 978-93-82242-27-7*L. G. Karancsi,* "The effect of nutrient supply on the yield and chlorophyll content of corn hybrids" *In: Csajbók, J. (eds.) The influence of some technological elements over the wheat and corn grains quality stored in Bihor and Hajdu Bihar counties* 31-36. ISBN 978-963-473-612-7 L. G. Karancsi, "Effectiveness of nutrient supply in corn on chernozem soil"12th Alps-Adria Scientific Workshop. "Soil fertility" Opatija, Croatia *Növénytermelés.* 62. 253-256. ISSN 0546-8191.