Examination of Nutrient and Water Utilization of Different Maize Genotypes on Chernozem Soil

Lajos Gábor Karancsi

Abstract**—**The research was set up on chernozem soil at the Látókép AGTC KIT research area of the University of Debrecen, Hungary. We studied yield, optimum fertilizer doses and water utilization of maize hybrids. Except for SC3850 and PR37M81 all other hybrids had the highest yields in the above treatment. Results showed that hybrid NX47279 produced the highest yield (14 972 kg ha-1) while the lowest result was realized by hybrid PR37M81 (13 402 kg ha-1). We examined optimal fertilizer doses of the hybrids. Results of the polynomial regression showed that in order to reach the highest yields, hybrids needed a treatment between 93 and 120 kg ha-1 N + PK. When examining yield per mm precipitation we found that hybrid NX47279 (59.0 kg mm-1) was the most effective regarding water utilization, while hybrid PR37M81 proved to be the worst in this respect (52.8 kg mm-1) at an optimal nutrient level.

Keywords**—** hybrids, maize, nutrient levels, water utilization

I. Introduction

MAIZE occupies the largest area of cultivation in Hungary which varies between 1.1 and 1.2 million hectares [1]. Besides water and nutrient supply, professional fertilization greatly determines the effectiveness of maize production. Determining the right doses of fertilizers is quite difficult due to the fact that fertilizer reaction, nutrient utilization capacity and crop year of the hybrid also have to be taken into consideration [2]. Reference [3] proved that nitrogen utilization of various maize genotypes (hybrids, inbred strains) is different. The amount of nutrients needed has to be determined based on the estimated yield and nutrient supply of the soil [4]. According to [5] 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. Studies of [6] describe a significant relationship between the fertilization and the yield of maize. Reference [7] 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. According to [8] successful crop production depends on water supply. When considering the effects and utilization of fertilizers, water utilization has to be taken into account [9]. Reference [10] concluded that it was water utilization that determined the yield enhancing effects of fertilizers. This was altered by crop rotation and irrigation.

Lajos Gábor 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.

The work/publication is partially supported by the TÁMOP-4.2.2/B-10/1-2010-0024 project. The project is co-financed by the European Union and the European Social Fund.

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.

In 2012 we used Pioneer and Syngenta hybrids (SC 3850, NX 47279, SE 4410, SE 5000, P 37N01, P 9494 és a PR 37M81) as a small parcel research in four repetitions. Our pre-crop was winter wheat. The fertilization covered six levels of treatments shown in Table I. 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.

TABLE I
APPLIED FERTILIZER DOSES (DEBRECEN, 2012)

Treatment	N	P_2O_5	K_2O
	kg ha^{-1}		
Control	0	0	0
1	30	22,5	26,5
2	60	45	53
3	90	67,5	79,5
4	120	90	106
5	150	112,5	132,5

The amount of precipitation in April 2012 was 20.7 mm, 21.7 mm less than the thirty-year average (42.4 mm). Precipitation in May was 13.1 mm more and in June 12.2 mm more compared to the long term average. The amount of precipitation in July (65.3 mm) was similar to the average of the past thirty years (65.7 mm). The amount of precipitation in August lagged behind the long term average (60.7 mm) as it was 4.1 mm. Values of the average temperature exceeded the long term monthly average during the crop year (Table II).

TABLE II
SOME IMPORTANT METEOROLOGICAL DATA (DEBRECEN, 2012)

Precipitation (mm)	**April**	**May**	**June**	**July**	**August**	**Total**
2012. year	20.7	71.9	91.7	65.3	4.1	253.7
30 year average	42.4	58.8	79.5	65.7	60.7	307.1
Temperature (°C)	**April**	**May**	**June**	**July**	**August**	**Average**
2012. year	11.7	16.4	20.9	23.3	22.5	19.0
30 year average	10.7	15.8	18.7	20.3	19.6	17.0

III. RESULTS AND DISCUSSION

We examined yields of the hybrids in 2012. We found that hybrid PR37M81 resulted in the lowest yield in the control treatment with 10.012 kg ha^{-1}. We received higher yields in the cases of hybrid P37M01 (11.581 kg ha^{-1}) and hybrid SE5000 (12.105 kg ha^{-1}) in the control treatment.

At levels N30 + PK and N60 + PK the lowest results were produced by PR37M81 (11.471 kg ha^{-1} and 12.517 kg ha^{-1}) while the best yields were given by hybrid SE 5000 (13.521 kg ha^{-1} and 14.082 kg ha^{-1}). Nutrient level N_{90} + PK proved to be the optimal amongst all levels. The lowest results in this treatment were also performed by hybrid PR37M81 (13.402 kg ha-1) while the highest values were measured in the case of hybrid NX47279 (14.972 kg ha^{-1}). Hybrid PR37M81 turned out to be the weakest again (12.760 kg ha^{-1}, 12.535 kg ha^{-1}) at nutrient levels N120 + PK and N150 + PK, while hybrid NX47279 gave the best results (14.073 kg ha^{-1} and 14.105 kg ha-1) as shown in Figure 1.

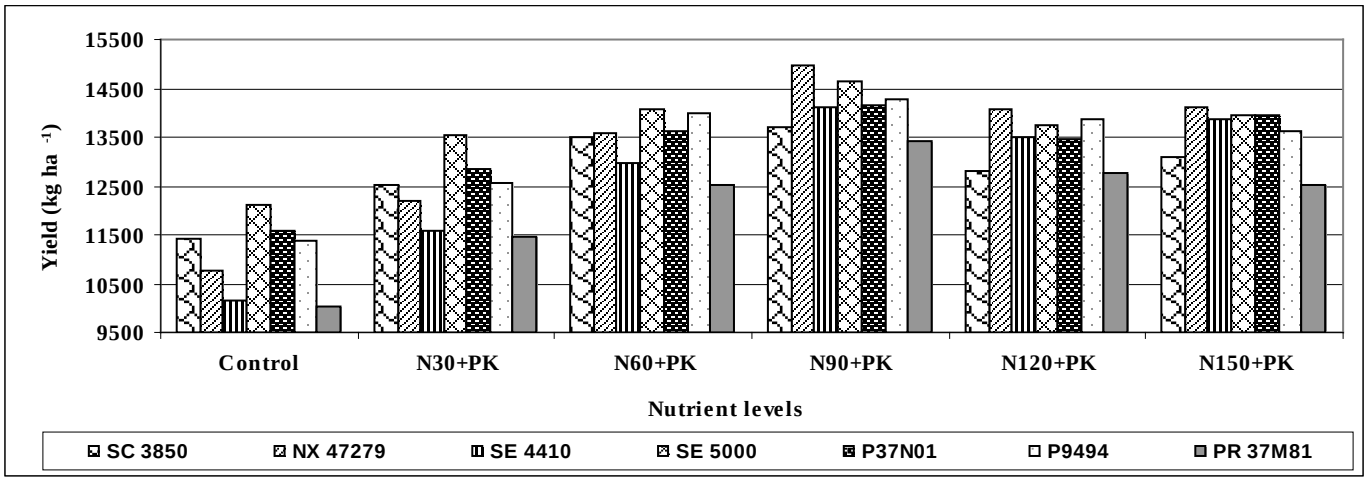

Fig. 1 Yields of examined maize hybrids in different nutrient treatments (Debrecen, 2012)

Examination of yield per 1 mm precipitation showed that hybrid PR37M81 gave the worst performance (39.5 kg mm^{-1}) while hybrid SE5000 achieved the best results (47.7 kg mm^{-1}) in the control treatment. The lowest specific yield at the optimum level of N_{90} + PK was also given by hybrid PR37M81 with 52.8 kg mm^{-1}, while hybrid NX47279 performed the best with 59.0 kg mm^{-1} (Figure 2.).

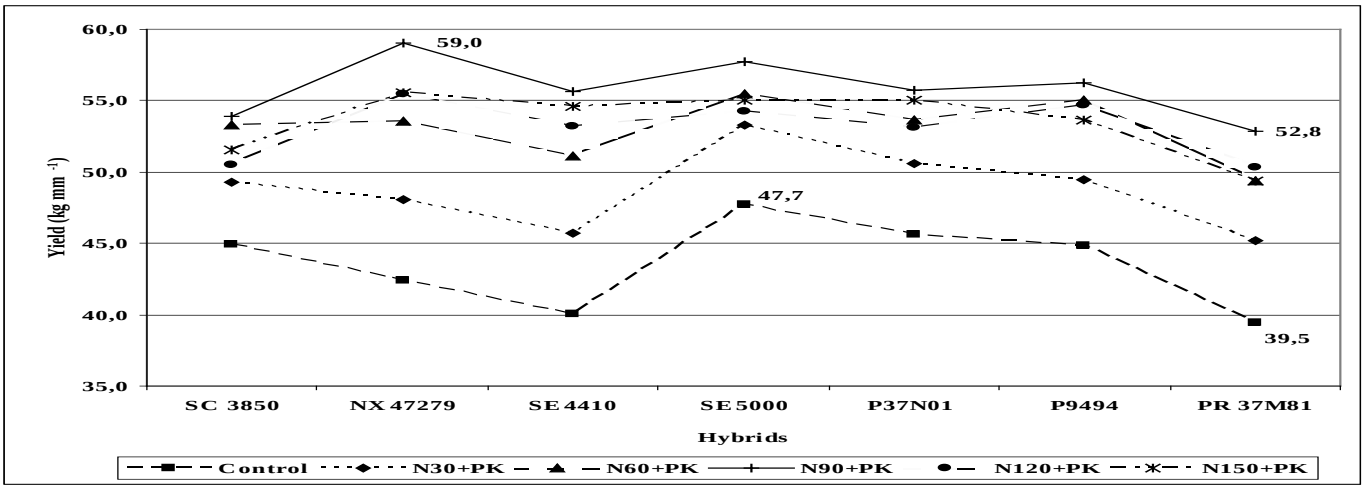

Fig. 2 Water utilization of, maize hybrids at different nutrient levels (Debrecen, 2012)

We fitted a polynomial trend line to the average of yield results of the hybrids and counted the polynomial regression equations of the species. Based on the results, we determined the optimum nitrogen values of the highest yields. The worst results were produced by hybrid PR37M81 (13.133 kg ha^{-1}). Based on the regression equation, 102 kg N + PK was needed to achieve the above mention numbers. The best yield was given by hybrid NX 47279 (14.518 kg ha^{-1}). This yield was produced by using up 111 kg N+PK fertilizers. The best fertilizer utilization was performed by hybrid SE 5000 as it used up 96 kg N+PK to produce a yield of 14.405 kg ha^{-1} (Figure 3, Figure 4, Figure 5).

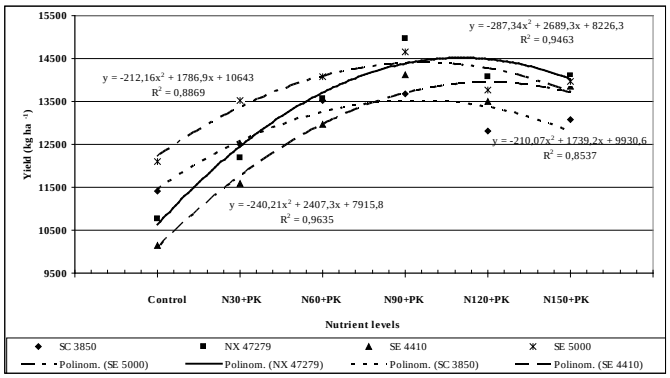

Fig. 3 Examination of the nutrient reaction of maize hybrids SC 3850, NX 47279, SE 4410 and SE 5000 by using regression analysis (Debrecen, 2012)

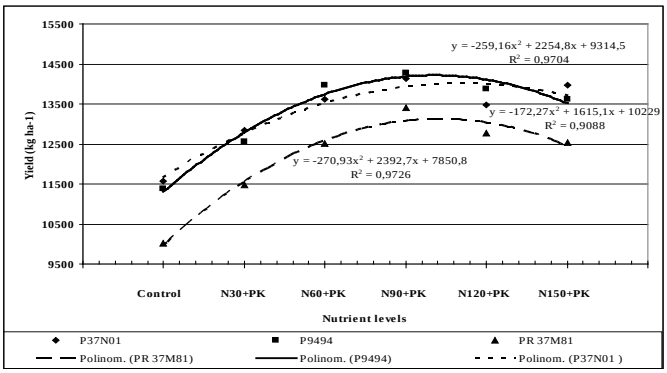

Fig. 4 Examination of the nutrient reaction of maize hybrids P37M81, P 9494 and PR37M81 by using regression analysis (Debrecen, 2012)

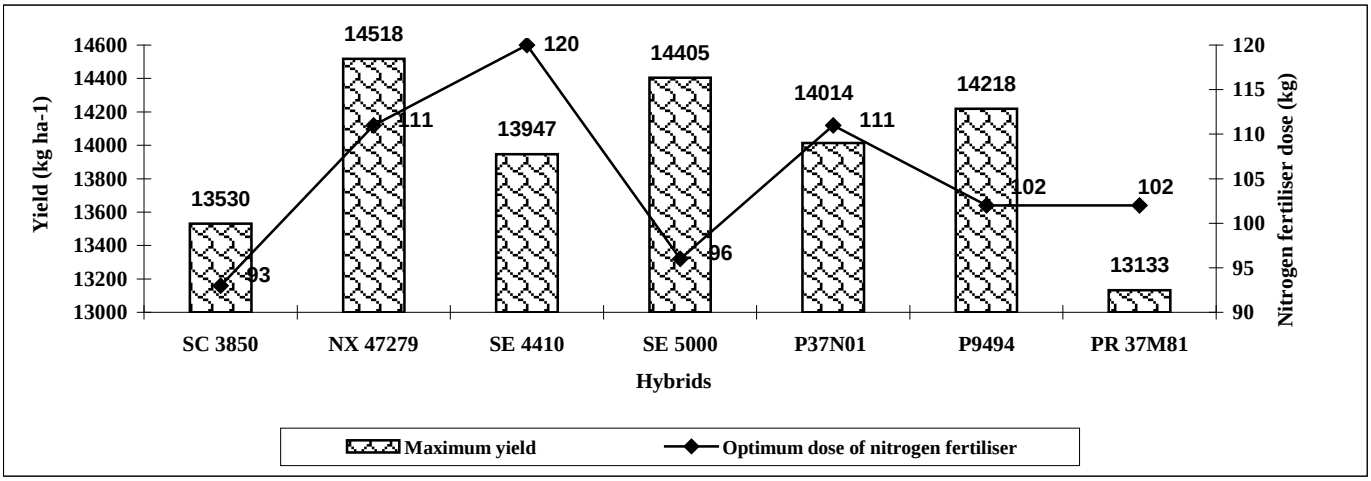

Fig. 5 Maximum yield and optimum nitrogen supply of maize hybrids by regression analysis (Debrecen, 2012)

IV. CONCLUSION

The research was set up on chernozem soil at the Látókép AGTC KIT research area of the University of Debrecen, Hungary. We studied yield, optimum fertilizer doses and water utilization of maize hybrids SC3850, NX47279, SE4410, SE5000, P37N01, P9494 and PR37M81 at various nutrition levels in 2012. Reference [11] fertilizer doses larger than 120 kg ha^{-1} N did not enhance yields. Moreover, in the case of our research this number was even smaller as fertilizer doses larger than 90 kg ha^{-1} did not enhance yields. Except for hybrid SC3850 and PR37M81, all other hybrids performed their best at this level. Results proved that the highest values were achieved by hybrid NX47279 (14972 kg ha^{-1}) while hybrid PR37M81 produced the worst results (13402 kg ha^{-1}). There were no statistically proven differences between N_{60}+PK and N_{120}+PK, between N_{60}+PK and N_{150}+PK and between N_{120}+PK and N_{150}+PK treatments. When examining yield per mm precipitation we found that hybrid SE5000 was the most productive in the control treatment (47.7 kg mm^{-1}) while hybrid NX47279 performed the best results at the optimum level of N_{90}+PK (59.0 kg mm^{-1}). Based on the results of the regression equation, hybrid PR37M81 used up 102 kg N + PK to achieve a 13133 kg ha^{-1} yield. The best yield was given by hybrid NX 47279 (14518 kg ha^{-1}) by using up 111 kg N+PK fertilizer.

ACKNOWLEDGMENT

The work/publication is partially supported by the TÁMOP-4.2.2/B-10/1-2010-0024 project. The project is co-financed by the European Union and the European Social Fund.

REFERENCES

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

[2] J. Nagy, Kukoricatermesztés. Akadémiai kiadó, Budapest. 2007

[3] Z. Berzsenyi, L. Q. Dang, A N-műtrágyázás hatása a kukorica- (Zea mays L.) hibridek szemtermésére és N-műtrágyareakciójára tartamkísérletben. Növénytermelés. 52. 3-4. 389-408. 2003.

[4] L. Radics, Szántóföldi növénytermesztés, Szaktudás Kiadó Ház Rt. Budapest. 2003.

[5] M. Sárvári, B. Boros, A kukorica hibridspecifikus trágyázása és optimális tőszáma. Agrofórum: a növényvédők és növénytermesztők havilapja. 20.27. 40-45. 2009.

[6] J. Zembery, V. Barek, H. Hornikova, P. Halaj, D.Halajova, Variability of yield components and yield of maize due to fertilization and weather conditions. Növenytermeles. 2011. 60. Supplement, 89-92. 12 ref. 10th Alps-adria scientific workshop. 2011.

[7] T Árendás, J. Sarkadi, D. Molnár, Műtrágyahatások kukorica-őszi búza dikultúrában erdőmaradványos csernozjom talajon. Növénytermelés. 47.1. 45-56. 1998.

[8] E. Széll, A kukorica vízellátásának javítása a termesztéstechnológia által. Agrofórum, 2007. 18. 3. 33-35. 2007.

[9] L. Pummer, J. Krisztián, S. Holló, M. Perényi, A műtrágya – csapadék – termés – kapcsolata kukorica tartamkísérlet mérési eredményei alapján. Növénytermelés. 44. 5-6. 535. 1995.

[10] P. Pepó, A kukorica (Zea mays L.) termése és növénydőlése száraz és csapadékos évjáratban csernozjom talajon. Növénytermelés. 58. 3. 4. 53-66. 2009.

[11] Cs. Rácz, J. Nagy, A víz- és tápanyagellátottság, illetve- hasznosulás megítélésének kérdései kukorica terméseredmények vonatkozásában. Növénytermelés. 60. 1. 6. 97-114. 2011.

Lajos Gábor Karancsi Place of birth: Berettyóújfalu, Hungary Date of birth: 16. 09. 1984. Education: Agicultural Engenieer, 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: Karancsi, L.G. – Pepó, P. (2012): Study of the effect of fertilization of maize (*Zea mays L.*) in crop years with different water-supply. Növénytermelés. 61. 89-92.; Karancsi L. G. – Dóka L. F. – Pepó P. (2012): Hibridspecifikus tápanyagellátás vizsgálata kukoricánál csernozjom talajon**.** Agártudományi Közlemények = Acta Agraria Debreceniensis. 48.91-97.; Karancsi L. G. (2012): Terméképző elemek alakulásának vizsgálata kukoricánál eltérő vízellátottságú évjáratokban. XVIII. Ifjúsági Tudományos Fórum, 2012. április 19. Keszthely. CD melléklet: ISBN: 978-963-9639-45-4.