International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:7, No:11, 2013

Effect of Nutrient Supply on Yield and Photosynthetic Parameters of Maize Hybrids

L. G. Karancsi, K. Máriás

Abstract**—**We examined the crop yield results of hybrids in 2012. We found out that in the control treatments the lowest yield was reached with the hybrid PR37M81: 10,012 kg ha^{-1}. The highest yield was in case of hybrid P37N01: 11,581 kg ha^{-1}. As we raised the nutrient doses the lowest yield of all examined nutrient levels was in case of hybrid PR37M81. We measured at N_{60}+PK nutrient level 12,517 kg ha^{-1}, at N_{120}+PK nutrient level 12,760 kg ha^{-1}, and at N_{150}+PK nutrient level 12,535 kg ha^{-1} yield results. At N_{60}+PK and N_{120}+PK nutrient level the highest yield was reached with the hybrid P9494 (N_{60}+PK: 13,970 kg ha^{-1}, N_{120}+PK: 13,871 kg ha^{-1}). In case of the N_{150}+PK fertilization treatment the hybrid P37N01 gave the highest yield results (13,962 kg ha^{-1}).

Keywords**—**Hybrids, maize, nutrient levels, SPAD and LAI values.

I. Introduction

THE relationship between the effect of vintage, fertilization and corn hybrids is very strong according to [1]. In excessively dry, droughty years fertilization did not have any yield raising results, while under favorable circumstances it could bring a yield raise of up to 50%. The type-specific fertilization is a fundamental factor of nutrient management. The different genotypes have different agronomic and vegetal-physiological features [2]. Finding the optimal fertilization dosage is one of the most difficult tasks in crop production technology. Nutrient exploitation facility, reaction on fertilizer and vintage effect have to be taken into consideration at each grew hybrid [3].

Growth analysis is a suitable method to examine the plants growth and ecological, agronomic factors influencing growth [4]. Reference [5] has found a strong relation between the leaf's chlorophyll-nitrogen content and the SPAD meter. Reference [6] has measured significantly higher chlorophyll contents in case of average nitrogen fertilization in a droughty year, than in years with beneficial water supply. According to [7] the chlorophyll concentration in corn correlates positively with the leaf's nitrogen concentration and nitrogen supply. The assimilation parameters of corn are influenced by the water supply and the fertilization [8], [9]. Reference [10] examined the connection between SPAD rates of corn leafs and the yield results, and stated that there is a middling strong positive connection between them. According to the results of [11] the photosynthetic activity after blooming and the chlorophyll content decreased much slower in new types of corn hybrids than in older types. Reference [12] stated that nitrogen fertilization and the hybrids have a significant effect on the leaf area of each plant, as well as on the plant height. Reference [13] proved that the rising nitrogen doses significantly increase the leaf area, however created a perfect microclimate for pathogens.

L. G. K. 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).

K. M. 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: mariaskaroly@gmail.com).

II. Materials and Methods

The research was set up on chernozem soil with lime patches at the Látókép AGTC MÉK 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 (see in Table I). The long-time experiment was set up in 1983.

In 2012 we used Pioneer hybrids (P 37N01, P 9494 and a PR 37M81) as a small parcel research in four repetitions. Our pre-crop was winter wheat. The fertilization covered four 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.

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

We determined the leaf area with the help of SunScan Canopy Analysis Systems (SS1) mobile leaf area measurer and the chlorophyll content with a SPAD-502 chlorophyll measurer, each 5-5 times. The measurement of plant height took place seven times, in each parcel we measured 5 average plants.

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	K_2O
							AL soluble	
							ppm	ppm
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, 2012)

Treatment	N	P_2O_5	K_2O
	kg ha^{-1}		
Control	0	0	0
1	60	45	53
2	120	90	106
3	150	112.5	132.5

TABLE III
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 the crop yield results of hybrids in 2012. We found out that in the control treatments the lowest yield was reached with the hybrid PR37M81: 10,012 kg ha^{-1}. The highest yield was in case of hybrid P37N01: 11,581 kg ha^{-1}. As we raised the nutrient doses the lowest yield of all examined nutrient levels was in case of hybrid PR37M81. We measured at N_{60}+PK nutrient level 12,517 kg ha^{-1}, at N_{120}+PK nutrient level 12,760 kg ha^{-1}, and at N_{150}+PK nutrient level 12,535 kg ha^{-1} yield results. At N_{60}+PK and N_{120}+PK nutrient level the highest yield was reached with the hybrid P9494 (N_{60}+PK: 13,970 kg ha^{-1}, N_{120}+PK: 13,871 kg ha^{-1}). In case of the N_{150}+PK fertilization treatment the hybrid P37N01 gave the highest yield results (13,962 kg ha^{-1}) (see Fig. 1).

In case of the SPAD result's examination we found out that in the control treatment, at the first measurement (21 May) the best result was reached with the hybrid P9494 (44.2), the lowest with the hybrid P37N01 (56.5). In the area where no fertilizer was used, in the blooming time (25 July) hybrid P37N01 brought the best results (56.5), while hybrid PR37M81 brought the lowest result (50.1). In the measurement on 22 August the lowest SPAD result was found at hybrid P9494 (7.1).

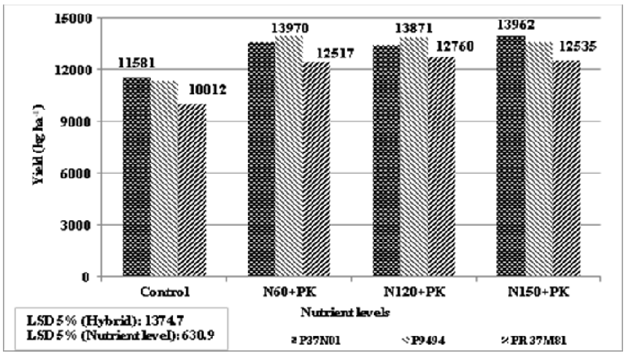

Fig. 1 Yields of examined maize hybrids in different nutrient treatments (Debrecen, 2012)

At the N_{60}+PK nutrient level and measurement of 21 May the lowest SPAD results were recorded in case of hybrid PR37M81 (32.5) and the highest in case of hybrid P9494 (36.5). The chlorophyll content measured at the time of blooming showed that the hybrid P9494 had the highest results (60.3) and the hybrid PR37M81 the lowest SPAD results (57.3). In the previously mentioned fertilization treatment at the time of measurement of 22 August the hybrid P37N01 reached the highest SPAD rate (53.1), while at hybrid PR37M81 the lowest (31.1).

In the previously mentioned fertilization treatment of 22 August we reached the highest SPAD rate with hybrid P37N01 (53.1) and the lowest with hybrid PR37M81 (31.1).

At the N_{120}+PK fertilization treatment the first measurement (21 May) showed the following results: hybrid P37N01 reached the lowest SPAD rates (31.9), hybrid P9494 the highest (38.0). In the measurement of 25 July we reached the highest SPAD rates (P37N01: 63.0, P9494: 60.0 and a PR37M81: 59.3). In the last measurement (22 August) the highest SPAD rate was reached by hybrid P37N01 (43.2), the lowest in case of hybrid P9494 (39.9).

At nutrient level N_{150}+PK the first measurement (21 May) showed the highest SPAD rates in case of hybrid P9494 (35.8). During the blooming the highest chlorophyll content was measured in case of hybrid P37N01 (63.8) and the lowest in case of hybrid PR37M81. In the measurement of 22 August the highest SPAD rate was recorded at hybrid PR37M81 (42.2) and the lowest at hybrid P37N01 (see Figs. 2-4).

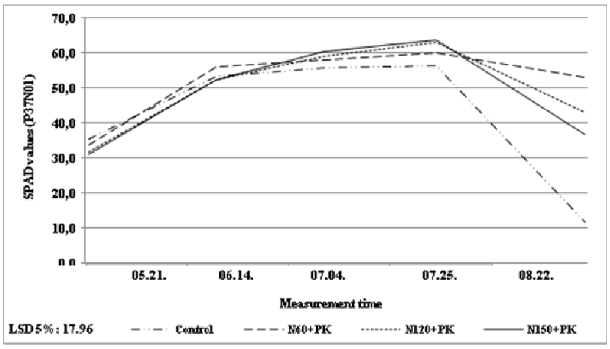

Fig. 2 The SPAD values of P37N01 hybrid

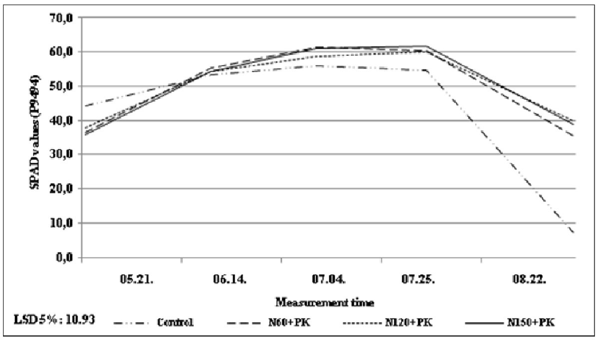

Fig. 3 The SPAD values of P9494 hybrid

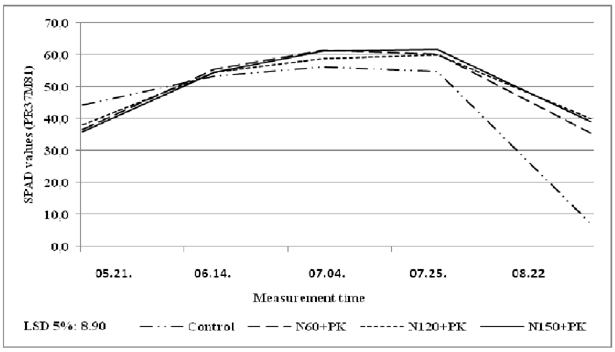

Fig. 4 The SPAD values of PR7M81 hybrid

Figs. 5-7 show the LAI rate for 1 m^2 and the dynamics at different measure times. We found out that in the control treatment the highest LAI rate was measured at the first measurement (21 May) in case of hybrid P9494 (0.8 m^2/m^2). At blooming time hybrid P37N01 gave the highest LAI rates (3.5 m^2/m^2). In case of the other two hybrids the examined rates were lower (3.2 m^2/m^2). At the last measurement (22 August) in the not fertilized area hybrid P37N01 gave the highest LAI rate (1.9 m^2/m^2), while hybrid PR37M81 the lowest (1.6 m^2/m^2).

At N_{60}+PK nutrient level in the measurement of 21 May the hybrid PR37M81 had the highest LAI rate (0.9 m^2/m^2), hybrid P9494 the lowest (0.7 m^2/m^2). At blooming time and on 22 August in case of hybrid P37N01 the highest LAI rate was measured (3.8 m^2/m^2 and 1.7 m^2/m^2), while PR37M81 hybrid the lowest (3.4 m^2/m^2 and 1.3 m^2/m^2).

In the fertilization treatment of N_{120}+PK the first measurement on 21 May gave the same results for all hybrids (0.8 m^2/m^2). At blooming time however the highest LAI rate was measured in case of hybrid P37N01 (3.5 m^2/m^2), the lowest in case of hybrid P9494 (3.2 m^2/m^2). At the last measurement hybrid P37N01 gave the highest (1.9 m^2/m^2), hybrid P9494 gave the lowest LAI rates (1.6 m^2/m^2).

In case of nutrient treatment N150+PK at the time of the first measurement (21 May) hybrid P37N01 gave the highest LAI rate (0.9 m^2/m^2). Both at the time of blooming and at the time of the last measurement hybrid P37N01 gave the highest LAI rate (3.7 m^2/m^2 and 2.1 m^2/m^2). The lowest LAI rate was measured at blooming time and at the measurement of 22 August at hybrid PR37M81 (3.4 m^2/m^2 and 1.8 m^2/m^2).

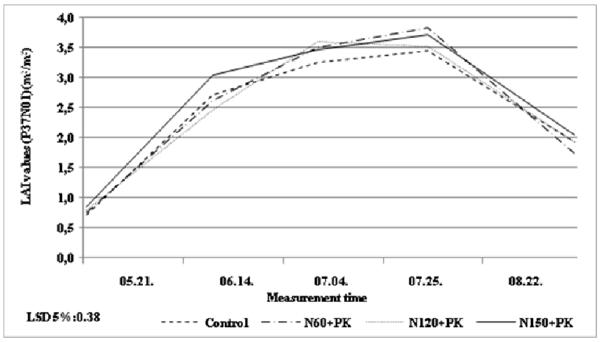

Fig. 5 The LAI values of the P37N01 hybrid

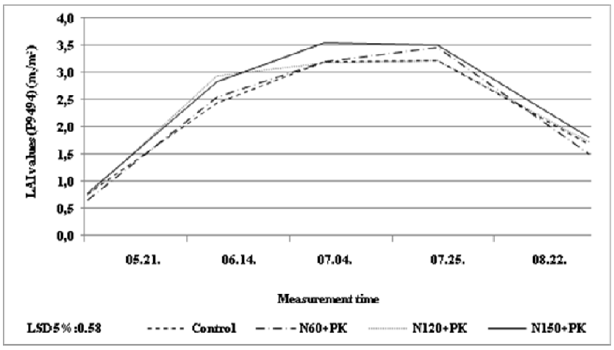

Fig. 6 The LAI values of the P9494 hybrid

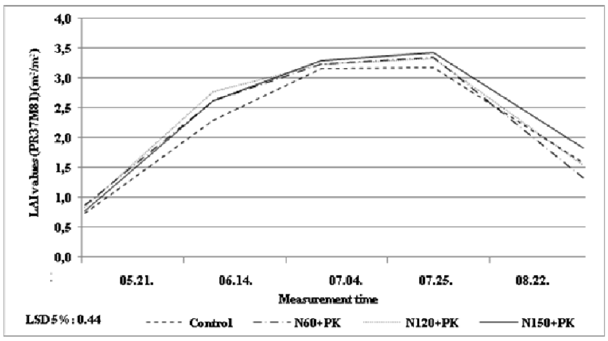

Fig. 7 The LAI values of the PR37M81 hybrid

IV. Conclusion

In case of the crop yield results we found out that the best results were measured in the not fertilized treatment at hybrid P37N02 (11,581 kg ha^{-1}). Nutrient level N_{60}+PK at hybrid P9494 proved to be optimal (13,970 kg ha^{-1}), in case of hybrid PR37M81 nutrient level N_{120}+PK, while in case of hybrid P37N01 nutrient level N_{150}+PK was the best with highest yield results. Significant results were recorded at all three hybrids between the control treatment and the N_{60}+PK, N_{120}+PK and N_{150}+PK nutrient treatments.

According to the SPAD results recorded on different nutrient levels we found that hybrid P37N01 showed the highest chlorophyll content on 25 July on all nutrient levels. In case of hybrids P9494 and PR37M81 we recorded the highest chlorophyll contents in the control treatments and on nutrient level N_{60}+PK on 4 July, and on fertilization treatments N_{120}+PK and N_{150}+PK at blooming time on 25 July.

We also found out that in the parcels treated with fertilizer the examined corn hybrid's chlorophyll content was higher than in the ones where no fertilizer was used, at the time of the last measurement on 22 August (P37N01: Control:11.7, N_{60}+PK: 53.2, N_{120}+PK:43.2, N_{150}+PK: 36.8; PR37M81: Control:8.0, N_{60}+PK: 31.1, N_{120}+PK: 42.1, N_{150}+PK: 42.4; P9494: Control:7.1, N_{60}+PK: 35.4, N_{120}+PK: 39.9, N_{150}+PK: 38.9).

Examining the leaf area index rates we can state that the highest rates were recorded at the time of blooming (25 July). In this period the LAI rates were between 3.2-3.8 m^2/m^2. In case of the last measurement (22 August) the highest LAI rates were recorded at hybrid P37N01.

Acknowledgment

This research was supported by the **European Union** and the **State of Hungary, co-financed by the European Social Fund** in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'.

References

[1] M. Sárvári - B. Boros, "A kukorica hibridspecifikus trágyázása és optimális tőszáma," *Agrofórum: a növényvédők és növénytermesztők havilapja.* 2009. vol. 20. no. 27. pp. 40-45.

[2] P. Pepó, "A tápanyag-gazdálkodás szerepe a környezetbarát, fenntartható növénytermesztésben," *Gyakorlati Agrofórum*, 2001, vol. 12. no. 7. 6-9.

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

[4] Z. Berzsenyi, D. Q. Lap, (2000) "Különböző tenyészidejű kukorica (Zea mays L.) hibridek növekedésének jellemzése Richards függvénnyel eltérő évjáratokban," *Növénytermelés.* 2007. vol. 49. no. 1-2. 95-116.

[5] G. Lemaire, M. H. Jeuffroy, F. Gastal, "Diagnosis tool for plant and crop N status in vegetative stage: Theory and practices for crop N management," *European Journal of Agronomy.* 2008, vol. 28. no. 4. 614-624.

[6] V. A. Széles, A. Megyes, J. Nagy, "Effect of N fertilisation on the chlorophyll content and grain yield of maize in different crop years," *Növenytermeles.* 2011. 60: Supplement, 161-164. 6 ref. 10^{th} Alps-adria scientific workshop.

[7] Z. Berzsenyi, D. Q. Lap, "A kukorica N-ellátottságának monitoringja SPAD-502 típusú klorofill mérővel," *Martonvásár: az MTA Mezőgazdasági Kutatóintézetének Közleményei.* 2001, vol. 13. no. 1. 7.

[8] E. Kutasy, J. Csajbók, H. É. Borbélyné, Ms M. Lesznyák, "A kukorica tápanyagellátása és a fotoszintézise közötti összefüggések eltérő évjáratokban," *V. Növénytermesztési Tudományos Nap*. Gazdálkodás-Klímaváltozás- Társadalom. 2009, 129-132.

[9] A. Széles, "The indication of nitrogen deficiency in maize growing using SPAD-502 chlorophyll meter," *Cereal Research Communications* 2007. vol. 35. no. 2, 1149-1152. 9 ref.

[10] V. A. Széles, "The effect of crop year and fertilization on the interaction between the spad value and yield of maize (*Zea mays* L.) within non-irrigated conditions,". *Cereal Research Communications.* 2008. vol. 36: no. 5, 1367-1370. 14 ref. 7^{th} Alps-Adria Scientific Workshop, Stara Lesna, Slovakia, 2008

[11] Ding L.,Wang K. J, Jiang G. M., Liu M. Z., Gao L. M., "Photosynthetic rate and yield formation in different maize hybrids," *Biologia Plantarum,* 2007, vol. 51. no. 1. 165-168.

[12] Z. Berzsenyi, "N- műtrágyázás hatása a kukorica (*Zea mays* L.) hibridek levélterületének és növénymagasságának növekedési dinamikájára tartamkísérletben," *Növénytermelés.* 2008, vol. 57. no. 2. 195-210.

[13] B. É. Lönhardné, I. Németh, S. Kadlicskó, "A levélterület és a gabonafertőzöttség összefüggése a különböző műtrágyázási szinteken," *Növénytermelés.* 1992, vol. 41. no. 3. 245-252.

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: L. G. Karancsi, "Examination of Nutrient and Water Utilization of Different Maize Genotypes on Chernozem Soi" *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.