RELATIONSHIP BETWEEN FERTILIZATION, LEAF AREA INDEX, PHOTOSYNTETIC ACTIVITY AND YIELD OF HYBRIDS

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Introduction

The hybrid-specific technologies have a determining role in the effective production. Maize hybrids have different genotypes and they react differently to the agrotechnical factors, such as fertilization. In Sárvári's (1986) experiment the most important nutrient was potassium besides nitrogen. The potassium fertilization raised the yield by 3-4 t ha $^{-1}$ beside suitable doses of nitrogen and phosphorous. Nutrient supply and photosynthetic activity influence the growth of hybrids. Leaf area index, LAI determines the plant's dry matter production in the vegetative period (Pethő 1993). Lönhardné and Németh (1989) emphasize that the leaf area developed during the first half of growing season has an important role in the potential yield. According to Petr et al.; (1985), leaves of maize produce the most assimilates at the 120-200 cm level. Lap (1992) says that the aim of plant production is to maximize the profitable yield, but in the experiments not only the yield quantities have to be examined but also the changes in the photosynthetic activity. Csajbók and Kutassy concluded that the photosynthetic activity was significant by different between the maize hybrids and the fertilizer doses. Ruzsányi (1974) found close connection between the dosage of nitrogen fertilizer and leaf area size. Regarding the nutrient supply Sárvári (1995) claims that the use of 150-200 kg ha^{-1} or bigger doses is unnecessary, uneconomic and pollutes the environment.

Material and methods

The experiment was carried out in Debrecen at the Experimental Station of the University of Debrecen Centre of Agricultural Sciences, Department of Crop Production and Applied Ecology. The soil of the experiment is leached chernozem soil. We have tested 10 various hybrids with their own genetic characteristics for five different fertilizer doses (Table 1.), in addition to the parcels without fertilization. The fore crop was maize. We sowed the hybrids on 20 April and they emerged on 2 May. The plant density of early maturing hybrids was 71000 plants ha^{-1} while for the hybrids with longer vegetation period it was 65000 plants ha^{-1}. In 2004, in the maize crop year (01 Jan.–31 Sept.) the precipitation was higher by 68.3 mm than the 30 years' average, but the distribution was unfavorable. On the whole, the weather of the experimental year was favorable for maize production. There was more precipitation compared to the previous year which helps the growth of maize.

1. table: The applied fertilizer doses (kg ha^{-1})

	N	P_2O_5	K_2O	Total active agent content
1	40	25	30	95
2	80	50	60	190
3	120	75	90	285
4	160	100	120	380
5	200	125	150	475

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Photosynthesis and LAI were measured with a LI 6400 photosynthesis and a LAI 2000 leaf area index measuring device on 24 June (11 June), 5 July, 26 July and 17 August. The instrument measures the CO_2 level of the emitted air from the cell and compares it with the CO_2 level of the incoming air and determines the absorbed CO_2.

Results and Discussion

Effect of fertilization on the yield

The favorable results reached were due to the rainy season. The average yield varied between 7.78-9.67 t ha^{-1}. In the control with no fertilization, the yields were higher than 3 t ha^{-1} in the case of every hybrid. Different seed moisture contents at harvest were caused by the variable genetic characteristic, moisture loss, the season effect and the differing growing season. The seed moisture content of FAO 400 and FAO 500 hybrids was more than 20% at harvest.

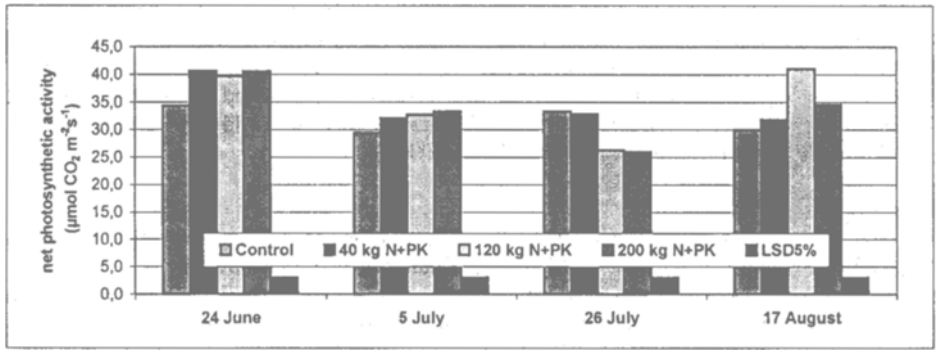
Hybrids DK 440, PR37M34, PR38A24, PR39D81 and PR36R10 reacted to higher fertilizer doses with significant yield increments but the higher doses depressed the yield of MV Maraton, DKC 5211 and Mv Vilma. The yield of PR39D81 changed between 3.54-10.16 t ha^{-1}. The first fertilizer dose (N 40 + PK) caused a yield increment of 4.84 t ha^{-1} compared to the yield of the control parcel (3.54 t ha^{-1}). The reaction to nutrient supply hybrids of DK 440 and PR37M34 was very good, the rising fertilizer doses improved the yield quantity, but it was not significant. Hybrid DK 4626 reached the best result, 11.65 t ha^{-1} with the fifth fertilizer dose, but it did not reach the reliable level. The hybrids MV Maraton, DKC 5211 and Mv Vilma gave the highest yield at the N 120, P 75, K 90 kg ha^{-1} fertilizer doses.

Effect of fertilization on the photosynthetic activity

We measured the photosynthetic activity and LAI of 5 hybrids: Mv Vilma, DKC 5211, PR39D81, PR38A24, DK 4626. For each hybrid the net photosynthetic intensity was the highest at the first measurement, the average was 38.8 μmol CO_2 m^{-2} s^{-1}. During the crop year it decreased continually at the five hybrids, but in the last measurements for the third and fifth fertilizer doses the photosynthetic activity was 41.1 and 34.5 μmol CO_2 m^{-2} s^{-1}, higher than in the previous two measurements.

At each measurement date the photosynthetic activity was the highest for PR39D81 and PR38A24 at the N120+PK fertilizer dose, more than 30 μmol CO_2 m^{-2} s^{-1} (Figure 1.). Regarding nutrient supply, there was a significant difference between the control and the third fertilizer dose (N 120, P 75, K 90) in every measurement. The year effect on the photosynthetic activity was favourable and the precipitation enhanced the efficacy of NPK treatments.

Figure 1.: Photosynthetic activity in the average of hybrids at different fertilizer doses (Debrecen, 2004)

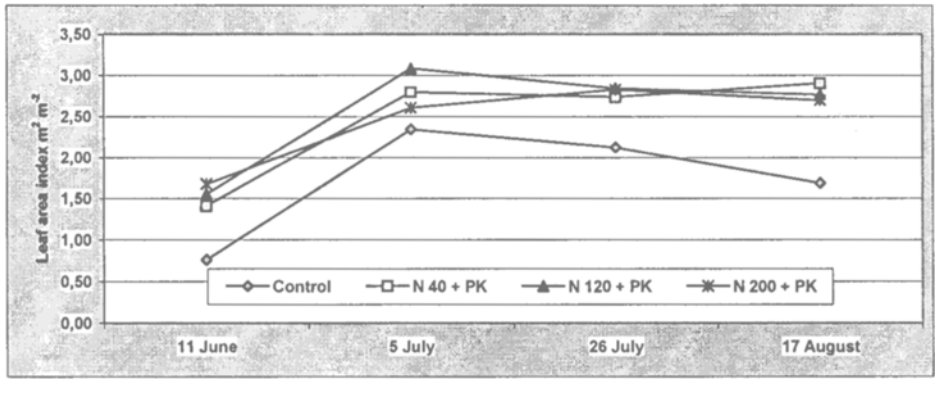


Effect of fertilization on leaf area index of the hybrids

The leaf area was the highest (2.35-3.09 m^2 m^{-2}) at the second measurement with the exception of fifth fertilizer dose where it was only 2.6 m^2 m^{-2}. There was a significant increase in the leaf area index, more than 1.3 m^2 m^{-2} compared to the first measurement. In the control parcels, the measured values were definitely lower (0.76-2.35 m^2 m^{-2}) than in the parcels with fertilization, we reached the best trial result, 2.74-3.09 m^2 m^{-2} at the N40+PK and the N120+PK nutrient levels (Figure 2.). In these two treatments, the leaf area index hardly decreased at the third and fourth measurement.

There was a significant difference between the results of the first and the second measurement, however, the third measurement did not show a significant difference. Regarding nutrient supply there was a significant difference between the control parcels and the first fertilizer dose at LSD 5%.

Figure 2.: Leaf area index in the average of hybrids at different fertilizer doses (Debrecen, 2004)



Summary

Several factors influence the quantity and stability of maize yield, the most important being the nutrient supply, the hybrid and precipitation. In 2004, during the maize growing season the precipitation was higher than the 30 years' average, by 68.3 mm, but the distribution was unfavorable. We tested ten hybrids with different genotypes. In the average of hybrids, there was a significant difference between the yield, the photosynthetic activity, the leaf area index in the control and the NPK treatment. The best results were reached at the N40+PK and N120+PK active ingredient doses, the higher doses depressed the yield. The agro-ecological optimum of NPK fertilization was N 120, P 75, K 90 kg.

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