EFFECT OF PLANT DENSITY ON THE MAIZE YIELD

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Introduction, literature review

Maize plays an important role in the Hungarian agriculture. This is supported by the fact that it is grown on a considerable portion (34%) of the arable land. 90% of maize is utilized as animal feed (GYŐRI, 2002).

The situation of the Hungarian maize production has changed considerably for the last few decades. In the period between 1960-1981, we have been among the leading nations of the world as regards both yields and genetic progress (MENYHÉRT, 1985). However, maize yields dropped after the change of regime. Yield fluctuation increased from the former 10-20% to 30-50%.

Increasing the plant density of maize was studied from several approaches: I'SÓ (1969) did not receive significantly lower yields by applying a smaller distance between rows. SÁRVÁRI (2001) has drawn the attention to the fact that a too high plant density has negative effects. In Germany, ERHARDT (2002) observed that the too high number of plant density was a stress factor. The different hybrids response differently to higher plant density. Besides optimal plant density, it is advisable to determine an optimal plant density interval (SÁRVÁRI ET AL., 2002): for hybrids of FAO 200-300 and FAO 400-500 68-72 thousand plants ha^{-1} and 60-65 thousand plants ha^{-1} are considered to be acceptable, respectively. On the basis of his experiments, SÁRVÁRI (2003) suggests the application of the lower limit value of these intervals because of the increase in the frequency of dry years.

Materials and methods

The experiments were carried out near Hajdúböszörmény on typical meadow soil. The soil was hardly cultivable and most of the phosphorous and potassium content was bound to the soil.

Weather was totally different in the two experimental years (2003-2004). 2003 was a very dry year. The amount of precipitation in the vegetation period of maize was 78.5 mm lower than the average. In the first half of the vegetation period, the amount of precipitation was lower than desirable, therefore, emergence and development were protracted. Drought was somewhat diminished by the greater amount of rain in July. The number of hot days reached 47 in the neighbourhood of Hajdúböszörmény.

On the contrary, precipitation in 2004 was above the average, in the vegetation period it was 93.2 mm higher than the average of 30 years. Also, the distribution of precipitation was favourable. The monthly mean temperatures followed the trend of the 30-years average.

The response of the hybrids was examined at the same four plant density values in both years: 45000 plants ha^{-1}, 60000 plants ha^{-1}, 75000 plants ha^{-1} and 90000 plants ha^{-1}.

In 2003, the applied fertilizer doses were as follows: N 124 kg ha^{-1}, P_2O_5 80 kg ha^{-1}, K_2O 130 kg ha^{-1}in the experiment. In 2004, N 145 kg ha^{-1}, P_2O_5 100 kg ha^{-1}, K_2O 120 kg ha^{-1} were applied in the plant density experiment.

Harvest was performed on 24 September and 11-12 October in 2003 and 2004, respectively. The experiments were analysed by analysis of variance.

Results and discussion

Results of the plant density experiments in 2003 proved that the response of hybrids to increasing plant density is also dependent upon the forecrop, the level of nutrient supply, the characteristics of the growing site and the efficacy of weed control besides the amount and

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distribution of precipitation in the vegetation period. In spite of the droughty year, yields were the highest at 90000 plants ha^{-1} plant density for all the seven examined hybrids (Figures 1 and 2). This was due to, firstly, the advantageous wheat forecrop and secondly, the early spring application of Kemira Power, which enabled the immediate uptake of nutrients by the plant.

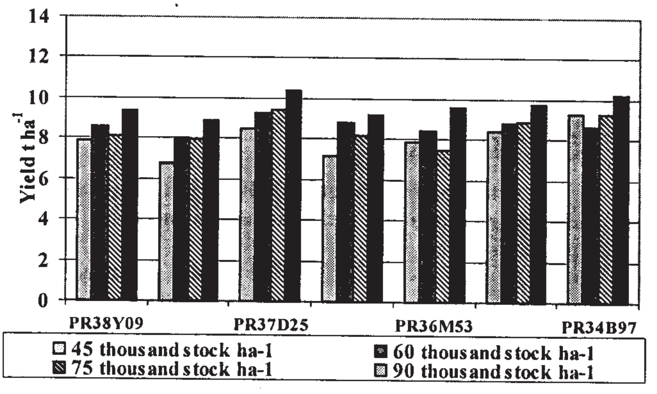

Figure 1: The effect of plant density on yield, 2003

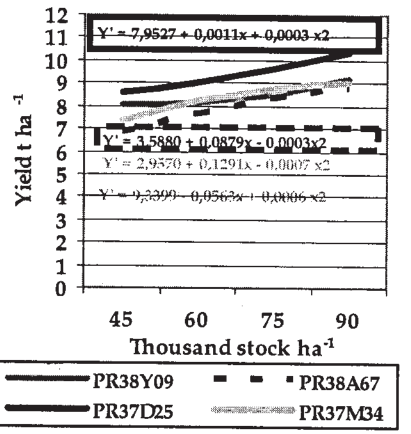

Figure 2: Relationship between the plant density and the yield of maize hybrids, 2003

The average yield of hybrids ranged between 6.75 t ha^{-1} and 10.42 t ha^{-1}. The highest yield at 90000 plants ha^{-1} plant density was obtained at the hybrids PR37D25 (10.42 t ha^{-1}), PR34B97 (10.24 t ha^{-1}) and PR36070 (9.79 t ha^{-1}).

When examining the yield-determining elements, we have found that the ear length of PR38Y09 was not influenced by plant density. However, ear length was the highest at 45-60 thousand plants ha^{-1} for all other hybrids, and it decreased with the increasing plant density. The number of kernel rows was influenced by plant density only at hybrids PR36M53 and PR38Y09, being the highest at 45 thousand plants ha^{-1} for these hybrids. The number of kernels in one row was higher at a higher plant density for the hybrids PR38Y09, PR34B97 and PR37M34, while for other hybrids it decreased with increasing plant density.

As a result of increasing plant density, the thousand kernel weight reduced for all hybrids. The highest value was measured at 60 000 plants ha^{-1} for PR3M34 (346.25 g), while for PR36N70 the highest kernel weight (335.0 g) was observed at the lowest plant density.
The moisture content of hybrids was low due to the dry weather. However, we noticed that the optimal plant density (60-75 thousand plants ha^{-1}) was the most favourable for water loss.
Due to the favourable year, the yield of best hybrids reached or exceeded 15 t ha^{-1} in 2004 (Figure 3). The highest yield was obtained at the highest plant density for all hybrids. However, the relationship between plant density and yield was significant only until reaching 75 000 plants ha^{-1} plant density. The best performance was obtained at the hybrids with a long vegetation period: PR36K20 (15.83 t ha^{-1}), PR35Y54 (15.8 t ha^{-1}) and PR34H31 (15.79 t ha^{-1}). In the wet year, the hybrids with a long vegetation period also responded well to increasing plant density.

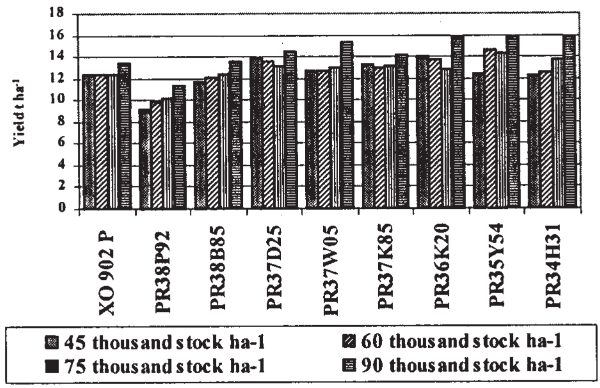

Figure 3: The effect of plant density on yield, 2004

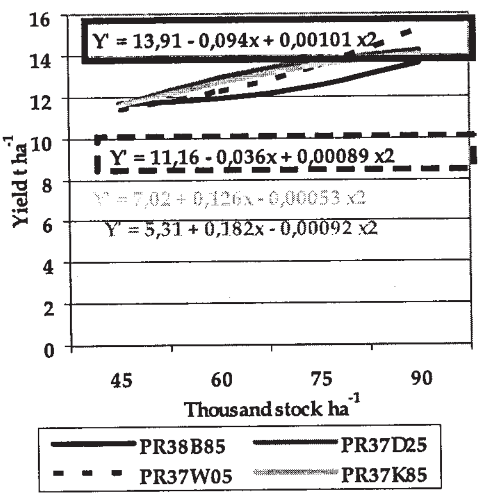

Figure 4: Relationship between the plant density and the yield of maize hybrids, 2004

Yields in this year increased proportionally with the increasing plant density (Figure 4). Yield was 14-15 t ha^{-1} at 90 000 plants ha^{-1} plant density. There was a tight correlation between yield increment and the increase in plant density. At a higher plant density, yield was significantly higher in almost all cases.
The fact that plant density did not influence ear length significantly was probably due to the favourable amount and distribution of precipitation. In wet years, the higher yields are obtained at higher plant densities, because the increase in plant density has a less negative effect on the individual yield (size of the ear) compared to a dry year. For hybrids XO 902 P and PR38P92, the difference was larger than 1.5 cm at different plant densities. Plant density did not have a significant effect on the number of kernel rows in this year either. Regarding the number of kernels, the reaction of the hybrids varied greatly. For XO 902 P, the number of kernels in one row was the lowest at 90 000 plants ha^{-1} density, while it did not change significantly at other plant densities. For PR38P92, the number of kernels in one row was the lowest at 45 000 plants ha^{-1} density and it increased with increasing plant density. For PR38B85 and PR35Y54, the number of kernels in one row was the highest at 45 000 plants ha^{-1} density and it decreased with increasing plant density. The difference in the response of hybrids can be explained by the different genetic characteristics.
The thousand kernel weight was very high for all 9 hybrids. In most of the cases, plant density did not have a modifying effect on it. This is also due to the even distribution of precipitation. As regards the moisture content of kernels, the same can be stated as in the previous year. It was lower in the more dense stock of plants. However, these values are much higher compared to those of 2003, ranging between 25-30% for the late-maturing hybrids.

Conclusions

Plant density is such an agrotechnical element the application of which does not require additional costs but only expertise. Such a high plant density (90 000 plants ha^{-1}) as applied in the experiments cannot be recommended for the practice even in a wet year. In droughty years, a lower plant density should be applied. Besides the optimal plant density, an optimal plant density interval should be determined for the different hybrids. Within this interval, we should choose that is optimal for us, which is influenced by the genetic characteristics, the year effect and the applied agrotechnique. In a dryer year, we should use the lower limit value, while in wet years or under irrigation the number of plants per hectare should be near the upper limit of the interval.

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