EFFECT OF SOWING TECHNOLOGY ON GRAIN YIELD OF MAIZE HYBRIDS

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Abstract

The yield and crop safety of maize are influenced by numerous ecological, biological and agrotechnical factors. It is of special importance to study one of the agrotechnical elements, the sowing technology of maize hybrids.

We have examined the effects of sowing technology on five maize hybrids of various genotype in a field experiment. The plant densities were 50, 70 and 90 thousand ha^{-1}, while the row distances were 45 and 76 cm. The experiment was set on the Látókép Experimental Farm of the University of Debrecen in 2013. The experiment was set in four replications, on chernozem soil. In the experiment Sarolta, DKC 4014, P 9175, PR 37M81 and P 9494 hybrids were used.

According to our experimental results, we have concluded that the increase of the plant density, the yield increased much more at the narrow row spacing. In the average of the hybrids the yield was higher at the 45 cm row spacing and at the plant density was 70 and 90 thousand plant ha^{-1}. In addition to plant density increase, it is necessary to determine the optimal plant density that the most favourable for the certain hybrid under the given conditions. To fulfil this aim, we have determined the optimal plant density corresponding to the maximum yield of the given hybrid, within the given plant density range. The optimal and applied plant densities numbers differ, since the optimal one could only be applied under ideal conditions. Since the agrotechnical actions cannot always be carried out in appropriate quality and one has to adapt to the weather conditions, thus we have determined a plant density range in the case of each hybrid.

Key words: maize, hybrids, row spacing, plant density, grain yield

INTRODUCTION

Shapiro and Wortmann (2006) found that decreasing row spacing from 0.76 to 0.51 m resulted in 4% more grain yield. Widdicombe and Thelen (2002) their results showed that corn grain yield increased 2 and 4 % when row width was narrowed from 76 cm to 56 cm and 38 cm. According to Lutz et al. (1971), Andrade et al. (2002) grain yields were increased as the width between rows decreased. Hunter et al. (1970) found that all hybrids that they examined increased in grain yield with each increase in population and gave small but significant yield increases to narrowing the row width. Gozubenli et al. (2004) found that, grain yield gradually increased with increasing plant densities up to 90000 plants ha^{-1} (10973 kg ha^{-1} mean). According to Mohenseni et al. (2013) the highest yield (11.14 t ha^{-1}) was produced in 80000 plants ha^{-1}. The lowest grain yield (9.09 t ha^{-1}) was produced in 60000 plants ha^{-1}. Plant density had not significant difference in 60000 and 70000 densities on grain yield.

According to Sárvári et al. (2002), in addition to the determination of the optimal plant numbers, the plant number optimum intervals of the hybrids have to be also determined, and their lower values have to be applied during production.

MATERIAL AND METHOD

We have investigated the plant number reactions of the maize hybrids of various genotypes in a field experiment in 2013, on the Látókép Experimental Farm of the University of Debrecen. In the experiment, we have applied the agrotechnique of the modern maize production. In the experiment, we have studied the plant number reactions of five maize hybrids (Sarolta, DKC 4014, P 9175, PR 37M81 and P 9494), in four replications. Three plant numbers (50, 70 and 90 thousand ha-1) and two row distances (45 and 76 cm) were set.

Table 1

The more important meteorological data in the maize vegetation period (Debrecen, 2013)

Months	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**Total/ Average**
Precipitation (mm) 30-year	33.5	42.4	58.8	79.5	65.7	60.7	38.0	379.2
Precipitation (mm)	136.3	48.0	68.7	30.8	15.6	32.2	47.6	378.6
Difference (mm)	102.8	5.6	9.9	-48.7	-50.1	-28.5	9.6	0.6
Temperature (^{o}C) 30-year	5.0	10.7	15.8	18.7	20.3	19.6	15.8	15.1
Monthly average	2.9	12.0	16.6	19.6	21.2	21.5	14.0	15.4
Difference (^{o}C)	-2.1	1.3	0.8	0.9	0.9	1.9	-1.8	0.3

During the vegetation period of maize (1/3–30/9/2013), the precipitation was 379.2 mm, which was practically identical to the 30-year average. In 2013, the high amount of precipitation in March (136.3 mm) was decisive, which refilled the water supply of the soil. The average temperature of the vegetation period was 15.4 ^{o}C, which slightly exceeded the multi-year average.

For the statistical analyses of the experiment, we have applied bi-factorial variance analysis (LSD, p=5%) with Microsoft Office Excel programme. The determination of the plant number interval was carried out with the application of regression equations with Excel. The determination of the plant number optimum intervals of the hybrids was conducted by the application of the LSD5% values with the consideration of the maximum yields.

RESULTS AND DISSCUSSION

In the year 2013, we have investigated the effects of the plant density increase and the application of different row distances on the yields of five hybrids of various genotypes.

The average yields of the hybrids at the 45 cm row spacing were as follow: 13.4 t ha^{-1}, at the plant density of 50 thousand ha^{-1}, 14.6 t ha^{-1} at 70 thousand ha^{-1}, and 15.5 t ha^{-1} at 90 thousand ha^{-1}. The increase of the plant density from 50 to 70 thousand ha^{-1} meant 8.12%, while that from 70 to 90 thousand ha^{-1} meant 5.69% yield amount increase. In contrast, at the 76 cm row spacing, the yields of the hybrids were the following: 13.6 t ha^{-1}, at the plant density of 50 thousand ha^{-1}, 14.0 t ha^{-1} at 70 thousand ha^{-1}, and 13.5 t ha^{-1} at 90 thousand ha^{-1}. The increase of the plant density from 50 to 70 thousand ha^{-1} meant 2.47 t ha^{-1} yield amount increase, while that from 70 to 90 thousand ha-1 meant -3.65% yield amount decrease. To summarize these findings, we can conclude that the highest yield excesses were resulted by the increase of the plant density from 50 to 70 thousand ha^{-1} at both applied row distances.

In the average of the hybrids, the decrease row spacing (from 76 to 45 cm), at the stock density of 50 thousand ha^{-1} resulted in -1.95% (-214 kg ha^{-1}) yield reduction, at 70 thousand ha^{-1} 4.29% (626 kg ha^{-1}), while at 90 thousand ha^{-1} 12.92% (1998 kg ha^{-1}) yield excess in the examined hybrids.

The hybrids of various genotypes responded to the changes of the plant density and row spacing differently. To the decrease of the row spacing, P 9494 responded with yield excess in all applied plant densities. The decrease of the row spacing caused yield decrease at the plant number 50 thousand ha^{-1}; the highest decrease was experienced in the hybrid P 9175: 12.44% (1754 kg ha^{-1}).

Table 2

The yields (t ha^{-1}) of the studied maize hybrids at different row distances and plant densities (Debrecen, 2013)

Grain yield (t ha^{-1})								
Hybrids	**Row spacing**							
	45 cm				**76 cm**			
	Plant density (thousand ha^{-1})			**Average**	**Plant density (thousand ha^{-1})**			**Average**
	50	**70**	**90**		**50**	**70**	**90**	
Sarolta	10.8	12.6	12.9	12.1	11.9	12.0	11.8	11.9
DKC 4014	13.0	13.2	14.8	13.7	12.2	13.8	12.8	12.9
P 9175	14.1	16.8	17.6	16.2	15.9	15.9	15.2	15.7
PR 37M81	12.5	12.9	14.4	13.2	13.0	12.5	13.2	12.9
P 9494	16.7	17.5	17.7	17.3	15.1	15.6	14.3	15.0
Average	13.4	14.6	15.5	14.5	13.6	14.0	13.5	13.7

SzD5% (A)	741 kg ha^{-1}	678 kg ha^{-1}
SzD5% (B)	564 kg ha^{-1}	525 kg ha^{-1}
SzD5% (A*B)	1283 kg ha^{-1}	1174 kg ha^{-1}

Every hybrid responded with yield excess to the increase of the plant density from 50 to 70 thousand ha^{-1} at the row spacing of 45 cm; at 76 cm the yield of PR 37M81 decreased, while that of the other examined hybrids increased. The increase of the plant density from 70 to 90 thousand ha^{-1} did not cause yield decrease at the row spacing of 45 cm, while at 76 cm Sarolta, DKC 4014, P 9175 and P 9494 responded to the plant density increase with yield decrease.

We have determined the optimal plant density corresponding to the yield maximum with regression equations in the range between 50 and 90 plant ha^{-1} (Figure 1, 2). During our calculations, we have determined the lower and upper values of the plant density interval only in the range of 50 to 90 thousand plant ha^{-1}.

As an effect of the application of different row distances, there were significant differences in the yield amounts of the studied hybrids. The changes of the plant density resulted in significant differences both of examined row spacing.

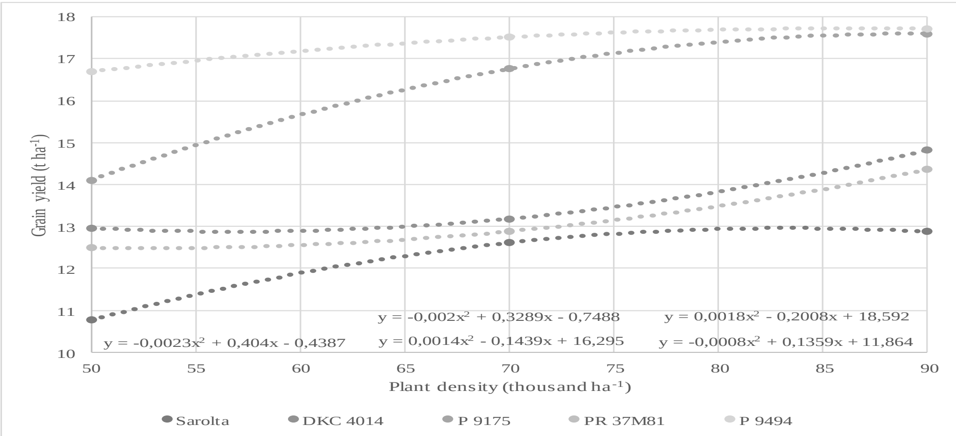

Figure 1: Relationship between the yields of the studied maize hybrids and plant density at 45 cm row spacing (Debrecen, 2013)

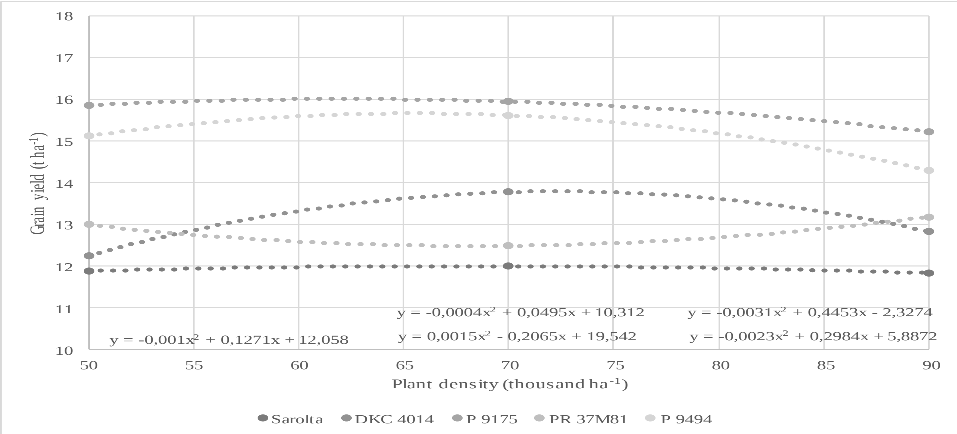

Figure 2: Relationship between the yields of the studied maize hybrids and plant density at 76 cm row spacing (Debrecen, 2013)

It is necessary to determine that plant number range within which the certain hybrid adapts to plant density increase. At the row spacing of 45 cm, the optimal plant density was 72,432 plant ha^{-1}; the plant density interval was 63.7-76.1 thousand plant ha^{-1}. At the row spacing 76 cm, the optimal plant density was 66,190 plant ha^{-1}; the plant number interval was in the range of 56.8 to 78.9 thousand $plant^{-1}$. Generally, the plant density close to the lover end-point of the interval has to applied in favour of crop safety, but it can vary depending on the crop year.

On the basis of the with of the interval, hybrids can be classified as ones producible in narrow or broad plant density interval. At he row spacing of 45 cm, the width of the interval was much narrower, the narrowest was DKC 4014, the broadest were in the cases of hybrids Sarolta and P 9494.

Table 3

Maximum grain yield and plant number optimums and interval of the studied maize hybrids (Debrecen 2013)

Hybrids	**Row spacing (45 cm)**				**Row spacing (76 cm)**			
	Opt. plant density	**Plant density interval**	**Inter val with**	**Max. grain yield**	**Opt. plant density**	**Plant density interval**	**Inter val with**	**Max. grain yield**
Sarolta	82.225	70,5-90,0	19,5	12.77	61.875	50,0-87,5	37,5	11.84
DKC 4014	55.778	54,5-57,0	2,5	12.99	71.823	63,0-81,0	18,0	13.66
P 9175	87.826	77,0-90,0	13,0	17.30	63,550	50,0-79,5	29,5	16.10
PR 37M81	51.393	50,0-53,5	3,5	12.60	68.833	66,5-71,0	4,5	12.43
P 9494	84.938	66,5-90,0	23,5	17.64	64.870	54,5-75,5	21,0	15.57
Average	72.432	63,7-76,1	12,4	14.66	66.190	56,8-78,9	22,1	13.92

CONCLUSIONS

Similarly to the research results of Shapiro and Wortman (2006), in the year of 2013, under the given weather, agrotechnical conditions, the decrease of the row distance from 76 to 45 cm resulted in increasing yield excess in the average of the hybrids, above the plant number of 50,000 plant ha^{-1}. The hybrids of various genotypes responded to the changes of the plant number and row distance differently. In the cases of the studied plant numbers and row distances, the applied hybrids caused significant differences in the development of the yield amounts. During their research, Hunter et al. (1970) also found that the yield of every hybrid increased with the increase of the plant number; and the decrease of the row distance significantly increased yield, although, not in a great extent. As an effect of the application of different row distances, there were significant differences in the yield amounts of the studied hybrids.

We have determined the plant number optimums and intervals, but there were hybrids, the yields of which linearly increased, therefore, the above parameters were not applicable. Based on the determination of the plant number optimum, at the row distance of 45 cm, higher plant numbers can be applied in the case of most of the hybrids; while at 76 cm, the case is the opposite, lower plant numbers are favourable for the majority of the hybrids. On the basis of the interval width, we can distinguish between hybrids producible in narrow and broad plant density interval.

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