DETERMINING ELEMENTS OF VARIETY-SPECIFIC MAIZE PRODUCTION TECHNOLOGY

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Abstract

In order to enchance the adaptability and yield stability of maize, the effect of nutrient supply and plant density on yield was studied on a calcareous meadow soil in Hajdúböszörmény. The effect of these crop rotation and planting time and grain moisture at harvesting time is also influenced by the close correlation between ecological and biological factors.The yield of maize in monoculture crop rotation decreased by 1-3 t ha^{-1} in each dry year during our experiment.
The fore crop determined the doses of fertilizers mainly influenced the doses of nitrogen. In triculture (peas – wheat – maize) crop rotation (after wheat fore crop) The optimum N-dose was 50-60 kg ha^{-1}, and in monoculture the optimum N-doses increased to 100-120 kg ha^{-1}. In monoculture crop rotation the soil fertility and the microbiological activity of soil is decreased. At early planting time the grain moistures wereless by 5-12 % lower compared to the late planting time. A 10 thousand plants ha^{-1} change in stock density can increase yield by 1.5-2.0 t ha^{-1}.

Keywords: crop rotation, monoculture, plant density, planting time, fertilization.

INTRODUCTION

Maize yields are largely dependent upon nutrient supply, sowing date and plant density.In earlier years Hungary was one of the leading countries in the world as regards the yields achieved in maize production (Menyhért, 1979), but at present besides unfavourable changes in climatic conditions, the level of NPK fertilization has also decreased. Kádár (2000) drew attention to the fact that fertilization should aim at supplementing deficient nutrients. Therefore, when planning fertilization, the amount of nutrients removed by the yield should be taken as the basis. According to Sárvári (1995), if both efficacy and environmental aspects are considered, the most favourable rate of N for maize on meadow soil is 60–120 kg ha^{-1} active ingredients, depending on the fore crop and the year.

According to the results of Balás–Hensch (1889), Fleischmann (1938), I'só (1959) and Pásztor (1958), the following factors should be taken into consideration when determining the optimal sowing time of maize: changes in temperature during the vegetation period, the date and frequency of frosts in late spring and early autumn, the composition and location of the soil.

In experiments on the growth dynamics of 5 hybrids with different vegetation periods, Berzsenyi et al. (1998) found that earlier sowing enhanced reproductive growth, while later sowing increased the early vegetative growth. Sárvári and Futó (2001) found a close correlation between sowing time and both yield and grain moisture content at harvest. The relationship between sowing time and yield was highly influenced by the distribution of precipitation during the vegetation period. Earlier sowing reduced the grain moisture content at harvest by 5–8%, which is a great advantage economically.

Széll and Csala (1984) found that, besides the response of the hybrid to increased plant density, the achievement of optimal plant density was primarily dependent upon the water and nutrient supplies.

Bocz (1974) determined that among the three major nutrients, a higher fertilizer rate may result in higher yields, but it can also have a greater negative effect under unfavourable conditions.

These agrotechnical factors exert their effect via interaction and not independently (Pepó, 2007).

MATERIAL AND METHODS

The soil of our experimental projects was meadow soil. The soil could be characterized by high clay content and pour phosphorus and medium potassium contents. Among the soil characteristic parameters it's important that the phosphorus and potassium fixation are very high.

In the last decade from ten years six years were dry and hot in our region. So the importance of crop-rotation is increasing and we have to intend to use appropriate crop rotation. The water demand of maize is fairly moderate, but the sensibility of maize to drought is high among the field crops.

Due to climate change, the weather extremes have increased. The 30-year average of precipitation in the Debrecen region – in the vegetation period of maize – was 345.1 mm. In the last decade from nineteen years nine years were dry and hot in our region. So the importance of crop-rotation is increasing and we have to intend to use appropriate crop rotation. The water demand of maize is fairly moderate, but the sensibility of maize to drought is high among the field crops *(Figure 1.)*.

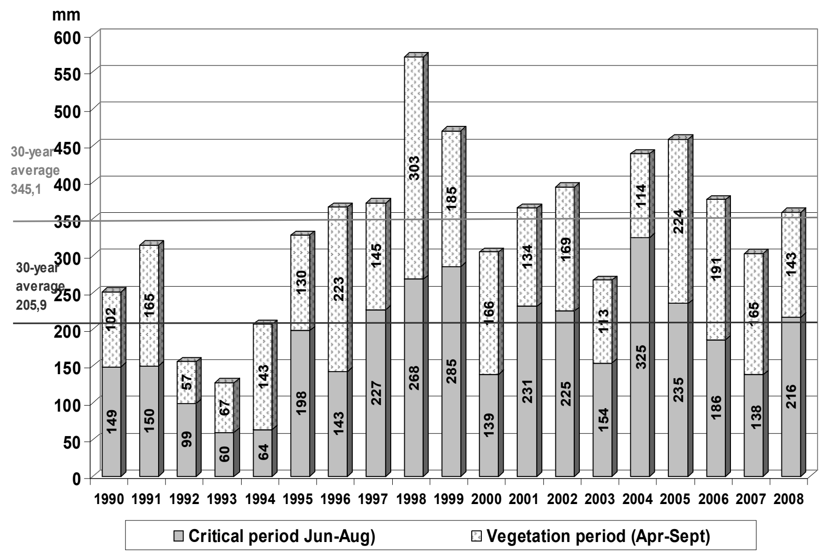

Figure 1. Precipitation data (mm) Hajdúböszörmény, 1990-2008

The 30-year average of the annual mean temperature was 9.84 ^oC, which increased by 1.5-2 ^oC in the past decades *(Figure 2.)*.

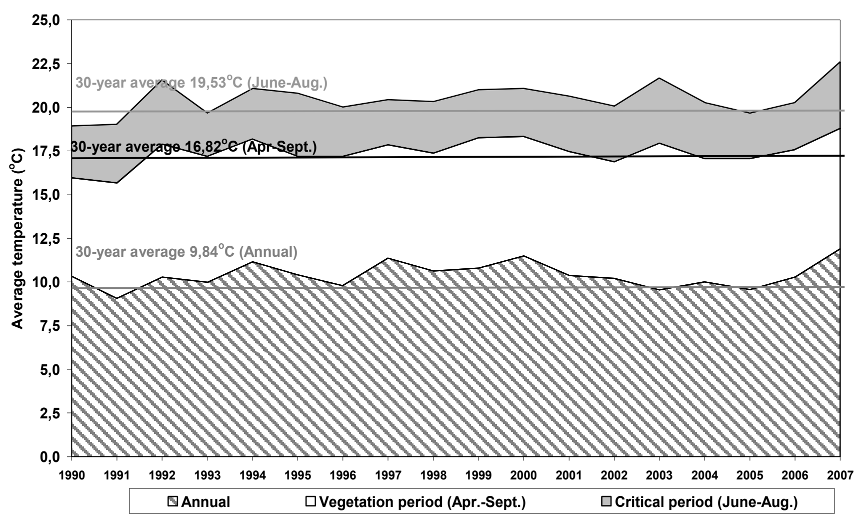

Figure 2. Temperature data (^oC) Hajdúböszörmény, 1990-2007

Table 1

The fertilizer rates (active ingredient kg ha^{-1} applied in the fertilization experiments.

Treatment	N	P_2O_5	K_2O
1	0	0	0
2	40	25	30
3	80	50	60
4	120	75	90
5	160	100	120
6	200	125	150

The plant densities were 20-100 thousand plants ha^{-1}. Sowing time experiment: 15. April, 25-27. April, 15-17. May.

The results were evaluated by analysis of variance parabolic regression analysis.

RESULTS AND DISCUSSION

The yields of maize in monoculture crop rotation decreased by 1-3 t ha^{-1} in each dry year during my experiment. The most favourable fore crop of maize was wheat, medium was the biculture crop rotation and the worst crop rotation was the monoculture *(Figure 3.)*.

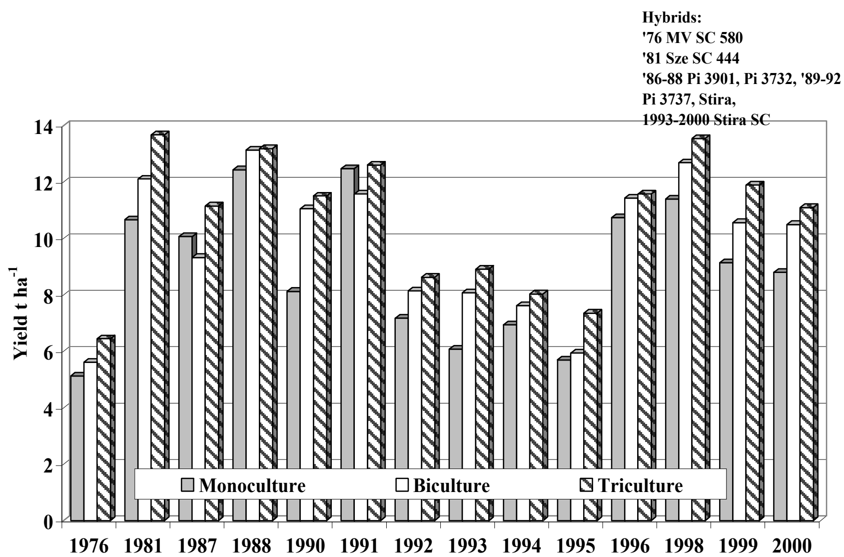

Figure 3. Effects of forecrops on maize yields
1976-2000

From the aspects of effectiveness and environmental protection the optimum fertilizer doses of maize hybrids are N 60-120, P_2O_5 45-90, K_2O 53-106 kg ha^{-1} depending on fore crop and crop year.

There is a strong correlation between the planting time and the yield of maize hybrids, but this interactive effect can be modified by the amount and distribution of precipitation in vegetation period. There is a stronger, even significant correlation between planting time and grain moisture at harvesting time.

At early planting time the grain moistures were less by 5-12 % lower compared to the late planting time and 4-5 % lower compared to the optimum planting treatment.

The optimum plant density depends on the genotype of hybrids, on agroecological conditions, on the effects of crop year, on the water- and nutrient supply and on the intensity of production.

A 10 thousand plants ha^{-1} change in stock density can increase yields by 1.5-2 t ha^{-1}, but over the optimum level yields are reduced.

Optimum plant density is modified by:

- the genetic characteristics of the hybrid,
- vegetation period of the hybrid,
- the growing site,
- the year effect,
- water and nutrient supply.

A higher than optimum plant density:

- increases water demand,
- increases the ratio of sterile plants,
- reduces the yield, increases the grain moisture per hectare, because the leaves dry early.

There are big differences among the plant density of different maize hybrids. There are hybrids sensitive to higher plant density and there are wide and narrow optimum plant density hybrids.

There are hybrids the yield of which reduces already above 60 thousand plants per hectare and there are hybrids with yields increasing up to 80 thousand plants per hectare *(Figure 4.)*.

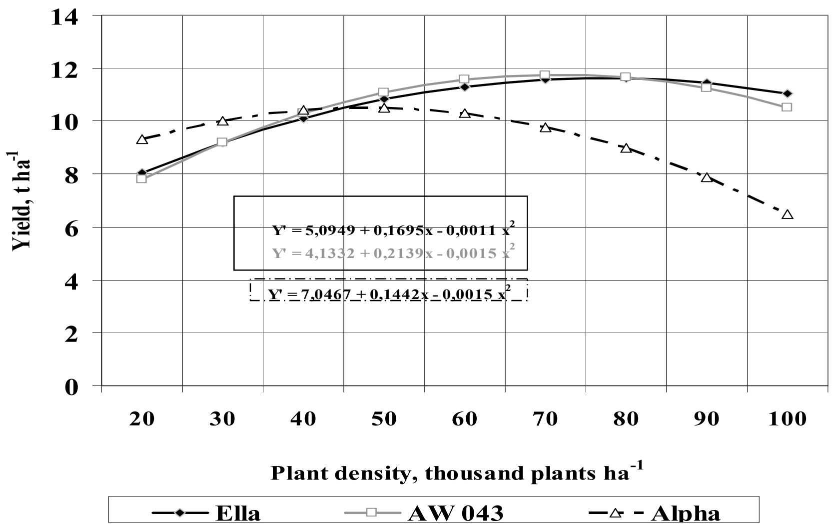

Figure 4. Relationship between plant density and the yield of maize hybrids Hajdúböszörmény, 1999

Considering the fact that the frequency of drought crop years increased and the usage of fertilizers dropped in the last ten years we suggest that the optimum plant density is 68-72 thousand ha^{-1} in the case of 200-300 FAO hybrids and 60-65 thousand ha^{-1} in 400-500 FAO hybrids.

In the next figure, the correlation between plant density and yield is presented again *(Figure 5.)*.

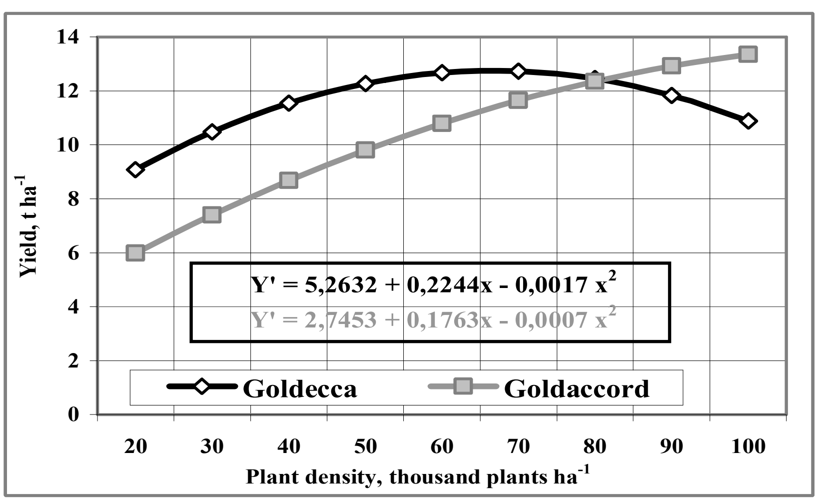

Figure 5. The effect of increasing plant density on the yield of hybrids in the studied period (2004)

In addition to optimum plant density, the optimum plant density interval to which the hybrids do not respond with yield reduction should also be determined (Table 2.).

Table 2

.Optimum plant density of the maize hybrids, 2001

Hybrid	Yield in the average of plant densities (t ha^{-1})	Optimum plant density (thousand plants ha^{-1})	Optimum plant density interval (thousand plants ha^{-1})	Interval range (thousand plants)	R^2 value of parabolic regression
Sprinter FAO 260	7.94	88	80-96	16	0.8933
PR39K38 FAO 290	9.70	90	80-90	10	0.7959
Sze 278 FAO 310	9.50	77	70-83	13	0.9000
Borbála FAO 310	8.85	86	79-93	14	0.8251
DK 391 FAO 320	11.76	79	73-85	12	0.5589
DK 440 FAO 330	12.81	60	60-80	20	0.5334
PR38M81 FAO 360	11.76	86	77-95	22	0.6693
PR37M34 FAO 370	12.82	78	72-84	12	0.9119
LG 23.94 FAO 370	12.97	86	81-91	10	0.9303
Celest FAO 440	13.70	69	62-76	14	0.5994
PR36R10 FAO 180	13.06	70	70-90	20	0.9617
PR36B08 FAO 500	13.39	79	73-84	11	0.7067
Mean	*11.52*	*79*		*14.5*	
SD5%	*Plant density*** *Hybrid**** *Interaction***	*0.62* *0.70* *2.14*			

CONCLUSIONS

We can summarize our results by saying that we have to use hybridspecific technologies in maize production. In the future we have to increase the level of inputs and have to apply the best appropriate hybrids and respecting to agroecologial conditions we can better utilize the genetic yield potential.

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