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Effect of hybrid and plant density on grain yield and yield components of maize (*Zea mays*)

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ABSTRACT

A study was carried out to find out optimum plant densities for maize (*Zea mays* L.), hybrids mostly cultivated as a second crop in Hatay, Turkey, during 2000 and 2001. Five maize hybrids ['Cargill 6127', 'Dekalb 626,' 'Dracma' ('Novartis'), 'Pioneer 3394' and Ttm 815] were examined at 6 plant densities [50,000, 60,000, 70,000, 80,000, 90,000 and 100,000 plants/ha]. The effects of hybrids and plant densities on yield and yield components were statistically significant, however, hybrid × plant density interaction effects were not significant. The highest grain yield was obtained from 'Dracma' and 'P 3394' hybrids (9,591 kg/ha and 9,170 kg/ha respectively). Grain yield increased with increasing plant densities up to 90,000 plants/ha (9,406 kg/ha) but slightly decreased at 100,000 plants/ha.

Key words : Maize, Hybrid, Plant density, Grain yield

Maize is one of the major cereal crops cultivated in the World. There have been many studies to determine the optimum plant density for corn. However, there is no single recommendation for all environmental factors as well as controlled factors such as soil fertility, hybrid selection, planting date and planting pattern (Olson and Sander, 1988).

The impact of plant density on cron yield has been studied extensively, as it varies substantially with genotype, management practice, location and year. Yield increases with increasing plant density up to a maximum for a corn genotype grown under a set of particular environmental and management conditions, and declines when plant density is increases further (Tollenaar *et al.*, 1994).

Larsen and Clegg (1999) found a full-season hybrid to give maximum yield at 85,000 plants/ha in central and eastern Nebraska. Farnham (2001) determined that corn grain yield increased from 10.1 to10.8 tonnes/ha as plant density increased from 59,000 to 89,000 plant/ha.

The objective of this study was to characterize optimum plant densities for maize hybrids mostly cultivated as a second crop within a year in Hatay ecological conditions.

MATERIALS AND METHODS

A field experiment was conducted at Mustafa Kemal University, Agricultural Faculty Research Farm, as a second crop of the year after wheat harvest during 2000 and 2001. The soil was clay loam having pH 7.7, and low in available phosphorus and organic matter content.

The experimental field was prepared after wheat harvest in June and corn seeds were hand-planted on 26 June in 2000 and at 22 June in 2001. N, P and K (90 kg/ha) was applied and mixed into soil before planting and N (180 kg/ha) was applied at knee-high stage as top-dressing. Weed control and irrigation were done when necessary.

The experiment was laid out in split-plot design with 3 replications. Maize hybrids ['Cargill 6127', 'Dekalb 626', 'Dracma' ('Novartis'), 'Pioneer 3394' and 'TM 815'] represented main plots and plant densities [50,000; 60,000; 70,000; 80,000; 90,000; and 100,000 plants/ha] represented subplots. Subplots were 4 rows (70 cm) wide by 5 m long.

Grain yield (adjusted to 15% moisture) and yield components (plant height, ear height, stem diameter, ear length, ear diameter, grain weight/ear) were determined in the centre 2 rows of each sub-plot.

RESULTS AND DISCUSSION

The effect of corn hybrids and plant densities on yield and yield components were significant during both years, with the exception of hybrid effect on ear height and grain weight/ear in 2001 and effect of plant density on ear height in 2001. Hybrid × plant density interaction effects were not statistically significant in both years. There were no significant interaction effects in combined analysis of 2 years except for year × plant density interaction for stem diameter and yield. Also hybrid and plant density effects were significant for all traits.

Table 1. Effects of hybrids on yield and yield components of maize in Hatay-Turkey

Hybrid	Plant height (cm)	Ear height (cm)	Stem diameter (mm)	Ear length (cm)	Ear diameter (mm)	Grain weight/ ear(g)	Grain yield (kg/ha)
			2000				
'C 6127'	189.0	97.6	18.7	17.4	42.0	148.8	8,130
'D 626'	204.9	98.3	20.1	15.3	48.6	172.2	9,272
'Dracma'	197.1	98.7	20.7	18.6	47.1	190.0	10,249
'P 3394'	191.8	99.2	18.8	16.8	47.7	177.8	9,426
'Ttm 815'	210.6	108.1	21.1	17.0	46.8	186.9	8,783
CD (P=0.05)	11.7	5.5	1.7	0.9	1.1	26.5	927
			2001				
'C 6127'	168.4	87.3	19.2	20.4	42.4	138.4	8,281
'D 626'	188.0	88.0	20.5	17.1	48.1	141.9	7,556
'Dracma'	161.8	72.2	19.5	18.5	47.0	145.3	8,933
'P 3394'	169.8	84.2	17.9	17.5	47.6	144.8	8,914
'Ttm 815'	184.8	95.0	20.6	17.1	47.8	137.8	7,813
CD (P=0.05)	7.4	NS	0.9	1.3	1.3	NS	742
			Mean				
'C 6127'	178.7	92.4	19.0	18.9	42.2	143.6	8,206
'D 626'	196.4	93.2	20.3	16.2	48.4	157.1	8,414
'Dracma'	179.4	88.0	20.1	18.5	47.1	167.6	9,591
'P 3394'	180.8	91.7	18.4	17.1	47.6	161.3	9,170
'Ttm 815'	197.7	101.5	20.8	17.0	47.3	162.4	8,298
CD (P=0.05)	6.4	6.6	0.9	0.7	0.8	13.7	546

Table 2. Effects of plant densities (plants/ha) on yield and yield components of maize in Hatay-Turkey

Density (plant/ha)	Plant height (cm)	Ear height (cm)	Stem diameter (mm)	Ear length (cm)	Ear diameter (mm)	Grain weight ear (g)	Grain yield (kg/ha)
			2000				
50,000	196.4	98.5	22.4	19.1	48.1	213.6	8,319
60,000	198.6	98.3	20.6	17.7	46.8	190.0	8,737
70,000	196.5	98.8	19.6	17.1	46.6	176.3	9,002
80,000	196.6	100.0	19.1	16.3	45.8	160.9	9,237
90,000	201.0	102.5	18.7	16.0	45.6	155.8	9,955
100,000	202.9	104.0	18.9	15.7	45.8	154.2	9,782
CD (P=0.05)	6.4	3.8	0.9	0.8	0.7	14.5	846
			2001				
50,000	172.8	85.2	20.7	19.3	47.2	168.3	7,323
60,000	173.7	86.5	20.3	19.0	46.9	155.9	7,921
70,000	171.5	84.6	19.6	18.4	46.6	139.3	8,091
80,000	174.9	86.7	19.4	17.8	46.6	140.1	8,920
90,000	175.8	86.0	18.9	17.6	46.6	128.5	8,857
100,000	178.7	89.0	18.3	16.7	45.6	117.8	8,685
CD (P=0.05)	4.7	NS	0.8	1.0	0.9	11.4	740
			Mean				
50,000	184.6	91.9	21.6	19.2	47.6	190.1	7,821
60,000	186.1	92.4	20.5	18.3	46.9	172.9	8,329
70,000	184.0	91.7	19.6	17.8	46.6	157.8	8,546
80,000	185.7	93.4	19.3	17.1	46.2	150.5	9,078
90,000	188.4	94.3	18.8	16.8	46.1	142.1	9,406
100,000	190.8	96.5	18.6	16.2	45.7	136.0	9,234
CD (P=0.05)	3.9	2.6	0.6	0.6	0.5	9.1	571

Performance of hybrids

Plant height, ear height and stem diameter were significantly affected by hybrids.

'Ttm 815' and 'D 626' had significantly taller plants (197.7 cm and 196.4 cm respectively, average) than other hybrids, the maximum ear height was in 'Ttm 815' (101.5 cm) as in plant height. Genotypic differences were observed for stem diameter, highest being in 'Ttm 815', 'D 626' and 'Dracma' (Table 1).

Plant height, stem diameter, and to some extent its yield potential are strongly influenced by environmental conditions during stem elongation, although there is considerable varietal variation in this characteristic (Duncan, 1975). Thiraporn *et al.* (1983) reported that there were varietal differences in plant and ear height. Similar observations, for plant height, ear height and stem diameter, were reported by Gozubenli *et al.* (2001).

Differences among ear characteristics of maize hybrids were significant. 'C 6127' and 'Dracma' had the longest ears, although 'D 626' and 'P 3394' hybrids had maximum ear diameter of 48.4 mm and 47.6 mm respectively. Grain weight/ear differed according to hybrid and highest values were obtained from 'Dracma', 'Ttm 815' and 'P 3394' hybrids (167.6 g, 162.4 g, 161.3 g respectively) (Table 1). These results are in corroboration with findings of Konuskan (2000).

The highest grain yield was obtained from 'Dracma' and 'P 3394' (Table 1). Farnham (2001) observed that there was a significant hybrids effect for grain yield, similar to the findings in the present study.

Responses to plant density

Plant characteristics of maize were significantly affected by plant densities. Higher plant densities produced taller plants and greater ear height with lower stem diameter (Table 2). Similar results were also reported by Konuskan (2000).

Ear length, ear diameter and grain weight/ear decreased with increasing plant densities. The highest ear length, ear diameter and grain weight/ear were obtained from the lowest (50,000 plants/ha), plant density (19.2 cm, 47.6 mm and 190.1 g, respectively), and the lowest values were obtained from the highest (100,000 plants/ha) plant density (16.2 cm, 45.7 mm, 136 g respectively; Table 2). The yield reduction/plant may be due to the effects of inter-plant competition for light, water, nutrients, and other yield limiting environmental factors (Olson and Sander, 1988). Grain yield increased with increasing plant densities up to 90,000 plants/ha (9,406 kg/ha, average), but slightly decreased at 100,000 plants/ha in both years and there were no significant differences among 80,000 plants/ha, 90,000 plants/ha and 100,000 plants/ha densities (Table 2).

Grain yield is the product of crop dry-matter accumulation and the proportion of the dry matter allocated to the grain (i.e., harvest index) and harvest index in corn declined when plant density increased above the critical plant density. For instance, the optimum plant density for corn hybrid 'Pride 5' was determined as 9.1 plants/m^2 (Tollenaar *et al.*, 1994).

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