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Effects of Single and Twin Row Planting on Yield and Yield Components in Maize

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Abstract: Maize hybrids response differently to various plant density and row configurations. A two-year field experiment was conducted in Agricultural Faculty research farm at Mustafa Kemal University in 2000 and 2001 growing seasons, to compare single and twin-row planting pattern and to determine optimum plant density for maize hybrid Dracma, commercially grown in Eastern Mediterranean Region of Turkey. The experimental design was a randomized complete block in a split-plot arrangement with three replications. Main plots were plant densities of 60000, 75000, 90000, 105000, 120000 and 135000 plants ha^{-1}. Split-plots were planting patterns (single row and twin row). The effects of plant density and planting patterns on grain yield were statistically significant. Grain yield gradually increased with increasing plant densities up to 90000 plants ha^{-1} (10973 kg ha^{-1} mean), then decreased in higher plant densities. There were no significant differences between 90000 plants ha^{-1} and 105000 plants ha^{-1} densities. Twin row planting pattern out-yielded single row and 10398 kg ha^{-1} and 9986 kg ha^{-1} grain yield obtained, respectively. This increase is important since without any additional input or cost.

Key words: Grain yield, maize, plant density, twin row

INTRODUCTION

Recent developments in maize genetics have enhanced plant density in the maize production systems by narrowing and intensifying the rows[1]. Yield can be increased with increased plant density up to a maximum for some maize genotypes grown under a set of particular environmental and management conditions and declines when plant density is increased further[2]. Hybrids developed in recent years are able to withstand higher plant density levels and greater grain yield than older hybrids[3, 4]. Widdicombe and Thelen[5] reported that plant density had a significant effect on grain yield and the highest plant density level evaluated (90000 plant ha^{-1}) resulting in the highest grain yield may have been too low to establish the true plant density for maximum yield. Porter *et al*.[6] reported inconsistent optimal plant density levels ranging from 86000 to 101270 plants ha^{-1} for corn grain yield across three Minnesota locations. Farnham[7] revealed that, corn grain yield was increased from 10.1 to 10.8 t ha^{-1} as plant density increased from 59000 to 89000 plant ha^{-1}.

Many researches conducted to determine optimum plant density and row spacing by different researchers in last decades. However, researches on twin row planting configurations are still new and needs further evaluation. Although the yield advantages of twin row maize have been inconsistent across various environments[8,9], several studies reported yield increase with twin row system[10,11]. Because yield response to single or twin row configuration was affected by hybrid, plant density, year and location. One of the main advantages of twin row maize has been the cost savings from not having to make any modifications to the corn header or tractor tire spacing.

The objective of this study was to compare single and twin-row planting pattern and to determine optimum plant density for maize hybrid Dracma, commercially grown in Eastern Mediterranean Region of Turkey.

MATERIALS AND METHODS

Field experiments were 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 of experimental site was clay loam having a pH 7.7, with low concentration of available phosphorus (17.2 kg ha^{-1}) and low organic matter content (0.23%).

The experimental field was prepared after wheat harvest in June. In this two-year experiment, commercial maize hybrid Dracma seeds were hand-planted at 26 June in 2000 and at 22 June in 2001. N-P-K (90 kg ha^{-1} for each) was applied and mixed into soil before planting and N (180 kg ha^{-1}) was applied at knee-high stage as top dressing. Weed control and irrigation were done when necessary.

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The experimental design was a randomized complete block in a split-plot arrangement with three replications. Main plots were plant densities of 60000, 75000, 90000, 105000, 120000 and 135000 plants ha^{-1}. Split-plots were planting patterns (single-row and twin-row). Split-plot size was 3.2 m by 5.0 m with four single or twin rows per plot. Single rows were planted with 80 cm apart and twin rows together were 20 cm apart with 60 cm distance between pairs. Grain yield (adjusted to 150 g kg^{-1} moisture) and yield components (tasseling period, plant height, stem diameter, ear length, ear diameter, grain weight ear^{-1} and grain yield) were determined by taking the measurements from center rows from each plot[12]. Data were analyzed using standard analysis of variance (ANOVA) technique and means were separated using least significant difference (L.S.D.) comparisons.

RESULTS AND DISCUSSION

The experimental results showed that the effects of plant densities on yield and yield components were significant with the exception of tasseling period. Effects of planting pattern on stem diameter, grain weight ear^{-1} and grain yield were significant, but other characteristics were not affected by planting pattern. Plant density x planting pattern interaction effects were not statistically significant in both years.

Response to plant density: Plant characteristics and grain yield of maize were significantly affected by plant densities, but tasseling periods were not affected and similar tasseling periods were observed among plant densities with 54.4 days on average. Higher plant densities produced taller plants with lower stem diameter (Table 1). These results showed that there were differences among plant densities in plant height and stem diameter. Plant height inclined with increased plant density up to 120000 plant ha^{-1} (Table 1). Stem diameter decreased with the increased plant density and the thinnest stem diameter (16.9 mm) was determined at 135000 plant ha^{-1} and the thickest stem diameter (20.4 mm) was determined at 60000 plant ha^{-1} (Table 1). Plant height and stem diameter were strongly influenced by environmental conditions during stem elongation as expected. Some researchers reported that taller plants with lower stem diameter were obtained with higher plant densities as a consequence of interplant competitions[13,14].

Ear length, ear diameter and grain weight ear^{-1} decreased with increasing plant densities. The highest ear length, ear diameter and grain weight ear^{-1} were obtained at the lowest (60000 plants ha^{-1}) plant density (19.7 cm, 47.2 mm and 195.1 g, respectively) and the lowest values were obtained at the highest (135000 plants ha^{-1}) plant density (16.6 cm, 44.8 mm and 110.5 g, respectively,

Table 1: Tasseling period, plant height and stem diameter of maize grown in different seeding rates and planting patterns

Seeding rates ($pl\ ha^{-1}$)	Tasseling period (day) 2000	2001	Mean	Plant height (cm) 2000	2001	Mean	Stem diameter (mm) 2000	2001	Mean
60000	53.5	56.0	54.8	187.9	170.0	179.0	20.8	20.0	20.4
75000	53.5	56.3	54.9	190.0	172.1	181.0	20.0	19.6	19.8
90000	53.7	57.2	55.4	197.8	175.5	186.6	19.4	18.9	19.1
105000	54.2	57.3	55.8	198.7	173.4	186.0	18.4	17.9	18.1
120000	54.0	57.2	55.6	198.0	180.9	189.5	17.9	16.7	17.3
135000	54.2	58.0	56.1	196.0	176.8	186.4	17.6	16.3	16.9
L.S.D. (5%)	N.S.	N.S.	N.S.	N.S.	N.S.	3.8	1.7	1.2	1.0
Planting pattern									
Single row	53.9	57.1	55.5	195.3	175.2	185.2	18.9	17.9	18.4
Twin row	53.7	56.9	55.3	194.2	174.4	184.3	19.1	18.5	18.8
L.S.D. (5%)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	0.5	0.3

Table 2: Ear length, ear diameter, grain weight ear^{-1} and grain yield of maize grown in different seeding rates and planting patterns

Seedings rates ($pl\ ha^{-1}$)	Ear length (cm) 2000	2001	Mean	Ear diameter (mm) 2000	2001	Mean	Grain weight ear^{-1} (g) 2000	2001	Mean	Grain yield (kg ha^{-1}) 2000	2001	Mean
60000	20.0	19.4	19.7	47.8	46.5	47.2	205.2	185.0	195.1	10385	9128	9757
75000	19.2	19.3	19.3	47.6	46.0	46.8	189.0	166.8	177.9	11002	9745	10373
90000	18.9	18.1	18.5	47.2	45.4	46.3	172.3	157.7	165.0	12230	9716	10973
105000	18.0	17.6	17.8	46.6	45.3	46.0	150.8	127.8	139.3	11490	10125	10807
120000	16.6	16.7	16.6	45.5	44.3	44.9	136.2	110.5	123.3	10813	8700	9757
135000	16.8	16.4	16.6	46.0	43.7	44.8	113.8	107.2	110.5	10218	8750	9484
L.S.D. (5%)	0.8	1.2	0.7	0.9	1.6	0.9	7.6	11.2	6.4	986	980	651
Planting pattern												
Single row	18.3	17.7	18.0	46.9	45.0	46.0	159.2	140.2	149.7	10848	9124	9986
Twin row	18.2	18.2	18.2	46.7	45.4	46.0	163.3	144.8	154.0	11198	9598	10398
L.S.D. (5%)	N.S.	0.5	N.S.	N.S.	N.S.	N.S.	N.S.	4.4	3.3	349	343	245

Table 2). It is well known that plants grown under less competition have higher potential yields than those under dense plantings and the grain yield of a single corn plant is reduced by the proximity to its neighbors. The yield reduction per plant may be due to the effects of interplant competition for light, water, nutrients and other yield-limiting environmental factors[15]. Many researchers reported that ear characteristics of maize significantly affected by plant densities[14,16-18].

Grain yield increased with increasing plant densities up to 90000 plants ha^{-1} (10973 kg ha^{-1} mean), but decreased in higher plant densities and there were no significant differences among 90000 plants ha^{-1} and 105000 plants ha^{-1} densities (Table2). 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 declines when plant density increases above the critical plant density. Our findings are in good agreement with the reports of many studies. For instance, the optimum plant density for corn hybrid Pride5 was determined as 9.1 plants m^{-2} by Tollenaar *et al.*[2]. Porter *et al.*[6] reported inconsistent optimal plant density levels ranging from 86000 to 101270 plants ha^{-1} for corn grain yield across three Minnesota locations.

Response to planting pattern: Tasseling period, plant height, ear length and ear diameter were not affected by planting pattern (Table 1 and 2). Stem diameter was significantly affected by planting patterns and 18.8 mm stem diameter measured at twin row planting, when 18.4 mm stem diameter measured on single rows (Table 1). Higher grain weight ear^{-1} obtained from twin row plantings than single rows (Table 2). Grain yield differences between single- and twin row plantings were statistically significant and mean grain yield of twin row planting was 10398 kg ha^{-1}, while 9986 kg ha^{-1} mean grain yield was obtained from single row (Table 2). Twin row planting resulted 4% more grain yield than single row. This increase is important since without any additional input or cost, 4% yield gain can be easily obtained, this becomes more important when considering large-scale maize farming.

Finck[11] indicated in a tree-year twin-row study that twins out-yielded 30-inch single rows. Stewart[10] reported that numerous hybrids showed yield advantages for twin rows with some hybrids more than others. However, yield advantages of twin row maize have been inconsistent across various years and locations. Using more hybrids in different environments may be a better approach for identifying best genotypes with stable yield increases.

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