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Original Article

Effect 0f Plant Density and Weed Interference on Morphological Characteristics and Yield of Corn (*Zea Mays* L.)

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ABSTRACT

Objective: Field experiment was conducted in 2009 to investigate the effects of plant density and weed interference on morphological characteristics and yield of corn (Zea Mays, L.) at Research Station of University of Tabriz, Tabriz, Iran. **Methods:** The experiment was arranged as split plot based on randomized complete block design with three replications. Plant density (D1, D2, D3 and D4: 5, 7, 10 and 16 plant m^{-2}, respectively) were assigned to main plots and three levels of weed interference ((W1, W2 and W3: weed free, between row weed interference and full-season weed interference) were allocated to the sub plots. **Results:** The Results showed that with increasing plant density, grain and biological yield increased, but cob weight, ear length, ear diameter and harvest index decreased. The highest amount of morphological traits and harvest index was obtained from 5 plant m^{-2}.The weed interference treatments had significant effects on above traits so the highest morphological traits, grain yield, biological yield and harvest index was obtained from weed free treatment. These results indicated that high plant densities because of decreasing weed interference and increasing grain and biological yield, is the effective agronomic solution for increasing corn performance in the field and can be used to reduce consumption of chemical pesticides in sustainable agriculture systems.

INTRODUCTION

Corn (Zea mays L.) is an important crop in Iran and weeds is one of the major reducing factors in its production. Therefore, weed control is an important management practice for corn production that should be carried out to ensure optimum grain and forage yield (Hajebrahimi et al., 2014).Weeds interference cause important yield losses worldwide with an average of 12.8% despite weed control application and 29.2% in the case of no weed control (Isik et al., 2006). Weeds are environmental limiting factors in many crops, and in the absence of appropriate and timely control reduced grain yield. The ability of damage weeds in corn fields is extremely high. Thus, despite the strict control weeds in agriculture ecosystems, 10 percent of agriculture production can be reduced due to weed competition with crops (Rahimian and Shariati, 1999). Water, mineral nutrients, Co_2 and light have all been considered as causal factors for the reduction in yield per plant (Cox, 1996).

Plant density is one of the most significant agronomic practices contributing towards grain yield, as well as

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other important attributes of this crop (Charles and Charles, 2006). One of the most important cultural practices to reduce impact of weed on crops is increasing crop competitiveness by increasing plant density.
The response of corn into plant density is changes due to in yield components more effective than other weeding plants (Normohamadi et al, 1997). Plant density has been recognized as a major factor determining the degree of plant-to-plant competition (Mather, 1961). The aim of this study investigates to impacts of differential plant density and weed interference at North West of Iran with the objective of evaluating the effect of weed interference and plant density on some of morphological traits and yield of maize.

2. MATERIALS AND METHODS

2.1. Site description and experimental design

Field experiment was inducted out in 2009 at the research Farm of the University of Tabriz, Iran (lat 38^0 05-N, long 46^0 17-E, alt 1360 m above sea level). The climate of research area is characterized by mean annual precipitation of 285 mm, mean annual temperature of 10^{0C}, mean annual maximum temperature of 16.6^{0C} and mean annual minimum temperature of 4.2^{0C}. The experiment was arranged as split plot %design with three replications. Plant density treatments (5, 7, 10 and 16 plant m^{-2}) were assigned to main plots and three weed interference levels (weed free, inter row interference and full season interference) were allocated to the sub plots.

2.2. Measurement of traits

Traits such as morphological characteristics measured by randomly selecting 10 plants in each plot. Harvest sample was taken of 2 m long from the two middle rows for measuring grain yield and other yield attributes. Statistical analysis of the data was performed with MSTAT-C software. Duncan multiple range test was applied to compare means of each trait at 5 probabilities.

3. Results

3.1. Morphological traits

Plant density and weed interference had significant effects on ear length, ear diameter and Cob weight (Table 1) but their interaction had no effect on these traits. Mean comparisons showed with increasing plant density these traits decreased, so the maximum rate of those was obtained from lowest density or 5 plant m^{-2} (Table 2). In high densities cause increasing competition between plants share assimilate for per ear reduced and ear length decreased (Sadeghi and Bohrani, 2002; Zamanian and najafi, 2002; feyzbakhsh et al. 2007). Faravani (1995) also reported that with increasing plant density Cob weight in per plant decreased. So 8 plant m^{-2} compared with 6 and 7 plant m^{-2} was less weight. Between ear length, ear diameter and Cob weight means the highest level was related to the lack of weed interference (Table 2).

Table 1:

Analysis of variance of selected parameters of corn affected by plant density and weed interference treatments

S.O.V	DF	Mean Square					
		Cob weight	Ear length	Ear diameter	Grain yield	Biological yield	Harvest index
R	2	0.921	0.467	0.084	42645.606	0.921	0.467
Plant density	3	208.353**	46.363**	0.542*	37790.748 *	208.353**	46.363**
Error	6	6.975	1.502	0.101	7666.309	6.95	1.502
Weed interference	2	131.575**	42.162*	0.774**	4648413.986 **	131.575**	42.162*
Interaction	6	8.221	2.345	0.078	37395.593	8.221	2.345**
Error	16	3.266	1.93	0.33	5602.800	3.266	1.93
C.V (%)		12.76	10.75	5.23	18.63	12.76	10.75

Ns=Non significant; * and ** = Significant at 5 % and 1% probability level, respectively

Table 2:
Mean comparisons for different traits of corn under different plant density treatments

Plant density	Ear length (cm)	Ear Diameter (mm)	Cob weight (g)	Biological yield (g/m²)	Grain yield (g/m²)
D_1	15.69^{a*}	3.797^{a}	20.01^{a}	3466^{a}	1020^{a}
D_2	13.69^{b}	3.453^{ab}	15.99^{b}	2865^{b}	960.8^{ab}
D_3	11.80^{c}	3.319^{b}	11.41^{c}	2654^{b}	914.8^{b}
D_4	10.48^{c}	3.242^{b}	9.234^{c}	1843^{c}	868.8^{b}
SE	0.4085	0.1059	0.8803	99.85	29.19

*The means with same letters in each column are not significantly different at $p \leq 0.05$. (D1, D2, D3 and D4: 5, 7, 10 and 16 plant/m², respectively)

Table 3:
Mean comparisons for different traits of corn under different irrigation treatments

Weed interference	Ear length (cm)	Ear Diameter (mm)	Cob weight (g)	Biological yield (g/m²)	Grain yield (g/m²)
W_1	14.95^{a*}	3.721^{a}	17.80^{a}	3842^{a}	1620^{a}
W_2	12.55^{b}	3.422^{b}	13.37^{b}	2679^{b}	805.6^{b}
W_3	11.25^{c}	3.216^{c}	11.32^{c}	1600^{c}	397.8^{c}
SE	0.4010	0.0524	0.5217	117.1	50.61

*The means with same letters in each column are not significantly different at $p \leq 0.05$. (W1, W2 and W3: Weed free, Inter row interference and Full season interference, respectively)

3-2- Biological yield

Table 4:
Effect of interactions between plant density(D1, D2, D3, D4) and weed interference (W1, W2, W3) on harvest index

Plant density	Weed interference	HI (%)
D_1 (5 plant m^{-2})	W_1	45.37^{bc}
	W_2	25.93^{e}
	W_3	16.81^{f}
D_2 (7 plant m^{-2})	W_1	48.84^{b}
	W_2	50.25^{b}
	W_3	73.57^{a}
D_3 (10 plant m^{-2})	W_1	40.35^{cd}
	W_2	27.83^{e}
	W_3	21.68^{ef}
D_4 (16 plant m^{-2})	W_1	36.70^{d}
	W_2	26.67^{e}
	W_3	19.91^{ef}

*The means with same letters in each column are not significantly different at $p \leq 0.05$. (D1, D2, D3, D4: 5, 7, 10, 16 plant/m2 and W1, W2, W3: Weed free, Inter row interference and Full season interference, respectively)

3.2. Biological yield

Analysis of variance indicated that, the biological yield was significantly affected by plant density and weed interference ($P<0.01$), but interaction between plant density and weed interference was not significant for this trait (Table 1). Means comparisons showed with increasing plant density these traits increased. Maximum biological yield (3466 g/m^2) was obtained from 16 plant m^{-2} and minimum biological yield (1843 g/m^2) obtained from 5 plant m^{-2} (Table 2).With increasing weed interference rate the biological yield decreased. The Maximum biological yield (3842 g/m^2) was obtained from weed free ($W_{1)}$ and minimum biological yield (2242 g/m^2) obtained from full-season weed interference(Table 2). Influence of biological yield from weed interference such as grain yield respectively. However, intensity influence of weed interference on biological yields more than grain yields. Reduction of biological yield and grain yield were85% and 75% in weed interference treatments, respectively. These results indicated that reproductive growth and grain yield of corn are more sensitive than biological yield to resources limitations (Fateh et al. 2007).

3.3. Harvest index

Analysis of variance showed significant effects of plant density and weed interference on harvest index. Also, interaction of plant density and weed interference for this trait was significant (Table 1). The maximum amount of harvest index was obtained from 7 plant m^{-2} and weed free treatments. The results of this research indicated that combinations of high plant densities and weed interference treatments have negative effects on reproductive growth and seed production and then low harvest index. High harvest index achieved from weed free treatment and density of 7 plant m^{-2}, but low harvest index obtained in full-season weed interference combinations with weed free treatment (Table 4).

3.4. Grain yield

Results showed that the effect of plant density and weed interference on grain yield was significant (Table 1).Maximum grain yield (1020 g/m^2) was obtained from 16 plant m^{-2} and minimum grain yield (868 g/m^2) from 5 plant m^{-2}(table 2). Hashemi Dezfouli and Herbert (1992) reported that with increasing plant densities, yield per plant decreased, but the total absorption of light by canopy and grain yield increased. On the other hand grain yield with increasing weed interference, decreased. The highest grain yield (1620 g/m^2) was obtained from weed free treatments. Reduction of grain yield at Full-season weed interference and between row weed interference treatments compared with weed free treatment was 50% and 75%, respectively.

Conclusion

In this experiment, plant density and weed interference showed significant effects on corn yield and its attributes. The highest grain yield recorded from D_4 (16 plant m^2 and W_1(weed free) treatments. Therefore high plant density and lack of weed interference for crops, such as corn is very important. Since the corn is very sensitive to weeds in early growth, lack of weed interference caused the rapid growth of corn before early-season weed competition and the maximum grain yield was obtained. This research indicated that high plant densities because of decreasing weed interference, is the effective agronomic solution for increasing corn performance in field. According to importance of integrated weed control in sustainable agriculture systems, the results obtained in this research can be used to reduce consumption of chemical pesticides and prevent the environmental pollution.

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