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ORIGINAL ARTICLE

Effect of Weed Interference on Performance of Grain Corn (*Zea mays* L.) At Different Plant Densities

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ABSTRACT
In order to evaluate the effect of weed interference and plant density on performance of grain corn, an experiment was carried out as split-plot based on randomized completed bloke design (RCBD) with three replications at the Agriculture Research Station, University of Tabriz, Iran in 2009. Plant density levels including: 5, 7, 10 and 16 plant/m-2 was allocated to the main plots and weed interference at three levels including: weed free (w1), once in a row weed interference (w2) and perfect weed interference (w3) were assigned to subplots. The results showed that weed interference on grain yield, 1000 seed weight, kernel weight and number of ear had a significant effect. With increasing of natural weed interference during growth period, grain yield, 1000 seed weight, kernel weight and number of ear decreased. Also, interaction between weed interference and plant density was significant in kernel weight of ear. Between different densities the greatest grain yield with 1020 g/m-2 obtained from 16 plant/m-2 and weed free treatment. Weeds in treatments of once in a row weed interference 50 percent and treatments of perfect weed interference in long of growth period 75 percent grain yield decreased. Results showed that with increasing plant density, corn can increase its competitiveness with natural weeds of field increased the grain yield. Generally, the results indicate that the sensitivity to weeds interference especially in low plant density due to the effect of early competitive start may influence extremely the yield of maize.
Key words: *Grain corn, Interference, Plant density, Weeds natural population and Yield*

INTRODUCTION

Corn is one of the most important agricultural plants which stands in the second place after wheat in production and is in the third place after wheat and rice in allocating planting area to itself. In recent years planting corn in Iran has become more important. The importance of this product and dedication of large planting area to it is due to its high adjustment power to various environmental conditions. In this regard it is one of the highly produced products of temperate, warm temperate, half tropical and humid regions (Nourmohammadi, et.al., 1997). One of the problems in producing corn is the problem of weeds which reduces corn yield through competition. At least ten percent of reduction in global agricultural production notwithstanding the sever control of weeds in most of agricultural systems can be attributed to weed competition effect (Rahimian and Shariatie, 2008).

Interference is a process in which two plants or two plant populations have reciprocal negative effect on each other. Negative interference between plant varieties is applied through competition and allelopathy (negative form), (Radoseviech, 1988). The degree of interference between field crops and weed has direct congruency with the density and the duration of plant taint to weed (Willcox, 1987). Makariyan, et.al. (2003) in their studies showed that if weeds of corn fields are not controlled, based on their number and type can reduce yield up to 10 - 100 percent. According to the estimations in recent years, the direct price of controlling weeds is about 17 percent of the value of the product (Chandler et.al., 1984. Willcox 1987).

Makariyan et.al. (2003) reported that increase in the density of plant is obtained by controlling the competition effect. In researchers' view the plant density has influenced the competition balance between the weeds and agricultural plant, and increase in plant density has caused reduction in the growth of weeds and waste resulted from competition (Carlson and Hill, 1985, Van Acker et.al. 1993). Controlling weeds in initial steps of corn growth in corn field is of paramount importance and results in natural advantage of corn plant (Imam, 2007). In a way that James, et.al. (2000) have also reported that the

weeds which have not been controlled during the first four weeks after the growth of plant, have reduced the yield of field crop in a significant way.

One way of controlling weed in corn fields is by increasing the density of plant in surface unit. Some studies have shown that with increasing the density of corn plant from four to ten plants/m2, the dry weed weight has decreased up to 50 percent (Tavana, et.al., 1994). In this respect, managing weeds is one of the key elements in most of the agricultural systems. Because of this, recognition of competition mechanisms has been lionized in order to utilize them in improving weed management.

Nowadays with regard to the extension of weed resistance to weedicides and their disturbing environmental effects, developing ecological strategies is considered as a safe and cheap preferencefor managing weed in order to reduce chemical consumption in stable agriculture (Dunan, et.al., 1995). This study has been designed and administered in order to evaluate the effect of natural weeds of field on the yield and evaluation of yield reduction potential resulted from the competition of natural field weed with corn and also identifying the best corn density in order to increase the effectiveness of agricultural, natural and cheap control of weeds.

Material and Methods

The experiment was carried out in planting year of 2009-2010 in Agriculture Research Station, Agriculture department; University of Tabriz located 8 km in East of Tabriz (Karkaj lands).

The result of soil analysis for the years 2005 and 2006 has been reported respectively as 7.2 and 7.5 for PH and EC: 186 and 218 µm centimeter, potassium 240 and 260 parts in million, phosphorus 19 and 14 parts in million, nitrogen 0.16 and 0.036 percent, organic material 0.9 and 0.85 percent, the amount of sand 58.8 and 62.8 percent, silet: 26 and 24 percent and argil 15.2 and 13.2 percent (Shafagh-Kolvanagh, et.al., 2009). The experiment was repeated three times in split-plot based on randomized completed bloke design (RCBD). The four levels of plant density included: 5, 7, 10 and 16 plants/m2 as the main plot and three levels of weed interference of natural population included: weed free, once in a row weed interference and perfect weed interference as subplot factor was applied as stated in the following:

Weed free interference (w1)

In this set, all the weeds of plots were weeded completely from the beginning of plant growth up to the end of the growth period every week.

Once in a row weed interference (w2)

In this part, the weeds of planting rows were weeded weekly in once in a row weed form from the beginning up to the end of growth period.

Perfect weed interference (w3)

In this part the weeds of the intended plots were not controlled from the beginning up to the end of growth period and the intended plots were completely filth by weeds up to the end of the growth period.

Kernel used in this study was of Hybrid single cross 704 type. This Hybrid is of late maturing corn variety which has great adaptation power and production yield. The first stages of preparing soil bed were done in fall 2009. First a rather deep plough was accomplished for initial preparation of the soil. Second steps which was providing the seed bed in spring including disc plowing, furrowing with the distance of 50 centimeter was operated as soon as the appropriate condition was provided. Final cropping was done after physiologic verification of corn when the moisture of the grains reached to about 15 percent. After removing the side effects, 10 plants werecropped outeach plot for estimating the intended attributes. Also, for identifying the final yield of the existing kernel in each plot, the plots were cropped up to about two square meters.

After doing the normality test of data and consistency of variances, analysis of variance and comparing means, the statistical analysis was adoptedbased on the statistical model of the related plan and by using MSTAT_C software. Comparing the means of the data was done by Duncan multi range test and drawing graphs was done by utilizing Excel software.

RESULTS AND DISCUSSION

1000 seed weight

According to the results of data analysis of variance the effect of various plant density levels and the interference of natural weeds on the weight of 1000 -seed was significant (Table 1). The results of comparing means (Figure 1) showed that by increasing the density of plantsthe weight of 1000 seeds decreased. Of course there was no significant difference between the densities of 7, 10, and 16. The highest weight for 1000 seeds was obtained as261.2 grams for the density of 5 plants/m2. In a study by Akintoy et.al. (1997) it was revealed that by increasingthe number of plant density the weight of 1000 seeds decreased, but this difference was significantbetween various densities. Poor-Yousef, et.al. (2001) showed in his experiment that by increasing the density, the weight of 1000 seeds decreased and stated

that this can be due to the reduction in inter-plant and intra-plant competition in lower densities and provision of processed matter and saved materials in leaves and stem.

Table1. Variance analysis of different plant density level effect and natural weed interference on some attributes of corn

		Mean Square			
S.O.V	**DF**	**1000 seed weight**	**Kernel weight in ear**	**number of kernels in ear**	**Grain yield**
R	2	17.768	195.876	2576.039	42645.606
Plant density	3	6835.969*	10089.588**	78690.321**	37790.748 *
Error	6	970.162	114.949	1736.012	7666.309
Weed interference	2	4098.287**	8389.195**	64971.529**	4648413.986 **
Interaction	6	558.155	358.409*	7563.518	37395.593
Error	16	240.207	121.339	5602.800	5602.800
C.V (%)		7.04	11.83	17.61	18.63

With the increase in weed interference the weight of 1000 seeds decreased (Figure 2) in a way that a significant difference was observed between the treatments and three treatments were placed in different statistical groups. The lowest weight of 1000 seeds was 202.6 grams and was related to the complete interference of weeds and the highest weight was 239.4 grams and was related to the free weed interference. Ardakaniyan (1996) reported that the reduction of 1000 seeds' weight was only significant in the high pressure of weeds treatment. This result is in accordance with the results of the studies done by other researchers such as Hashemi-Dezfouli and Herbert (1992), Ulger and Poleneit (1979), and Cox (1996).

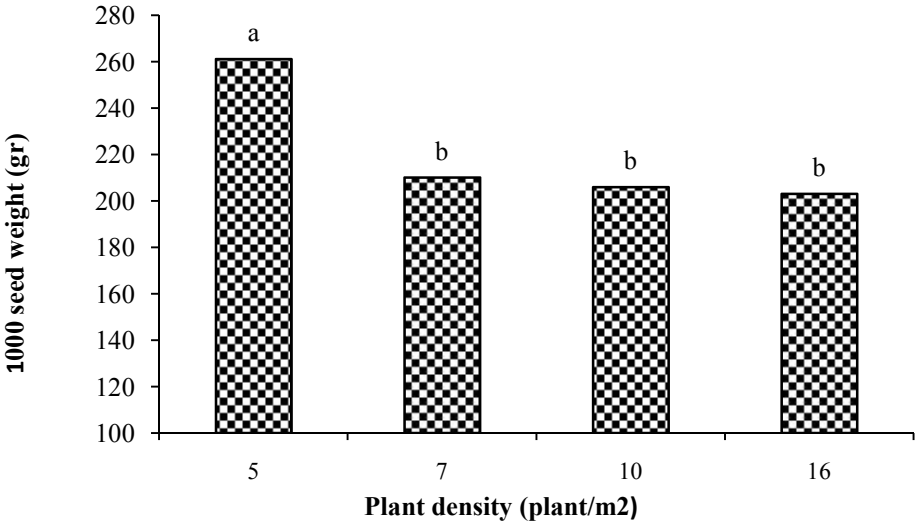

Figure 1.the average weight of 1000 seeds in different plant densities. Different letters indicate significant difference between treatments.

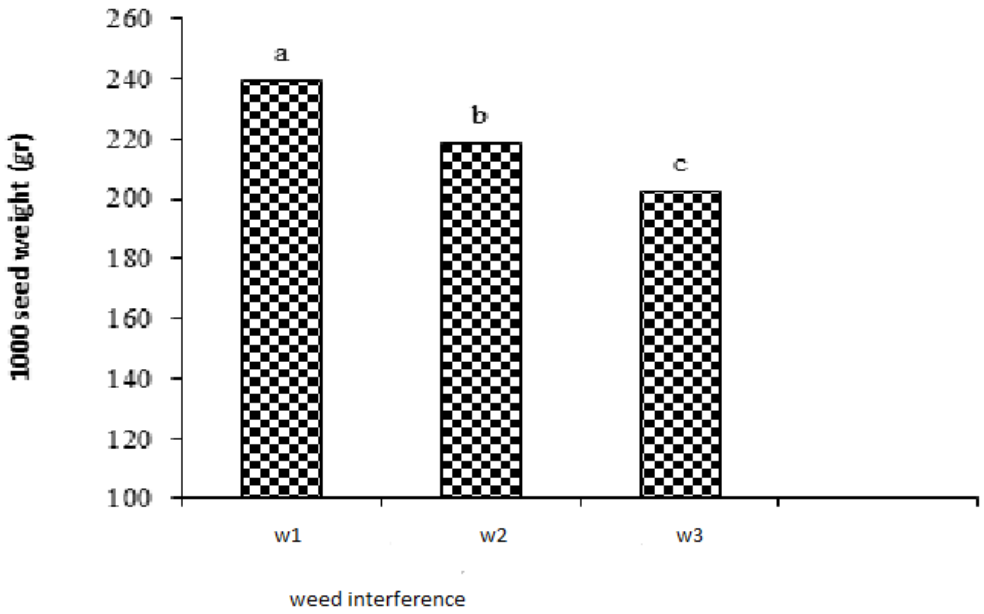

Figure 2. The average weight of 1000 seeds in various weed interference. Different letters indicate significant difference between treatments.

Kernel weight in ear

The kernel weight was significantly influenced by the plant density and natural weed interference (Table 1). The interaction between plant density and weed interference had a significant influence on the kernel weight in ear (Figure 3). Based on the obtained results from comparing means (Figure 3), with increase in plant density the kernel weight in ear decreased.

Sharifi and Tajbakhsh (2007) showed that kernel weight in ear for different levels of plant density, for lower densities was the most and for high densities due to the reduction of solar radiation penetration and reduction of photosynthesis materials in grain filling period has been the least. Nourmohammadi, et.al. (1997) also showed in an experiment that with increase in the density of ear length and kernel weight in ear (the average production of one plant) decreases, but the grain yield increases to some certain degrees in hectare and then decreases. Generally speaking the kernel weight in ear in interfered treatments was less than the pure corn production treatments. Regarding the fact that the interaction between plant density and weed interference was significant in the attribute of seed weight, the heaviest ear grain weight was related to weed free interference treatment and for plant density of 5 plants/m2 with the weight of 161.7 grams and the lightest seed weight in ear was related to perfect weed interference treatment and density of 10 plants/m2 with the weight of 50.41 grams. It can be inferred that in the density of 10 plants compared to the density of 16 plants/m2 because of the intra and inter variety competition the kernel weight in ear has significantly decreased. But in the density of 16 plants/m2 although there was an increase in density, the only reason for seed weight reduction was the intra variety competition, because with increase in the density the weeds' competition decreased.

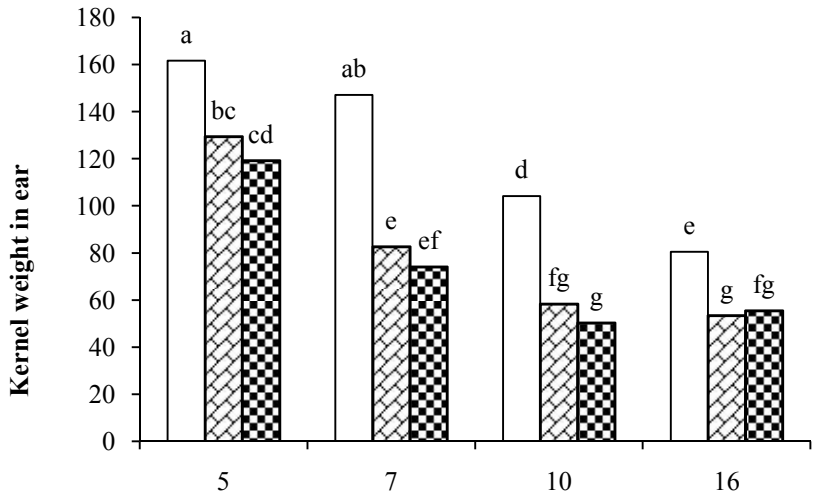

Figure 3. The average weight of kernel in ear in treatment composition of corn density and weed interference. Different letters indicate significant difference between treatments.

The number of kernels in ear

The number of kernels in ear is significantly influenced by the plant density and natural weed interference. But, the interaction between the surfaces of plant density and weed interference was not significant (Table 1). According to the results of comparing means (Figure 4) the number of kernels in ear decreases with the increase in density. The reduction of kernel number in each ear in high densities is due to the increase in competition between grain filling locations for processed material and also increase in the time delay between the pollination period and silk emersion time which is the main reason for sterility and filling of single grains of corn (Wilson and Alison, 1978 and Hashemi-Dezfouli and Herbert, 1992). Reduction of corn grain as a result of increase in plant density has also been reported by other researchers. Ulger, et.al. (1997) concluded that with increase in plant density, the number of grains in each ear significantly decreased.

The number of kernels in ear with increase in weed interference period decreased and with decrease in the period duration of weed interference increased (Figure 5). The highest number for seeds was for weed free interference treatment. Weed free interference and perfect interference respectively allocated 503.8 and 358.1 kernels in ear to themselves. This shows that the number of kernels in ear weed free interference and lack of interference treatments comparing to the perfect weed interference had an increase of 145.7 seeds or in better words increased 40.68percent. Other researchers such as Shafagh-Kolvanagh(2008), Shafagh-Kolvanagh, et.al. (2008, 2009) in soy bean, Mousvai, et.al in peas (2009), Zehtab Salmasi,et.al. in winter barely (2009), have reported the significant effect of weed interference on the number of seeds. The results of this experiment are in accordance with that done by Andrade, et.al. (1993), Evans, et.al. (2003), Sadeghi and Bohrani (2001), Rafie (2007), Hosseini, et.al. (2009), and Saberi, et.al. (2010) on corn. The reduction of ear seed number is due to the decrease in the number of fertilized flowers in initial steps of flower formation, weak pollination, the lack of coincidence between tassels and silkemersion and sterility of flowers after pollination (Ulger and Poleneit, 1979).

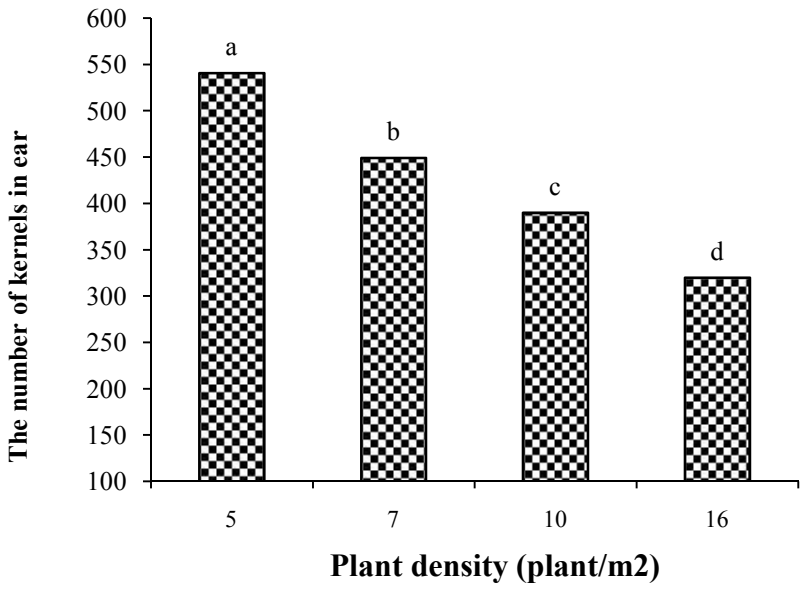

Figure 4. The average number of kernel in ear in various corn densities. Different letters indicate a significant difference between treatments.

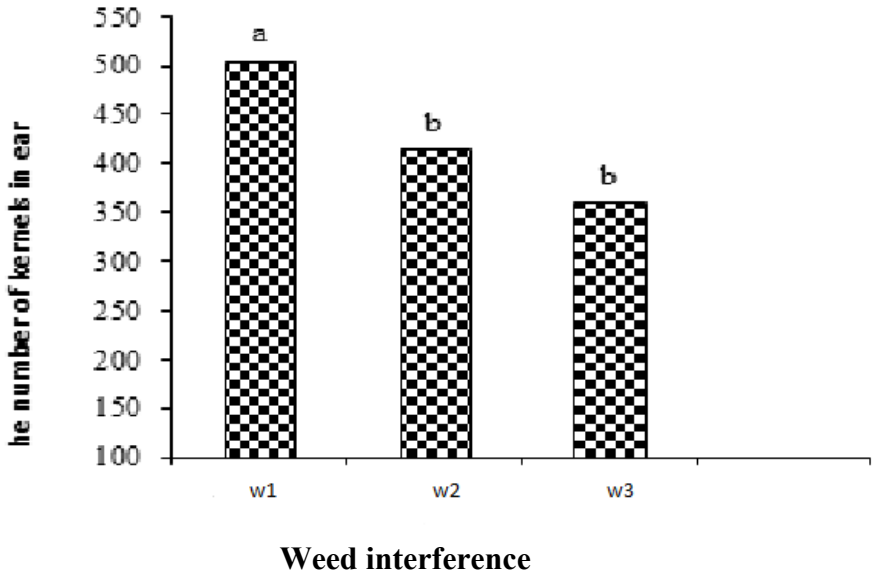

Figure 5. The average numbers of kernels in ear in various weed interferences. Different letters indicate significant difference between treatments.

Grain yield

According to the table related to data variance analysis the density of corn had a significant influence on grain yield (Table 1). In a way that the highest grain yield was obtained from density of 16 plant per square meter which was 1020 grams per square meter, and the least was obtained from density of 5 plant per square meter with the weight of 868.8 (Figure 6). The high grain yield for density of 16 plants can be related to the appropriate coverage of field and the eligible use of environmental factors.

Gozebenli, et.al. (2004) also investigated the planting design and corn density and reported that the yield of grain corn in densities more than 10 plants per square meter increased significantly.The influence of natural weeds of the field on grain yield was also significant (Table 1). In a way that irrespective of plant density, because of weed interference during growth period the grain yield decreased. In a way thatgrain yield in weed interference free treatments was more than interactional treatments in various densities (Figure 7). The increase in general yield of grain in densities of 16 plants per square meter is due to the

increase in the competition potential of agricultural plant with natural weeds of farm. Other researchers have also reported that the increase in the density of plant has effects on restricting the computational effects of weeds (Makariyan, et.al. 2002, Nurse and Ditommaso, 2005). According to the obtained results of this research it was indicated that with increase in the interaction of natural population of corn field weeds grain yield (Figure 7), each seed weight (Figure 2), the number and weight of grain in corn (Figures 3, 4) decreased.

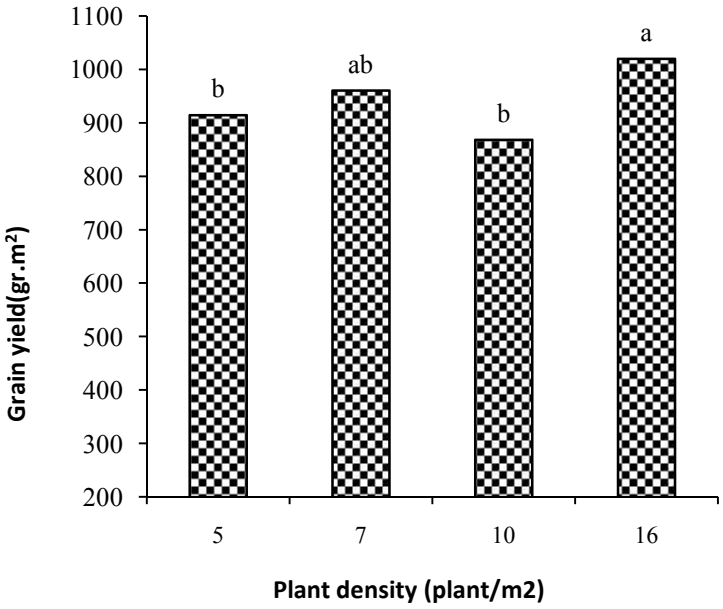

Figure 6.The average grain yield in various densities of corn. Different letters indicate significant difference between treatments.

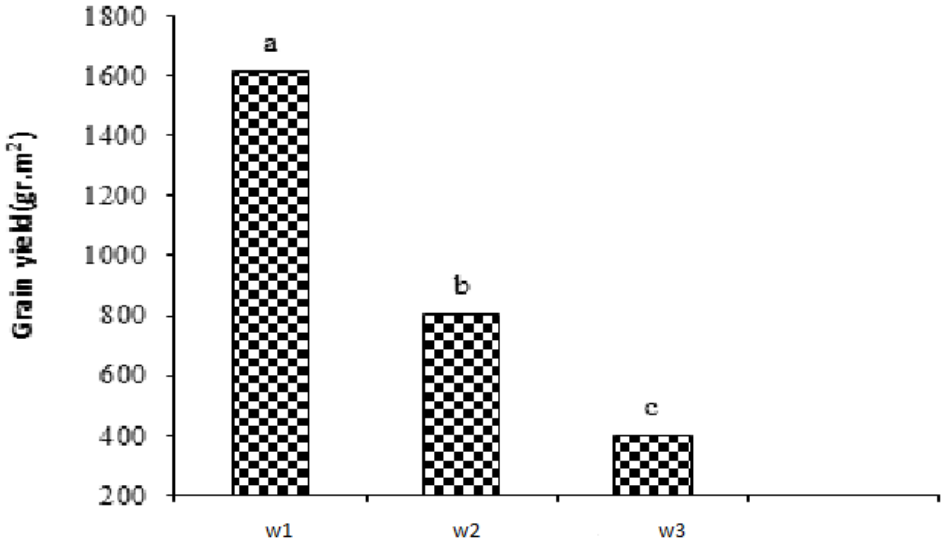

Figure 7.The average grain yield in various weed interference.
Different letters indicate significant difference between the treatments.

Some researchers have mentioned that increase in the weed interference period is one of the main factors in grain yield reduction. In a way that Mohammadi (2004), Mohammadi, et.al. (2005) in studying the interference of natural weeds of the farm with peas and Hamzei, et.al. (2007) in his study mentioned the interference of natural weeds of the farm with rape seedalsoShafagh-Kolvanagh(2008) and Shafagh-

Kolvanagh, et.al. (2008, 2009) in studying the interference of natural farm weeds with soy beans stated that the increase in the period of weed interference with the decrease in the gathering of dry matter decreased the produced biomass. Following this, stubble yield and grain yield also decreased.

CONCLUSION

Considering different parts represented that considering the fact that corn in initial steps of growth is more sensitive than weeds, treatments in which controlling weed has been started from the beginning of growth have had the highest yield. In this experiment it was indicated that the agricultural strategyof increasing density is effective in reducing the weed interference insofar as it can be stated that the sensitivity to weed interference especially in low densities because of the soon competition, influences the corn yield severely. With regard to the importance of incorporated controlling of weeds in stable agricultural systems, the results of this study can be useful in suggesting strategies for reducing chemicals consumption and reducing the pollution of natural environment. In a way that with increase in the plant density the corn power in competing weeds increases. On the other side, the grain yield increased with the increase in plant density and was less influenced by the corn field natural weeds competition.

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