Investigation of competitive reactions of red root pigweed (*Amaranthus retroflexus* L.) and corn (*Zea mays* L.)

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ABSTRACT

In order to determine the effects of density of red root pigweed on growth and physiological parameters of corn, an experiment was conducted in Faculty of Agriculture, Islamic Azad University of Fasa, located in southeastern region of Fars Province in Iran. The experiment involved the effects of various densities of red root pigweed at five levels including zero, 1, 2, 4, and 8 plants in each meter of plant row on the yield and yield components of single cross 500 corn variety, carried out in the form of complete randomized blocks design in three replications under farm conditions. The results showed that the highest yield of corn was obtained under no pigweed treatment, which had no significant difference with the treatment involving the density of one pigweed plant in each meter of planting row. The lowest yield for corn was obtained when the density of pigweed was 8 plants, which had no significant statistical difference with the treatment involving 4 plants of pigweed in each meter of planting row. Among the yield components, the highest weight of 1000 grains, the number of grains in each cob, and the number of grains in each row of corn cob were obtained under the treatment involving no pigweed and the lowest values for these components were obtained under the treatment involving eight plants of pigweed in each meter of planting row, with no significant difference with the 4 plant treatment.

Key words: Corn, Density, Red root pigweed, Yield.

INTRODUCTION

Corn (*Zea mays* L.) is a plant which spread very early all around the world due to its good features. Annually, more than 100 million hectares of farms are allocated to corn. After wheat and rice, corn is the third largest crop in terms of farm land. In Iran, corn is in the fourth place after wheat, barley, and rice. One of the problems with corn production is the issue of weeds, which reduce the yield of corn (Feizabadi et al., 2010).

The focus in the majority of studies regarding the competition between weeds and crops is on the effects of competition on production efficiency or yield reduction. Red root pigweed (*Amaranthus retroflexus* L.) can create such a competition with corn (Xiaoyan et al., 2015). Lindquist and Mortensen (1998) found out that increasing the measure of corn’s leaf area, increasing the speed of canopy closure, and increasing the height with the highest level of leaf area could increase the resistance of corn and its ability to compete with weeds; these characteristics can be changed through agricultural operations such as increasing corn density, reducing the distance between rows, and crop improvement.

The emergence of competition between two species (agricultural crop and weed) will affect the growth and development characteristics of both species. In competition studies, the effects of the presence of weed on the yield and the growth of the crop are often considered; however, it will be better to also study the effects of the crop on the growth of the weed (Bastian, 2000). The results of the studies carried out by Vazin (2012) showed that reducing the intensity of photosynthesis photons flow passing the canopy, due to high density of corn, can lead to a reduction in the production of dry matter in red root pigweed. In this case, the major part of the leaf area and the dry matter in red root pigweed are directed upwards.

In an experiment carried out by Saayman and Van de Venter (1996) on a variety of red root pigweed (*Amaranthus palmeri*) in densities of 0.5 to 0.8 plants in each meter of planting row and in two different germination stages (along with corn and 4-5 leaf stage), the corn leaf area index was higher in the first cultivation date than the second one due to the interference of red root pigweed. Moreover, the biomass of the agricultural crop, which is usually considered as the most prominent criterion for the effects of competition, had a positive correlation with the changes in leaf area index. Measuring the corn leaf area index in the silk stage significantly indicates the density pressure and the time for the growth of red root pigweed. Red root pigweeds were emergenced alongside the corn crops, with densities of 0.5 to 8 shrubs in each meter of planting row, reduced the corn leaf area index 5 to 36 percentage points.

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on average, while the growth of red root pigweed at the 3-5 leaf stage of the corn, there was no significantly decrease in the corn leaf area index. The accumulation of corn’s dry matter had a similar pattern (Vahedi, 2015).

The loss from weed in developing countries has been reported as 25 per cent, while it is 10 per cent in developed countries (Joanna and Agnieszka, 2013; Kropff and Lotz, 1992). Despite the intense control of weeds, 10 per cent of agricultural crop loss in the world can be attributed to the effects of the competition from weeds (Park et al., 2003), which is 12.5 percent for corn crops. The competition between weeds and corn has been a challenge for producing this crop in the twentieth century all around the world and it still continues in the twenty-first century (Rajcan and Swanton, 2001). In Iran, red root pigweed is considered one of the important weeds competing with corn (Feizabadi et al., 2010). Therefore, determining the effects of density of red root pigweed on the yield and yield components of single cross 500 variety of corn under farming conditions was one of the objectives of this study.

MATERIALS AND METHODS

In order to evaluate the effects of the competition from red root pigweed on the yield and yield components of single cross 500 varieties of corn under farming conditions, an experiment was conducted in the Faculty of Agriculture, Islamic Azad University of Fasa, located at the southeastern region of Fars Province in Iran. Fasa City is located between eastern longitudes of 53°19' to 54°15' and northern latitudes of 28°31' and 29°24'. Fasa has a very hot and dry climate and has a 1370 meter altitude from the sea level.

The experiment was conducted in the form of randomized compete block design (RCBD) in three replications. Treatments included various densities of red root pigweed at five different levels including 0, 1, 2, 4, and 8 plants in each meter of planting row. The length of each experimental plot was 400 cm and its width was 300 cm. The activities for preparing the plot included tillage and fertilizing before the cultivation. The utilized fertilizers included 280 grams of Urea for each plot (180 gram after the growth and 140 grams after cultivation), 100 grams of super phosphate triple, and 230 grams of sulfate potassium for each experimental plot. After preparing the plot, the cultivation process (cultivation date) was conducted. The distance between rows for corn was 75 cm and in the rows the distance was considered 20 cm. Red root pigweed seeds first underwent a standard germination test to ensure the germination possibility of the seeds and assured growth of the weeds, they were cultivated at the same time with the corn grains, and after germination, they were thinned based on selected densities. Irrigation of the experimental plots was conducted in a submerged method based on the treatment. The final harvest was conducted after the corn crops were physiologically matured and after the termination of irrigation. In order to measure the yield parameters of the corn, considering the effects of vegetated field border, six plants of corn were harvested from each plot and 3 square meters were considered for determining the yield of the grain and the plants were cut. Then, the plant in each shrub were cut from the aerial organs, among which ten cobs were randomly selected and put in different bags based on each experimental plot. After the cobs were completely dry, the sum of the weight of the aerial organ and the cobs in each experimental plot were used for obtaining the biological yield of the corn. Then, the grains in each cob were separated, cleaned from the remains of other organs, and used to obtain the grain yield based on 25 percent humidity. Therefore, it was necessary to utilize a humidity measuring device for cereal grains. Ultimately, after calculating the reduction in the humidity, the grain yield was also obtained based on a 14 per cent humidity. The yield components of corn included the number of grain rows on each cob, the number of grains in each row, the weight of 1000 grains, and the number of grains in each cob.

The obtained data were analyzed using of SAS 9.2.1 software application. In order to compare the data averages, Duncan’s multiple range test (DMRT) at the 5 percent probability level was used.

RESULTS AND DISCUSSION

The Effects of Pigweed density on corn yield

Biological yield: Based on the results of the average square variance analysis, the effects of density of red root pigweed on the biological density of corn was found significant (Table 1). With an increase in the density of red root pigweed, the biological yield of corn decreases, and the highest decrease in the biological yield of corn was related to the density of eight plants of red root pigweed in each meter of planting row, which was equal to 18746.62 kg per hectare, and there was no significant difference with the treatments involving two and four plants of red root pigweed in each meter of planting row. The highest biological yield of corn was obtained with the control treatment (without the presence of red root pigweed), which was equal to 26653.88 kg per hectare, and there was no significant difference with the treatments involving one and two plants of red root pigweed in each meter of planting row (Table 2). The results showed that the presence of the pigweed affected the yield of corn crops due to competition over the available resources, and consequently, the growth of corn crops was restricted due to the limitation of resources for photosynthesis, which was compatible with the results of Rajcan and Swanton (2001).

Economic yield (Grains): Based on the results of the average square variance analysis, the effects of concentration of red root pigweed on the grain yield of corn was significant (Table 1). With an increase in the density of red root pigweed, the grain yield of corn decreases. The lowest grain performance for corn grains was equal to 6787.54 kg per
The results obtained from this experiment were compatible with the results of Feizabadi et al. (2010) about the reduction in the biological yield and grain yield of corn by increasing the concentration of red root pigweed. Other researchers have also mentioned the reduction in the yield of corn with the increase in the density of red root pigweed. The reason for the lack of significant difference in the reduction of corn grain yield in higher densities of red root pigweed may be the intraspecies competition of pigweed species for obtaining resources, which is compatible with the results of Starhan et al. (2000).

The Effects of the density of Red Root Pigweed on yield components of Corn

**Number of grain rows in Cob:** The effects of various densities of red root pigweed on the number of grain rows in the corn cob were not significant (Table 1). The results show that red root pigweed has a lower impact on the number of grain rows in corn cobs, which may be because of the fact that this component is mainly related to the genetic characteristics of the plant. The number of grain rows in corn cobs among various treatments involving different densities of pigweed was obtained between 12 and 12.66 rows (data not presented).

**The number of grains in the cob rows:** By increasing the density of red root pigweed, the number of grains in the cob rows starts to decrease. The lowest number of grains in the cob rows was obtained in the density of eight pigweed plants in a meter of planting row, which was equal to 26.58 grains, and the treatment involving four pigweed plants in each meter of planting row had no significant difference. This was while the greatest number of grains in a cob row was related to the control treatment (without pigweed), which was equal to 39.66 grains, with no significant difference with the treatment involving one plant of pigweed in each planting row (Fig 1-a).

The results obtained in this study were compatible with the results of Ballare and Casal (2000) regarding the reduction in the number of grains in each row of corn cobs by increasing densities of red root pigweed in the unit of area.

**The weight of 1000 grains:** The weight of 1000 grains was affected by various treatments involving different densities of red root pigweed. Accordingly, the highest weight of 100 grains was related to the treatment without pigweed and in this treatment, the weight of 1000 corn grains was equal to 309 grams. The lowest weight of 1000 corn grains was equal to 204 grams, obtained in the treatment involving eight plants of pigweed in each meter of corn row. In fact, by increasing the number of pigweed plants to 8 plants in each meter of the corn row, 25.5 per cent of the weight of 1000 corn grains was reduced.

There was no significant statistical difference between the treatments with four and eight pigweed shrubs in each meter of corn row regarding the weight of 1000 grains. Moreover, there was no significant statistical difference between the treatments with one and two pigweed plants in each meter of corn row (Figure 1-b).

### Table 1: Variance analysis of square averages for the effects of pigweed concentration on the performance and performance parameters of corn crops in farm experiment

| Source of variation | Degree of freedom | Biological yield | Economic yield (grains) | Weight of 1000 grains | The number of grains in cob | The number of grain rows in cob | The number of grains in cob row |
|---------------------|------------------|------------------|-------------------------|-----------------------|-----------------------------|---------------------------------|-------------------------------|
| Replication         | 2                | 1279188.00**     | 15949.00**              | 106.06**              | 256.20**                    | 0.26**                          | 2.95**                        |
| Pigweed density     | 4                | 218498144.00**** | 28089863.00**           | 531.40**              | 1596.276**                  | 0.40**                          | 76.12**                       |
| Error               | 8                | 3029741.00       | 803617.00               | 1391.99               | 1391.11                     | 0.60                           | 2.40                          |
| Change coefficient  |                  | 9.67             | 10.23                   | 4.98                  | 9.43                        | 6.31                           | 4.82                          |

Ns= not significant * significant at 5 percent probability level ** significant at 1 percent probability level

### Table 2: Effects of red root pigweed density on biological yield and economic yield of corn in the farming experiment

| Density of pigweed (shrubs in meter of planting row) | Biological yield of corn (kg per hectare) | Economic yield of corn (kg per hectare) |
|-----------------------------------------------------|------------------------------------------|----------------------------------------|
| 0                                                   | 26653.88a                                | 9417.11a                               |
| 1                                                   | 25047.67a                                | 8596.85ab                              |
| 2                                                   | 22396.49ab                               | 8158.59bc                              |
| 4                                                   | 19873.62b                                | 7149.45cd                              |
| 8                                                   | 18746.62b                                | 6787.54d                               |

Rows with at least one similar letter do not have a significant difference based on Duncan’s multiple range test (DMRT) at the 5 percent probability level.
Fig 1: Effects of Pigweed density on the Number of Grains in each Row (a), the Weight of 1000 Grains (b), and the Number of Grains in each Corn Cob (c). Columns with at least one similar letter have no significant difference at the 5 percent probability level based on Duncan’s multiple range test (DMRT)
There are conflicting results regarding the effects of pigweed density on the weight of 1000 grains of corn. For instance, the results of Vahedi (2015) indicated the significant impact of the density of red root pigweed on the weight of 1000 corn grains, which is compatible with the results of the current study. On the other hand, Vazin (2012) argue that the density of red root pigweed has no significant impact on the weight of 1000 corn grains, which is in contradiction to the results of the current study.

**Number of grains in each cob:** By increasing the density of redroot pigweed, the number of grains in each corn cob decreased and the lowest number of grains in each cob was related to the treatment involving the density of 8 pigweed plants in each row of corn, while the highest number of grains in each cob was related to the control treatment. Moreover, there was no significant difference between the two treatments involving four and eight plants in each meter of corn row (Fig 1-c). Accordingly, Feizabadi et al. (2010) reported the reduction of the number of grains in each corn cob by increasing the density of red root pigweed, which is compatible with the results of the current study.

**CONCLUSION**

The results of the study show that red root pigweed is a significant weed in corn farms and the presence of this weed in the farm will lead to a reduction in the crop yield. The results of the farming experiment show the effects of various density of red root pigweed on the density as well as the yield components of corn grains. By increasing the density of red root pigweed, the yield components of corn decrease and the highest level of decrease is observed in the treatments involving the density of 4 and 8 pigweed plants in each meter of corn row. There was no significant statistical difference between the densities of 4 and 8 pigweed plants in each corn row, which may be because of the intraspecies competition of the pigweed.

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