

Planting pattern could increase competitive power in sugar beet (*Beta vulgaris*) cultivars at interference with redroot pigweed (*Amaranthus retroflexus*)

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Abstract: Producing high yielding sugar beets of superb quality is the goal of all sugar beet growers. In order to evaluation of effects of redroot pigweed density and planting pattern on some physiological and agronomical characteristics in two sugar beet cultivars a factorial field experiment was conducted during 2012 based on RCBD at the Research Station of Salmas, East Azerbaijan, Iran. The studied treatments were redroot pigweed densities (0, 4, 8 and 12 plants per meter row), planting patterns (zigzag and linear) and sugar beet cultivars (Jolgeh and Shirin). Planting pattern of zigzag was higher effective than linear pattern on sugar beet LAI, and in linear pattern crop LAI reduced 57 cm² per square meter. When crop grew along with 12 weed plants per meter row, its LAI reduced from 712 cm² in weed-free plots up to 308 cm². Jolgeh cultivar in zigzag cropping method had the highest green cover (80.5%), but Shirin cultivar experienced significant reduction in green cover as grew in linear pattern. Green cover percentage of redroot pigweed in Jolgeh variety×zigzag pattern was the lowest (11.3%) as compared to the treatment of Shirin variety×linear pattern (21.9%). Sugar beet above-ground biomass in zigzag pattern was greater than linear pattern; and Jolgeh variety was more effective than Shirin variety. Root yield in full-season interference of 12 weed plants per meter row was 66 kg/ha when each weed plant removed from plots. Sugar percentage reduced nearly 0.15% per weed plant increasing. In conclusion we recommend zigzag planting pattern of sugar beet Jolgeh variety, to reduce weed competition and increase yield in semi-arid region. The stepwise regression analysis verified that the crop LAI and biomass had a marked increasing effect on the root yield of sugar beet.

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Introduction

Producing high yielding sugar beets of superb quality is the goal of all sugar beet growers (Bird et al., 2010). On a global basis, weeds are considered to be responsible for about 10% reduction of crop yield (Froud-Williams 2002). Several species of *Amaranthus* are known to be important weeds that reduce crop yield. Redroot pigweed (*Amaranthus retroflexus* L.) and smooth pigweed (*A. hybridus* L.) populations have increased throughout the West Azerbaijan province in Iran. They constitute nearly 45-55% of the total weed flora of the region (Karimi 2003). Sugar beet is an important crop in this province and often grown in rotation with cereals.

Weeds that emerge along with or immediately after the crop plants especially in higher densities can usually reduce their yields (Mirshekari et al., 2010). Economical yield loss threshold of weed control programs depends on many factors such as cultivar (Seem et al., 2003), climate, weed population density and dominant weeds in the region (Martin et al., 2001 & Seem et al., 2003) and weed interference duration (Massinga et al., 2001). When only two redroot pigweeds per meter of row emerged with soybean crop yield reduced by 12%, but weeds emergence at

the second nodal stage of soybean did not cause significant effect on yield (Dielman et al., 1995). Redroot pigweeds those emerged with more densities than crop plants were taller and produced greater biomass (Horak and Loughin, 2000). Mirshekari (2008) reported that sugar beet LAI and biomass reduced, when weed density increased and redroot pigweed emerged earlier, and weed density was more effective than its interference time. In treatments with low sugar beet LAI, redroot pigweed LAI was more. Full-season interference of 16 redroot pigweed per meter of row decreased sugar beet root yield from 75 t ha⁻¹ in control to 58 t ha⁻¹. Also, increasing of each weed plant, reduced sugar yield 0.3-1.3 t ha⁻¹.

Narrower row widths and planting pattern may be used as part of integrated weed management. Narrower rows significantly reduced biomass of weeds. Corn yields increased significantly (10 to 15%) only when narrower rows were used. Intra-specific competition between corn plants in the higher density significantly reduced early corn growth and offset any gain in yield from reduced weed competition (Murphy et al., 1996).

This study was aimed to evaluation of effects of redroot pigweed density and crop planting pattern on

some physiological and agronomical characteristics in two sugar beet cultivars in semi-arid regions.

Materials and Methods

Field experiment was conducted on a sandy loam soil during 2012 growing season at the Agricultural Research Station of Salmas, East Azerbaijan, Iran. The experimental field had been in a potato-wheat rotation cycle for the last two years. The experimental area was ploughed in the fall and manured with 15 t ha⁻¹. Fields were cultivated, disked, furrowed and then platted in the spring before sowing the seeds. Fertilizers used, in spring and before sowing, were 110, 100 and 120 kg ha⁻¹ of ammonium phosphate, potassium sulfate and urea, respectively. The sugar beet hybrids were sown on 18 May, 2012. The studied treatments were redroot pigweed densities (0, 4, 8 and 12 plants per meter row), planting patterns (zigzag and linear) and sugar beet cultivars (Jolgeh and Shirin). All plots were hand removed for other weed species in growth season. Plots were irrigated immediately after sowing to assure uniform emergence.

The experimental design was a factorially randomized complete block with three replications. All data were analyzed using the MSTAT-C software. Treatment means were separated using Fischer's Protected LSD at P<0.05.

To formulate the relationship between 3 independent growth variables in sugar beet measured in our experiment with a dependent variable, multiple regression analysis was carried out for the leaf area index (X₁), green cover (X₂) and above ground biomass (X₃) as independent variables and root yield (X₄) as a dependent variable. Furthermore, the stepwise regression analysis was also carried out for the data obtained to test the significance of the independent variables affecting the sugar yield as a dependent variable.

Results and Discussion

Analysis of variance of data

Effects of weed density on crop LAI and sugar percentage were significant at 1% and 5% probability levels, respectively. Effect of planting pattern on crop LAI (5%), crop green cover (5%), root yield (5%) and weed green cover (1%) were significant. Effect of cultivar on crop and weed green covers, crop biomass and root yield were significant at 5% probability level. Interaction of planting pattern×cultivar on crop and weed green covers and crop biomass were significant at 5% probability level.

Mean comparisons of data

Leaf area index (LAI)

Planting pattern of zigzag was higher effective than linear pattern on sugar beet LAI at 120 days after sowing, and in linear pattern crop LAI reduced 57 cm² per square meter. Abd-el Vahab and Marina (2011) in an experiment on lambsquarters (*Chenopodium album*) competition in different planting pattern of maize (*Zea mays*) understood that in double row cropping, crop leaf area and yield could be increased. Because in this cropping method canopy closure may happened earlier, as Saberi et al. (2007) emphasized on it.

As we expected, with increasing of redroot pigweed density, LAI of sugar beet decreased significantly, therefore when crop grew along with 12 weed plants per meter row, its LAI reduced from 712 cm² in weed-free plots up to 308 cm² (Fig. 1). A growth analysis study conducted by Barkhi et al. (2007) indicated that maize LAI was a major effective parameter on its yield, when crop competed with redroot pigweed as full-season interference. In the present study sugar beet yield had a positive and significant correlation with its LAI.

Increasing corn density from 7 to 10 plants m⁻² or decreasing row width from 75 to 50 cm significantly increased corn leaf area index (LAI), and reduced photosynthetic photon flux density (PPFD) available for a mixture of weed species located below the corn canopy (Murphy et al., 1996).

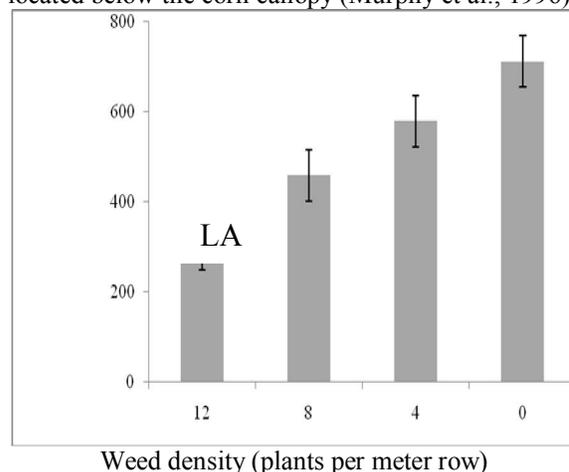


Figure 1. Sugar beet leaf area index as affected by weed density.

Crop green cover

Mean comparisons revealed that Jolgeh cultivar in zigzag cropping method had the highest green cover (80.5%), but Shirin cultivar experienced significant reduction in green cover as grew in linear pattern (Fig. 2).

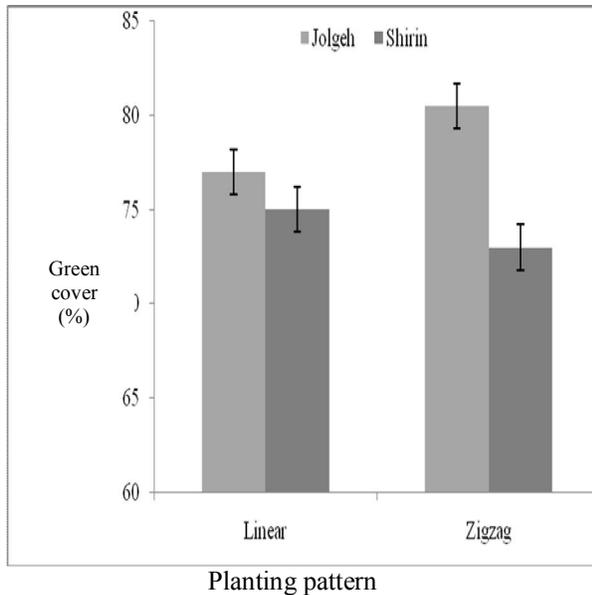


Figure 2. Sugar beet green cover as affected by planting pattern and cultivar.

Weed green cover

Green cover percentage of redroot pigweed in Jolgeh variety×zigzag pattern was the lowest (11.3%) as compared to the treatment of Shirin variety×linear pattern (21.9%).

Crop biomass

Weeds compete with crop plants for environmental resources like nutrients, water and light. They, thus, significantly reduce crop yield, impair crop quality and bring about substantial financial loss to the farmer (Froud-Williams 2002). Due to effective light transmission by canopy, sugar beet above-ground biomass in zigzag pattern was greater than linear pattern; and also, Jolgeh variety was more effective than Shirin variety (Fig. 3) with a view to radiation absorption, because of higher leaves number per plant.

Root yield

In this experiment there was a significant difference between Jolgeh (77.75 kg/ha) and Shirin varieties. In those crop varieties with higher leaves number and biomass yield could be improve. Root yield in full-season interference of 12 weed plants per meter row was 66 kg/ha when each weed plant removed in plots (Fig. 3). These results are in good agreement with those reports by Mirshekari et al. (2010). In Tranel et al. (2003) study, in those treatments with lower weeds biomass, crop biologic yield and yield was in advance. Also, Saberi et al. (2007) resulted that with increasing of weed density, sunflower yield and its components reduced, statistically.

Sugar percentage

The highest and the lowest sugar percentage obtained from weed-free and full-season weed interference treatments, respectively, and sugar percentage reduced nearly 0.15% per weed plant increasing (Fig. 3).

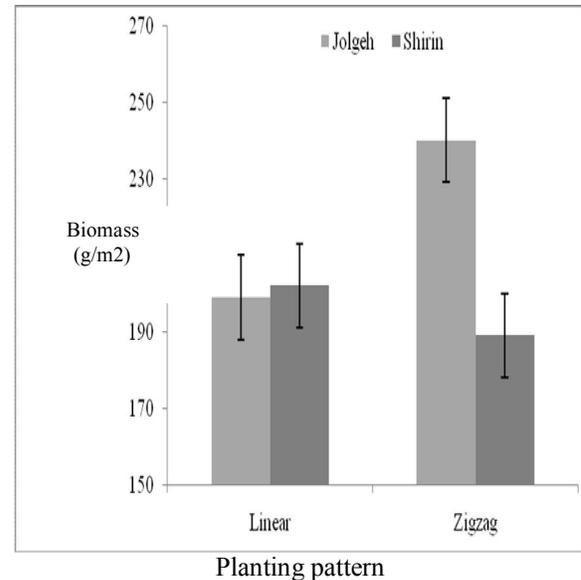


Figure 3. Sugar beet biomass as affected by planting pattern and cultivar.

Multiple regression

The multiple regression equation is shown as follows:

$$\text{Sugar yield (kg ha}^{-1}\text{)} = 0.409 + 0.0016 (X_1) + 0.0050 (X_2) + 0.0190 (X_3)$$

Also, the resulted stepwise regression equation is shown as follows:

$$\text{Sugar yield} = 4.29 + 0.0089 (X_1) + 0.0067 (X_3); R^2 = 0.88.$$

Conclusion

In conclusion we recommend zigzag planting pattern of sugar beet Jolgeh variety, to reduce weed competition and increase yield. The stepwise regression analysis verified that the crop LAI and biomass had a marked increasing effect on the root yield of sugar beet.

References

1. Abd-el Vahab, E., and Z., Marina, 2011, Competition between maize and lambsquarters (*Chenopodium album*). Egy. J. Agric. Sci., 11: 11-15.
2. Barkhi, A., M.H., Rashed Mohassel, M., Nassiri Mahallati, and M., Hosseini, 2007, Effects of planting pattern and density on growth parameters, yield and yield components on

- maize under competition with redroot pigweed. *J. Agrono. Res.*, 4 (2): 243-252.
3. Bird, G.W., W.K., William, J.M., Mc Grath, C.L. Sprague, and S.S., Poindexter, 2010, Optimizing sugar beet production through soil quality management. A Research study, MSU Department of Crop and Soil Sciences 4p.
 4. Dielman, A., A.S., Hamill, S.F., Weise, and C.J., Swanton, 1995, Empirical models of redroot pigweed (*Amaranthus* spp.) interference in soybean (*Glycine max*). *Weed Sci.*, 43: 612-618.
 5. Froud-Williams, R.J., 2002, Weed competition. In weed management handbook: Ed. R.E.L. Naylor, Blackwells, pp. 16-38.
 6. Horak, M.J., and T.M., Loughin, 2000, Growth analysis of four *Amaranthus* species. *Weed Sci.*, 48:347-355.
 7. Karimi, H., 2003, Iran weed flora. Tehran Univ. Publ., Iran, 420 p.
 8. Martin, S.G., R.C., Van Aker, and L.F., Friesen, 2001, Critical period of weed control in spring canola. *Weed Sci.*, 49: 326-333.
 9. Massinga, R.A., R.S., Currie, M.J., Horak, and J., Boyer, 2001, Interference of palmer amaranth in corn. *Weed Sci.*, 49: 202-208.
 10. Mirshekari, B., 2008, Efficiency of empirical competition models for simulation of sugar beet (*Beta vulgaris* L.) yield at interference with redroot pigweed (*Amaranthus retroflexus* L.). *Iran. J. Sugar beet.*, 24 (2): 73-91.
 11. Mirshekari, B., A., Javanshir, and H., Kazemi Arbat, 2010, Interference of redroot pigweed (*Amaranthus retroflexus* L.) in green bean (*Phaseolus vulgaris* L.). *Weed Biol. Manag.*, 10: 120-125.
 12. Murphy, S.D., Y., Yakubu, S., Weise, and C., Swanton, 1996, Effects of planting patterns and inter-row cultivation on competition between corn and late emerging weeds. *Weed Sci.*, 44: 856 - 870.
 13. Saberi, A., D., Mazaheri, and H., Heydari Sarifabad, 2007, Study effect of planting pattern and density on physiological parameters and biomass accumulation in maize (*Zea mays* cv. 647). *J. Agric. Sci. Nat. Res.*, 13: 136-146.
 14. Seem, J.E., N.G., Cramer, and D.V., Monks, 2003, Critical weed-free period for 'Beauregard' sweet potato (*Ipomoea batatas*). *Weed Technol.*, 17:686-695.
 15. Tranel, T., T.S., Weaver, and P., Milberg, 2003, Interference by the weed *Parthenium hysterophorus* L. with grain sorghum: Influence of weed density and duration of competition. *Int. J. Pest Manag.* 48 (3): 183-188.

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