Biological Forum – An International Journal **7**(1): 1055-1058(2015)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Relationship between Bean Crop Productivity and Weed Appearance

Bahram Mirshekari* and Reza Siyami**

**Department of Agronomy and Plant Breeding, Tabriz Branch, Islamic Azad University, Tabriz, IRAN*
***Young Researchers and Elite Club, Tabriz Branch, Islamic Azad University, Tabriz, IRAN*

(Corresponding author: Bahram Mirshekari)
(Received 12 March, 2015, Accepted 19 April, 2015)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Green bean is an important pulse crop in this province and often grown in rotation with cereals. Field experiments were conducted at the Agricultural Research Station of Islamic Azad University of Tabriz, Iran. The treatments were weed-infested and weed-free in same periods. For weed-infested plots, redroot pigweeds were hand removed after 2, 4, 6, 8, 10 and 14 weeks after bean emergence (WABE) and were kept weed free thereafter. For weed-free experiment, redroot pigweeds that were provided from transplanted seedlings in green bean rows were allowed to compete with green bean plants from 2, 4, 6, 8, 10 and 14 WABE thereafter. A sigmoid model provided the best fit for the maximum weed-infested experiment. The relationship of green bean yield with weed-free period was best described by a polynomial equation. Green bean biomass was not affected by redroot pigweed after the first four weeks of interference; however a significant loss in crop biomass occurred thereafter in comparison with full-season weed-free plots. Yield loss of green bean due to redroot pigweed interference ranged from 3% in weed removal in 2 WABE to 68% in full-season weed-infested plots. Percent yield loss of bean varied with redroot pigweed time of emergence. We concluded that if growers use pre-plant incorporated or pre-emergence herbicides, they should use those with enough soil residual activity to control weeds until eight WABE.

Key words: Crop biomass, Polynomial equation, Weed removal.

INTRODUCTION

Green bean is an important pulse crop in this province and often grown in rotation with cereals. Critical period of weed control (CPWC) program depends on many factors such as cultivar (Seem *et al.,* 2003), climate, weed population density and dominant weeds (Seem *et al.* 2003) and weed interference duration (Massinga *et al.,* 2001). When only two redroot pigweeds per meter row emerged with soybean [*Glycine max* (L.) Merr.], crop yield reduced by 12.3%, but weeds emergence at the second nodal stage of soybean did not cause significant effect on its yield (Dielman *et al.,* 1995). Redroot pigweed that emerges in June grew faster by 0.03 cm for each growing degree day than the plants emerged one month later (Horak and Loughin, 2000). Limited use of herbicides, due to their adverse effects on sustainability of agricultural ecosystems in recent decades has been advocated (Burnside *et al.* 1998). Late-emerging weeds may not reduce crop yields. The time interval between early and late emergence is the critical period of weed control (Burnside *et al.,* 1998; Miri and Ghadiri, 2006). Controlling weeds beyond this period may not be necessary for optimum crop yield (Swanton et al., 1999). This period has been determined for many crops. In soybean it occurs between 9 to 38 days after planting (DAP) to control hemp sesbania [*Sesbania exaltata* (Rof) Cory.] (Van Acker *et al.,* 1993). In cotton (*Gossypium hirsutum* L.) the period is less than 65 DAP (Bryson, 1990) and for safflower (*Carthamus tinctorius* L.) is up to flowering (Miri and Ghadiri 2006). This period for dry bean (*Phaseolus vulgaris* L.) was 3 to 5 or 6 weeks after sowing (Burnside *et al.,* 1998).

There is no published information on weed interference in green bean. The main object of this study was evaluation effects of weed emergence on crop productivity of a new released hybrid of bean, Cantander.

MATERIALS AND METHODS

Field experiments were conducted at the Agricultural Research Station of Islamic Azad University of Tabriz, Iran. Fertilizers used, in spring and before sowing, were 150, 100 and 15 kg ha^{-1} of ammonium phosphate, potassium sulfate and urea, respectively. Each plot consisted of six green bean rows spaced 50 cm apart. The green bean hybrid 'Cantander' , was inoculated with *Rhizobium phaseoli* and sown at four centimeter depth with a density of 100,000 plants ha^{-1} on 5th May, 2012, and 7th May, 2013. The treatments were weed-infested and weed-free in same periods. For weed-infested plots, redroot pigweeds were hand removed after 2, 4, 6, 8, 10 and 14 weeks after bean emergence (WABE) and were kept weed free thereafter.

For weed-free experiment, redroot pigweeds that were provided from transplanted seedlings in green bean rows were allowed to compete with green bean plants from 2, 4, 6, 8, 10 and 14 WABE thereafter. Also all plots were hand removed for other weed species in growing season. Plots were irrigated immediately after sowing to assure uniform emergence.

The experimental design in each year was a 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 level. Regression analysis was performed to describe the relationship between bean yield and duration of redroot pigweed interference using the REG PROCEDURE of SAS. A sigmoid model provided the best fit for the maximum weed-infested experiment. The model was as follows (Ghosheh *et al.,* 1996):

$$Y = A + B * Exp (-CX^2)$$

where, Y: green bean yield (kg ha^{-1}), A + B: yield of redroot pigweed-free check plots, C: coefficient of redroot pigweed interference duration and X: weeks of redroot pigweed-infested period. The relationship of green bean yield with weed-free period was best described by the polynomial equation as follows:

$$Y = a + b_1X + b_2X^2 + b^3X^3$$

where, Y: green bean yield (kg ha^{-1}), a, b_1, b_2 and b_3: coefficients of redroot pigweed interference duration and X: weeks of redroot pigweed-free period (Ghosheh *et al.,* 1996). Predicted bean yield loss of 5% and 10% were chosen to determine maximum weed-infested and minimum weed-free periods.

RESULTS AND DISCUSSION

Green bean biomass was not affected by redroot pigweed after the first four weeks of interference; however a significant loss in crop biomass occurred thereafter in comparison with full-season weed-free plots. Number of stem branches of green bean in weedy check plots was reduced by 65% as compared with weed-free plots. (Table 1). Redroot pigweed biomass was reduced when duration of interference decreased (Tables 1 and 2). The number of branches per green bean plant decreased, when the duration of weed interference increased. Comparison of stem height of green bean and redroot pigweed at different weed-infested durations was depicted in Table 3. Height of redroot pigweed at early interference durations, was shorter than that of green bean in both years, while redroot pigweed suppressed height of green bean 8 WABE.

Table 1: Influence of weed-infested periods on some traits of green bean and redroot pigweed.

Weed-infested periods (WABE)	Number of branches per green bean plant	Green bean Biomass (kg ha^{-1})	Redroot pigweed Biomass (g m^{-2})	Green bean yield (kg ha^{-1})
2	12.5	665	69.2	6010
4	11.9	643	84.5	5722
6	8.6	575	180.2	4220
8	7.3	532	237.7	2523
10	6.6	493	282.6	2059
14	4.5	443	292.3	2016
Weed free check	13.0	674	0	6175
LSD (0.05)	1.2	34	3.9	123

Each value averaged over two years of experiment. WABE means weeks after bean emergence.

Table 2: Influence of weed-free periods on some traits of green bean and redroot pigweed.

Weed-free periods (WABE)	Number of branches per green bean plant	Green bean Biomass (kg ha^{-1})	Redroot pigweed Biomass (g m^{-2})	Green bean Yield (kg ha^{-1})
2	5.5	464	295.5	2124
4	6.5	495	270.0	3386
6	8.9	576	211.0	4849
8	10.8	616	171.0	5792
10	12.0	645	70.0	5966
14	12.5	674	35.1	6175
Weedy check	5.0	443	295.5	2016
LSD (0.05)	1.4	25	28.6	217

Each value averaged over two years of experiment. WABE means weeks after bean emergence.

Yield loss of green bean due to redroot pigweed interference ranged from 3% in weed removal in 2 WABE to 68% in full-season weed-infested plots (Tables 1 and 2). Removal of redroot pigweed two WABE and interference of redroot pigweed at 10 WABE until harvesting provided a similar green bean yield to the season-long weed-free control. However, when redroot pigweed interference was lasted for four weeks or longer after green bean emergence, yield was reduced significantly. Redroot pigweed interference up to 10 WABE reduced green bean yield 67% compared with the weed-free check plots (Table 1). The CPWC using 5% yield loss was between 1.9 to 8.5 WABE (13 to 68 days after bean emergence). The CPWC for 10% yield loss, it was between 2.7 to 7.8 WABE (19 to 55 days after bean emergence) (Fig.1).

Eftekhari *et al.* (2006) reported that the number of side branches per plant in soybean decreased significantly when the period of weed interference increased. Weed interference duration of six WABE or more and weed-free period of less than eight weeks greatly reduced the number of pod bearing branches per plant (Table 1). Green bean biomass, as reported by Eftekhari et al. (2006) on soybean, was also affected by early-emergence of redroot pigweed. However, its emergence at 10 WABE did not cause a substantial reduction in green bean biomass (Tables 1 and 2). This result might be due to the late emergence of redroot pigweed plants that grow slower and are weaker than green bean during growing season. Redroot pigweed biomass in check plots was 295.5 g m^{-2}, while it decreased 2.7 g m^{-2} per each day when its emergence was delayed (Table 2). These results are in agreement with those reported by Eftekhari *et al.* (2006), who studied on interference of weeds with soybean. It has been also reported that with increasing of 100 g m^{-2} weeds biomass, bean yield decreased 1.4 kg ha^{-1} (Burnside *et al.*, 1998). Predicted yield values for weed-infested duration were obtained by the equation:

Y = 1654.72 + 4816.33* Exp (-0.02 X^2), R^2 = 0.96.

Predicted yield values for weed-free duration were obtained by the equation:

Y = 1845.31 + 187.75 X + 70.29 X^2 - 4.43 X^3, R^2 = 0.98.

CPD means critical period duration at 5% or 10% yield loss; and WABE means weeks after bean emergence.

Comparing stem height of green bean and redroot pigweed at different weed-infested durations (Table 3), it can be concluded that heights of redroot pigweed and green bean depending on weed emergence time would vary. Stem height of redroot pigweed at four weeks interference duration was shorter than green bean, but in later interference durations, redroot pigweed height increased as compared to green bean. This result could be attributed to relatively high temperature in region that has increased competitiveness of redroot pigweed in compared with green bean. Stem height is one of the important traits for light interception and higher ability of competition (Barnes et al. 1990; Miri and Ghadiri, 2006). Percent yield loss of bean varied with redroot pigweed time of emergence. Green bean yield from season-long weed-free plots averaged over years was 6.18 t ha-1 (Table 1).

Table 3: Stem height of green bean and redroot pigweed at different periods after emergence.

Year	WABE	Green bean height (cm)	Redroot pigweed height (cm)	Differential height
2012	0	-	-	-
	2	8	6	-2
	4	15	11	-4
	6	19	19	0
	8	24	32	+8
	10	30	40	+10
	14	31	83	+52
LSD (5%)		3.25	7.33	-
2013	0	-	-	-
	2	8	5	-3
	4	15	11	-4
	6	20	20	0
	8	25	35	+10
	10	31	45	+14
	14	34	93	+59
LSD (5%)		3.89	9.00	-

WABE means weeks after bean emergence.

Weeds, which emerged two weeks after green bean emergence, did not decrease crop productivity, significantly (Tables 1, 2).

Significant reduction in green bean yield with increasing of redroot pigweed interference duration indicates that redroot pigweed is highly competitive with bean, and it's competition beyond two WABE, results in greater yield loss of green bean (Table 1). As late emerging redroot pigweed was not as competitive as early emerging one, the yield reductions at ? 6 WABE based on weed-infested periods (Table 1) or < 8 WABE based on weed-free periods (Table 2) would not be acceptable to commercial growers. Similar results have been reported by Aguyoh and Masiunas (2003) and Evanylo and Zehnder (1989) on snap bean, Dielman et al., (1995) and Eftekhari et al. (2006) on soybean. A maximum of 10% acceptable yield loss could be considered to determine the CPWC for most crops. These results suggest that, when green bean hybrid 'Cantander', is grown in 50 cm row spacing, to prevent such a loss in green bean, redroot pigweed should be removed from field at 1.9 WABE based on weed-infested period.

A green bean crop should be grown without redroot pigweed for 7.8 WABE, so that yield losses will not exceed that of 10% (Fig. 1). We concluded that if growers use pre-plant incorporated or pre-emergence herbicides, they should use those with enough soil residual activity to control weeds until eight WABE.

REFERENCES

Aguyoh, J.N., Masiunas, J.B. (2003). Interference of redroot pigweed (*Amaranthus retroflexus*) with snap beans. *Weed Sci.* **51**, 202-207.

Barnes, P.W., Beyshlag, W., Rayel, R., Flint, S.D., Caldwell, M.M. (1990). Plant competition for light analyzed with a multi species canopy structure in mixtures and monocultures of wheat and wild oat. *Oecologia*. **82**, 560-566.

Bryson, C.T. (1990). Interference and critical period of removal of hemp sesbania (*Sesbania exaltata*) in cotton (*Gossypium hirsutum*). *Weed Technol.* **4**, 833-837.

Burnside, O.C., Wiens, M.J., Holder, B.J., Weisberg, S., Ristau, E.A., Johnson, M.M., Cameron, J.H. (1998). Critical period for wed control in dry beans (*Phaseolus vulgaris* L.). *Weed Sci.* **46**, 301-306.

Dielman, A., Hamill, A.S., Weise, S.F., Swanton, C.J. (1995). Empirical models of redroot pigweed (*Amaranthus* spp.) interference in soybean (*Glycine max*). *Weed Sci*. **43**, 612-618.

Eftekhari, A., Shirani Rad, A.H., Rezai, A.M., Salehian, H., Ardakani, M.R. (2006). Determination of critical period of weeds control in soybean (*Glycine max* L.) in Sari. *Iranian J. Crop Sci.* 7(4), 347-364.

Evanylo, G.K., Zehnder, G.W. (1989). Common ragweed (*Ambrosia artemisiifolia* L.) interference in snap bean at various soil potassium levels. *Appl. Agric. Res*. **4**, 101-105.

Ghosheh, H.Z., Holshouser, D.L., Chandler, J.M. (1996). The critical period of johnson grass (*Sorghum halepense*) control in field corn (*Zea mays*). *Weed Sci.* **44**, 944-947.

Horak, M.J., Loughin, T.M. (2000). Growth analysis of four *Amaranthus* species. *Weed Sci.* **48**, 347-355.

Massinga, R.A., Currie, R.S., Horak, M.J., Boyer, J. (2001). Interference of palmer amaranth in corn. *Weed Sci*. **49**, 202-208.

Miri, H.R., Ghadiri, H. (2006). Determination of the critical period of weed control in fall-grown safflower (*Carthamus tinctorius* L.). *Iranian J. Weed Sci.* **2**(1), 1-16.

Seem, J.E., Cramer, N.G., Monks, D.V. (2003). Critical weed-free period for 'Beauregard' sweet potato (Ipomoea batatas). *Weed Technol.* **17**, 686-695.

Swanton, C. J., Chander, K. and Shrestha, A. (1999). Weed seed return influenced by the critical weed-free period in corn. *Can. J. Pl. Sci.* **79**, 165-167.

Van Acker, R.C., Swanton, C.J., Weise, S.F. (1993). The critical period of weed control in soybean [*Glycine max* (L.) Merr.]. *Weed Sci.* **41**, 194-200.