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Crop-weed competition in French bean (*Phaseolus vulgaris* L.) under dry temperate conditions of North-western Himalaya

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Abstract

Fourteen treatments comprising of a set of weedy and weed-free conditions up to 0, 40, 60, 80 days after sowing (DAS) and harvest, hand weeding twice, alachlor at 1.50 kg/ha, pendimethalin at 1.50 kg/ha and alachlor at 1.0 + pendimethalin at 1.0 kg/ha were evaluated in French bean at Mountain Agricultural Research and Extension Centre, Sangla during *kharif* 2003 and 2004. Weed competition index increased from 2.3 to 59.9 with increase in duration of weedy condition. On the other hand, increase in weed-free period for different duration from sowing to 80 DAS decreased weed competition index from 0.4 to 37.3 and increased weed control efficiency from 18.3 to 100%. Weed-free condition up to 60 DAS and beyond had no significant effect on pods/plant, seeds/pod and seed and haulm yields over full season weed-free condition. Hand weeding at 20 and 40 DAS was as good as weed-free check in influencing yield attributes and yield of French bean. The season-long weedy condition caused 59.9% reduction in seed yield of French bean. Alachlor and pendimethalin each at 1.50 kg/ha produced grain yield of 2733 kg/ha and 2642 kg/ha, respectively, which were at par with hand weeding twice at 20 and 40 DAS (2989 kg/ha).

Key words: Crop-weed competition, competition index, weeds, yield, French bean.

Introduction

Dry temperate region of North-western Himalayas, constitute potential areas for successful cultivation of French bean. The area has made a rapid stride in its cultivation and emerges to be a major cash crop during the last thirty years. Presently, the crop occupies about 20% of the total cultivated area in the dry temperate zone of Himachal Pradesh. Among several factors responsible for low yield of French bean, competition offered by weeds is the most important. In the dry temperate zone of N-W Himalayas, crop is grown with frequent irrigation, which further intensifies the problem of weeds. It faces competition from several flushes of weeds resulting in heavy yield losses ranging from 38.4 to 79.2% (Rana *et al.* 1999, Rana 2002a&b), depending upon magnitude, nature and duration of weed infestation. Studies had been carried out to evolve herbicidal and/or integrated weed management in French bean (Kumar *et al.* 1997, Rana *et al.* 1999, Rana 2002a&b, Rana *et al.* 2004) for the dry temperate zone of North-western Himalayas. Information on critical period of weed-crop competition in French bean under the dry temperate condition of North-western Himalaya is lacking. Therefore, the present investigation was undertaken.

Material and Methods

An experiment was conducted during the *kharif* seasons of 2003 and 2004 at the research farm of Mountain Agricultural Research and Extension Centre, Sangla (2590 m altitude). The soil of the test sites was sandy loam with pH 6.9, 1.7-1.9% organic matter, 280-300 kg available N/ha, 17.6-22.4 kg available P/ha and 195 kg available K/ha. The average rainfall in the growing season is about 400 mm. During winter, area experiences 200-400 cm of snowfall and remains covered with snow for most part of the season. Therefore, the crop production activities are feasible only during *kharif*. Sowing of French bean variety 'SRC-74' (Kailash) was done in rows 30 cm apart on 18 May 2003 and 4 May 2004 using 80 kg seed/ha. The crop was harvested on 10 October 2003 and 2 October 2004. The crop was fertilized with 30 kg N, 60 kg P_2O_5 and 30 kg K_2O/ha through urea, single superphosphate and muriate of potash, respectively at sowing. The experiment consisting of fourteen treatments comprising of a set of weedy and weed-free conditions up to 20, 40, 60, 80 DAS, and harvest,

hand weeding twice (20 and 40 DAS), alachlor at 1.50 kg/ha, pendimethalin at 1.50 kg/ha and alachlor at 1.0 + pendimethalin at 1.0 kg/ha was conducted in randomized block design with three replications. Pre-emergence application of herbicides was made 2 DAS. Herbicides were sprayed with manually operated knapsack sprayer using 800 l water/ha. Weed removal as per the treatment was done with the help of a local hand weeding tool 'khilni'. Two quadrats of 50 cm x 50 cm were placed randomly in each plot to record weed count. After drying in hot air oven (70±1 °C for 72 hours), weed dry weight was recorded. Yields were recorded from net plot (10.5 m^2). Weed competition index, weed control efficiency, weed management index (WMI), Agronomic management index (AMI) and integrated weed management index (IWMI) were worked out as per the methods outlined by Walia (2003).

Results and Discussion

Predominant weed flora in the experimental field in 2003 was composed of *Poa annua* (41.4%), *Equisetum arvense* (31.3%), *Gallinsoga parviflora* (20.2%) and *Amaranthus* sp (5.1%) besides *Malva rotundifolia* and white clover constituting 1% each. *Digitaria sanguinalis* (94.6%) was the most predominant weed in 2004. The other weeds were *Chenopod* (4.3%), *Polygonum* (1.3%) and *Malva* (1.3%).

The trends in the count and dry weight of weeds, yield attributes and yield of French bean were almost similar during both the years. There was progressive increase in the population of weeds with increase in duration of weed infestation and appreciable reduction in weed population was registered when weed infestation was checked periodically (Table 1). All the treatments were significantly superior in reducing species-wise and total weed count as compared to weedy till harvest. Similarly, significant decrease in weed dry matter accumulation was recorded when competition-free environment prolonged from 20 to 80 DAS, and throughout. The highest weed weight was recorded under weedy check throughout (i.e. weedy check till harvest), closely followed by weed-free till 20 DAS. Hand weeding (20 and 40 DAS) and herbicides recorded significant reduction in weed dry weight as compared to weedy check throughout. The superiority of hand weeding, alachlor, pendimethalin and their combinations in controlling weeds in French bean has been documented (Rana *et al.* 1999, Rana 2002a&b).

Yield attributes and yield of French bean were severely hampered by the presence of weeds as pods/plant, seeds/pod, seed and haulm yield which were significantly influenced by different weed free and weedy periods (Table 2). Due to least weed-crop competition for nutrients, moisture, space and sunlight, the higher values of yield attributes and yields were recorded in the plots kept weed-free till 60 DAS and beyond, and weedy until 40 DAS. However, variation for mean seed yield was not significant. Severe reduction in yield occurred when weed-free conditions were maintained for the first 40 DAS and weedy up to 60 DAS. This indicated that 40-60 DAS was the critical period for weed control point of view in French bean. The yield levels in general showed a declining trend with increasing weedy period. The minimum yield, however, was recorded in the weedy check followed by weed infestation up to 80 DAS, weed-free up to 20 DAS, and weedy up to 60 DAS due to severe weed-crop competition in these treatments. Hand weeding (20 and 40 DAS) was as good weed-free up to 60 DAS and throughout, and weedy up to 20 DAS. Alachlor and pendimethalin each at 1.50 kg/ha produced grain yield of 2733 kg/ha and 2642 kg/ha, respectively, which were at par with hand weeding twice at 20 and 40 DAS (2989 kg/ha).

Reduction in yield due to weed competition throughout the cropping period was 59.9% as compared to weed-free conditions. When weedy conditions were maintained for first 20, 40, 60 and 80 DAS, the reduction in seed yield was 2.3, 7.39, 34.3 and 50.9%, respectively. On mean basis, weed competition index increased with increase in duration of weedy condition ranging from 2.3 to 59.9% (Table 3). On the other hand, increase in weed-free period for different duration from sowing to 80 DAS decreased weed competition index to 0.4 from 37.3, and increased weed control efficiency from 18.3 to 100%. Weed-free till 20 DAS registered the highest WMI (Weed management index), AMI (Agronomic management index) and IWMI (Integrated weed management index) as compared to other treatments. This was followed by HW 20 and 40 DAS, weed free till 60 DAS and weed-free 40 DAS.

Critical period of crop weed competition

The reduction in yield was greater when weeding was delayed by 60 days (Table 2 and Fig 1). Keeping the crop weed-free for initial 40 days resulted in 20.3% yield reduction compared with

Table 1. Effect of treatments on weed count (No. m^{-2}) and dry weight

Treatments	*Poa*	*Equisetum*	*Digitaria*	Broad-leaved weeds		Total weed count			Total weed dry weight (g/m^2)		
	2003	2003		2003	2004	2003	2004	Mean	2003	2004	Mean
Weed free till											
20 DAS	1.2	3.2	12.6	3.7	3.6	5.4	13.5	10.3	10.7	12.9	11.9
	(1)	(13)	(164)	(15)	(20)	(29)	(184)	(107)	(115)	(166)	(141)
40 DAS	0.7	3.2	10.9	0.7	4.5	3.2	11.7	8.7	9.2	10.5	9.9
	(0)	(13)	(119)	(0)	(20)	(13)	(139)	(76)	(85)	(110)	(97)
60 DAS	1.2	1.4	10.7	0.7	4.7	1.6	11.8	8.5	6.1	9.5	8.0
	(1)	(3)	(113)	(0)	(25)	(4)	(139)	(71)	(37)	(91)	(64)
80 DAS	0.7	0.7	10.5	0.7	3.9	0.7	11.2	7.9	0.7	7.0	5.0
	(0)	(0)	(111)	(0)	(15)	(0)	(125)	(63)	(0)	(49)	(24)
Harvest	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Weedy till											
20 DAS	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
40 DAS	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
60 DAS	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
80 DAS	1.2	1.8	0.7	0.7	0.7	2.0	0.7	1.6	0.9	0.7	0.8(0)
	(1)	(5)	(0)	(0)	(0)	(7)	(0)	(3)	(0)	(0)	
Harvest	7.4	6.5	15.3	6.0	3.7	11.5	15.8	13.8	12.7	13.5	13.1
	(55)	(41)	(235)	(36)	(13)	(132)	(248)	(190)	(162)	(182)	(172)
Hand weeding (20&40 DAS)	1.2	1.4	9.8	1.4	3.3	2.4	10.4	7.6	7.1	9.9	8.6
	(1)	(3)	(101)	(3)	(12)	(7)	(113)	(60)	(50)	(98)	(74)
Alachlor at 1.50 kg/ha	0.7	6.1	12.7	2.9	5.3	6.7	13.8	10.9	5.0	9.8	7.8
	(0)	(37)	(163)	(8)	(28)	(45)	(191)	(118)	(25)	(97)	(61)
Pendimethalin at 1.50 kg/ha	1.7	5.9	10.1	2.6	1.9	6.8	10.3	8.8	6.0	7.9	7.0
	(3)	(37)	(103)	(8)	(4)	(48)	(107)	(77)	(35)	(62)	(49)
Alachlor at 1.0 + Pendimethalin at 1.0 kg/ha	1.7	4.8	10.7	2.6	3.5	5.9	11.3	9.1	4.1	9.2	7.1
	(3)	(24)	(123)	(8)	(12)	(35)	(135)	(85)	(17)	(84)	(51)
LSD (P=0.05)	0.9	2.1	2.4	1.5	2.1	1.8	2.2	1.6	1.0	1.3	0.9

Data transformed to square root transformation ($\sqrt{x+0.5}$). Data given in parentheses are the means of original values.

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Table 2. Effect of treatments on yield attributes and seed and haulm yields (kg/ha) of French bean

Treatments	Pods/plant			Seeds/pod			Seed yield			Haulm yield		
	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean	2003	2004	Mean
Weed free till												
20 DAS	8.3	5.7	7.0	3.93	3.73	3.83	3027	840	1934	3046	1270	2158
40 DAS	8.3	8.5	8.4	4.53	3.93	4.23	3485	1433	2459	3407	1505	2456
60 DAS	10.0	10.7	10.4	4.47	4.53	4.50	3552	2521	3036	3500	2189	2844
80 DAS	10.1	10.1	10.1	4.73	4.47	4.60	3694	2451	3073	3315	2234	2774
Harvest	9.1	11.1	10.1	4.80	4.20	4.50	3429	2740	3085	3481	2594	3038
Weedy till												
20 DAS	8.9	11.7	10.3	4.40	4.27	4.33	3320	2707	3014	3111	2044	2578
40 DAS	9.0	10.0	9.5	4.67	4.07	4.37	3176	2539	2857	3287	2126	2707
60 DAS	9.0	7.1	8.0	4.73	3.87	4.30	2926	1128	2027	2676	1468	2072
80 DAS	7.6	4.4	6.0	4.40	3.60	4.00	2535	494	1515	2433	571	1502
Harvest	7.1	4.5	5.8	4.67	3.33	4.00	2046	429	1238	1954	385	1170
Hand weeding (20&40 DAS)	9.2	11.0	10.1	4.47	4.47	4.47	3268	2709	2989	2880	2117	2499
Alachlor at 1.50 kg/ha	11.9	9.0	10.5	4.60	3.80	4.20	3537	1929	2733	3074	1455	2265
Pendimethalin at 1.50 kg/ha	11.6	9.9	10.7	4.13	4.13	4.13	2889	2396	2642	2907	1625	2266
Alachlor at 1.0 + Pendimethalin at 1.0 kg/ha	10.7	8.9	9.8	4.47	3.80	4.13	2929	2020	2475	3000	1170	2085
LSD (P=0.05)	1.5	2.2	1.4	NS	0.66	0.32	456	462	287	736	520	458

weedy throughout. Thus initial weed-free conditions favoured the crop growth. Among weed infested treatments, infestation for initial 20 and 40 days did not cause significant reduction in seed yield. This was because of emergence of large number of weeds, which accumulated substantial dry matter and competed for the available resources. The LSD (P=0.05) for seed yield was 287 kg or 9.3% of the weed free check. By using the LSD= 9.3%, it can be seen that the seed yield (lower by 9.3% of the highest) was statistically at par with weed free check, when weedy period lasted only up to 40 days and weed free period up to 53 days or more (Fig 1) caused non-significant reduction. Therefore, an extrapolated critical period of weed competition ranged from 40 to 53 days in French bean. Chhokar *et al.* (1995) also used similar technique to determine the critical period of weed competition.

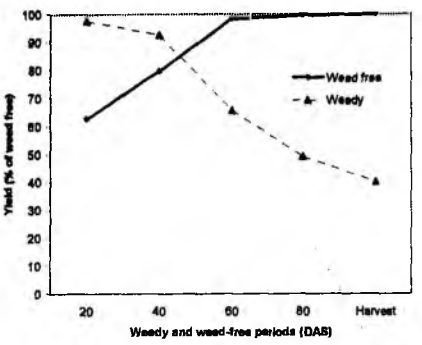


Fig 1. Critical period of weed-crop competition in French bean

Thus it can be inferred from this study that a farmer can adopt any method of weed control, the effect of which can last until this critical period (40-53 DAS) of crop-weed competition.

Table 3. Treatment effects on various indices

Treatments	Weed competition index	Weed control efficiency (%)	Weed management index (WMI)	Agronomic management index (AMI)	tegrated weed management index (IWMI)
Weed free till					
20 DAS	37.3	18.3	3.1	2.07	2.57
40 DAS	20.3	43.4	2.3	1.27	1.77
60 DAS	1.6	63.0	2.3	1.31	1.81
80 DAS	0.4	85.9	1.7	0.73	1.23
Harvest	0.0	100.0	1.5	0.49	0.99
Weedy till					
20 DAS	2.3	100.0	1.4	0.43	0.93
40 DAS	7.4	100.0	1.3	0.31	0.81
60 DAS	34.3	100.0	0.6	-0.36	0.14
80 DAS	50.9	99.9	0.2	-0.78	-0.28
Harvest	59.9	0.0	-	-	-
Hand weeding (20&40 DAS)	3.1	56.9	2.5	1.49	1.99
Alachlor at 1.50 kg/ha	11.4	64.4	1.9	0.87	1.37
Pendimethalin at 1.50 kg/ha	14.3	71.8	1.6	0.58	1.08
Alachlor at 1.0 + Pendimethalin at 1.0 kg/ha	19.8	70.6	1.4	0.41	0.91

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