Research reports

Crop-weed competition studies in French bean (*Phaseolus vulgaris* L.)

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Abstract

Field studies were conducted during 1994–95 and 1995–96 to determine the critical period of weed control in the French bean crop at Jabalpur, India. The treatment consisted of either allowing weeds to infest the crop for increasing duration after planting or maintaining plots weed free for increasing duration after planting. The major weeds infesting the French bean crop were chicory (*Cichorium intybus* L.), common lambsquarters (*Chenopodium album* L.), common vetch (*Vicia sativa* L.), and strawberry clover (*Trifolium fragiferum* L.).

Competition with the weeds throughout the crop season reduced the seed yield of French bean by 83.3%. Allowing the plots to remain weedy up to 30 days after sowing (DAS) reduced the seed yield by 4.6% but when the weeds were allowed to grow in association with the crop for further 15 days (up to 45 DAS), the reduction of seed yield was 29.05%. This marked reduction was due to severe competition offered by weeds. Seed yield was increased when the initial weed free duration was extended up to 60 days and further increase in the duration of weed free had no beneficial effect on the grain yield. Hence, the critical period of weed control occurred between 30 and 60 DAS.

Introduction

Introduction of French bean (*Phaseolus vulgaris* L.) to the plains of northern and central India, as a winter season crop, is one of the commendable contributions to Indian Agriculture in the recent years. Uncontrolled weeds can reduce French bean yields by as much as 70% (Woolley 1989). The time of weed removal has an important effect on the growth and yield of the crop. Removing weeds at any time during growing season may not be beneficial. Stage of weed removal is as important as removal *per se*. Therefore, it is necessary to identify the critical period of crop-weed competition to render the weed control practices more effective and economical.

Hall *et al.* (1992) described the critical period of weed control as representing the time interval between two separate components. The first component is the maximum length of time that weeds, which emerge with the crop, can remain before they reduce crop yield. The second component is the length of time a crop must be kept weed free after planting so that those weeds emerging later do not reduce yield. The two components can be integrated to identify a single critical period of weed control, recognized as the duration over which neither component provides an acceptably low yield loss; weed control must be effective within a period of overlap between the two components. Understanding the critical period of weed control during French bean growth will allow farmers to better manage weeds in production fields. The objective of this study was to determine the critical period of weed control in the French bean crop.

Materials and methods

The field experiment was conducted during the winter season of 1994–95 and 1995–96 at Jabalpur. The soil was clay-loam in texture, low in available nitrogen (240 kg N ha^{-1}), medium in available phosphorus (41 kg P_2O_5 ha^{-1}) and high in available potassium (434 kg K_2O ha^{-1}) with a pH of 6.6. Treatments consisted of weedy conditions for the first 15, 30, 45 and 60 days after sowing (DAS) and up to harvest (140 DAS), and weed free conditions for the first 15, 30, 45 and 60 DAS and up to harvest (Table 1), replicated three times in randomized block design. The French bean variety 'Contender' was planted in rows 30 × 10 cm apart on 9 November 1994 and 4 November 1995. A fertilizer dose of 50 kg N and 60 kg P_2O_5 ha^{-1} was applied in seed furrows at planting and a remaining 50 kg N ha^{-1} was top dressed after first irrigation (25 DAS). Weed population (m^{-2}) and weed dry weight (g m^{-2}) were recorded at 30, 60 and 90 DAS and at harvest (140 DAS) by placing a quadrat of 50 × 50 cm randomly at four places in each plot. The crop was irrigated three times and adequately protected against insects, pests and diseases. Treatments were separated using Fishers Protected LSD at the P=0.05 level.

Results and discussion

Effect on weeds

The crop was infested mainly with broad leaf weeds. The dominant weed species in order of number were chicory (*Cichorium intybus* L.) (31%); common lambsquarters (*Chenopodium album* L.) (25%); common vetch (*Vicia sativa* L.) (20%), strawberry clover (*Trifolium fragiferum* L.) (19%) and others (5%). Chicory dominated all other weeds throughout the crop season.

Maximum weed population was recorded at 30 DAS in unweeded plots (Table 1) and declined at subsequent stages of crop growth. It implies that the majority of weeds in French beans emerged by this time and competition among weeds and with the crop at subsequent stages caused reduction in the weed population. The growth of French bean during early stages is quite slow. The crop develops a closed canopy over the soil surface at later stages, which results in suppression of weeds. The length of initial weed free period affected the emergence of weeds at stages subsequent to completion of the weed free period. More emergences of weeds occurred when the crop was kept free of weeds initially for a shorter duration as compared to a longer duration (Table 1). Reduced emergence of weeds at later stages is further indicative of the competitive effects of the crop with the advancement of growth. These results are in agreement with those reported by Singh and Singh (1992) in chickpeas.

Weed biomass proved to be a better indicator of weed interference than weed density (Woolley 1989). Dry weight produced by chicory was greater than that produced by common lambsquarters, common vetch and strawberry clover in unweeded plots through out the period of crop growth. There was an increase in the weed biomass with the advancement of growth. The highest rate of weed dry matter production in unweeded plots was observed during 60–90 DAS (Table 1). This indicated a high degree of competition during this period. Weed dry matter production at the stages subsequent to completion of initial weed free duration, decreased with increases in duration of weed free condition. Weed dry matter produced in plots free of weeds for the first 45 DAS or beyond was low as a result of fewer emergences of weeds at the subsequent stages. Similar findings were reported by Woolley *et al.* (1993) and Tyagi *et al.* (1993).

Yield and yield attributes

Increasing duration of weed interference after planting decreased the average number of pods per plant and 100-seed weight. However, changes in the average number of seeds per pod were not significant. There was a drastic reduction in harvest index of the crop when weeds were allowed to grow up to harvest. This might be due to higher weed population, multi-layered canopy and mixed community that enabled the weeds to intercept higher solar radiation, resulting in reduced photosynthesis by the crop. Pods per plant and seed weight increased with increasing duration of weed free period. Maximum 100-seed weight (58 g) was recorded with weed free up to harvest that was at par with weed free up to 60 DAS.

Competition with weeds for the full crop season resulted an 83.3% reduction in seed yield of French bean (Table 2). The extent of yield loss increased with an increase in duration of the initial weed competition period. There was non-significant (P= 0.05) increase in the grain yield due to increases in the weed free condition beyond the first 60 DAS. Weed emergence after 60 days of initial weed free condition was low as the crop smothered the weeds. When the crop was kept free of weeds for the first 30 days only, there was 29.2% reduction in grain yield. This was much more than caused by the weeds during first 30 DAS (4.6%). This is attributed to the fact that a large number of weeds emerged even after 30 DAS and produced more dry matter leading to a high degree of competition with the crop. This relationship is illustrated clearly in Figure 1 where it can be seen that weeds emerging within the first 30 DAS have only a small effect on yield, as is the case for weeds emerging 60 DAS. Hence, the period 30–60 DAS may be considered as critical stage for crop-weed competition in French bean.

Table 1. Effect of crop–weed competition on weed population and weed dry weight at various stages of crop growth (average data of two years).

Treatment (DAS)	weed population m^{-2} DAS				weed dry weight (g m^{-2}) DAS			
	30	60	90	harvest	30	60	90	harvest
Weedy for the first								
15	0	0	0	0	0.0	0.0	0.0	0.0
30	464	0	0	0	41.7	0.0	0.0	0.0
45	570	0	0	0	40.0	0.0	0.0	0.0
60	465	324	0	0	42.7	126.7	0.0	0.0
up to harvest	637	433	326	183	46.7	176.7	348.7	380.7
Weed free for the first								
15	187	185	155	74	13.5	102.7	296.7	372.0
30	0	119	92	42	0.0	44	73.3	246.3
45	0	84	79	51	0.0	19.7	70.0	177.3
60	0	0	37	47	0.0	0.0	68.0	143.3
up to harvest	0	0	0	0	0.0	0.0	0.0	0.0
LSD (P=0.05)	241	171	38	25	7.4	24.5	38.5	86.6

Table 2. Effect of crop-weed competition on yield attributes, yield and harvest index of French bean (average data of two years).

Treatment (DAS)	Pods per plant	Seeds per pod	100 seed weight (g)	Seed yield (kg ha^{-1})	Harvest index	Yield loss (%)
Weedy for the first						
15	7.6	3.3	55.3	1286	40.1	1.15
30	7.1	3.3	54.2	1241	38.2	4.6
45	5.2	3.3	53.3	923	36.8	29.05
60	5.6	3.5	53.0	547	31.4	57.95
up to harvest	4.6	3.3	52.2	217	23.1	83.32
Weed free for the first						
15	4.0	3.1	50.9	556	35.0	57.13
30	6.5	3.1	51.0	921	39.2	29.21
45	7.1	3.5	54.5	1099	38.6	15.23
60	7.2	3.5	57.9	1225	38.9	5.84
up to harvest	7.3	3.3	58.0	1301	34.2	0.0
LSD (P=0.05)	2.4	NS	2.0	125	–	–

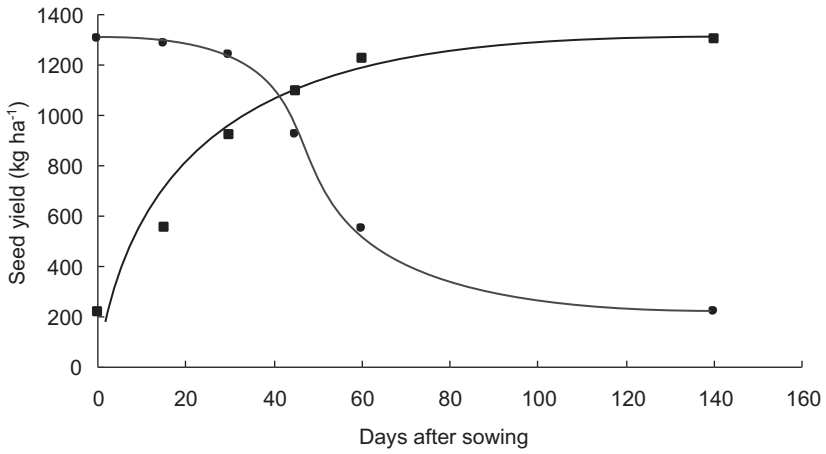

Figure 1. Crop yield as affected by increasing duration after planting of the crop maintained as either weed free (■) or weed infested (●).

Conclusion

It may be concluded that French bean is sensitive to weed competition. The critical period of weed removal is between 30 and 60 DAS in northern India. If growers use pre-plant incorporated or pre-emergence herbicides, they should use those with enough soil residual activity to control weeds until 60 DAS. Use of post emergence herbicides should be designed to give weed control from 30 to 60 DAS.

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