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Effect of integrated weed management on growth of *kharif* French bean (*Phaseolus vulgaris* L.)

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Abstract
A field experiment was carried out at experimental farm of Agronomy section, College of Agriculture, Latur during *Kharif* 2018 to study the effect of applications of pre emergence and post emergence herbicides on growth attributes of *kharif* French bean (*Phaseolus vulgaris* L). The experiment was laid out in a Randomized Block Design with seven treatments and replicated thrice.
Maximum Plant height plant^{-1} (33.87 cm) at harvest were recorded with the weed free treatment (T_6) which was found at par with the Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) (T_1), treatment Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE) + One hoeing at 30 DAS (T_3) and Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1} at 20 DAS + one hoeing at 30DAS (T_4).
Maximum mean number of branches plant^{-1}(10.10), Mean plant spread plant^{-1} (46.23 cm) were recorded with the weed free treatment (T_6) which was found at par with the Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE) + One hoeing at 30 DAS (T_3) and Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1} at 20 DAS + one hoeing at 30DAS (T_4).
While, maximum total dry matter accumulation at harvest plant^{-1}(17.27g), were recorded with the weed free treatment (T_6) which was closely followed by the Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE) + One hoeing at 30 DAS (T_3) and Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1} at 20 DAS + one hoeing at 30DAS (T_4).

Keywords: Herbicides, weed management, French bean, growth, height, plant spread, dry matter, branches

1. Introduction
Common bean (*Phaseolus vulgaris* L.) is a herbaceous annual plant grown worldwide for its edible grain, green leaves and green pods. However the dry seeds are the ultimate economic product. French bean locally called 'rajmash' (*Phaseolus vulgaris*) is grown as a minor pulse crop and mostly cultivated during *Kharif* (rainy season). It is a short duration crop, which can be included in crop rotations after harvest of mungbean/urdbean as it has been found economically advantageous over wheat.
Though, it is a legume crop, it does not nodulate in roots either with native rhizobia or commercially produced cultures. Thus, it requires higher dose of nitrogen. Plant has fibrous roots which draw moisture and nutrients mostly from upper layer of soil surface. In world French bean is cultivated on an area of 282 M ha with a production of 18.95 million tonnes, in which Brazil rank first. In India French bean is cultivated on an area 3.94 million ha with a production and productivity of 2.8 million tonnes and 7.1 q/ ha respectively (Anonymous 2006) [1].
Among the major constraints, initial heavy infestation of weeds is one of the important factors, which hinders its overall growth and productivity (Malik and Malik, 1994) [2]. Since initial growth rate of French bean is slow compared to weeds and the interspaces covered by weeds severely affected crop growth and yield. Due to high moisture and nutrients in rajmash field, weeds become a problem, thus their timely control is necessary to exploit the yield potential (Srivastava *et al*. 2013) [3].
It is an established fact that weeds, due to their competition for water, light and nutrients reduce crop yields, but little is known about the physiological interaction between crop plants and weeds that brings about the reduction in growth which indirectly results in yield reduction (Aspinall and Milthorpe, 1959) [4].
Weed management is one of the most important factors impacting agricultural productivity. Weeds directly compete with crops for limited resources which reduce crop yield and increase the cost of production. Weeds also impede the efficiency of crop harvest and harbour insects and diseases that can be harmful to crops. There are three goals of any weed management system: reduce weed density, reduce the amount of damage that a given density of weeds

inflicts on an associated crop, and alter the composition of weed communities towards less aggressive and easier-to-manage species. Although the yield losses due to weed depend on composition of weed flora, extent of infestation and the crop canopy, decides yield loss but it has been estimated that weeds alone can reduce the yield to the tune of 20-60 per cent.

Among the various weed management options herbicide use is not only efficient method but it is cost effective also. On the other hand, physical weed control measure *viz.* hand weeding are safe but labour intensive.

Keeping this view the present study was carried out to study the effect of pre-emergence and post-emergence herbicides alone and in combination with hand weeding on growth and growth attributes of *kharif* French bean.

2. Materials and Methods

A field experiment was conducted during *kharif* season of 2018-19 at Experimental Farm, Agronomy Section, College of Agriculture, Latur. The experimental site was low in available nitrogen (129.31 kg ha^{-1}), low in available phosphorus (20.42 kg ha^{-1}), high in available potassium (460.00 kg ha^{-1}) and alkaline (p^H 8.1) in reaction. The soil was clayey in texture with moderate moisture holding capacity which was good for normal growth. Mechanical analysis of soil was done by International Pipette Method (Piper, 1966) [5], Available nitrogen by alkaline potassium permanganate method (Subbiah and Asija, 1956) [6], available phosphorous by Olsen method (Olsen *et al*., 1954) [7] and available potassium by Flame emission method (Jackson, 1967) [8].

The experiment was laid out in a Randomized Block Design with seven treatments and replicated thrice. The treatments were (T_1) Pendimethalin 30% EC @1.0 kg a.i.ha^{-1} (PE), (T_2) Quizalofop-p-ethyl 5% EC 100 g a.i. ha^{-1} at 20 DAS (POE), (T_3) Pendimethalin 30% EC @ 1.0 kg a.i.ha^{-1} (PE) + One hoeing at 30 DAS, (T_4) Quizalofop-p- ethyl 5% EC 100 g a.i. ha^{-1} at 20 DAS + One hoeing at 30 DAS, (T_5) One hoeing followed by One hand weeding (Farmers practice), (T_6) Weed free (Three hand weeding) and (T_7) Weedy check.

Gross and net sizes of plots were 4.8m × 4.5m and 4.2m × 3.9m respectively. Sowing was done by dibbling method on 10th July 2018 with spacing 45cm × 10 cm. Half dose of nitrogen and full dose of phosphorous and potassium applied as basal dose and remaining half dose of nitrogen was top dressed at 30 DAS. The crop was harvested on 24 sept 2018. The recommended cultural practices and plant protection measures were taken. Pre-emergence application of pendimethalin was done on next day of sowing and post-emeregence application of herbicide was done 20 DAS. Weeds at harvest were collected using $1m^2$ quadrate.

3. Growth attributes were worked out as follows,

3.1 Plant height (cm)

The plant height was measured in cm from the base of plant up to base of top most fully opened leaf at 30,45,60 DAS and at harvest.

3.2 Number of branches plant $^{-1}$

The numbers of branches per plant from the five observational plants were counted at 15 days interval from 30 DAS till harvest.

3.3 Plant spread (cm)

The spread of the plant was measured in cm from the two opposite growing branches. The observations were recorded periodically at an interval of 15 days from 30 DAS till harvest of the crop.

3.4 Dry matter accumulation plant^{-1} (g)

The weight of dry matter is an index of productive capacity of the plant. Hence, one representative plant from gross plot was randomly uprooted at each observation i.e. at 30, 45, 60 DAS and finally at harvest. The roots of plant uprooted for dry matter study from each gross plot were removed. This separated plant was sun dried in the first instance and oven dried at 65 + 2 °C temperature till constant weight obtained. The constant weight was recorded as total dry matter weight (g) plant^{-1} for each treatment

3.5 Statistical analysis and interpretation of data

Data obtained on various variables were analyzed for "Analysis of variance method" (Panse and Sukhatme, 1967) [9]. The total variance (S^2) and degree of freedom (n-1) were partition into different possible sources. The variances due to different treatments calculated and compared with error variance for finding out 'F' value and ultimately for testing the significance at P = 0.05. Wherever, results were found significant critical difference was calculated for comparison for treatment mean at 5% level of significance.

4. Results and Discussion

Almost all the growth attributing characters *viz*., Mean plant height (cm), Mean plant spread (cm), number of branches, dry matter plant^{-1} were significantly influenced by various treatments during active growth and maturity.

4.1 Plant height (cm)

Plant height was increased continuously up to harvest. The increase in plant height was maximum in between 30-45 DAS indicating grand growth period. There after the plant height was increased with decreasing rate till maturity.

The weed free treatment (T_6) recorded maximum plant height at harvest of French bean as compared to all other treatments. But it was found at par with (T_1) Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE), application of Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + one hoeing at 30 DAS (T_3) and application of Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1} at 20 DAS (POE) + one hoeing at 30 DAS (T_4) upto 60 DAS. It might be due to effective control of weeds up to 45 DAS which enhanced the crop growth. Similar kind of results was obtained by Kavad *et al.* (2016) [10] and Gelot *et al.* (2018) [11].

4.2 Number of branches plant^{-1}

The number of branches plant^{-1} was increased continuously up to 60 DAS. Maximum number of branches plant^{-1}(8.69) was recorded at 60 DAS and remains constant at harvest. The higher no. of branches recorded with the weed free treatment (T_6) but it was found at par with application of Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + one hoeing at 30 DAS (T_3) and application of Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1} at 20DAS (POE) + one hoeing at 30 DAS (T_4). This might be happened due to effective weed control. Similar kind of results was obtained by Panotra and Kumar (2016) [12].

4.3 Plant spread (cm)

The mean plant spread was increased continuously up to 45 DAS and thereafter decreased. The higher mean plant spread was recorded with the weed free treatment (T_6). But it was found at par with application of Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + one hoeing at 30 DAS (T_3) and application

of Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1} at 20DAS (POE) + one hoeing at 30 DAS (T_4). This might be happened due to effective weed control, which reduced the competition for space, resulted in more plant spread. Similar kind of results were obtained by Patel *et al.* (2018) [13].

4.4 Dry matter accumulation plant^{-1} (g)

The total dry matter production plant^{-1} (g) increased continuously up to maturity. The total dry mater accumulation per plant increased till harvest.

The weed free treatment (T_6) recorded higher dry matter plant^{-1} at harvest which was closely followed by application of Pendimethalin 30% EC @ 1.0 kg a.i. ha^{-1} (PE) + one hoeing at 30 DAS (T_3) and application of Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1} at 20DAS (POE)+ one hoeing at 30 DAS (T_4). It might be due to no competition for resources between crop plants and weeds due to effective weed control up to 45DAS which helped the plant to grow with full potential. These results are in conformity with Patel S (2018) [13] and Prachand *et al.* (2015) [14].

Table 1: Mean plant height (cm) of French bean as influenced by various treatments at different crop growth stages.

Treatments	Days after sowing			
	30	45	60	AH
T_1- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE)	19.10	27.80	33.10	33.13
T_2- Quizalofop-p-ethyl 5% EC @100 g a.i. ha^{-1} at 20 DAS (POE)	18.70	26.97	30.17	30.23
T_3- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1} (PE) + One hoeing at 30 DAS	18.63	27.40	32.00	32.03
T_4- Quizalofop-p- ethyl 5% EC @100 g a.i. ha^{-1} at 20 DAS + One hoeing at 30 DAS	18.43	27.24	30.36	30.43
T_5- One hoeing followed by One hand weeding (farmers practice)	18.07	26.47	30.20	30.27
T_6- Weed free	18.40	29.37	33.80	33.87
T_7- Weedy check	21.93	25.2	27.95	27.99
SE+	0.69	0.70	1.12	1.12
C.D. at 5%	2.12	2.14	3.45	3.46
General mean	19.04	27.17	30.66	30.71

Table 2: Mean number of branches of French bean as influenced by various treatments at different crop growth stages

Treatments	Days after sowing		
	30	45	60
T_1- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1} (PE)	4.57	5.80	7.93
T_2- Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1}at 20 DAS (POE)	4.53	5.33	7.70
T_3- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE) + One hoeing at 30 DAS	4.60	6.60	9.20
T_4- Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1}at 20 DAS + One hoeing at 30 DAS	4.57	6.47	8.93
T_5- One hoeing followed by One hand weeding (farmer practice)	4.40	6.13	8.27
T_6- Weed free	4.67	7.07	10.10
T_7- Weedy check	4.33	5.67	8.67
S.E.±	0.13	0.24	0.42
CD at 5%	NS	0.73	1.28
General Mean	4.52	6.15	8.69

Table 3: Mean plant spread (cm) of French bean as influenced by various treatments at different crop growth stages

Treatments	Days after sowing		
	30	45	60
T_1- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE)	35.35	36.14	41.30
T_2- Quizalofop-p-ethyl 5% EC @100 g a.i. ha^{-1} at 20 DAS (POE)	34.87	38.73	41.21
T_3- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1} (PE) + One hoeing at 30 DAS	35.68	39.87	45.33
T_4- Quizalofop-p- ethyl 5% EC @100 g a.i. ha^{-1} at 20 DAS + One hoeing at 30 DAS	35.63	39.57	44.07
T_5- One hoeing followed by One hand weeding (farmers practice)	33.12	38.97	41.33
T_6- Weed free	36.14	43.47	46.23
T_7- Weedy check	34.99	36.40	37.61
S.E.±	1.17	1.38	1.30
CD at 5%	NS	4.25	3.99
General Mean	35.11	39.02	42.44

Table 4: Mean total dry matter (g) plant^{-1} of French bean as influenced by different treatments at various crop growth stages.

Treatments	Days after sowing			
	30	45	60	AH
T_1- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1} (PE)	4.59	10.70	12.50	12.67
T_2- Quizalofop-p-ethyl 5% EC @ 100 g a.i. ha^{-1}at 20 DAS (POE)	4.77	10.77	12.37	12.80
T_3- Pendimethalin 30% EC @1.0 kg a.i.ha^{-1}(PE) + One hoeing at 30 DAS	4.87	14.83	15.93	16.83
T_4- Quizalofop-p- ethyl 5% EC @ 100 g a.i. ha^{-1}at 20 DAS + One hoeing at 30 DAS	4.88	12.80	14.50	15.77
T_5- One hoeing followed by One hand weeding (farmer practice)	3.75	12.10	13.10	13.47
T_6- Weed free	4.92	16.29	16.93	17.27
T_7- Weedy check	3.74	10.77	11.17	11.30
S.E.±	0.13	0.77	0.82	0.56
CD at 5%	0.40	2.38	2.52	1.72
General Mean	4.50	12.61	13.50	14.3

5. Conclusion

On the basis of above findings it may be inferred that for achieving maximum basic growth attributes *viz*., plant height, Mean plant spread (cm), mean number of branches plant^{-1} (cm) and dry matter plant^{-1} (g) which indirectly influences the yield potential of the crop, the weed free treatment (T_6) was found effective.

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