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Effect of Integrated Nutrient and Weed Management of French Bean (*Phaseolus vulgaris* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment on "Effect of integrated nutrient and weed management of French bean (*Phaseolus vulgaris* L.)" was carried out during the 2018-19 and 2019-20 in *Rabi* season at the college research farm of T. D. Post Graduate College, Jaunpur, UP. The experiment was laid out in split plot design with five weed management treatments and four nutrient management treatments with three replications. Herbicides *viz.,* pre-emergence (Pendimethalin) and post emergence (Quizalofop-ethyl & Imazethapyr) and two hand weeding at 20 and 40 DAS under weed management with an objective to study the effect of pre and post-emergence herbicides under integrated nutrient management on weed flora and their growth in French bean. This investigation recorded minimum weed density, weed dry weight and significantly higher results received that plant growth in terms of plant height (cm), number of branches plant^{-1}, dry matter production plant^{-1}, LAI, grain and straw yield and biological yield under two hand weeding (20 & 40 DAS) plots. Among

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the herbicide's application, Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS was significantly superior to all the other herbicide application treatments and nutrient application was recorded with 100% RDF which was significantly superior to all the other nutrient management treatments during both the years of experimentation.

Keywords: French bean; herbicides; weed management; growth; branches; dry matter.

1. INTRODUCTION

French bean (*Phaseolus vulgaris* L.) commonly known as Rajmash is an important pulse crop with 20.69 to 25.81% grain protein, 72.42% carbohydrates, 1.72% fat and 5.83 mg iron [1]. Globally, being one of the premier crops, it occupies 28.2 million hectares area with an annual production of 18.95 million tonnes. Amongst the French bean producing countries, Brazil ranks first in area and production. In India, traditionally, cultivated in the hilly tracts of Jammu & Kashmir, Himanchal Pradesh, Uttar Pradesh, Bihar Orissa and some parts of Maharashtra (Mahabaleshwar and Ratnagiri regions) in cultivation of French bean. Due to its specific adoption to cool and long growing season prevailing in the above-mentioned region [2] makes the crop to perform well under existing condition of the area.

Ahlawat et al. [3] observed that *Echinochloa colonum L., Amaranthus viridis, Cyperus rotundus, Chenopodium album, Portulaca gudrifida, Melilotus indica* and *Melilotus alba* were the major weed species constituting about 90 per cent of the total weed population.

Prajapati et al*.* [4] reported that weed control treatments, 0.75 kg pendimethalin a.i. ha^{-1} applied at pre-emergence + hand weeding at 45 DAS resulted in the lowest weed population (4.95 m^{-2}) and dry weight (7.32 g m^{2}).

Singh et al*.* [5] revealed that the pendimethalin fb quizalofop-p-ethyl had significant potential to minimize the weed dynamics of *Chenopodium album*, *Melilotus alba*, *Melilotus indica* and *Cyperus rotundus* which, resulted in marked reduction on total weed density (41.48 and 41.11 nos m^{2}), weed dry weight (45.62 and 44.68 g m^{2}) and weed index of crop growth and showed higher weed control efficiency over the alone application of Pendimethalin.

Chavan et al*.* [6] found out that maximum plant height plant^{-1} (33.87 cm) at harvest, maximum mean number of branches plant^{-1} (10.10), mean plant spread plant^{-1} (46.23 cm) and 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 at 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 30 DAS (T_4).

Among the various weed management options herbicide use is not only efficient method but it is cost effective. On the other hand, physical weed control measure *viz.* hand weeding is safe but labour intensive [7,8].

2. MATERIALS AND METHODS

A field experiment was conducted at Pili Kothi College research farm of Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh. during *Rabi* season 2018-19 and 2019-20. Which is geographically situated between 25.74^{o} N latitude to 82.68^{o} E longitude and at an altitude of 82 m above mean sea level. The climate is semi-arid with hot summer and cold winter. The site is located in typical saline-alkali belt of Indo-Gangetic alluvium Plaine of Eastern Uttar Pradesh.

The experiment was laid out in split plot design with 20 combination of five weed management treatments (W_1: Weedy check (Control), W_2: Pendimethalin @ 1.25 kg a.i. ha^{-1} as pre emergence, W_3: Quizalofop-ethyl @ 50 g a.i. ha^{-1} at 20 DAS, W_4: Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS and W_5: Two hand weeding at 20 and 40 days after sowing and four nutrient management treatments (N_1: 75% RDF, N_2: 75% RDF + 25% N through vermicompost, N_3: 75% RDF + 25% N through FYM and N_4: 100% RDF) with three replications. The experimental field was divided into 60 plots. Each gross plot size was 15 m^{2} (5m × 3 m) and net plot size was 9.6 m^{2} (4m× 2.4 m) and row to row distance was maintained at 30 cm and plant to plant distance was 10 cm. The recommended cultural practices and plant protection measures were taken. Pre-emergence application of Pendimethalin was done after sowing and post-emergence application of Quizalofop-ethyl and Imazethapyr herbicide was

done 20 DAS. The experiment variety, HUR-137 (Hindu University Rajma-137), was developed in 1990 at the Banaras Hindu University in Varanasi, Uttar Pradesh. The colour of the seed is brown red with a maturity period of 110-120 days. The yield potential of the variety is 25-30 q ha^{-1}.

1. Weed Density (No. m^{-2})

Species wise weed counts were recorded for estimating weed density, a quadrate of 0.25 m^2 (0.50 × 0.50 m) was placed between first and fourth row in one side of each plot. Individual species wise counts were grouped into grasses, sedges and broad-leaved weeds and expressed as number m^{-2}.

2. Total weedS Dry Weight (gm^{-2})

Weeds enclosed in a quadrate of 0.25 m^2 (0.50 × 0.50 m) were cut at ground level washed with tap water. Further samples were shade dried followed by oven drying at 70 ºC for 48 hours, and then sample were weighed. The weed dry weight was expressed in g m^{-2}.

3. Plant Height (cm)

The plant height (cm) was measured from base of the plant to the tip of the youngest leaf and the average height of the five tagged plants sample was calculated.

4. Number of Branches $Plant^{-1}$

Total numbers of branches were counted from the five tagged plants and average number of branches $plant^{-1}$ was calculated.

5. Dry Matter Production $Plant^{-1}$ (gm^{-2})

Five randomly selected plants were pulled out and cleaned of soil and were air dried. These samples then were transferred to hot air oven, regulated at 70 °C± 1°C for 48 hrs., and dried to a constant weight and finally their weights were recorded and average dry weight $plant^{-1}$ was worked out.

6. Leaf Area Index (LAI)

Leaf area was calculated by following formula as given below:

$$LAI = \frac{\text{Leaf area}}{\text{Ground area}}$$

7. Grain and Straw Yield (kg ha^{-1})

Yield of grain and straw from net plot was recorded after drying the bundles under sun to a standard moisture condition, the grain and straw yield per plot was then converted to determine yield per hectare.

8. Biological Yield

The biological yield retains to the weight of both grain + straw constitute the biological yield.

3. RESULTS AND DISCUSSION

The plant growth observation recorded from trial in terms of dry matter production $plant^{-1}$ was slow in the early stages of crop growth. Significant improvement in growth attributes was recorded under application of Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS which was found significantly superior to all other herbicide treatments during both the years of experiment in given Table 3. In case of fertility levels was recorded with 100% RDF which was significantly superior over 75% RDF, 75% RDF + 25% N through vermicompost and 75% RDF + 25% N through FYM at all stages of crop growth during both the years of investigation. Huge decrease in crop-weed contest was seen under French bean because of the different weed management treatments which not just preferred the yield plants by further developing accessibility of dampness, supplements, light and space, yet additionally diminished all weed obstruction working with lively development and improvement of harvest. Similar trends were reported by Tana et al. [9], Chavan et al. [6] and Hamid and Rasool [10].

1. Weed Density (No. m^{-2})

The observations regarding weed count were significantly influenced by weed management and fertility level during experimental years. Observations were recorded sequentially during both the years (2018-19 and 2109-20) and are summarized species wise. In general, weed densities of the various species were recorded minimum during second year as compared to first year of experimentation due to effective control of weeds in second year. Individual weed density in weedy check plot of the experiment in given Table 1.

Table 1. Individual weed density in weedy check plot of the experiment

S. No.	Weed flora	Density (Number/m^{-2}) of weeds							
		40 DAS		60 DAS		80 DAS		At harvest	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
A.	**Sedges**								
1.	*Cyperus rotundus*	1.58	1.55	2.98	2.8	3.58	3.52	3.42	3.32
	Sub total	1.58	1.55	2.98	2.8	3.58	3.52	3.42	3.32
B.	**Dicot weeds**								
1.	*Melilotus alba*	1.4	1.36	1.56	1.52	2.22	2.1	1.9	1.82
2.	*Chenopodium album*	44.81	42.92	48.47	46.05	134.21	130.2	128.86	124.19
3.	*Melilotus indica*	1.16	1.13	1.6	1.56	2.94	2.8	2.74	2.66
	Sub total	47.37	45.41	51.63	49.13	139.37	135.1	133.5	128.67
	Total	48.95	46.96	54.61	51.93	142.95	138.62	136.92	131.99

Table 2. Effect of different treatments on weeds dry weight (g m^{-2}) and dry matter production $plant^{-1}$

Treatments	Weeds dry weight (g m^{-2})				Dry matter production $plant^{-1}$			
	40 DAS		60 DAS		40 DAS		60 DAS	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
(A) Weed management								
W_1	5.37 (28.37)	5.18 (26.29)	6.48 (41.50)	6.31 (39.37)	4.06	4.63	9.54	9.67
W_2	4.11 (16.35)	3.84 (14.27)	4.90 (23.52)	4.68 (21.43)	5.12	5.84	11.02	11.18
W_3	4.98 (24.34)	4.77 (22.26)	6.01 (35.58)	5.87 (33.96)	4.74	5.40	11.13	10.27
W_4	4.05 (15.91)	3.81 (14.02)	4.87 (23.25)	4.67 (21.30)	5.30	6.04	11.44	11.61
W_5	3.20 (9.72)	3.13 (9.28)	3.86 (14.38)	3.59 (12.37)	5.59	6.67	12.12	12.28
SEm±	**0.03**	**0.02**	**0.02**	**0.22**	**0.05**	**0.05**	**0.11**	**0.11**
CD (P=0.05)	**0.09**	**0.08**	**0.05**	**0.72**	**0.16**	**0.18**	**0.37**	**0.37**
(B) Nutrient management								
F_1	4.33 (18.27)	4.11 (16.41)	5.23 (26.90)	5.03 (24.82)	4.71	5.44	10.08	10.97
F_2	4.43 (19.16)	4.24 (17.45)	5.33 (27.90)	5.17 (26.19)	5.02	5.79	11.14	11.29
F_3	4.40 (18.87)	4.20 (17.15)	5.30 (27.62)	5.10 (25.54)	4.89	5.64	10.95	11.11
F_4	4.47 (19.45)	4.29 (17.89)	5.35 (28.16)	5.17 (26.20)	5.23	6.01	11.27	11.42
SEm±	**0.02**	**0.04**	**0.02**	**0.20**	**0.09**	**0.10**	**0.20**	**0.21**
CD (P=0.05)	**0.06**	**0.11**	**0.06**	**0.59**	**0.25**	**0.29**	**0.59**	**0.60**

Note: (W_1) Weedy Check (Control), (W_2) Pendimethalin @ 1.25 Kg a.i. ha^{-1} at pre-emergence, (W_3) Quizalofop-ethyl @ 50 g a.i. ha^{-1} at 20 DAS, (W_4) Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS, (W_5) Two hand weeding at 20 & 40 days after sowing, (F_1) 75% RDF, (F_2) 75% RDF + 25% N through vermicompost, (F_3) 75% RDF + 25% N through FYM, (F_4) 100% RDF.

**Figures in parentheses are the original value*

Table 3. Effect of different treatments on Plant height (cm), Number of branches plant^{-1} and Leaf area Index (LAI)

Treatments	Plant height (cm)				Number of branches plant^{-1}				Leaf area Index (LAI)			
	40 DAS		60 DAS		40 DAS		60 DAS		40 DAS		60 DAS	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
(A) Weed management												
W_1	22.43	23.06	28.70	29.81	7.06	7.51	9.69	9.72	0.52	0.55	1.27	1.46
W_2	25.49	26.64	34.40	35.73	8.51	8.95	11.82	11.90	0.64	0.68	1.57	1.81
W_3	26.32	26.80	31.94	33.18	7.74	8.18	10.98	11.10	0.60	0.64	1.47	1.70
W_4	27.42	28.06	34.95	36.31	8.56	9.02	12.06	12.12	0.67	0.72	1.65	1.90
W_5	28.51	29.28	41.11	42.71	9.45	10.02	12.86	12.95	0.71	0.75	1.74	2.00
SEm±	**0.04**	**0.05**	**0.11**	**0.07**	**0.04**	**0.04**	**0.18**	**0.18**	**0.007**	**0.008**	**0.02**	**0.02**
CD (P=0.05)	**0.13**	**0.16**	**0.37**	**0.22**	**0.13**	**0.13**	**0.57**	**0.58**	**0.02**	**0.024**	**0.06**	**0.07**
(B) Nutrient management												
F_1	24.47	24.89	31.92	32.65	7.95	8.44	11.13	11.19	0.47	0.51	1.42	1.65
F_2	26.58	27.40	34.97	36.55	8.36	8.11	11.60	11.69	0.68	0.72	1.59	1.82
F_3	25.97	26.86	33.92	35.51	8.22	8.63	11.44	11.53	0.63	0.67	1.53	1.77
F_4	27.12	27.93	36.06	37.50	8.53	9.05	11.75	11.83	0.74	0.78	1.63	1.87
SEm±	**0.02**	**0.04**	**0.09**	**0.06**	**0.03**	**0.04**	**0.15**	**0.16**	**0.01**	**0.01**	**0.03**	**0.03**
CD (P=0.05)	**0.06**	**0.11**	**0.25**	**0.19**	**0.10**	**0.11**	**0.45**	**0.45**	**0.04**	**0.04**	**0.09**	**0.10**

Note: (W_1) Weedy Check (Control), (W_2) Pendimethalin @ 1.25 Kg a.i. ha^{-1} at pre-emergence, (W_3) Quizalofop-ethyl @ 50 g a.i. ha^{-1} at 20 DAS, (W_4) Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS, (W_5) Two hand weeding at 20 & 40 days after sowing, (F_1) 75% RDF, (F_2) 75% RDF + 25% N through vermicompost, (F_3) 75% RDF + 25% N through FYM, (F_4) 100% RDF.

Table 4. Effect of different treatments on yield

Treatments	Yield					
	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Biological yield (kg ha^{-1})	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
(A) Weed management						
W_1	915.40	925.20	1339.32	1351.10	2255.33	2276.31
W_2	1566.89	1592.56	2149.43	2158.37	3716.33	3750.93
W_3	1513.56	1545.45	2132.12	2153.07	3645.69	3698.53
W_4	1870.23	1889.31	2337.52	2355.49	4207.75	4244.81
W_5	1999.78	2020.70	2648.25	2665.56	4648.03	4686.26
SEm±	1.46	1.18	2.40	3.12	2.75	3.70
CD (P=0.05)	4.80	3.92	7.97	10.34	9.12	12.26
(B) Nutrient management						
F_1	1493.37	1511.10	2032.36	2049.24	3525.73	3560.35
F_2	1601.26	1619.40	2156.16	2168.55	3757.43	3787.95
F_3	1539.88	1564.65	2086.58	2105.63	3626.46	3670.28
F_4	1658.19	1683.43	2210.69	2223.46	3868.88	3906.89
SEm±	2.20	1.26	2.19	1.70	3.37	2.27
CD (P=0.05)	6.40	3.67	6.37	4.96	9.78	6.60

Note: (W_1) Weedy Check (Control), (W_2) Pendimethalin @ 1.25 Kg a.i. ha^{-1} at pre-emergence, (W_3) Quizalofop-ethyl @ 50 g a.i. ha^{-1} at 20 DAS, (W_4) Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS, (W_5) Two hand weeding at 20 & 40 days after sowing, (F_1) 75% RDF, (F_2) 75% RDF + 25% N through vermicompost, (F_3) 75% RDF + 25% N through FYM, (F_4) 100% RDF.

2. Total Weeds Dry Weight (gm^{-2})

Data revealed that herbicide application reduced the weeds dry weight at all stages of growth. Weed dry weight was reduced by Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS which was on par with Pendimethalin application @ 1.25 kg a.i. ha^{-1} at pre-emergence and Quizalofop- ethyl @ 50 g a.i. ha^{-1} at 20 DAS during both the year. Minimum weeds dry weight was recorded with two hand weeding at 20 & 40 days after sowing and maximum with weedy check (Control) during both the years of trial as shown in Table 2.

3. Dry Matter Production $Plant^{-1}$ (g)

In case of weed management treatments, maximum dry matter production $plant^{-1}$ was recorded with two hand weeding at 20 and 40 days after sowing and was significantly superior to other weed management treatments at different stages of crop growth during both the year of experimental trial. Herbicide application of Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS produced highest Dry matter production $plant^{-1}$ among different herbicide treatments during both years of trial as shown in Table 2.

4. Grain and Straw Yield (kg ha^{-1})

Data revealed that grain yield (kg ha^{-1}) was highest in two hand weeding at 20 and 40 days after sowing and was significantly superior than other weed management treatments during the period of investigation. In case of herbicides, Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS performed best and was superior to other herbicide treatments.

Maximum straw yield was recorded with two hand weeding at 20 and 40 days after sowing and was significantly superior over other weed management treatments during the trial period of both years as shown in Table 4.

5. Biological Yield

Maximum biological yield of French bean was recorded with two hand weeding at 20 & 40 days after sowing and was significantly superior than other weed management treatments during the trial period of both years. In case of herbicides, Imazethapyr @ 50 g a. i. ha^{-1} at 20 DAS performed best and was superior to other herbicide treatments as shown in Table 4.

4. CONCLUSION

Based on the results of two years of experiments, it was found that the application of imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS as a post-emergence herbicide and applying fertiliser application 75% RDF + 25% N through vermicompost was an efficient approach to reducing weeds and increasing French bean yields.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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