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Post-emergence herbicides for weed management in French bean

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ABSTRACT

Experiment was conducted to investigate the effects of imazthapyr and quizalofop-ethyl in different doses (50, 75 and 100 g/ha) with two interval (20-25 and 30-35 DAS), hand weeding twice (20 and 40 DAS) in comparison to unweeded control on yield and yield components of French bean during *Rabi* season of 2009 to 2011 under irrigated condition on Inceptisols. Among herbicides, application of imazethapyr at 100 g/ha at 20 DAS produced lowest weed index and highest weed efficiency and seed yield (1.24 t/ha). Imazethapyr at 100 g/ha at 20-25 DAS gave more economic profit (₹28869/ha) followed by imazethapyr at 100 g/ha at 30-35 DAS (₹27780/ha). None of the herbicides showed phytotoxicity to crop and was compatible with French bean. Imazethapyr and quizalofop-ethyl at lower concentration did not provide satisfactory weed control in rajmash field.

Key words: Economics, French bean, Imazethapyr, Post-emergence, Quizalofop-ethyl

In Maharashtra, French bean locally called 'rajmash' (*Phaseolus vulgaris***)** is grown as a minor pulse crop and cultivated during *Kharif* (rainy season). However, with the development of new genotypes, the crop has been introduced during *Rabi* season particularly in the Vidarbha region. 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. 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).

During its early growth stage, weed competes with it leading to severe competition. Since, initial growth of rajmash is very slow, the initial period of growth (30-45 DAS) is most crucial for crop-weed competition. In addition to slow initial crop growth, wider crop spacing also facilit crop-weed competition which poses a serious limitation in rajmash production and thus, estimated seed yield loss may likely to go to the extent of 45-65% under unweeded condition. During winter season, dominance of broad-leaved weeds in the early stages of crop growth period is mainly due to their fast growth and deep root system, which enables them to easily tap soil moisture and nutrients.

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Manual and mechanical methods of weed control are quite effective, but they are costly and time consuming. Thus, chemical weed control becomes a promising option to control the weeds during crop growth period. Herbicides like fluchloralin as pre-plant-incorporation (PPI) and pendimethalin as pre-emergence (PE) have been recommended for weed control, however these are effective only during initial period (up to 30 DAS). Thus, for the effective control of weeds throughout the crop season, use of post-emergence herbicides is necessary. There is also a possibility that use of single post-emergence herbicides may replace the above and raise the income of farmers. Recently some herbicides, particularly imazethapyr and quizalofop-ethyl have been used for selective control of post-emergent weeds in pulses. Therefore, the present investigation was undertaken for development of proper weed control schedule in rajmash.

MATERIALS AND METHODS

Field experiment was conducted at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *Rab*i season 2009-10 and 2010-11 and during 2011-12 at Regional Research Center, Amravati under AICRP on MULLaRP. The soil of experimental site was clayey with pH 7.8, having available N 235 kg/ha, P 20.9 kg/ha, K 323 kg/ha and organic carbon 4.1 g/kg. The experiment was laid out in randomized complete block design having three replications. The treatment comprised of weedy check (without removal of weeds) and hand weeding twice at 25 and 35 DAS and two post-emergence

herbicides, *viz*. imazethapyr (50, 75 and 100 g/ha) and quizalofop-ethyl (50, 75 and 100 g/ha). All the herbicides were applied at 20 and 30 days after sowing (DAS) with knapsack sprayer fitted with flat-fan nozzle using 500 liter water/ha.

Seeds were sown in furrows at 45 x 10 cm apart using 90 kg seed/ha. Uniform dose of 90 kg N + 60 kg P/ha through urea, and SSP, respectively were applied. Half of N and full dose of P were applied at sowing while remaining half N was top dressed after 30 DAS at optimum soil moisture.

Data on weed density and dry weight of weeds were recorded at 45 DAS and at harvest using quadrates 1 x 1 m. The weed samples were first dried under sun and then in hot air oven at 70 °C for three days for recording the dry matter.

Yield attributes and seed yield of French bean were recorded at the time of harvest. The economic analysis of each treatment was done on the basis of prevailing market rates of the inputs used and outputs obtained under each treatment. The required plant population (45 cm row to row and 10 cm plant to plant) was maintained by thinning plants after three weeks of sowing. The economics of treatments were computed on the basis of prevailing market prices of the inputs used and outputs obtained under each treatment. The market price of imazethapyr and quizalofop-ethyl was ₹1500 and ₹1475/liter, respectively, whereas, cost of two hand weeding 20 and 40 DAS) amounted to ₹ 4800. The sale price of French bean seed was taken at 28/kg.

RESULTS AND DISCUSSION

Weed flora

Weed flora in experimental field consisted of grasses like, *Brachiaria* sp., *Cynodon dactylon;* sedges like *Cyperus rotundus* and broad-leaved weeds like *Parthenium hysterophorous, Physalis minima, Convolvulus arvensis, Euphorbia geniculata* and *Digeria arvensis.* However, grassy weed like *Cyperus rotundus* and broad-leaved weed like *Parthenium hysterophorous, Physalis minima, Convolvulus arvensis* and *Digeria arvensis* dominated over other weeds in the rajmash field and *Cynodon dactylon* were not effectively controlled by any of the herbicides.

Among herbicides and cultural methods of weed control, application of imazethapyr 100 g/ha at 20-25 and 30-35 DAS, respectively followed by quizalofop-ethyl 100 g/ha at 30-35 DAS recorded the lowest dry weight of weeds at all the growth stages followed by application of their respective lower doses. However, higher dose of quizalofop-ethyl *i.e.* 100 g/ha at 20-25 DAS recorded higher dry weight of weed over application of same dose at 30-35 DAS (Table 1). This might be due to grassy weeds generally arises late in the season. However, imazethapyr was effective against annual broad-leaf weeds like *P. hysterophorus, P. minima, D. arvensis, C. arvensis, E. geniculata* and grassy weeds like *Bracharia* sp. and perennial sedges like *C. rotundus.*

Table 1. Growth, yield attributes, seed yield and economics of rajmash as influenced by different treatments

Treatment	Plant height (cm)	Pods/ plant	Seed index (g)	Yield (t/ha)				Net returns (x10^3 ` /ha)	B:C ratio
				2009	2010	2011	Pooled		
Quizalofop-ethyl 50 g/ha at 20-25 DAS	32.2	14.2	41.8	1.05	1.02	0.90	0.99	20.87	1.50
Quizalofop-ethyl 50 g/ha at 30-35 DAS	37.7	15.5	40.6	1.04	0.98	0.86	0.96	19.88	1.44
Quizalofop-ethyl 75 g/ha at 20-25 DAS	33.0	16.9	42.5	1.10	1.13	1.01	1.08	23.64	1.65
Quizalofop-ethyl 75 g/ha at 30-35 DAS	35.2	17.2	40.7	1.08	1.09	0.97	1.05	22.49	1.58
Quizalofop-ethyl 100 g/ha at 20-25 DAS	35.9	18.0	41.9	1.12	1.17	1.05	1.12	24.52	1.67
Quizalofop-ethyl 100 g/ha at 30-35 DAS	37.8	15.8	41.3	1.17	1.13	1.02	1.10	24.03	1.64
Imazethapyr 50 g/ha at 20-25 DAS	34.7	16.5	42.3	1.11	1.10	0.99	1.07	23.49	1.69
Imazethapyr 50 g/ha at 30-35 DAS	37.2	18.4	41.0	1.17	1.07	0.96	1.07	23.59	1.71
Imazethapyr 75 g/ha at 20-25 DAS	36.6	18.8	43.3	1.16	1.12	1.03	1.11	24.44	1.71
Imazethapyr 75 g/ha at 30-35 DAS	37.0	17.4	43.2	1.19	1.21	1.10	1.17	26.59	1.86
Imazethapyr 100 g/ha at 20-25 DAS	36.7	19.4	42.4	1.24	1.32	1.17	1.24	28.87	1.97
Imazethapyr 100 g/ha at 30-35 DAS	35.6	17.4	41.7	1.26	1.26	1.11	1.21	27.78	1.89
Weedy check	38.1	14.7	40.3	0.98	0.85	0.84	0.89	18.79	1.50
HW twice at 20 DAS and 40 DAS	36.8	17.6	41.1	1.38	1.33	1.17	1.30	27.85	1.59
LSD (P=0.05)	1.68	2.63	1.36	0.08	0.11	0.13	0.08	2.05	-

Table 2. Dry weight of weed at harvest, weed control efficiency and weed index at harvest as influenced by different treatments

Treatment	Weed dry weight (g/m^2)			Weed control efficiency (%)			Weed index (%)		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Quizalofop-ethyl at 50 g/ha at 20-25 DAS	18.0	7.58	4.10	75.3	85.9	89.1	23.7	22.5	19.2
Quizalofop-ethyl at 50 g/ha at 30-35 DAS	16.0	5.12	4.27	78.1	90.5	88.7	24.8	25.2	22.1
Quizalofop-ethyl at 75 g/ha at 20-25 DAS	14.3	2.82	3.77	80.4	94.8	90.0	20.5	14.3	11.1
Quizalofop-ethyl at 75 g/ha at 30-35 DAS	13.7	2.25	4.10	81.2	95.8	89.1	21.8	17.0	14.3
Quizalofop-ethyl at 100 g/ha at 20-25 DAS	12.2	1.45	4.13	83.3	97.3	89.1	18.6	11.2	8.2
Quizalofop-ethyl at 100 g/ha at 30-35 DAS	9.7	1.22	4.90	86.7	97.7	87.0	15.6	14.5	11.1
Imazethapyr at 50 g/ha at 20-25 DAS	13.3	6.5	3.10	81.8	87.9	91.8	19.9	16.4	12.9
Imazethapyr at 50 g/ha at 30-35 DAS	11.1	4.7	3.17	84.8	91.3	91.6	15.1	18.8	15.1
Imazethapyr at 75 g/ha at 20-25 DAS	8.8	2.39	2.87	87.9	95.6	92.4	16.0	14.7	10.3
Imazethapyr at 75 g/ha at 30-35 DAS	6.8	2.16	2.67	90.7	96.0	92.9	14.0	8.6	4.6
Imazethapyr at 100 g/ha at 20-25 DAS	4.4	0.72	2.49	93.9	98.6	93.4	10.6	2.0	3.5
Imazethapyr at 100 g/ha at 30-35 DAS	2.3	0.63	2.40	96.8	98.8	93.6	8.8	4.9	4.1
Weedy control	73.0	54.0	37.7	0.0	0.0	0.0	29.2	34.2	23.4
HW twice at 20 and 40 DAS	11.0	1.1	3.23	84.9	97.9	91.4	0.0	0.0	0.0
LSD (P=0.05)	4.23	4.25	1.27	-	-	-	-	-	-

Yield

The highest yield attributes, *viz*. plant height, pods/plant and grain weight/plant were recorded in HW (Table 1). Among the herbicides applied treatments, highest yield attributes were recorded with imazethapyr 100 g/ha at 20-25 DAS followed by its application at 30-35 DAS. Amongst post-emergence herbicides, lower doses *i.e.* 50 g/ha at early stage (20-25 DAS) and late stage (30-35 DAS) were less effective compared to higher doses *i.e.* 75 and 100 g/ha.

Application of imazethapyr at 75 g/ha at 20-25 and 30-35 DAS was found effective in weed control, however, their lower levels *i.e.* 50 g/ha was observed ineffective in weed control during *Rabi* season. Imazethapyr being freely translocated in plants through roots and shoots could effectively controlled broad-leaved as well as grassy weeds. Meena *et al.* (2011) reported efficient control of weeds by imazethpyr at 100 g/ha over lower doses in soybean. In current investigation also, application of imazethapyr at 100 g/ha at 20-25 DAS effectively controlled emerged grassy, sedges and broad-leaved weeds. Thus, these findings corroborate with the result obtained by Ali (2011) in mungbean.

Spray of quizalofop-ethyl was adequate in plots where grassy weeds were dominated and it failed to control broad-leaved weeds in comparison to imazethapyr. On the contrary, lower seed yield under quizalofop-ethyl could be attributed to its poor weed control efficiency and higher weed index against broad-leaved weeds. Nevertheless, hand weeding at twice recorded significantly lower weed biomass (5.11 g/m^2) and higher weed control efficiency (91.4%) over all other treatments (Table 2). Amongst herbicidal treatments, higher weed control efficiency was observed with imazethapyr 100 g/ha at 30-35 DAS closely followed by the same dose at 20-25 DAS. Similarly, minimum weed index was recorded with imazethapyr 100 g/ha at 30-35 and 20-25 DAS, respectively over rest of the herbicide treatments and weedy check as the treatment effectively controlled both broad-leaved and grassy weeds. Severe crop-weed competition and harsh environment in weedy check condition might have led to reduced yield in weedy check. Similar results were recorded by Nanadan *et al*. (2011) in blackgram. Kumar *et al.* (2014) recorded maximum seed yield in French bean with fluchloralin 1.00 kg/ha and pendimethalin 1.0 kg/ha with a corresponding value 1.11 and 1.10 t/ha. These also increased the nutrient uptake by French bean crop at various crop growth stages over weedy check and other treatments during both the years.

Economics

Higher net return amongst the herbicides treatments in French bean was realized with the application of imazethapyr 100 g/ha at 20-25 DAS (₹ 28869/ha) closely followed by hand weeding twice (₹ 27855) and application of imazthapyr 100 g/ha at 30-35 DAS (₹ 27780). This higher yield was due to effective control of broad-leaved weeds coupled with low cost of application of herbicides (Table 1). Similar economics was also reported by Ram *et al.* (2012). Kumar *et al.* (2014) reported significantly increased in net return over weedy check, with B:C ratio of 1.18 and 1.12 during two years with application of fluchloralin 1.00 kg/ha and pendimethalin 1.00 kg/ha in French bean. However,

the minimum values of cultivation cost (₹12554/ha), net return (₹18788/ha) and BCR (1.50) were recorded under weedy check treatment where cost of cultivation could hardly be met up by returns because of loss in yield due to weeds. These results confirm the findings of Srivastava *et al*. (2013) also. It was concluded that that application of imazethapyr 100 g/ ha at 20 DAS can be useful for effective and economical weed control in French bean (*Phaseolus vulgaris*).

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