International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(3): 565-567

Received: 07-03-2020
Accepted: 09-04-2020

Naresh Kumar
Princpal Scientist, RRS, Rohtak (CCSHAU), Haryana, India

Meenakshi Sangwan
District Extension Specialist, KVK, Rohtak (CCSHAU), Haryana, India

Dilbag Singh
Assistant Scientist, RRS, Rohtak (CCSHAU), Haryana, India

VS Hooda
District Extension Specialist, KVK, Jind (CCSHAU), Haryana, India

Corresponding Author:
Naresh Kumar
Princpal Scientist, RRS, Rohtak (CCSHAU), Haryana, India

Bio-efficacy of different herbicides in cluster bean

Naresh Kumar, Meenakshi Sangwan, Dilbag Singh and VS Hooda

DOI: https://doi.org/10.22271/chemi.2020.v8.i3g.9269

Abstract
A field experiment "Efficacy of different herbicides in cluster bean" was conducted during the kharif seasons of 2018 and 2019 at Research Farm of RRS, Rohtak. Major weed flora in experiment includes *Trianthema portulacastrum, Digera arvensis, Echinochloa colona, Amaranthus viridies* etc. The season long growth of weeds reduced cluster bean yield up to 43.4 % and 44.6% during 2018 and 2019, respectively as compared to weed free condition. Sequential application of clethodium 120 g/ha 4 WAS resulted into significantly higher visual weed control and better crop yield as compared to alone application of pendimethalin 1000 g/ha PRE, whereas alone application of imazethapyr 70 g/ha PRE and imazethapyr + imazamox (RM) 70 g/ha PRE remained at par with it including weed free conditions during both the years of study. Thus, alone application of imazethapyr 70 g/ha PRE and imazethapyr + imazamox (RM) 70 g/ha PRE may be more economical and suitable for getting higher weed control and cluster bean yield avoiding one more application of herbicides as sequential application.

Keywords: Cluster bean, herbicide efficacy, clethodium, imazethapyr + imazamox, pendimethalin, sequential application

Introduction
Cluster bean {(*Cyamopsis tetragonoloba* (L.) Taub.}, a *kharif* pulse crop popularly known as guar, is a drought tolerant and deep rooted legume crop requiring very low inputs. As guar is a rainy season crop and due to frequent rains the weed population increases tremendously because of favorable environment for weeds to thrive, and which compete for nutrients, moisture and space, causing considerable yield reduction. Critical period of crop weed competition in cluster bean has been identified as 20-30 DAS and presence of weeds beyond this cause severe yield reductions by 47 to 92% (Bhadoria *et al.*, 2000 and Yadav, 1998) [1, 5]. Bio-efficacy of various herbicides have been evaluated against weed flora in cluster bean. Punia *et al*. (2011) [3] reported that imazethapyr applied as PPI, PRE and POE controls monocot and dicot weeds and had a strong residual life, while Sangwan *et al*. (2016) [4] observed that sequential application of imazethapyr 100 g/ha 3 WAS *fb* propaquizafop 62.5 g/ha at 6 WAS and imazethapyr + imazamox 70 g/ha at 3 WAS *fb* propaquizafop 62.5 g/ha at 6 WAS, were found effective in controlling weeds and increasing productivity in cluster bean without any residual effect on succeeding mustard crop. Maximum net returns in cluster bean could be realized with the integrated application of imazethapyr 100 g/ha + HW 35 DAS (Dhaker *et al*., 2009) [2]. Thus, there is need to evaluate dose and time of application of these herbicides further for effective control of weed flora in cluster bean along with integration of new herbicides. Keeping these points in view, the present experiment was planned to evaluate "Bio-efficacy of different herbicides in cluster bean"

Materials and Methods
Field experiment was conducted at Research Farm of Regional Research Station, Rohtak (CCS HAU) during the *Kharif* season of 2018 and 2019. The soil of experimental field was sandy loam. Total rainfall 224.8 mm and 204.0 was received during the growing season of 2018 and 2019, respectively. The experiment was laid out in a Randomized Block Design, having 10 treatment combinations with three replications. Treatments consisted of two hand weeding at 25 and 45 DAS (days after sowing), two mechanical weeding at 25 & 45 DAS, pendimethalin 1000 g/ha PRE (pre emergence) alone and followed by clethodium 120 g/ha 4 WAS, imazethapyr 70 g/ha PRE alone and followed by clethodium 120 g/ha 4 WAS (weeks after sowing), imazethapyr + imazamox (RM) 70 g/ha PRE alone and followed by clethodium

120 g/ha 4 WAS, weedy check and weed free. Cluster bean variety HG-365 was sown on 14th June during 2018 and on 22nd June during 2019 in the plot size of 5.0 m x 3.0 m at a spacing of 30 cm x 15 cm R-R and P-P with seed rate using 20 kg/ha. All management practices other than the weed control treatments were consistent with the recommended package of practices for the CCS HAU, Hisar. Application of PRE and POE (post emergence) herbicides in different treatments were done by using flat fan nozzle mounted on a backpack sprayer with a spray discharge of 625 l/ha for PRE and 300 l/ha. Observations for total weed density were recorded by randomly placing quadrate (0.25 m^2) in each plot at 60 DAS. Visual weed control in cluster bean was observed on 0-100 scale where 0 = no effect and 100 = complete control. The crop was harvested on 3rd October and 7th October during 2018 and 2019, respectively. Benefit-cost ratio was calculated using the following formula:

$$\text{B: C ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}} \times 100$$

Data were analyzed using software S.P.S.S version 7.5. to evaluate the differences between treatments. Where the ANOVA indicated that treatment effects were significant, means were separated at $p<0.05$ and adjusted with Fisher's Protected Least Significant Difference (LSD) test.

Results and Discussion

Total weed density and visual weed control

Application of pendimethalin 1.0 kg/ha PRE significantly reduced weed density of both grassy and broad leaf weeds in the crop as compared to weedy check (Table 1) but remained significantly poor than all other treatments which might be due to reduced efficacy of pendimethalin at later stage of crop growth. This was similar with the findings of Sangwan *et al*. (2016) [4] where lower efficacy of pendimethalin was recorded at later stage of crop growth. Maximum density of weeds was observed under pendimethalin 1.0 kg/ha PRE followed by two mechanical weeding at 25 & 45 DAS at 60 DAS (Table1). Significantly reduced weed density and higher visual weed control was observed under sequential application of clethodium 120 g/ha 4 WAS as compared to alone application of pendimethalin 1000 g/ha PRE whereas alone application of imazethapyr 70 g/ha PRE and imazethapyr + imazamox (RM) 70 g/ha PRE remained at par with it including weed free conditions during both the years of study.

Yield and economics of cluster bean crop

Weedy check significantly reduced the yield of cluster bean and B:C resulting more than 40 % lower yield of crop as compared to weed free situation (Table 2). Use of 2 HW at 25 and 45 DAS resulted into significant increase in number of pods per plant and cluster bean yield as compared to 2 mechanical weeding at 25 and 45 DAS, alone application of pendimethalin 1000 g/ha PRE and weedy check while it remained at par with all other treatments including alone application of imazethapyr 70 g/ha PRE and weed free situations during both years (Table 2). Sequential application of clethodium 120 g/ha 4 WAS resulted into significantly more crop yield as compared to alone application of pendimethalin 1000 g/ha PRE whereas alone application of imazethapyr 70 g/ha PRE and imazethapyr + imazamox (RM) 70 g/ha PRE remained at par with it including weed free conditions during both the years of study. Alone application of imazethapyr 70 g/ha PRE and imazethapyr + imazamox (RM) 70 g/ha PRE remained more economical by giving higher B: C than all other treatments.

It may be concluded from the present study that alone application of imazethapyr 70 g/ha PRE and imazethapyr + imazamox (RM) 70 g/ha PRE may be more economical for getting higher cluster bean yield as compared to sequential application of herbicides with effective weed control.

Table 1: Effect of weed control treatments on weed density and visual weed control in cluster bean

Sr. No.	Treatments	Grassy weeds (No./m^2) 60 DAS		Broadleaf weeds and sedges (No./m^2) 60 DAS		Visual weed control (%)	
		2018	2019	2018	2019	2018	2019
1.	Weed free	0	0	0	0	100	100
2.	Weedy check	86.5	98.6	130.2	135.4	0	0
3.	2 HW at 25 and 45 DAS	5.3	6.1	10.3	10.7	90.0	85.0
4.	2 mechanical weeding at 25 and 45 DAS	12.2	14.3	28.3	29.4	80.0	80.0
5.	Pendimethalin PRE 1000 g/ha	18.3	53.6	37.5	39.0	55.0	50.0
6.	Pendimethalin PRE 1000 g/ha *fb* clethodium 120 g/ha 4 WAS	7.2	8.2	12.3	12.7	95.0	90.0
7.	Imazethapyr 70 g/ha PRE	8.0	9.1	10	10.4	98.4	95.0
8.	Imazethapyr 70 g/ha PRE *fb* clethodium 120 g/ha 4 WAS	6.1	7.0	10.4	10.8	98.0	95.0
9.	Imazethapyr + imazamox (RM) 70 g/ha PRE	6.5	7.4	11.2	11.6	98.0	95.0
10.	Imazethapyr + imazamox (RM) 70 g/ha PRE *fb* clethodium 120 g/ha 4 WAS	6.6	7.5	10.2	10.6	98.0	95.0
LSD (p=0.05)		5.8	5.5	9.1	9.46	-	-

Table 2: Effect of weed control treatments on yield and yield attributes of cluster bean

Sr. No.	Treatments	Pod length (cm)		No. of pods (No./plant)		Yield (q/ha)		B-C ratio	
		2018	2019	2018	2019	2018	2019	2018	2019
1.	Weed free	8.4	8.5	133	121.03	14.5	13.0	2.16	1.97
2.	Weedy check	7.0	7.1	71	64.61	8.2	7.2	1.78	1.59
3.	2 HW at 25 and 45 DAS	8.5	8.3	130	118.3	14.0	12.8	2.32	2.15
4.	2 mechanical weeding at 25 and 45 DAS	8.0	7.9	110	100.1	10.6	9.8	2.01	1.89
5.	Pendimethalin PRE 1000 g/ha	8.1	8	107	97.37	11.1	10.0	2.22	2.04
6.	Pendimethalin PRE 1000 g/ha *fb* clethodium 120 g/ha 4 WAS	8.5	8.4	124	112.84	13.1	11.9	2.51	2.29
7.	Imazethapyr 70 g/ha PRE	8.4	8.5	126	114.66	14.0	12.4	2.95	2.64
8.	Imazethapyr 70 g/ha PRE *fb* clethodium 120 g/ha 4 WAS	8.5	8.4	123	111.93	14.2	12.5	2.78	2.48
9.	Imazethapyr + imazamox (RM) 70 g/ha PRE	8.4	8.5	122	111.02	13.8	12.6	2.86	2.65
10.	Imazethapyr + imazamox (RM) 70 g/ha PRE *fb* clethodium 120 g/ha 4 WAS	8.5	8.5	128	116.48	14.0	12.7	2.70	2.49
LSD (p=0.05)		1.31	1.27	11.4	10.31	1.92	1.78	-	-

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