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Effect of Weed Management in Clusterbean under Dryland Conditions of Western Rajasthan

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Abstract: On farm trials (OFTs) were conducted during kharif 2020 and 2021 at Dabra and Maulasar villages of Didwana tehsil of Nagaur district of Rajasthan with the objective to study the effect of weed management in clusterbean under dryland conditions of western Rajasthan. Four treatments of weed control i.e., weedy check, imazethapyr + imazamox (ready mix) 40 g ha^{-1} applied at 20 days after sowing (DAS), imazethapyr 50 g ha^{-1} applied at 20 DAS and weed free plot were imparted in this trial. Results showed that, crop in weed free condition recorded significantly higher growth parameters, yield attributes and seed yield (0.993 t ha^{-1}) followed by application of imazethapyr + imazamox (ready mix) 40 g ha^{-1} applied at 20 DAS (0.948 t ha^{-1}). The increase in grain yield due to application of imazethapyr + imazamox (ready mix) 40 g ha^{-1} applied at 20 DAS over the farmers' practice (Imazethapyr 50 g ha^{-1}applied at 20 DAS) was 9.22%. Application of imazethapyr + imazamox (ready mix) 40 g ha^{-1} applied at 20 DAS provided maximum net returns (Rs 49399 ha^{-1}) and BC ratio of 3.27.

Key words: Economics, clusterbean, on farm trial, weed management, yield.

Clusterbean [*Cyamopsis tetragonaloba* (L.) Taub] is one of the most drought-resistant deep-rooted and annual legumes produced as feed, fodder, green manure, vegetables, and seed in arid conditions of Rajasthan. It has grown into a commercial and industrial crop due to the galactomannan or gum content which constitutes 30-35% of the endosperm of its seed. Clusterbean gum is extensively used as a sizing agent in the paper and textile industries as well as a potent flocculent and filtrent in mining and metallurgical operations. (Sharma *et al*., 2017; Kumawat *et al*., 2017). The crop is mostly cultivated in Rajasthan, Haryana, Gujarat, and Punjab in India's dry regions, as well as to a lesser extent in Uttar Pradesh and Madhya Pradesh.

As a crop grown during the kharif season, it is severely weed-infested, which can reduce its seed yield up to 45.46% (Sangwan *et al*., 2016). Since clusterbean is a crop grown during the rainy season, the weed population grows significantly as a result of the frequent rains. Weeds compete with the primary crop for nutrients, moisture, and space, which significantly reduces productivity. According to Patel *et al*. (2005), the critical crop weed competition period is between 20 and 30 days after

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sowing (DAS). Both grass and broadleaved weeds are a problem in the clusterbean crop. Clusterbean yield are severely reduced by weed competition throughout the growing season, to the tune of 47% to 92%, depending on the weed infestation (Punia *et al*., 2011). While hand weeding is a traditional and efficient method of managing weeds, its economic viability is severely constrained by the lack and high cost of labor during peak weeding seasons (Vyas and Kushwah, 2008). In such circumstances, exploring the use of suitable herbicides, either alone or in combination with hand weeding, emerges as a potentially efficient and cost-effective weed management strategy. Hence, this study aims to identify a suitable post-emergence herbicide for clusterbeans.

Materials and Method

Field trials were carried out at 10 different farmer's field of Dabra (Panchayat Dabra) and Maulasar (Panchayat-Maulasar) villages of Didwana Tehsil of Nagaur district (27°27'N and 74°53' E and at 302 mmsl) of Rajasthan condition during Kharif, 2020 and 2021 (July to September). The soil of the study area was loamy sand. Each trial plot was of 30 x 30 m. Through field visits, PRA surveys, focus group discussions, and farmer meeting in villages, the farmers were chosen. The clusterbean variety RGC-1033 was used by the farmers in this farm trial. In kharif 2020 and 2021, the total amount of rain received was 492 and 475 mm, respectively. However, in 2021, due to late onset of the monsoon (in August), and persistent rain during the crop maturity stage had an impact on crop productivity and quality. The crop was sown between 2 to 4th July and 1 to 3rd August and harvested between 4 to 5th October and 25 to 27th October during 2020 and 2021, respectively. The crop was grown entirely under rainfed conditions.

Scientists visited demonstrations and farmer's fields regularly. Imazethapyr + imazamox (ready mix) and imazethapyr were applied @ 500 L water hectare^{-1} for application with the help of knapsack sprayer fitted with flat-fan nozzle. For continued development of the research and extension initiatives, the farmer's feedback data was also recorded. The demonstration sites were used to organize the extension activities such as training, scientist visits, and field days. Using a quadrate with a 1 x 1 m measurement, observations on the number of weeds present at harvest were made at five randomly chosen locations within each plot. At harvest, weed dry matter from the net plot was recorded. The effectiveness of weed management can be determined by comparing the weed population of the treated plot to that of the unweeded control. Weed control efficiency at harvest was worked out based on weed count m^2 by adopting the formula (Varshney, 1990).

$$\frac{\text{WPC-WPT}}{\text{WPC}} \text{ x } 100$$

where,

WPC - Weed population in weedy check plot;
WPT - Weed population in treated plot

The yield obtained per net plot was converted into yield per hectare on an area basis and expressed in t ha^{-1}.

Observations pertaining to agronomic and yield attributing traits (Table 2 and 3) were recorded from 25 different randomly selected plants from each plot.

Results and Discussion

Field observations showed the occurrence of *Sorghum halepense*, *Cyperusrotundus, Cynodon dactylon, among monocot weeds and Amaranthus viridis, Amaranthus spinosus, Digera arvensis, Trianthema portulacastrum* and *Commelina benghalensis* in field in descending order during the crop growth.

Weed density, weed dry matter and weed control efficiency at harvest: Imazethapyr + imazamox (ready mix) 40 g ha^{-1} applied at 20 DAS (3 to 4 leaf stage) significantly reduced the density and dry weight of grassy and broad-leaved weeds in clusterbean as compared to weedy check and other herbicidal treatment during both the years (Table 1). The maximum density (65.10 m^{-2}) and dry weight of weeds i.e., 735.93 kg ha^{-1} was recorded under unweeded field. Further, data revealed that highest weed control efficiency (Table 1) was recorded in weed free check (100%) followed by application of imazethapyr + imazamox (ready mix) 40 g ha^{-1} applied at 20 DAS (51.77). This was mainly due the reason that, the regular weeding at emergence of weeds made sure that the weeds were practically absent in this treatment. The

Table 1. Effect of weed management on weed density, weed dry matter and weed control efficiency at harvest in clusterbean

Treatments	Weed density (No. m^{-2})			Weed dry matter ($kgha^{-1}$)			Weed Control Efficiency (%)		
	2020	2021	Average	2020	2021	Average	2020	2021	Average
Weedy check	67.75	62.45	65.10	750.43	721.43	735.93	0.00	0.00	0.00
Imazethapyr @ 50 g a.i.ha^{-1} at 20 DAS	43.84	41.34	42.59	435.32	412.03	423.68	41.99	42.89	42.43
Imazethapyr+Imazamox (premix) @ 40 g a.i. ha^{-1} at 20 DAS	36.54	33.56	35.05	364.54	345.32	354.93	51.42	52.13	51.77
Weed free (by hand weeding)	0.00	0.00	0.00	0.00	0.00	0.00	100.00	100.00	100.00

minimum weed control efficiency was recorded with unweeded plot. Imazethapyr + imazamox (factory mix) 40 g ha^{-1} and imazethapyr alone at 40 g ha^{-1} when applied at 3-4 leaf stage significantly reduced the dry weight and density of broad leaf weeds in clusterbean as compared to weedy check Singh *et al*. (2013). Postemergence application of imazethapyr + imazamox (ready mix) applied @ 40 g ha^{-1} showed lowest weed density and dry weight of both grassy and broad-leaved weeds (Singh *et al*. 2016). Sharma *et al*. (2017) found that among different herbicides treatments, imazethapyr + imazamox @ 40 g ha^{-1} (PoE) at 20 DAS showed highest WCE (91.84, at 60 DAS) and minimum WI (6.0) in clusterbean. Brar (2018) found that lower weed dry matter and higher weed control efficiency observed in treatment imazethapyr + imazamox @ 40 g a.i. ha^{-1} at 2-3 leaf stage of weeds

Yield attributes: All the weed management treatments significantly influenced the growth and related parameters compared to weedy check, which in turn increased the yield attributes viz., pod $plant^{-1}$, seed pod^{-1} and 1000 seed weight which ultimately reflected into significantly higher seed and haulm yields. Application of imazethapyr + imazamox at 40 g ha^{-1} and imazethapyr alone at 50 g ha^{-1} at 20 DAS (3 to 4 leaf stage) increased the pods $plant^{-1}$ and seed pod^{-1} and consequently seed and straw yield of clusterbean compared to weedy check during both the years (Table 2). The higher yield and yield attributes under these treatments were attributed to weed reduction (Singh *et al*. 2013 and Singh *et al*. 2016). Sharma *et al*. (2017) found that among different herbicides treatments, imazethapyr + imazamox @ 40 g ha^{-1} (PoE) at 20 DAS showed the highest values of yield attributes in clusterbean. Brar (2018) also described that combined application of imazethapyr + imazamox as most effective herbicides to enhance the yield attributes of clusterbean.

Yield : Different integrated weed management practices (Table 3) recorded marked effect on yield of clusterbean. The maximum seed and haulm yield of 0.993 and 2.57 t ha^{-1}, respectively were found under treatment of weed free crop condition followed by imazethapyr+imazamox (premix) @ 40 g a.i. at 20 DAS (0.948 and 2.523 t ha^{-1}, respectively). The per cent increase in seed yield due to imazethapyr + imazamox (premix) @ 40 g a.i. at 20 DAS were 0.922 and 3.485 over Imazethapyr @ 50 g a.i. at 20 DAS and weedy check treatments, respectively. This might be due to the fact that removal of weeds twice in the field controlled weeds which emerged during early as well as later stages of crop growth resulted in excellent performance

Table 2. Effect of weed management on yield parameters in clusterbean

Treatments	Number of pod $plant^{-1}$			Number of seed pod^{-1}			Test weight (g)		
	2020	2021	Average	2020	2021	Average	2020	2021	Average
Weedy check	26.8	18.3	22.55	5.80	5.73	5.77	23.8	22.9	23.35
Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS	28.3	21.1	24.70	6.23	6.12	6.18	24.2	24.1	24.15
Imazethapyr+Imazamox (premix) @ 40 g a.i. ha^{-1} at 20 DAS	30.2	23.4	26.80	6.52	6.31	6.42	24.7	24.4	24.55
Weed free (by hand weeding)	32.7	26.2	29.45	6.67	6.46	6.57	25.2	24.7	24.95

Table 3. Effect of weed management on yield of clusterbean

Treatments	Seed yield (t ha^{-1})			Haulm yield (t ha^{-1})			Biological yield (t ha^{-1})		
	2020	2021	Average	2020	2021	Average	2020	2021	Average
Weedy check	0.762	0.643	0.703	2.250	2.21	2.230	3.012	2.853	2.933
Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS	0.992	0.743	0.868	2.487	2.432	2.460	3.479	3.175	3.327
Imazethapyr+Imazamox (premix) @ 40 g a.i. ha^{-1} at 20 DAS	1.072	0.823	0.948	2.557	2.489	2.523	3.629	3.312	3.471
Weed free (by hand weeding)	1.121	0.865	0.993	2.623	2.516	2.570	3.743	3.3.81	3.562

compared to herbicides specially those applied alone. Effective control of weeds by integrated weed control practices provided better space and resources i.e., moisture, nutrients, solar radiation etc., for crop plant which could improve to higher yields. Singh *et al*. (2013) reported that the application of imazethapyr + imazamox at 40 g ha^{-1} and imazethapyr alone at 40 g ha^{-1} significantly increased the seed yield of clusterbean compared to weedy check. Singh *et al*. (2016) observed that seed and straw yield in clusterbean were also superior with imazethapyr + imazamox 40 g ha^{-1} applied at 3 to 4 leaf stage. Sharma *et al*. (2017) found that among different herbicides treatments, imazethapyr + imazamox @ 40 g ha^{-1} (PoE) at 20 DAS showed highest seed (1.959 t ha^{-1}) and stover yield (6.383 t ha^{-1}) of clusterbean.

*Economics***:** The economic parameters were influenced by the integrated weed management practices (Table 4). The net returns and benefit: cost ratio was maximum for imazethapyr + imazamox at 40 g ha^{-1} at 20 DAS (Rs. 49399 ha^{-1} and 3.26) during both the years. The higher benefits obtained under these treatments were also due to comparatively less cost of herbicides than hand weeding as well as higher seed and haulm yield of clusterbean. Singh *et al*. (2013) reported that the application of imazethapyr + imazamox significantly increased the net return of clusterbean. Singh *et al*. (2016) observed that net return and B: C ratio was superior with imazethapyr + imazamox 40 g ha^{-1} applied at 3-4 leaf stage in clusterbean. In monetary terms significantly higher net return (Rs. 49399 ha^{-1}) were obtained from imazethapyr + imazamox @ 40 g ha^{-1} (PoE) at 20 DAS (Sharma *et al*., 2017).

Conclusion

Based on the results of the two-year On-Farm Trials of clusterbean, the current study concluded that effective control of weeds and improved productivity and profitability can be attained with the application of imazethapyr + imazamox at 40 g ha^{-1} at 20 DAS under dryland conditions of Rajasthan. Farmers realized the economic benefits of the above mentioned dose because it was effective for controlling broad as well as narrow weeds resulting higher yield and economics of clusterbean.

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Table 4. Effect of weed management on economics of clusterbean

Treatments	Gross return (Rs ha^{-1})			Net Return (Rs ha^{-1})			BC Ratio		
	2020	2021	Average	2020	2021	Average	2020	2021	Average
Weedy check	52725	58370	55548	34025	38770	36398	2.82	2.98	2.90
Imazethapyr @ 50 g a.i. ha^{-1} at 20 DAS	65766	66535	66151	45106	45046	45076	3.18	3.10	3.14
Imazethapyr+ Imazamox (premix) @ 40 g a.i. ha^{-1} at 20 DAS	70221	72163	71192	49314	49483	49399	3.36	3.18	3.27
Weed free (by hand weeding)	73050	75095	74073	49200	49195	49198	3.06	2.90	2.98

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