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RESEARCH ARTICLE

Impact of herbicides on weeds and productivity of clusterbean in western Rajasthan

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ABSTRACT

The clusterbean is confined mainly as rainfed crop during kharif season in Rajasthan. Clusterbean is severely infested by many broad-leaved and grassy weeds which cause considerable loss of clusterbean productivity and economic returns. A field experiment was conducted for two consecutive years *i.e. Kharif* 2021 and 2022 on sandy loam soils of Western Rajasthan to assess the effect of new herbicide molecules on weed management and productivity of clusterbean (cultivar HG 2-20). A randomized block design (RBD) with four replications was used. The post-emergence application of propaquizafop 2.5% + imazethapyr 3.75% w/w (propaquizafop + imazethapyr) 135 g/ha at 20 days after seeding recorded maximum weed control efficiency, clusterbean growth, yield attributes, seed yield, net return and B:C ratio of 2.0 and was at par with weed free.

Keywords: Clusterbean, Economics, Pendimethalin, Propaquizafop + imazethapyr, Weed management

INTRODUCTION

Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] is a drought tolerant grain legume thrives well in semiarid regions of Rajasthan. It needs abundant sunshine, moderately frequent rainfalls and well-drained soil for productive and fruitful outputs (Jain *et al*. 2019). It has significant importance as raw material in industries for making guar gum, a gel forming fiber obtained after refining the seeds. Clusterbean is also cultivated as a catch crop, green manure and vegetable crop in different parts of the country. India is the main producers of clusterbean and accounting more than 80% of global production and lead in exports of guar and its by-products (Kumar *et al*. 2013). India covers 6.82 million hectares with a production of 4.79 million tons and productivity of 0.7 t/ha (Kumar *et al.* 2024). The northwestern parts of country encompassing states of Rajasthan, Gujarat, Haryana and Punjab contribute 87 and 82% of the country's area and production, respectively. In Rajasthan, the area under clusterbean is high (2.88 m ha) due to its drought hardy nature and better performance under moisture stress compared to traditional legume crops (Anonymous 2024).

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The realized productivity of clusterbean is low as against its potential productivity as it is cultivated mainly in marginal lands and sown as catch crop. Further, weeds that infest during cropping season cause a significant reduction (47%) in productivity of the crop (Jain and Singh 2000, Bamboriya *et al*. 2024). The severity and extent of weeds density and biomass in the clusterbean varies depending crop management practices adopted (Choudhary *et al*. 2024). and it is important to identify effective and economical weed management practices. Herbicides usage to manage weeds is replacing the traditional practice of weeding i.e. manual weeding and hoeing due to scarcity of manual labour as well as high cost of labour and herbicide usage is helpful to reduce the production cost (Yadav *et al.* 2019). Thus, this study was carried out to evaluate the efficacy of new herbicides molecules and compare them with the traditional practice *i.e.* manual hoeing in clusterbean.

MATERIALS AND METHODS

The field study was carried out at Instructional Farm, College of Agriculture Sumerpur, Agriculture University Jodhpur, Rajasthan for two consecutive Kharif seasons of 2021 and 2022. The soil of the experimental field was sandy loam in texture, slightly alkaline in pH (7.80), low in organic carbon (0.26 %), low in available nitrogen (197.3 kg/ha), medium in available phosphorus (27.80 kg/ha) and high in available potassium (283.0 kg/ha). Eight weed management treatments were tested, *viz*. weedy

check; pre-emergence application (PE) of pendimethalin 38.7CS (pendimethalin) 500 g/ha (currently recommended); post-emergence (PoE) of fomesafen 11.1% + fluazifop-p-butyl 11.1% SL (fomesafen + fluazifop-p-butyl) 220 g/ ha at 20 days after seeding (DAS); imazethapyr 35%+ imazamox 35 % WDG (imazethapyr + imazamox) 40 g/ha PoE at 20 days after seeding; sodium-acifluorfen 16.5% + clodinafop-propargyl 8% EC (sodium-acifluorfen + clodinafop-propargyl) 250g/ha PoE at 20 DAS; propaquizafop 2.5% + imazethapyr 3.75% w/w (propaquizafop + imazethapyr) 135 g/ha PoE at 20 DAS; imazethapyr 10% SL (imazethapyr) 40 g/ha PoE at 25 DAS and weed free check (manual weeding up to 45 DAS). The clusterbean crop variety HG 2-20 was sown manually, with the onset of monsoon, keeping the row distance of 30 cm and seed rate of 15 kg seed/ha during the first fortnight of July and harvested in first week of October in the respective years. The recommended package of practices was used for crop cultivation. The basal fertilizer dose of 20 kg/ha N and 40 kg/ha P was applied at the time of sowing. The herbicides were applied as per treatment using knapsack sprayer fitted with flat fan nozzle as per schedule including manual hoeing and weeding in respective experimental units. The weeds data was collected by randomly placing 0.25 m^2 quadrat at two places in each plot. The gross plot size was 5.0 m × 4.8 m while net plot size was 4.0 × 3.6 m. Observations were taken of weed parameters at 60 DAS and growth and yield attributes at harvest of the crop as per standard procedure.

RESULTS AND DISCUSSION

Effect on weeds

The weeds infested in the experimental plot include: *Amaranthus viridis, Euphorbia hirta, Aristida depressa, Portulaca oleracea, Digera arvensis, Cenchrus biflorus, Corchorus tridense, Commelina benghalensis, Phyllanthus niruri, Eleusine verticillata* and *Trianthema portulacastrum* among broad-leaved weeds and *Cenchrus biflorus, Eragrostis pilosa* and *Eragrostis tenella* among grassy weeds.

The pooled and individual years data of weed dry matter production (weed biomass), weed control efficiency, weed index and herbicide efficiency index showed significant variations among the treatments (**Table 1**). The mean minimum weed biomass and mean maximum weed control efficiency was recorded in weed free check while among the herbicides, propaquizafop + imazethapyr 135 g/ha PoE at 20 DAS was found superior over pendimethalin 500 g/ha and recorded higher mean herbicide efficiency index. Fomesafen +fluazifop-p-butyl (ready mix) 220 g/ha PoE at 20 DAS recorded next significant higher weed control efficiency but caused mild phytotoxicity on crop. These herbicides controlled the broad-leaved and grassy weeds better than pendimethalin applied alone and minimized the competition of weeds with crop for resources, *viz.* light, nutrients and moisture as observed by Jagdesh and Raju (2021) and Yadav *et al.* (2022).

The regular weeding as the weeds emerged in weed free resulted in practically complete absence of weeds. The weed free environment up to 40 DAS caused highest reduction of weed biomass due to prolonged effect of hoeing on controlling the weeds and enhanced crops shading effect on weeds as reported by Singh *et al.* (2016) and Patil *et al.* (2021).

Effect on crop

The average mean clusterbean plant height, and number of branches per plant, various yield

Table 1. Efficiency of weed management treatments in managing weeds in clusterbean

Treatment	Weed biomass (g/ m^2) at 60 DAS			Weed control efficiency (%) at 60 DAS			Weed index (%)			Herbicide efficiency index (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Weedy check	186.3	193.8	190.0	0.0	0.0	0.0	34.4	22.6	28.5	0.00	0.00	0.00
Pendimethalin 500 g/ha PE	71.2	60.8	66.0	61.5	68.4	65.0	15.0	7.2	11.1	0.90	0.86	0.88
Fomesafen+ fluazifop-p-butyl 220 g / ha PoE at 20 DAS	53.7	63.8	58.7	70.6	67.0	68.8	17.0	15.0	16.0	1.14	0.50	0.82
Imazethapyr + imazamox 40 g /ha PoE at 20 DAS	62.3	63.9	63.1	66.0	66.9	66.5	20.8	8.1	14.5	0.88	0.77	0.83
Sodium- acifluorfen + clodinafop-propargyl 250g/ha PoE at 20 DAS	67.8	67.4	67.6	63.2	65.0	64.1	23.5	15.0	19.3	0.67	0.46	0.57
Propaquizafop + imazethapyr 135g /ha PoE at 20 DAS	51.2	60.0	55.6	72.1	69.0	70.6	4.0	5.0	4.5	1.75	0.98	1.37
Imazethapyr 40 gm/ha PoE at 25 DAS	61.2	61.3	61.2	67.1	68.0	67.6	15.5	8.1	11.8	1.02	0.84	0.93
Weed free check	37.4	38.0	37.7	79.6	80.4	80.0	0.0	0.0	0.0	2.47	2.41	2.44
LSD (p=0.05)	16.7	19.7	10.9	-	-	-	-	-	-	0.67	1.31	0.62

DAS = days after seeding; PE= pre-emergence application; PoE = post-emergence application

attributes, *viz*. number of pods/plant and number of seeds/pod and seed yield at harvest were highest with propaquizafop + imazethapyr 135 g/ha PoE at 20 DAS as against the currently recommended pendimethalin 500 g/ha (**Table 2**). The manual hoeing twice at 25 and 40 DAS maintained its superiority over all the treatment in respect of all crop characters. The increase in height was attributed to the weed free environment with the application of various herbicides (Yadav *et al*. 2021).

The traditional practice of weed management i.e. manual weeding twice recorded maximum yield attributes of the crop. However, the test weight was found non-significant during both the years. The weed free environment provides the crop the reater resources availability particularly nutrient, water and light at the critical crop stage due to reduced weed crop competition during critical period (Borana *et al*. 2021 and Jain and Parewa 2022). The better initial growth induced more flower and pod production with timely supply of resources might have reduced shedding of flowers and pods, which led to a positive source-sink gradient of photosynthates translocation (Yadav *et al.* 2019).

The harvest index was not influenced significantly on mean basis as well as in individual years. It might be due to lesser infestation of weeds that encourage proper translocation of photosynthates from source to sink as report by Dubey *et al.* (2018).

Economics

The highest mean gross returns were recorded with hand weeding twice at 25 and 40 DAS followed by propaquizafop + imazethapyr 135 g/ha PoE at 20 DAS and lowest gross returns was recorded in weedy check. The other herbicidal treatments also recorded a higher gross return than the weedy check.

The highest mean net return and mean benefit: cost ratio (2.00) was recorded with propaquizafop + imazethapyr 135 g/ha PoE at 20 DAS due to lower cost of cultivation and higher economic yield of clusterbean. Nearly equivalent net returns and B:C

Table.2. Effect of different weed management treatments on the growth and yield attributes of clusterbean

Treatment	Plant height (cm) at 90 DAS			No. of branches/ plant			No. of pods/ plant			No. of seeds/ pod		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Weedy check	73.2	60.5	66.9	3.9	3.2	3.5	43.5	37.2	40.3	7.8	7.4	7.6
Pendimethalin 500 g/ha PE	78.2	66.2	72.2	5.2	4.3	4.8	61.7	55.2	58.5	8.0	8.0	8.0
Fomesafen + fluazifop-p-butyl 220 g/ha PoE at 20 DAS	75.3	61.8	68.5	4.7	3.8	4.3	61.7	52.7	57.2	8.0	7.4	7.7
Imazethapyr + imazamox 40 g/ha PoE at 20 DAS	79.0	64.4	71.7	5.2	4.2	4.7	64.1	57.8	61.0	8.0	7.8	7.9
Sodium- acifluorfen + clodinafop- propargyl 250 g/ha PoE at 20 DAS	76.7	59.9	68.3	4.5	3.7	4.1	59.4	51.6	55.5	7.9	7.4	7.6
Propaquizafop + imazethapyr 135 g/ha PoE at 20 DAS	83.3	65.9	74.6	5.4	4.4	4.9	66.4	59.1	62.7	8.1	7.8	8.0
Imazethapyr 40 g/ha PoE at 25 DAS	81.4	66.4	73.9	5.2	4.4	4.8	64.0	58.1	61.0	7.8	7.9	7.9
Weed free check	84.2	75.2	79.7	5.5	4.5	5.0	66.4	59.4	62.9	8.2	8.1	8.1
LSD (p=0.05)	7.46	8.69	4.81	0.65	0.60	0.37	6.60	5.43	3.59	0.72	0.65	0.41

DAS = days after seeding; PE= pre-emergence application; PoE = post-emergence application

Table 3. Efficiency of different weed management treatments on productivity of clusterbean

Treatment	Test weight (g)			Seed yield (kg/ha)			Haulm yield (t/ha)			HI (%)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
Weedy check	30.8	30.3	30.5	730	630	680	2.17	1.87	2.02	25.17	25.08	25.13
Pendimethalin 500 g/ha PE	32.5	31.5	32.0	980	790	880	2.54	2.06	2.30	27.84	27.66	27.75
Fomesafen + fluazifop-p-butyl 220 g/ha PoE at 20 DAS	32.1	30.8	31.4	960	730	840	2.59	1.94	2.26	27.17	27.25	27.21
Imazethapyr + imazamox 40 g/ha PoE at 20 DAS	32.7	31.3	32.0	930	780	860	2.52	2.05	2.29	26.99	27.58	27.29
Sodium- acifluorfen + clodinafop-propargyl 250 g/ha PoE at 20 DAS	31.6	30.8	31.2	910	730	820	2.51	2.00	2.26	26.60	26.61	26.61
Propaquizafop + imazethapyr 135 g/ha PoE at 20 DAS	32.5	31.5	32.0	1070	810	940	2.66	2.07	2.37	28.60	27.95	28.27
Imazethapyr 40 g/ha PoE at 25 DAS	31.7	31.0	31.3	970	780	880	2.59	2.09	2.34	27.25	27.22	27.24
Weed free check	32.5	31.8	32.1	1100	850	970	2.66	2.15	2.41	29.17	28.26	28.71
LSD (p=0.05)	NS	NS	NS	120	71	59	0.25	0.19	0.13	NS	NS	NS

DAS = days after seeding; PE= pre-emergence application; PoE = post-emergence application

Table 4. Efficiency of different weed management treatments on the economics of clusterbean cultivation

Treatment	Gross returns (x10³ Rs/ha)			Net returns (x10³ Rs/ha)			B:C ratio		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean
Weedy check	38.06	32.50	35.28	24.46	18.90	21.68	1.80	1.39	1.59
Pendimethalin 500 g/ha PE	50.86	40.95	45.90	34.38	24.47	29.42	2.09	1.48	1.79
Fomesafen + fluazifop-p-butyl 220 g / ha PoE at 20 DAS	50.02	37.70	43.86	33.52	21.20	27.36	2.03	1.28	1.66
Imazethapyr + imazamox 40 g /ha PoE at 20 DAS	48.46	40.56	44.51	32.85	24.95	28.90	2.10	1.60	1.85
Sodium-acifluorfen + clodinafop-propargyl 250 g/ha PoE at 20 DAS	47.32	37.70	42.51	31.95	22.33	27.14	2.08	1.45	1.77
Propaquizafop + imazethapyr 135g /ha PoE at 20 DAS	55.43	41.86	48.65	39.23	25.66	32.45	2.42	1.58	2.00
Imazethapyr 40 gm/ha PoE at 25 DAS	50.65	40.56	45.60	35.37	25.29	30.33	2.32	1.66	1.99
Weed free check	57.10	43.94	50.52	38.70	25.54	32.12	2.10	1.39	1.75

*DAS = days after seeding; PE= pre-emergence application; PoE = post-emergence application

ratio were recorded with imazethapyr 40 g/ha PoE at 25 DAS and hand weeding twice at 25 and 40 DAS. Year to year variation in cost of cultivation, which consequently reflected the benefits were due to variability in cost of inputs and outputs. The observations of this study on economic viability and agronomic feasibility of the technology for clusterbean cultivation confirmed the findings of Jain and Jain (2025).

Based on the results of this study, it canbe concluded that propaquizafop + imazethapyr 135 g/ha PoE at 20 DAS be profitably used and recommended in clusterbean, instead of pendimethalin and hand weeding twice, as it significantly improved the weed management and increased clusterbean productivity with better economic returns. However, location specificity verification is required before recommendation.

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