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Response of weeds to different herbicides and their time of application in clusterbean

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ABSTRACT

A field experiment was conducted under loamy sand soil during *Kharif* (rainy season), 2018 at Swami Keshwanand Rajasthan Agricultural University, Bikaner to evaluate the bio-efficacy of herbicides in clusterbean as affected by time of application. Results revealed that imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) and pendimethalin + imazethapyr at 0.80 kg/ha as PE resulted in the lowest weed density and dry weight of both monocot and dicot weeds. Higher weed control efficiencies were also noted under these treatments. Plant height, pods per plant, seeds per pod and seed and straw yields, net returns and benefit: cost ratio were also superior with imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) and pendimethalin + imazethapyr at 0.80 kg/ha as PE compared to the other treatments.

Clusterbean (*Cyamopsis tetragonoloba*) popularly known by its vernacular name “guar”, is an important drought-hardy leguminous crop. It is mainly grown under rainfed condition in arid and semi-arid regions of Rajasthan during *Kharif* (rainy) season. Seeds of guar contain 28–33% gum. Clusterbean is mainly cultivated in marginal and rainfed areas where inadequate weed management is a major constraint in harnessing its production potential. Being a rainy season crop, it suffers badly due to severe competition by mixed weed flora. Saxena *et al.* (2004) reported yield reduction of 53.7% due to weed infestation. Hand-weeding is a traditional and effective method of weed control, but untimely rains, unavailability of labour on time and higher labour cost are the major limitations of manual weeding. Under such a situation, the only alternative that needs to be explored is the use of suitable herbicide which may be effective and economically viable. Application of pendimethalin at 0.75–1.0 kg/ha as pre-emergence was effective against weeds in clusterbean (Dhaker *et al.* 2009), but inadequate moisture and prevailing western winds at time of sowing in this arid region resulted in surface soil-moisture deficit which reduces the efficiency of pre-emergence herbicides (Punia *et al.* 2011). Herbicide application time is an important aspect and has its own importance. Application of herbicide at the time of sowing reduced the weed load at early stage while application of herbicide at post-emergence may be helpful to reduce the quantity of herbicide. To control mix flora of weeds, herbicide mixtures can be used to increase the efficacy of weed control. However, information on use of herbicide mixtures in clusterbean is meager and therefore, an attempt has been made to test some pre- and post-emergence herbicide mixtures in clusterbean.

A field experiment was carried out during the *Kharif* season of 2018 at Instructional farm of Swami Keshwanand Rajasthan Agricultural University, Bikaner. Fifteen treatments consists of weedy check, weed free, one hand weeding at 25 DAS, pendimethalin at 0.75 kg/ha as PE, pendimethalin at 0.75 kg/ha as PPI, pendimethalin + imazethapyr at 0.80 kg/ha as PPI, pendimethalin + imazethapyr at 0.80 kg/ha as PE, pendimethalin + oxyfluorfen at 0.45 kg/ha as PPI, pendimethalin + oxyfluorfen at 0.45 kg/ha as PE, pendimethalin + oxyfluorfen at 0.56 kg/ha as PPI, pendimethalin + oxyfluorfen at 0.56 kg/ha as PE, imazethapyr + imazamox at 40 g/ha as PoE (20 DAS), imazethapyr + imazamox at 50 g/ha as PoE (20 DAS), oxyfluorfen at 150 g/ha as PE and oxyfluorfen at 50 g/ha as PoE (20 DAS), was laid out in a randomized block design with three replications. The soil of the experimental field was loamy sand with low in organic carbon (0.11%), available nitrogen (81.41 kg/ha), available phosphorus (32.4 kg/ha) and medium in available potassium (328 kg/ha) with pH 8.4. Clusterbean variety ‘*RGC 1066*’ was sown on 17 July 2018 with crop geometry of 30 × 10 cm under recommended package of practices. The total rainfall received during the season was 230.2 mm with 8 rainy days. Fertilizers were applied uniformly through urea and diammonium phosphate at the rate of 20 kg N and 40 kg P/ha. Monocot and dicot weeds were counted from randomly selected area of 0.25 m^2 using 0.5 x 0.5 m quadrant at 30 DAS and at harvest and converted into one square meter. Weeds plants were dried at 65^{o}C for 48 h before determining dry weight. The data on total weed count and weed dry matter were subjected to square root transformation (x+0.5) to normalize their distribution (Gomez and Gomez 1984).

Effect on weed

The major weed flora of experimental field consisted of *Cenchrus biflorus, Digera arvensis, Corchorus trilocularis, Tribulus terrestris, Cleome viscose, Phyllanthus niruri, Amaranthus viridis, Cynodon dactylon* and *Cyperus rotundus*. Among the weed-management practices, imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) showed significant reduction in the density and dry weight of weeds in clusterbean than the weedy check and the other herbicide treatments and found at par with imazethapyr + imazamox at 40 g/ha as PoE (20 DAS) and pendimethalin + imazethapyr at 0.80 kg/ha as PE (**Table 1**). This was simply due to the fact that both the treatments were almost the same in controlling in early as well as late flushes of the weeds. Punia *et al.* (2011) also reported better control of weeds in clusterbean with the use of imazethapyr. Further, pendimethalin + imazethapyr at 0.80 kg/ha as PE performed very well in controlling all the categories of weeds. This treatment was found significantly superior to weedy check. The superiority of this treatment in controlling monocot weeds over rest ones was because of the fact that early growth of monocot weeds was checked by pendimethalin + imazethapyr. Similar results were also reported by Samant and Mohanty (2017) in mungbean. Imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) belongs to group of imidazolinone. It is selective and applied as post-emergence with a view to control late emerging weeds. It inhibits the plastid enzyme acetolactate syntheses in plants which catalyses the first step in the biosynthesis of essential branched chain amino acids (Valine, leucine, isoleucine). Saltoni *et al.* (2004) suggested that imazethapyr is an imidazolinones herbicide, which is absorbed both by the roots and the shoots. It can effectively control a broad spectrum of weeds. Results also corroborate with the findings of Sangeetha *et al.* (2013) and Khairnar *et al.* (2014). Imazethapyr + imazamox at 50 g/ha as PoE (20 DAS), imazethapyr + imazamox at 40 g/ha as PoE (20 DAS) and pendimethalin + imazethapyr at 0.80 kg/ha as PE were found to be among more effective treatments that controlled the weeds to the extent of 90.64, 83.90 and 80.91%, respectively (**Table 2**). This variation in weed control efficiency is directly associated with the weed density under these treatments. Inhibition of germination of weeds and their growth following application of different herbicides might have reduced the growth of weeds causing mortality of weeds as discussed earlier in the text. These seem to be the most spectacular reasons of accumulating lesser density of weeds and as a consequence of higher weed control efficiencies.

Table 1. Effect of weed control measures on weed density in clusterbean

Treatment	Weed density (no./m^2)			Weed dry weight (g/m^2)		
	Monocot	Dicot	Total	Monocot	Dicot	Total
Pendimethalin at 0.75 kg/ha as PE	4.46(20.3)	4.04(16.3)	5.98(38.3)	17.43(312.0)	16.97(301.7)	24.35(613.7)
Pendimethalin at 0.75 kg/ha as PPI	5.81(35.7)	5.27(28.0)	7.84(63.7)	21.31(496.3)	19.69(408.3)	29.09(905.0)
Pendimethalin + imazethapyr at 0.80 kg/ha as PPI	4.42(19.7)	4.17(17.0)	6.05(36.7)	19.20(369.7)	13.95(198.3)	23.83(568.0)
Pendimethalin + imazethapyr at 0.80 kg/ha as PE	3.55(12.3)	3.17(9.7)	4.74(27.7)	14.30(215.0)	12.06(148.3)	19.00(363.3)
Pendimethalin + oxyfluorfen at 0.45 kg/ha as PPI	5.67(32.3)	5.51(30.3)	7.93(62.7)	24.04(718.7)	21.73(480.0)	34.15(1198.7)
Pendimethalin + oxyfluorfen at 0.45 kg/ha as PE	5.90(36.7)	5.24(28.7)	8.10(65.3)	22.98(581.7)	21.43(492.7)	32.78(1074.3)
Pendimethalin + oxyfluorfen at 0.56 kg/ha as PPI	5.06(25.7)	5.87(34.3)	7.71(60.0)	21.51(562.3)	23.09(546.3)	32.06(1108.7)
Pendimethalin + oxyfluorfen at 0.56 kg/ha as PE	6.03(36.3)	4.73(22.0)	7.66(58.3)	23.47(551.7)	18.67(352.3)	30.07(904.0)
Imazethapyr + imazamox at 40 g/ha as PoE (20 DAS)	3.07(9.0)	2.73(7.3)	4.10(16.3)	10.83(118.7)	10.03(104.0)	14.92(222.7)
Imazethapyr + imazamox at 50 g/ha as PoE (20 DAS)	2.44(5.7)	2.32(5.0)	3.29(10.7)	8.24(70.3)	7.90(64.3)	11.40(134.7)
Oxyfluorfen at 150 g/ha as PE	6.78(46.0)	5.51(30.3)	8.72(76.3)	31.23(996.3)	22.93(533.0)	38.77(1529.3)
Oxyfluorfen at 50 g/ha as PoE (20 DAS)	6.29(39.3)	5.68(32.0)	8.45(71.3)	20.61(429.3)	21.92(494.0)	30.11(923.3)
One hand weeding at 25 DAS	5.22(27.7)	4.72(22.7)	7.00(50.3)	20.52(421.3)	20.20(409.3)	28.79(830.7)
Weedy check	7.72(59.3)	7.52(56.3)	10.77(115.7)	28.33(805.3)	31.51(1005.7)	42.43(1811.0)
Weed free	0.71(0.0)	0.71(0.0)	0.71(0.0)	0.71(0.00)	0.71(0.0)	0.71(0.0)
LSD (p=0.05%)	0.80	0.80	0.82	6.20	3.57	5.17

Values transformed to $\sqrt{x+0.5}$ and actual values are in parentheses

Effect on crop

Pendimethalin at 0.75 kg/ha as PE, pendimethalin + imazethapyr at 0.80 kg/ha as PE, imazethapyr + imazamox at 40 g/ha as PoE (20 DAS) and imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) recorded significantly higher yield attributes *i.e.* pods per plant and seeds per pod compared to weedy check and other treatments and were statistically at par with weed free (**Table 3**). This was attributed to minimum infestation of weeds together with lesser competition for other growth resources *i.e.* light, space, water, nutrients. Thus, reduced crop-weed competition resulted into overall improvement in crop growth as reflected by plant height consequently resulted into better development of reproductive structure and translocation of photosynthetes into the sink. Among the herbicide performance of imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) was found significantly superior in increasing number of pods per plant and seed per pods over pendimethalin at 0.75 kg/ha as PPI, pendimethalin + oxyfluorfen at 0.45 kg/ha as PPI, pendimethalin + oxyfluorfen at 0.45 kg/ha as PE, pendimethalin + oxyfluorfen at 0.56 kg/ha as PPI, pendimethalin + oxyfluorfen at 0.56 kg/ha as PE. The results corroborate with the findings of Singh *et al.* (2018).

Pendimethalin + imazethapyr at 0.80 kg/ha as PE, imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) and imazethapyr + imazamox at 40 g/ha as PoE (20 DAS) recorded significantly higher yields to weedy check and were statistically at par with weed free. Amongst herbicide treatments, performance of pendimethalin + imazethapyr at 0.80 kg/ha as PE was found significantly superior in enhancing the seed, straw and biological yields over rest of herbicides. Our results confirmed the findings of Kumar *et al.* (2016). The reduced crop weed competition caused significant increase in plant height and yield attributes ultimately led to higher seed yield of clusterbean. The significant improvement in seed yield as a result pendimethalin + imazethapyr 0.80 kg/ha as PE and imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) could be ascribed to the fact that yield of crop depends on several yield components which are interrelated. Weed index also witnessed lower value due to these treatments in comparison to weedy check (**Table 2**). The variation in crop-weed competition under different treatments as associated with variation in weed biomass production was eventually reflected in the weed competition indices. Results showed that imazethapyr + imazamox at 50 g/ ha as PoE (20 DAS) exhibited the lowest weed competition of 6.44 per cent, as against of 66.07 per cent noted under weedy check in comparison to weed free treatment and maximum under oxyfluorfen at 150 g/ha as PE (96.58).

Imazethapyr + imazamox at 40 g/ha as PoE (20 DAS) and pendimethalin + imazethapyr at 0.80 kg/ha as PE were noted to be the next superior treatments wherein yield reduction due to presence of weeds was 8.85 and 6.88%, respectively as compared to weed free. The higher dry weight by weeds and corresponding reduction in grain yield appeared to be directly associated with variation in weed competition indices among different treatments. These results were in accordance with the findings of Yadav *et al.* (2015) and Kaur *et al.* (2016).

Table 2. Effect of weed control measures on weed control efficiency and weed index in clusterbean

Treatment	Weed control efficiency (%)			Weed index (%)	Plant height (cm)	No. of pods/ plant	No. of seeds/ pod
	Monocot	Dicot	Total				
Pendimethalin at 0.75 kg/ha as PE	66.52	70.29	68.73	17.32	115.47	43.87	8.27
Pendimethalin at 0.75 kg/ha as PPI	41.24	47.61	45.69	30.85	109.76	39.33	8.00
Pendimethalin + imazethapyr at 0.80 kg/ha as PPI	67.70	69.59	68.51	18.01	111.83	43.23	8.40
Pendimethalin + imazethapyr at 0.80 kg/ha as PE	79.57	82.42	80.91	6.88	116.41	47.00	8.47
Pendimethalin + oxyfluorfen at 0.45 kg/ha as PPI	46.63	44.35	45.55	30.43	104.30	40.20	8.40
Pendimethalin + oxyfluorfen at 0.45 kg/ha as PE	38.54	47.84	43.58	58.22	85.21	32.40	7.80
Pendimethalin + oxyfluorfen at 0.56 kg/ha as PPI	57.69	37.01	48.39	34.72	103.46	38.05	7.97
Pendimethalin + oxyfluorfen at 0.56 kg/ha as PE	36.03	59.59	49.37	61.89	82.94	30.07	7.73
Imazethapyr + imazamox at 40 g/ha as PoE (20 DAS)	80.84	87.40	83.90	8.85	116.07	47.01	8.53
Imazethapyr + imazamox at 50 g/ha as PoE (20 DAS)	89.89	91.24	90.64	6.44	117.94	47.58	8.60
Oxyfluorfen at 150 g/ha as PE	22.41	43.77	34.39	96.58	43.88	13.40	6.80
Oxyfluorfen at 50 g/ha as PoE (20 DAS)	33.50	41.45	38.62	85.04	67.29	20.53	7.27
One hand weeding at 25 DAS	54.69	58.52	56.91	32.34	103.64	41.27	7.97
Weedy check	0.00	0.00	0.00	66.07	93.10	26.47	7.20
Weed free	100.00	100.00	100.00	0.00	124.52	48.57	8.87
LSD (p=0.05%)					5.81	4.77	0.44

Table 3. Effect of weed control measures on weed density in clusterbean

Treatment	Yield (t/ha)			Cost of cultivation ($x10^3$ ₹/ha)	Gross returns ($x10^3$ ₹/ha)	Net returns ($x10^3$ ₹/ha)	B:C ratio
	Seed	Straw	Biological				
Pendimethalin at 0.75 kg/ha as PE	1175	3.95	5.13	18.80	56.77	37.97	3.02
Pendimethalin at 0.75 kg/ha as PPI	982	3.63	4.61	18.80	48.13	29.33	2.56
Pendimethalin + imazethapyr at 0.80 kg/ha as PPI	1154	3.75	4.91	19.13	55.52	36.39	2.90
Pendimethalin + imazethapyr at 0.80 kg/ha as PE	1310	4.24	5.55	19.13	62.99	43.86	3.29
Pendimethalin + oxyfluorfen at 0.45 kg/ha as PPI	978	3.31	4.29	19.20	47.32	28.12	2.46
Pendimethalin + oxyfluorfen at 0.45 kg/ha as PE	589	1.97	2.56	19.20	28.45	9.25	1.48
Pendimethalin + oxyfluorfen at 0.56 kg/ha as PPI	920	3.20	4.12	19.51	44.66	25.15	2.29
Pendimethalin + oxyfluorfen at 0.56 kg/ha as PE	537	1.72	2.25	19.51	25.76	6.25	1.32
Imazethapyr + imazamox at 40 g/ha as PoE (20 DAS)	1283	4.14	5.43	18.98	61.65	42.66	3.25
Imazethapyr + imazamox at 50 g/ha as PoE (20 DAS)	1322	4.21	5.54	19.25	63.43	44.18	3.30
Oxyfluorfen at 150 g/ha as PE	48	0.19	0.24	19.70	2.38	-17.31	0.12
Oxyfluorfen at 50 g/ha as PoE (20 DAS)	211	0.82	1.03	18.51	10.39	-8.11	0.56
One hand weeding at 25 DAS	962	3.46	4.42	20.04	46.96	26.92	2.34
Weedy check	482	1.82	2.30	17.91	23.68	5.77	1.32
Weed free	1418	4.25	5.66	23.23	67.47	44.23	2.90
LSD (p=0.05%)	125	0.51	0.59	-	-	-	-

Economics

The net returns of ₹ 44234/ha were obtained with weed free, which was followed by ₹ 44185/ha under imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) (**Table 3**). As far as benefit cost ratio is concerned maximum benefit: cost ratio was also obtained with imazethapyr + imazamox at 50 g/ha as PoE (20 DAS) (3.30) followed by application of pendimethalin + imazethapyr at 0.80 kg/ha as PE (3.29). The lowest benefit: cost of 1.32 was recorded under weedy check. Among the weed control treatments, minimum net return and B:C were obtained under oxyfluorfen at 150 g/ha as PE and the respective value of net returns and benefit: cost ratio under this treatment were ₹ 17312/ha and 0.12. The higher seed yield recorded with this treatment might be responsible for higher net return. These results were in agreement with the findings Sangeetha *et al.* (2013) and Pratap *et al.* (2018).

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