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Effect of different herbicides on weed dynamics in green gram under western arid region of Rajasthan

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Abstract

A field experiment was carried out at SKRAU Bikaner during *kharif*, 2022 on loamy sand soil to evaluate the "Effect of the weed management in green gram [*Vigna radiata* (L.) Wilczek] under Western arid region of Rajasthan". The experiment was laid out in randomized block design with 10 treatments and 3 replications. The treatments comprised of weedy check, weed free, Pendimethalin 750 g ha^{-1} PE, Diclosulam 20 g ha^{-1} PE, Flumioxazin 75 g ha^{-1} PE, Pendimethalin + Imazethapyr (30+2) 800 g ha^{-1} PE, Imazethapyr 50 g ha^{-1} PoE, Quaizalofop + Imazethapyr (7.5+15) 65 g ha^{-1} PoE, Imazethapyr + Imazamox (35+35) 50 g ha^{-1} PoE, Sodium acifluorfen + clodinafop (16.5+8) 240 g ha^{-1} PoE. Among the herbicides, pre emergence application of Pendimethalin + Imazethapyr 800 g ha^{-1} recorded highest weed control efficiency (92.7%) and weed index (3.36) due to reduction in total weed density (1.71 no. m^{-2}) and weed dry matter (3.35 g m^{-2}).

Keywords: Green gram, herbicides, weed control efficiency, weed free

Green gram, also known as mungbean, is the fourth most widely produced pulse crop in India after chickpea, pigeonpea and blackgram. The lack of high-yielding varieties, dependence on monsoon-based cultivation, poor soil fertility and high prevalence of pests and diseases are key factors limiting production, with weed infestation being one of the major challenges. The rainfall during the rainy season causes weeds to grow profusely and hamper growth of green gram. Crop and weeds compete for resources such as light, water, nutrients and space. Owing to the abundance of weeds, growing green gram demands a lot of labor and farmers do not receive profitable yield. About 30 to 80 % reduction in grain yield of green gram was observed during summer and *kharif* seasons respectively while 70-80% during *rabi* season due to severe crop weed competition (Algotar *et al*., 2015). For green gram, the crop weed competition period extends from around 20 to 30 days after sowing. Presence of weeds at critical period can result in significant yield losses that may vary from 30% to 85% (Mirjha *et al*., 2015). Jinger *et al.* (2016) reported that green gram was susceptible to weed competition during the first four to five weeks after sowing (WAS) because of the intial slow growth of green gram. The combination of pre and post emergence herbicides or some ready-mix herbicide combinations minimizes the crop weed competition and significantly controls the weed species in green gram (Rathika *et al*., 2023). For efficient weed control, several pre emergence and post emergence herbicides must be evaluated because hand weeding is expensive and labour intensive. Thus an experiment was conducted with an objective to identify suitable herbicides in isolation or their mixtures applied on green gram.

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Materials and Methods

A field experiment was carried out at SKRAU Bikaner during *kharif*, 2022 on loamy sandy soil. The experiment was laid out in randomized block design with 10 treatments and 3 replications. The soil of the experimental field was loamy sand (85% sand, 8.5% silt and 6.5% clay) with poor in organic carbon (0.15%), low in available nitrogen (92.9 kg/ha), medium in available phosphorous (14.6 kg/ha) and potassium (207.6 kg/ha). The soil was slightly alkaline in reaction with pH (8.3). The climate of this zone is typically arid characterized by aridity of the atmosphere and slight salinity in the rhizosphere with extremes of temperature both in summers and winters. The experiment consists of weedy check, weed free, Pendimethalin 750 g ha^{-1} PE, Diclosulam 20 g ha^{-1} PE, Flumioxazin 75 g ha^{-1} PE, Pendimethalin + Imazethapyr (30+2) 800 g ha^{-1} PE, Imazethapyr 50 g ha^{-1} PoE, Quaizalofop + Imazethapyr (7.5+15) 65 g ha^{-1} PoE, Imazethapyr + Imazamox (35+35) 50 g ha^{-1} PoE, Sodium acifluorfen + clodinafop (16.5+8) 240 g ha^{-1} PoE. Green gram variety MH-421 was sown with crop geometry of 30 × 10 cm and seed rate of 16 kg ha^{-1}. A pre-sowing irrigation was given immediately before land preparation. Two post sowing irrigations were given to green gram. The canal water was applied through sprinkler system.

Weed control efficiency was calculated using the following formula (Varshney, 1990).

$$WCE\ (\%) = \frac{X - Y}{X} x\ 100$$

Whereas,

WCE= Weed control efficiency

X= Weed dry matter in weedy check plot

Y= Weed dry matter in treated plot

Weed index was calculated by the following formula (Yadav and Mishra, 1982).

$$WI\ (\%) = \frac{X - Y}{X} x\ 100$$

Whereas,

X = Yield from weed free plot (kg ha^{-1})

Y= Yield from weedy check plot (kg ha^{-1})

Data analysis was done through analysis of variance using the F test. Before statistical analysis, the data of weed density were subjected to square root transformation (√(x+0.5)) to normalize their distribution as per Gomez and Gomez (1984). While presenting the results of weed density and dry matter and nutrient uptake by weeds, the columns of data where weed did not exist due to employment of weed free treatments, have been left blank and the statistical analysis was done after subtracting respective degrees of freedom of weed competition periods. The critical differences for the treatment comparison were worked out, wherever, the "F" test was found significant at 5 per cent level of significance.

Results and Discussion

Weed Flora

In the experimental field of green gram, there was abundance of *Amaranthus spinosus* L., *Digera arvensis* L., *Trianthema portulacastrum* L., *Gisekia poredious* L., *Euphorbia hirta* L., *Portulaca oleracea* L., *Cleome viscosa* L., *Tribulus terrestris* L., *Corchorus tridense* L., *Eleusine verticillata* L., *Eragrastris tennela* L. and *Aerva tomentosa* L. are broad leaved weeds. *Aristida depressa* L., *Cenchrus biflorus* L., and *Dactyloctenium aegyptium* L. are grassy weeds. *Cyperus rotundus* L. and *Cyperus deformis L.* are sedges.

Effect on Weed Density

At 35, 70 DAS and at harvest, the lowest weed density was observed under weed free treatment. Treatments imazethapyr + imazamox 50 g ha^{-1} PoE, quizalofop + imazethapyr 65 g ha^{-1} PoE, imazethapyr 50 g ha^{-1} PoE and sodium aceflurofen + clodinofop 240 g ha^{-1} PoE (1.20,1.25,1.53 and 1.86 weeds m^{-2}, respectively) were found superior to application of rest treatments at 35 DAS. At 70 DAS and harvest, the lowest weed density was observed under pendimethalin + imazethapyr 800 g ha^{-1} PE and pendimethalin 750 g ha^{-1} PE (2.03, 2.11 and 1.71, 1.96 weeds m^{-2}, respectively) which remained statistically at par with each other and these treatments were significantly superior over rest. At 35 DAS, higher weed control efficacy of imazethapyr+imazamox in reducing weed density might be due to broad-spectrum activity and its greater efficiency to reduce cell division of meristems and carbohydrate translocation in the susceptible plants as a result of which weeds died rapidly. Similar findings were observed by Gupta

et al. (2017), Punia *et al.* (2017). The lower weed density at 70 DAS and at harvest was mainly due to the application of Pendimethalin + Imazethapyr 800 g ha^{-1} PE which was efficient in reducing the weed population and similar results were reported Singh *et al.* (2018), Kumar *et al.* (2019).

Effect on weed dry matter

Weed free treatment recorded the lowest dry weight of broad leaved, grassy and total weeds compared to all other weed control treatments. The weed dry weight at 35 DAS was recorded significantly the lowest in imazethapyr + imazamox 50 g ha^{-1} (0.24 g m^{-2}) followed by quizalofop + imazethapyr 65 g ha^{-1} PoE (0.28 g m^{-2}), imazethapyr 50 g ha^{-1} PoE (0.96 g m^{-2}), and sodium aceflurofen + clodinofop 240 g ha^{-1} PoE (1.03 g m^{-2}). At 35 DAS more reduction in dry weight of grassy weeds with application of imazethapyr+imazamox was might be due to the more effectiveness of imazamox. At 70 DAS and harvest, pendimethalin + imazethapyr 800 g ha^{-1} PE (4.48 and 3.35 g m^{-2}) was significantly reduced the dry matter of weeds which was at par with pendimethalin 750 g ha^{-1} PE (5.67 and 4.64 g m^{-2}) which might be due to completion of life cycle of weeds which might got earlier. Singh *et al.* (2017) Kumar *et al.* (2019), also reported similar findings.

Effect of weed control treatments on weed control efficiency and weed index in green gram

All weed control treatments efficiently controlled broad leaved as well as grassy weeds. The highest weed control efficiency was recorded under weed free treatment (100%) followed by pendimethalin + imazethapyr 800 g ha^{-1} PE (92.77%), pendimethalin 750 g ha^{-1} (90.00%), diclosulam 20 g ha^{-1} PE (88.96%), flumioxazin 100 g ha^{-1} PE (85.28%) whereas, the lowest (0.00%) was recorded in weedy check. Similar findings also reported by Raju *et al.* (2017), Udhaya *et al.* (2021). Highest weed index was recorded under weedy check (48.33%). Among the herbicides the highest weed index of (50.87%) was recorded with application of diclosulam 20 g ha^{-1} PE. Data further indicated that the lowest weed index was recorded under pendimethalin + imazethapyr 800 g ha^{-1} PE (3.36%), pendimethalin 750 g ha^{-1} PE (4.68%). By significantly reducing weed growth,

Table 1. Effect of weed control measures on weed density (number m^{-2}) in green gram

Treatments	Broad leaved weeds			Grassy leaved weeds			Total weed density		
	35 DAS	70 DAS	Harvest	35 DAS	70 DAS	Harvest	35 DAS	70 DAS	Harvest
Weedy check	*4.10(16.33)	5.58(30.59)	4.67(21.35)	2.96(8.26)	4.68(21.46)	3.36(10.81)	5.01(24.59)	7.25(52.04)	5.71(32.16)
Weed free	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
Pendimethalin @750 g ha^{-1} PE	2.32(4.90)	1.38(1.41)	1.67(2.30)	2.21(4.37)	1.74(2.52)	1.25(1.06)	3.13(9.27)	2.11(3.94)	1.96(3.36)
Diclosulam @20 g ha^{-1} PE	2.54(5.98)	1.71(2.45)	1.87(3.00)	2.44(5.45)	1.97(3.41)	1.26(1.09)	3.45(11.43)	2.52(5.85)	2.14(4.09)
Flumioxazin @75g ha^{-1} PE	2.68(6.66)	2.33(4.95)	2.27(4.66)	2.67(6.65)	2.60(6.25)	1.64(2.20)	3.71(13.31)	3.42(11.20)	2.71(6.86)
Pendimethalin + Imazethapyr (30+2) @800 g ha^{-1} PE	2.23(4.47)	1.33(1.35)	1.46(1.66)	2.13(4.05)	1.67(2.30)	1.14(0.80)	3.00(8.52)	2.03(3.65)	1.71(2.46)
Imazethapyr @ 50 g ha^{-1} PE	1.41(1.50)	2.78(7.26)	2.49(5.72)	0.91(0.34)	2.96(8.27)	2.30(4.81)	1.53(1.84)	4.00(15.52)	3.32(10.53)
Quizalofop + Imazethapyr (7.5+15) 65 g ha^{-1} PoE	1.13(0.78)	2.66(6.59)	2.37(5.13)	0.88(0.28)	2.94 (8.17)	2.18(4.27)	1.25(1.06)	3.91(14.76)	3.15(9.40)
Imazethapyr + Imazamox (35+35) 50 g ha^{-1} PoE	1.10(0.73)	2.51(5.84)	2.24(4.56)	0.85(0.22)	2.61 (6.30)	2.05(3.71)	1.20(0.95)	3.55(12.14)	2.96(8.27)
Sodium Aceflurofen 16.5+ clodinafop 8% @ 240g ha^{-1} PoE	1.59(2.05)	2.79 (7.32)	2.64(6.50)	1.19(0.91)	3.08(8.98)	2.53(5.92)	1.86(2.96)	4.10(16.30)	3.59(12.42)
SEm+/-	0.07	0.08	0.08	0.04	0.05	0.05	0.06	0.06	0.07
CD at 0.05 %	0.21	0.25	0.23	0.12	0.16	0.15	0.17	0.19	0.22

*Data outside parentheses were transformed to ($\sqrt{(x+0.5)}$) before analysis

herbicides improved crop growth, enhanced photosynthesis and biomas accumulation and eventually helped in smothering weeds, which led to increased weed control efficiency and lowest weed index. Similar findings also reported by Naidu *et al.* (2012), Singh *et al.* (2017), Kumar *et al.* (2019).

Table 2. Effect of weed control measures on weed dry matter in green gram

Treatments	Broad leaved weeds (g m^{-2})			Grassy leaved weeds (g m^{-2})			Total weed dry matter (g m^{-2})		
	35 DAS	70 DAS	Harvest	35 DAS	70 DAS	Harvest	35 DAS	70 DAS	Harvest
Weedy check (control)	11.2	40.1	34.4	4.36	11.9	9.92	15.5	52.0	44.3
Weed free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pendimethalin @ 750 g ha^{-1} PE	4.02	3.94	3.69	2.47	1.73	1.02	6.49	5.67	4.71
Diclosulam @20 g ha^{-1} PE	4.92	5.74	3.11	3.40	2.12	1.24	8.31	7.86	5.12
Flumioxazin @75g ha^{-1} PE	5.16	7.37	4.12	4.67	3.81	2.71	9.83	11.1	6.83
Pendimethalin + Imazethapyr @ 800 g ha^{-1} PE	3.29	2.74	2.26	2.22	1.74	1.09	5.52	4.48	3.35
Imazethapyr @ 50 g ha^{-1} PE	0.96	9.51	7.03	0.20	6.46	5.00	1.16	15.9	12.0
Quizalofop + Imazethapyr (7.5+15) 65 g ha^{-1} PoE	0.28	8.55	6.93	0.13	6.27	4.57	0.41	14.8	11.5
Imazethapyr + Imazamox (35+35) 50 g ha^{-1} PoE	0.24	8.08	6.88	0.12	4.92	3.93	0.35	13.0	10.8
Sodium Aceflurofen 16.5 + clodinafop 8% @ 240 g ha^{-1} PoE	1.03	12.2	7.68	0.46	7.22	6.39	1.49	19.4	14.0
SEm+/-	0.14	0.53	0.29	0.09	0.19	0.24	0.20	0.58	0.32
CD at 0.05 %	0.41	1.56	0.85	0.27	0.56	0.73	0.60	1.72	0.95

Table 3. Effect of weed control treatments on weed control efficiency and weed index in green gram

Treatments	Weed control efficiency (%)	Weed index (%)
Weedy check (control)	-	48.3
Weed free	100	-
Pedimethalin @ 750 g ha^{-1} PE	90.0	4.68
Diclosulam @ 20 g ha^{-1} PE	88.9	50.8
Flumioxazin @75 g ha^{-1} PE	85.2	16.4
Pendimethalin + Imazethapyr @ 800 g ha^{-1} PE	92.7	3.36
Imazethapyr @ 50 g ha^{-1} PE	74.0	31.7
Quizalofop + Imazethapyr (7.5+15) 65 g ha^{-1} PoE	75.2	31.3
Imazethapyr + Imazamox (35+35) 50 g ha^{-1} PoE	76.7	19.4
Sodium Aceflurofen 16.5+ clodinafop 8% @ 240g ha^{-1} PoE	69.6	35.9

Table 4. Effect of weed control measures on nutrient content and uptake by weeds in green gram

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
Weedy check (control)	2.25	1.53	1.57	10.42	7.08	7.27
Weed free	0.00	0.00	0.00	0.00	0.00	0.00
Pendimethalin @1.0kg ha^{-1} PE	1.99	1.19	1.29	0.93	0.55	0.60
Diclosulam @20 g ha^{-1} PE	2.03	1.21	1.33	1.04	0.63	0.67
Flumioxazin @75g ha^{-1} PE	2.08	1.34	1.36	1.42	0.92	0.93
Pendimethalin + Imazethapyr @ 800 g ha^{-1} PE	1.94	1.15	1.25	0.65	0.39	0.42
Imazethapyr @ 50 g ha^{-1} PE	2.27	1.39	1.41	2.73	1.65	1.69
Quizalofop + Imazethapyr (7.5+15) 65 g ha^{-1} PoE	2.24	1.38	1.36	2.57	1.59	1.56
Imazethapyr + Imazamox (35+35) 50 g ha^{-1} PoE	2.14	1.35	1.37	2.31	1.45	1.48
Sodium Aceflurofen 16.5+ clodinafop 8% @ 240g ha^{-1} POE	2.23	1.40	1.44	3.15	1.97	2.03
SEm+/-	0.09	0.05	0.11	0.11	0.07	0.15
CD at 0.05 %	0.28	0.15	0.33	0.33	0.20	0.45

Effect of weed control measures on nutrient content and uptake by weeds in green gram

Although no significant variation was observed in nutrient content (N, P and K) among any treatments but the highest and lowest content was recorded under weedy check and Pendimethalin + Imazethapyr @ 800 g ha^{-1} PE (2.25, 1.53, 1.57 and 1.94, 1.15, 1.25 % respectively). Similarly, highest nutrient uptake was recorded under weedy check due to uncontrolled growth of weeds which resulting in severe competition of nutrients with crops. Lowest nutrient uptake was recorded with Pendimethalin + Imazethapyr @ 800 g ha^{-1} PE (10.42, 7.08, 7.27 and 0.65, 0.39, 0.42 kg ha^{-1} respectively) due to less weed population resulting in lesser removal of nutrients by weeds. Reduced nutrient uptake by weeds under the influence of different weed control measures had been also reported by Chhodavadia *et al.* (2013) and Kavita *et al.* (2014).

Conclusion

Based on the observations, it can be concluded that Pendimethalin + Imazethapyr @ 800 g ha^{-1} PE recorded the minimum number of weed density, total weed dry weight and maximum weed control efficiency followed by pre emergence application of Pendimethalin @ 750 g/ha PE kg ha^{-1}.

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