

# Effect of pre- and post-emergence herbicides on crop growth, yield and profitability of greengram under western arid region of Rajasthan

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## ABSTRACT

A field experiment was conducted at SKRAU Bikaner during *kharif*, 2022 on loamy sand soil to evaluate the effect of pre- and post-emergence herbicides on crop growth, yield and profitability of green gram [*Vigna radiata* (L.) Wilczek] under western arid region of Rajasthan. The experiment was designed in a randomized block design, with 10 treatments and three replications. The experiment comprises of ten treatments viz., weedy check, weed free, pendimethalin 750 g ha<sup>-1</sup> PE, diclosulam 20 g ha<sup>-1</sup> PE, flumioxazin 75 g ha<sup>-1</sup> PE, pendimethalin + imazethapyr (30+2) 800 g ha<sup>-1</sup> PE, imazethapyr 50 g ha<sup>-1</sup> PoE, quazalofop + imazethapyr (7.5+15) 65 g ha<sup>-1</sup> PoE, imazethapyr + imazamox (35+35) 50 g ha<sup>-1</sup> PoE and sodium acifluorfen + clodinafop (16.5+8) 240 g ha<sup>-1</sup> PoE. Among all the weed management practices, weed free treatment recorded highest plant height, dry matter accumulation, number of branches and dry weight of nodules. Among different herbicides, pre-emergence application of pendimethalin + imazethapyr (30+2) 800 g ha<sup>-1</sup> PE recorded highest growth parameters, yield attributes viz. pod plant<sup>-1</sup>, seed pod<sup>-1</sup>, test weight (g) and seed yield followed by pendimethalin 750 g ha<sup>-1</sup> PE. pendimethalin + imazethapyr (30+2) 800 g ha<sup>-1</sup> PE also recorded highest net returns (Rs. 54130) and B:C ratio (3.01). The minimum growth parameters, yield and yield attributes found in weedy check and diclosulam 20 g ha<sup>-1</sup> PE.

**Keywords:** Arid region, greengram, imazethapyr, pendimethalin, weed management

Food legumes are often regarded as poor man's meat (Ferreira *et al.*, 2021), as they are relatively affordable source of dietary protein in India. Green gram is a popular culinary legume due to its high nutritional value as well as delicious taste (Sudhakaran and Bukkan, 2021). Green gram is also known as "green pearl" because of its remarkable nutritional value (Nair *et al.*, 2013).

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Green gram contains 25-28% protein, 3.5-4.5% fiber, 4.5-5.5% ash, and 60-65% carbohydrates by dry weight. The grains also contain vitamins A (94 mg), C (8 mg), iron (7.3 mg), calcium (124 mg), magnesium (189 mg), phosphorus (367 mg), and foliate (549 mg) (Muchomba *et al.*, 2023). Legumes can meet their own nitrogen demand as they can fix atmospheric nitrogen (58–109 kg ha<sup>-1</sup>) in mung bean in a symbiotic relationship with Rhizobium bacteria (Mehandi *et al.* 2019). India contributes more than 70% of world's green gram production (Green gram Outlook, 2025) with a production of 42.44 lakh tones and covering about an area of 35.27 Lakh ha (GoI, 2024-25). Rajasthan leads with

9.97 lakh hectares (64% of the country) and 26% of total green gram production in 2022-23, followed by Karnataka, Madhya Pradesh, and Haryana. (Indiastat, 2023).

Greengram is a short-duration crop, so it is important to manage weeds properly to boost yield. (Singh *et al.*, 2019). Weed infestation is a major obstacle for green gram production (Jeetarwal *et al.*, 2025). It is also a poor competitor for weeds due to its early, slow growth habit, and if timely weed management measures are neglected, yield losses could be severe, perhaps close to 90% (Azam *et al.*, 2018). Heavy weed competition in green gram results in a yield reduction of 60-80% (Kumar *et al.*, 2017). Weed competition is most severe in green gram during the first 30 days of sowing.

Hand weeding was a former prevalent method of controlling weeds and it performed effectively but herbicide application will be needed for weed control in green gram during the peak period of weed infestation due to labor shortages, frequent rains and rising labor costs (Kumar *et al.*, 2022). The use of pre-emergence herbicides ensures a weed-free environment during the early stages of crop establishment by hampering weeds at the time of germination (Rahul *et al.*, 2025). pendimethalin (dinitroaniline group herbicide) is widely recommended as a pre-emergence herbicide in green gram cultivation. It is highly effective against annual grassy weeds, but it also controls broad leaved weeds, so-called broad-spectrum action herbicide (Nihal *et al.*, 2025). Post-emergence herbicides, such as imazethapyr and quizalofop, can effectively manage weeds during seedling stages in standing crops (Singh *et al.*, 2020). Selective ecologically friendly herbicide mixtures can be an effective alternative for weed management, limiting the spread of new weed species and preventing herbicide resistance (Rahul *et al.*, 2026). However, there is a need to evaluate the efficacy of different herbicides either sole application or combined application on crop growth, yield and profitability of green gram under western arid region of Rajasthan.

#### MATERIALS AND METHODS

A field experiment was conducted at SKRAU

Bikaner during *kharif*, 2022 on loamy sandy soil. The experiment was designed in randomized block design with 10 treatments replicated thrice. The experiment comprises of ten treatments viz., weedy check, weed free, pendimethalin 750 g ha<sup>-1</sup> PE, diclosulam 20 g ha<sup>-1</sup> PE, flumioxazin 75 g ha<sup>-1</sup> PE, pendimethalin + imazethapyr (30+2) 800 g ha<sup>-1</sup> PE, imazethapyr 50 g ha<sup>-1</sup> PoE, quizalofop + imazethapyr (7.5+15) 65 g ha<sup>-1</sup> PoE, imazethapyr + imazamox (35+35) 50 g ha<sup>-1</sup> PoE, sodium acifluorfen + clodinafop (16.5+8) 240 g ha<sup>-1</sup> PoE. 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 (92.96 kg/ha), medium in available phosphorous (14.68 kg/ha) and potassium (207.6 kg/ha). The soil was slightly alkaline in reaction with P<sup>H</sup> (8.3).

The greengram variety MH-421 was sown at a seed rate of 16 kg ha<sup>-1</sup> with crop geometry of 30 × 10 cm. A proper dose of nitrogen (20 kg ha<sup>-1</sup>) and phosphorus (40 kg ha<sup>-1</sup>) was applied as a basal dose using urea and a single super phosphate by drilling in furrows 30 cm wide at an average depth of 8-10 cm. 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. The plan of layout was followed in laying out of 4.0 m × 3.0 m plots with sprinkler irrigation. For a uniform plant population, thinning was done by manually 15 days after sowing, ensuring plant-to-plant distance at 10 cm. The number of plants per square meter row length was counted from five randomly selected places in each plot at 35 days after sowing and at harvest. The mean plant stand was calculated and expressed as plant stands per hectare. Five tagged plants per plot were measured at 35, 70 DAS and harvest; mean height recorded in cm. Dry matter was recorded by uprooting five plants per plot at 35, 70 DAS and harvest, oven-dried at 600°C to constant weight and expressed as g plant<sup>-1</sup>. Five plants were carefully plucked as random from each plot, without damaging the roots or nodules. After thorough washing in running water, the roots and nodules were dried in shades, and the dry weight of the nodules (mg) was taken. Harvested produce from each net plot was sun-dried, weighed using a spring balance and recorded as biological

yield (kg plot<sup>-1</sup>). The cost of cultivation for each treatment was subtracted from the gross returns worked out for the respective treatment to arrive at net returns for each treatment.

The experimental data recorded for growth, yield and other characters were statistically analyzed with the help of fisher's analysis of variance technique (Fisher, 1950). 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

### Effect of herbicides on crop growth parameters

Analysis revealed that all treatments had a significant effect on plant height and dry matter at 35, 70 DAS and harvest as compared to the weedy check (Table 1). Weed free treatment recorded highest plant height and dry matter production over rest of the treatments which was found statistically at par with pendimethalin + imazethapyr 800 g ha<sup>-1</sup> PE and pendimethalin 750 g ha<sup>-1</sup> PE. The minimum plant height was recorded under diclosulam 20 g ha<sup>-1</sup> PE which was at par with weedy check. This could be correlated to reduced crop weed competition in the early stages of crop growth, as well as an increase in crop nutrient intake which encouraged taller plants and increased leaf area of assimilation surface which contributed to crop dry matter pro-

duction. Similar results were reported by Barik *et al.*, (2024), Indra *et al.*, (2024).

In case of number of branches plant<sup>-1</sup> treatment pendimethalin + imazethapyr 800 g ha<sup>-1</sup> PE proved to be best. Absence of weeds might have resulted in increased crop nutrient and water absorption, as well as increased photosynthetic processes, led to increased cell division and elongation, resulting in more branches. Weedy check treatment resulted in a lesser number of branches per plant due to weed competition for resources. Consequently, decreased crop productivity in absorbing nutrients, water and carbohydrates, thereby affecting growth. Singh *et al.*, (2018) and Jaswal *et al.*, (2022) also reported similar results.

The dry weight of nodules plant<sup>-1</sup> at 50 DAS was recorded highest (29.02 mg) and lowest (21.21 mg) with weed free treatment and weedy check, respectively. Poor weed control resulted to increased crop-weed competition and stunted plant growth which in turn caused a decrease in dry matter of nodules. These results were supported by findings of Mishra *et al.*, (2017) and Sen *et al.*, (2023).

### Effect of herbicides on yield parameters

Data revealed that yield attributing characters like pods plant<sup>-1</sup> and seeds pod<sup>-1</sup> were significantly improved with the application of herbicides over weedy check and diclosulam 20 g ha<sup>-1</sup> PE. Weed free treatment recorded highest number of

**Table 1. Effect of weed control measures on growth parameters of green gram.**

Treatments	Plant height (cm)			Plant dry (g plant <sup>-1</sup> ) matter accumulation			Branches plant <sup>-1</sup>	Dry weight of nodules (mg plant <sup>-1</sup> )
	35 DAS	70 DAS	Harvest	35 DAS	70 DAS	Harvest		
Weedy check (control)	27.13	48.67	50.93	0.25	3.82	9.13	2.86	21.21
Weed free	33.00	59.08	61.30	0.42	6.43	16.23	4.27	29.02
Pendimethalin @ 750 g ha <sup>-1</sup> PE	31.54	58.30	59.31	0.38	6.07	16.13	4.14	27.23
Diclosulam @ 20 g ha <sup>-1</sup> PE	26.30	48.23	49.82	0.24	3.61	9.23	2.87	24.25
Flumioxazin @ 75 g ha <sup>-1</sup> PE	29.70	55.16	57.00	0.33	5.96	15.44	3.93	26.29
Pendimethalin + imazethapyr @800 g ha <sup>-1</sup> PE	32.36	58.59	60.33	0.39	6.17	16.18	4.21	28.03
Imazethapyr @ 50 g ha <sup>-1</sup> PE	28.48	53.21	54.36	0.30	5.47	14.69	3.54	25.47
Quizalofop + imazethapyr (7.5+15) 65 g ha <sup>-1</sup> PoE	28.96	53.57	54.67	0.31	5.90	14.79	3.76	25.43
Imazethapyr + imazamox (35+35) 50 g ha <sup>-1</sup> PoE	29.38	55.11	54.82	0.31	5.90	15.12	3.90	26.11
Sodium aceflurofen 16.5 + clodinafop 8 @240g ha <sup>-1</sup> POE	28.19	53.19	53.99	0.27	5.38	14.31	3.44	25.41
SEm±	1.15	0.88	0.97	0.05	0.24	0.53	0.23	0.97
CD at 0.05 %	3.41	2.62	2.87	NS	0.71	1.58	0.68	2.88

Pods and seeds  $\text{pod}^{-1}$  followed by pendimethalin + imazethapyr 800 g  $\text{ha}^{-1}$  PE and pendimethalin 750 g  $\text{ha}^{-1}$  PE. The number of pods per plant showed notable differences as a result of crop weed competition and treatment effects. The lowest number of pods found in weedy check due to presence of weeds. Similar results were reported by Jaswal *et al.*, (2022) and Vyvahare *et al.*, (2023).

All yield parameters like seed yield, straw yield and biological yield were reported highest in weed free treatment followed by pendimethalin + imazethapyr 800 g  $\text{ha}^{-1}$  PE and pendimethalin 750 g  $\text{ha}^{-1}$  PE. These treatments resulted in higher yields due to reduced weed dry matter, resulting in minimizing crop-weed competition and creating a favorable environment for crop development. Green gram seed yield may increase due to

improved plant growth, increased yield attributes and reduced crop-weed interference. Similar results were also reported by Virk *et al.*, (2018), Singh *et al.*, (2019), Udhaya *et al.*, (2021). It has been found that uncontrolled weed growth resulted in yield losses of up to 70% in green gram, indicating that a substantial amount of nutrients and other resources taken up by the weeds created a stress condition for the crop plant, affecting green gram growth and yield directly. This was supported by Gopakumar and Menon (2022).

### Effect on economics

All weed management practices had a higher net return than weedy check and diclosulam 20 g  $\text{ha}^{-1}$ . The maximum net return of (Rs. 54130) and benefit: cost ratio (3.01) was obtained with the

**Table 2. Effect of weed control measures on yield attributes and yield parameters in green gram**

Treatments	Pod $\text{plant}^{-1}$	Seed $\text{pod}^{-1}$	Test weight (g)	Seed yields ( $\text{kg ha}^{-1}$ )	Straw yields ( $\text{kg ha}^{-1}$ )	Biological yields ( $\text{kg ha}^{-1}$ )	Harvest index (%)
Weedy check (control)	20.6	7.5	34.85	610	1431	2041	29.87
Weed free	28.3	10.0	38.04	1180	2771	3717	31.75
Pendimethalin @ 750 g $\text{ha}^{-1}$	27.4	9.6	37.23	1125	2556	3548	31.70
Diclosulam @20 g $\text{ha}^{-1}$ PE	21.0	7.9	34.25	580	1258	1838	31.55
Flumioxazin @75g $\text{ha}^{-1}$ PE	26.1	9.1	36.29	986	2130	3117	31.65
Pendimethalin + imazethapyr @800 g $\text{ha}^{-1}$ PE	27.6	9.8	37.36	1140	2618	3592	31.75
Imazethapyr @ 50 g $\text{ha}^{-1}$ PE	24.6	8.2	35.47	805	1747	2552	31.55
Quizalofop + imazethapyr (7.5+15) 65 g $\text{ha}^{-1}$ PoE	25.3	8.5	35.43	810	1750	2560	31.64
Imazethapyr + imazamox (35+35) 50 g $\text{ha}^{-1}$ PoE	26.0	9.0	36.11	950	2052	3002	31.65
Sodium aceflurofen 16.5+ clodinafop 8% @ 240 g $\text{ha}^{-1}$ POE	23.3	8.1	35.41	755	1624	2379	31.70
SEm $\pm$	0.86	0.26	1.05	46	97.0	143	0.29
CD at 0.05 %	2.55	0.76	NS	138	288.0	424	0.87

**Table 3. Effect of weed control measures on economics.**

Treatments	Gross return ( $\text{₹ ha}^{-1}$ )	Net return ( $\text{₹ ha}^{-1}$ )	B:C Ratio
Weedy check (control)	43507	19907	2.00
Weed free	83857	55690	2.98
Pendimethalin @ 1.0 g $\text{ha}^{-1}$	79932	53044	2.97
Diclosulam @ 20 g $\text{ha}^{-1}$ PE	41211	15653	1.61
Flumioxazin @ 75 g $\text{ha}^{-1}$ PE	70109	44501	2.74
Pendimethalin + imazethapyr @ 800 g $\text{ha}^{-1}$ PE	81038	54130	3.01
Imazethapyr @ 50 g $\text{ha}^{-1}$ PE	57231	31923	2.26
Quizalofop + imazethapyr (7.5+15) 65 g $\text{ha}^{-1}$ PoE	57575	30767	2.15
Imazethapyr + imazemox (35+35) 50 g $\text{ha}^{-1}$ PoE	67526	41954	2.64
Sodium aceflurofen 16.5+ clodinafop 8% = @ 240 g $\text{ha}^{-1}$ POE	53678	27890	2.08
SEm $\pm$	3293	3669	-
CD at 0.05 %	9785	10901	-

application of pendimethalin + imazethapyr 800 g ha<sup>-1</sup> PE, followed by pendimethalin 750 g ha<sup>-1</sup> (Rs. 53044 ha<sup>-1</sup>) and (2.97). Higher net returns may be the result of this treatment higher seed yield. Similar results were correlate with findings of Sharma *et al.*, (2019) Patnaik *et al.*, (2022).

#### CONCLUSION

It can be concluded that weed free treatment recorded superior growth parameters, yield at-

tributes and seed yield which was closely followed by pendimethalin + imazethapyr (30+2) 800 g ha<sup>-1</sup> PE and pendimethalin 750 g ha<sup>-1</sup> PE but, better net returns and B:C ratio was observed under the treatments pendimethalin + imazethapyr (30+2) 800 g ha<sup>-1</sup> PE and pendimethalin 750 g ha<sup>-1</sup> PE. Hence, in places where there is shortage of labours and hand weeding is not possible we can suggest to farmers to adopt the above-mentioned herbicides for weed management.

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