Indian Journal of Weed Science (2025) **57**(4): 442–446
http://dx.doi.org/10.5958/0974-8164.2025.00076.7

RESEARCH ARTICLE

Evaluation of post-emergence herbicides to manage weeds in greengram of South-Eastern Rajasthan

Versha Gupta, Khajan Singh, S.L. Yadav, S.N. Meena, Rajesh Kumar, R.S. Narolia, Nupur Sharma and R.K. Meena

Received: 29 July 2025 | Revised: 11 November 2025 | Accepted: 13 November 2025

ABSTRACT

A field experiment was conducted during three consecutive *Kharif* seasons (2020, 2021 and 2022) at Agricultural Research Station, Kota, Rajasthan, India to identify most effective post-emergence herbicides to managing weeds and improve greengram productivity. The experiment was laid out in Randomized Block Design with three replications and eight treatments. The weed free recorded minimum weed density and biomass, higher weed control efficiency, maximum and significantly higher growth, yield attributes and yields followed by hand weeding twice. Amongst herbicides, post-emergence application (PoE) of fomesafen + fluazifop-p-butyl 220 g/ha recorded lower weed density and biomass, higher weed control efficiency, maximum and significantly higher greengram growth, yield attributes and yields being at par with propaquizafop + imazethapyr 33.3 g/ha + 50 g/ha PoE and sodium-acifluorfen + clodinafop-propargyl 140 g/ha + 70 g/ha PoE over rest of the treatments. Maximum and significantly higher net returns and B:C ratio were also recorded with propaquizafop 33.3 g/ha + imazethapyr 50 g/ha PoE which was at par with fomesafen + fluazifop-p-butyl 220 g/ha PoE and sodium-acifluorfen 140 g/ha + clodinafop-propargyl 70 g/ha PoE.

Keywords: Economics, Fomesafen + fluazifop-p-butyl, Greengram, Propaquizafop + imazethapyr, Sodium-acifluorfen + clodinafop-propargyl, Weed management

INTRODUCTION

Greengram (*Vigna radiata* L. Wilczek), is one of the most important and extensively cultivated pulse crops in arid and semi-arid regions of India. In India, during 2023-24, greengram was cultivated in an area of 51.9 lakhs hectares with 31.0 lakh tonnes production and 0.6 t/ha productivity, according to the Department of Economics and Statistics, Ministry of Agriculture & Farmers Welfare, Government of India. Rajasthan led in greengram cultivation during 2023-24 with an area of 23.64 lakhs hectares, production of 8.12 lakhs tonnes accounting for 45% of nationwide production. Greengram is a self-pollinated annual crop belongs to family Leguminosae. It is known for its nutritive value and digestibility, containing higher protein contents (28%), fat (1.3%), carbohydrate (60.4%) and reasonable number of vitamins and essential micronutrients (Akhtar *et al.* 2013). The calorific value of greengram is 334 cal/100g and chemically it contains mineral (3.5%), lysine (20.43%), methionine (0.10%), calcium 124 mg, phosphorus 3.26 mg and iron 7.3 mg. The greengram makes valuable green manures and can be used as cover crop. Apart from these, it also fixes atmospheric nitrogen of about 30-40 kg/ha as a leguminous crop and improves the soil fertility (Ghumare *et al.* 2014). Consumed in various forms such as 'dal', 'halwa' (a sweet dessert), boiled dry beans, sprouted and roasted, greengram is also a good source of riboflavin and vitamin C.

Weeds pose a serious threat to the productivity of greengram due to greater competition for nutrients, water, space and sunlight (Sahu *et al.* 2019). Weed management in greengram is a challenging factor, mainly in *Kharif* season due to unpredictability of rains, entailing to non-workable conditions of soil in rainy days and timely non-availability of labour (Leva *et al.* 2018). Weeds have competitive nature and withstand in adverse condition and weeds compete with greengram for water, nutrient, space and light causing severe yield losses, if not effectively managed during the critical period (Mishra *et al.* 2016, Bagariya *et al.* 2025). The weed infestation in greengram is severe during rainy season and as a result, the quantity and quality of the seed are reduced substantially (Shukla *et al.* 2025). Hand

Agricultural Research Station, Ummedganj, Agriculture University, Kota, Rajasthan 324001, India

* Corresponding author email: guptavershakota@gmail.com

weeding is a traditional and effective method but untimely rains, unavailability of labour at peak time and increasing labour cost are the main limitations (Gupta *et al.* 2019). Weeds can also be mechanically managed but due to continuous rainfall during the season makes the manual/mechanical weeding impracticable (Shweta and Singh 2005). Mechanical practices such as hand weeding and inter–culturing is effective but unavailability of labour and incessant rains during the early crop season normally limit the weeding operations. The conventional methods of weed control are time consuming, expensive and laborious. Therefore, herbicide usage under such circumstances becomes indispensable and was found to be a cost-effective alternative (Khairnar *et al.* 2014, Bajiya *et al.* 2025). Many weed species don't germinate at the planting time and have ungerminated reserve seeds in the soil which germinate in the staggered manner in standing greengram crop. So, pre-emergence herbicides might just not be able to provide substantial weed control and are unable to take care of weeds completely until critical period. Two hand weeding or intercultural operations are to be followed at some later stage which is a costly affair. In rainy season, very narrow time range available for planting huge acreage, sometimes compel the farmers to forego the use of pre-emergence herbicides and mannual/mechanical weeding in standing crop due to financial and manpower constraints and unpredictable conditions of rain. Herbicides with broad spectrum action will control all the type of weeds effectively (Bajiya *et al.* 2025). Pre-emergence herbicides like pendimethalin and post-emergence herbicides like imazethapyr, fluzifop-p-butyl, propaquizafop, sodium-aciflourfen and fomesafen, whether used individually or in ready mix formulations, were found effective in controlling weed emergence and growth during the initial stages of greengram in the *Kharif* season. Effective herbicide use can provide a weed-free environment during the critical early growth stages of greengram, ensuring optimal crop development and ultimately enhancing greengram productivity (Bhowmick and Gupta 2005). It is crucial to develop sustainable and economically viable solutions to combat weeds in greengram. Thus, the present study was undertaken to assess the performance of post-emergence herbicides for broad-spectrum weed management and identify effective and economic option to manage weeds in *Kharif* (rainy season) greengram.

MATERIALS AND METHODS

A field experiment was conducted during three consecutive *Kharif* seasons (2020, 2021 and 2022) at Agricultural Research Station, Kota, Rajasthan. The experiment consisted of eight treatments including: post-emergence application (PoE) of imazethapyr 55 g/ha at 20 days after seeding (DAS); fluazifop-p-butyl 250 g/ha PoE at 20 DAS; propaquizafop 2.5% + imazethapyr 3.75% ME (propaquizafop + imazethapyr) (ready-mix) 33.3 g/ha +50 g/ha PoE at 20 DAS; sodium-acifluorfen 16.5% EC 140 g/ha + clodinafop-propargyl 8% EC (sodium-acifluorfen + clodinafop-propargyl) (ready-mix) 140 g/ha + 70 g/ha PoE at 20 DAS; fomesafen + fluazifop-p-butyl (ready-mix) 220 g/ha PoE at 20 DAS; hand weeding twice at 20 and 40 DAS; weed free and weedy check. The experiment was laid out in Randomized Block Design with three replications.

The soil of the experimental field was clay loam, slightly alkaline, medium in available N and K and low in available P and S. Greengram variety: IPM 02-03 was used with a seed rate of 20 kg/ha and row spacing of 30 cm. Recommended dose of fertilizers (20 kg N + 40 kg P/ha) were applied at the time of sowing through Single super phosphate (SSP) and urea. Post-emergence herbicides were applied at 20 DAS by using 500 l/ha of water with knapsack sprayer fitted flat fan nozzle. Weed density was recorded by using 0.25 m^2 quadrat at all growth stages in all the treatments and then converted into number of weeds/ m^2. The data on total weeds density was subjected to square root transformation to normalize their distribution (Blackman and Roberts 1950). Weed control efficiency was calculated at 30, 60 DAS and at harvest in each treatment on the basis of weed dry matter (weed biomass) based on adopted formula by Umrani and Boi (1982).

$$\text{WCE (\%)} = \frac{\text{DMC} - \text{DMT}}{\text{DMC}} \times 100$$

Where:

WCE= Weed control efficiency,

DMC = Weed dry matter in weedy check plot

DMT = Weed dry matter in treated plot

Greengram growth parameters i.e. plant height, branches/plant and yield attributes i.e. pods/plant, seeds/pod, 100 seed weight was recorded at harvest. Net returns were calculated using current input and output prices during the crop season. The benefit-cost ratio was calculated by dividing from the cost of cultivation. The data was analysed using standard ANOVA for randomized block design and the significance of differences in treatment means was compared to critical differences at the 5% level of probability. To assess the relationshp and regression coefficients between grain yield (Y) and the independent variables (X) such as branches per plant, pods per plant, seeds per pod and 100 seed weight were worked out using the procedure given by Snedecor and Cochran (1968). The regression equations were also fitted and tested for significance.

RESULTS AND DISCUSSION

Effect on weeds

The weed flora in the experimental field consisted of *Echinochloa crus-galli*, *Echinochloa colonum* and *Cynodon dactylon* among grassy weeds and *Eclipta alba*, *Commelina benghalensis*, *Amaranthus viridis*, *Trianthema portulacastrum*, *Celosia argentic*, *Capsularis silaris*, *Phyllanthus niruri*, *Corchorus olitorius*, *Alternanthera Caracas ana* among the broad-leaved weeds, *Cyperus rotundus* and *Cyperus iria* among sedges. The grassy weeds are predominant (60%), followed by sedges (25%) and broad-leaved weeds (15%).

Weed density and weed biomass at 60 DAS and at harvest were higher than at 30 DAS. At all the stages of observation, weedy check recorded significantly higher weed density and biomass than any other treatment.

Among the herbicide treatments, fomesafen + fluazifop-p-butyl 220 g/ha (ready-mix) PoE, propaquizafop 33.3 g/ha + imazethapyr (ready-mix) 50 g/ha PoE and sodium-acifluorfen 140 g/ha + clodinafop-propargyl (ready-mix) 70 g/ha PoE recorded significantly lower weed density at 30, 60 DAS and at harvest and were statistically at par with each other with respect to weed density at all the stages (**Table 1**). Similarly, weed biomass was lowest at 30 DAS with fomesafen + fluazifop-p-butyl (ready-mix) 220 g/ha PoE, among the all-herbicidal treatments. At 60 DAS, lowest weed biomass was observed with fomesafen + fluazifop-p-butyl (ready-mix) 220 g/ha PoE followed by propaquizafop 33.3 g/ha + imazethapyr (ready-mix) 50 g/ha PoE which are statistically at par with each other. At greengram harvest, fomesafen + fluazifop-p-butyl (ready-mix) 220 g/ha PoE, propaquizafop 33.3 g/ha + imazethapyr 50 g/ha (ready-mix) PoE and sodium-acifluorfen 140 g/ha + clodinafop-propargyl 70 g/ha (ready-mix) PoE were at par with each other confirming the findings of Singh *et al.* (2014). These herbicides performed better than other herbicidal treatments as the predominant weed species are susceptible to these groups of herbicides.

Maximum weed control efficiency was observed at 30 DAS with weed free check followed by hand weeding twice at 20 and 40 DAS. Fomesafen + fluazifop-p-butyl (ready-mix) 220 g/ha PoE recorded significantly higher weed control efficiency at 30, 60 DAS and at harvest. Next best treatments were propaquizafop 33.3 g/ha + imazethapyr 50 g/ha (ready- mix) PoE and sodium-acifluorfen 140 g/ha + clodinafop-propargyl 70 g/ha (ready-mix) PoE. The variation in weed biomass under various treatments is directly related to the variation in weed control efficiency and the observed highest weed control efficiency was due to the higher reduction in weeds biomass at early stages of crop growth.

Table 1. Effect of weed management treatments on weed density and biomass in greengram (pooled data of 3 years)

Treatment	Weed density (no./m^2)			Weed biomass (g/m^2)			Weed control efficiency (%)		
	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest
Weedy check	15.18 (230.66)	18.51 (342.71)	14.23 (209.82)	10.19 (103.33)	11.95 (142.33)	9.75 (94.65)	0.00	0.00	0.00
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)	100.0	100.0	100.0
Hand weeding twice at 20 and 40 DAS	3.35 (11.00)	4.06 (16.18)	3.23 (10.00)	2.67 (6.62)	4.43 (19.16)	3.04 (8.75)	93.59	86.54	90.76
Imazethapyr 55 g/ha PoE	9.40 (88.24)	12.13 (147.35)	9.02 (83.12)	6.72 (44.63)	8.51 (71.86)	5.99 (35.44)	56.81	49.51	62.56
Fluazifop-P-butyl 250 g/ha PoE	9.03 (81.07)	9.81 (117.43)	9.15 (85.34)	6.39 (40.32)	7.90 (61.87)	5.95 (34.85)	60.98	56.53	63.18
Propaquizafop 33.3 g/ha + imazethapyr (ready- mix) 50 g/ha PoE	6.85 (46.52)	9.03 (64.26)	6.57 (42.04)	4.75 (22.11)	6.77 (45.32)	4.61 (20.74)	78.60	68.16	78.09
Sodium-acifluorfen 140 g/ha + clodinafop-propargyl (ready-mix) 70 g/ha PoE	6.88 (47.54)	8.57 (73.51)	6.20 (37.53)	5.01 (24.65)	7.02 (48.81)	4.87 (23.26)	76.14	65.70	75.43
Fomesafen + fluzifop-p-butyl (ready-mix) 220 g/ha PoE	6.24 (38.71)	7.62 (59.19)	6.09 (35.52)	4.17 (16.86)	6.53 (42.11)	4.47 (19.49)	83.68	70.41	79.41
LSD (p=0.05)	0.98	1.44	1.01	0.43	0.44	0.45			

**Square root transformed values. * Figures in parentheses are original values. PoE: post-emergence application; DAS: days after seeding

Effect on greengram growth, yield attributes and yield

The highest number of branches/plant, yield attributes, higher grain yield and straw yield were recorded under weed free followed by hand weeding twice at 20 and 40 DAS. Among the herbicides; fomesafen + fluazifop-p-butyl (ready-mix) 220 g/ha PoE recorded maximum and significantly higher branches/plant, yield attributes, higher grain yield and straw yield, which was at par with propaquizafop 33.3 g/ha + imazethapyr 50 g/ha (ready- mix) PoE and sodium-acifluorfen 140 g/ha + clodinafop-propargyl 70 g/ha (ready-mix) PoE. The plant height remained similar among the treatments (**Table 2**) due to better control of all categories of weeds by these treatments that resulted in lower nutrient depletion and lesser weeds biomass and thereby increasing the nutrient uptake of crop growth and yield attributes and yield of greengram confirming the earlier findings of Naidu *et al.* (2011).

The adequate availability of light, space as well as better edaphic and nutritional environment along with improvement in physiological and morphological characters of the plant in rhizosphere led to greater photosynthetic rate, thereby more accumulation of dry matter under better treatments. Contrary to this, unrestricted weed growth throughout the crop season in weedy check plots arrested the crop

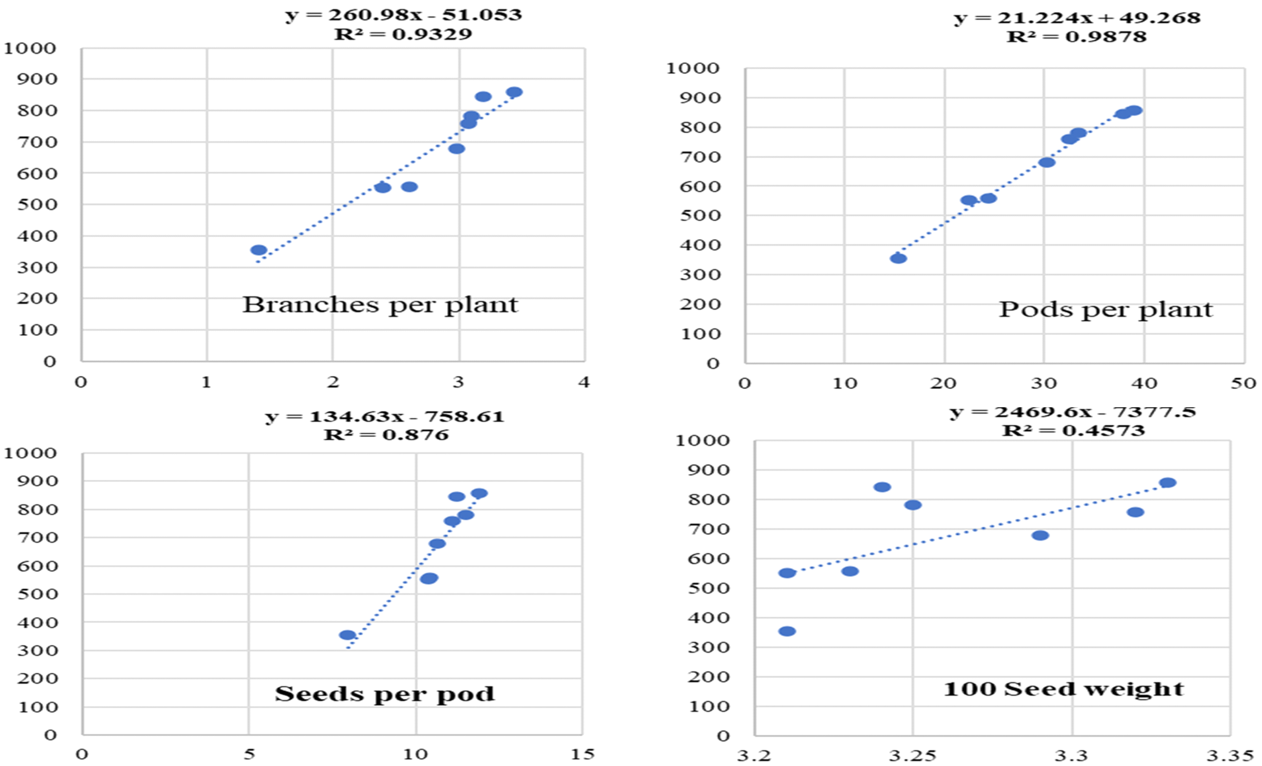

Figure 1. Relationship between branches per plant, pods per plant, seeds per pod and 100 seed weight (X) and greengram grain yield (Y)

Table 2. Effect of weed management treatments on growth, yield and economics of greengram (pooled data of 3 years)

Treatment	Plant height (cm) at harvest	Branches/ plant (no.)	Pods/ plant (no.)	Seeds/ pod (no.)	100 seed weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Net returns (₹/ha)	B:C ratio
Weedy check	53.44	1.41	15.30	7.95	3.21	356	531	5353	1.25
Weed free	56.49	3.44	38.93	11.88	3.33	858	1247	29541	1.87
Hand weeding twice at 20 and 40 DAS	53.80	3.19	37.92	11.23	3.24	844	1160	28505	1.84
Imazethapyr 55 g/ha PoE	53.82	2.40	22.47	10.38	3.21	553	821	17032	1.72
Fluazifop-P-butyl 250 g/ha	54.29	2.61	24.41	10.43	3.23	558	762	15818	1.62
Propaquizafop 33.3 g/ha + imazethapyr (ready-mix) 50 g/ha PoE	53.08	3.08	32.55	11.10	3.32	758	1011	32257	2.36
Sodium-acifluorfen 140 g/ha + clodinafop-propargyl (ready-mix) 70 g/ha PoE	54.32	2.98	30.28	10.63	3.29	679	1010	26562	2.13
Fomesafen + fluzifop-p-butyl (ready-mix) 220 g/ha PoE	53.33	3.10	33.43	11.50	3.25	782	1112	32572	2.28
LSD (p=0.05)	NS	0.36	3.70	1.51	NS	103	164	6873	0.27

PoE: post-emergence application; DAS: days after seeding growth due to high degree of crop-weed competition confirming the findings of Yadav *et al*. (2022) and Shilurenla *et al*. (2022).

Economics

Maximum and significantly higher net returns (Rs. 32572/ha) were recorded with fomesafen + fluazifop-p-butyl 220 g/ha PoE which was at par with propaquizafop 33.3 g/ha + imazethapyr 50 g/ha PoE and sodium-acifluorfen 140 g/ha + clodinafop-propargyl 70 g/ha PoE over rest of treatments. The B:C ratio was significantly higher with propaquizafop 33.3 g/ha + imazethapyr 50 g/ha PoE followed by fomesafen + fluazifop-p-butyl 220 g/ha PoE and sodium-acifluorfen 140 g/ha + clodinafop-propargyl 70 g/ha PoE (**Table 2**). These results are in conformity with those reported by Susmita *et al*. (2017). The higher B:C ratio achieved under superior treatments might be due to higher seed and straw yield and higher returns per rupees investment than poor yielding treatments. **.**

Regression studies

The regression coefficients (b) and regression equations were worked out to quantify the amount of change in grain yield of greengram for a unit change in growth and yield attributes of crop. It was observed that every unit increase in branches per plant, pods per plant, seeds per pod and 100 seed weight increased the grain yield of greengram by 260.98, 21.22, 134.63, and 2469.6 kg/ha, respectively in pooled analysis (**Figure 1**).

Conclusion

It may be concluded that effective and economic management of weeds with higher greengram yield and higher economic returns (benefit cost ratio) can be achieved with propaquizafop 33.3 g/ha + imazethapyr (ready-mix) 50 g/ha PoE or fomesafen + fluazifop-p-butyl (ready-mix) 220 g/ha PoE or sodium-acifluorfen 140 g/ha + clodinafop-propargyl 70 g/ha PoE at 20 DAS.

REFERENCES

Akhtar MJ, Ahmad I, Asghar HN and Khalid M. 2013. Influence of *rhizobium* applied in combination with micronutrients on greengram. *Pakistan Journal of Life and Social Science* **11**(1): 53–59.

Bagariya SS, Shivran H, Sharma OP, Dadarwal LK, Dhayal LS and Sharma V. 2025. Response of greengram (*Vigna radiata* L.) to weed control practices in Rajasthan. *International Journal of Advanced Biochemistry Research* SP-9(9): 443–445.

Bajiya R, Lakhran H, Danga N, Mundiyara R and Sutaliya R. 2025. Efficacy of different post-emergence herbicides against complex weed flora in greengram. *Indian Journal of Weed Science* **57**(1): 62–66.

Bhowmick MK and Gupta S. 2005. Herbicidal-cum-integrated approach to weed management in greengram. *Journal of Crop and Weed* **1**(2): 75–77.

Blackman GE and Roberts HA 1950. Studies on selective weed control. *Journal of Agricultural Sciences* **40**: 62–69.

Ghumare V, Rana M, Gavkare O and Khachi B. 2014. Bio-fertilizers-increasing soil fertility and crop productivity. *Journal of Industrial Pollution Control* **30**(2): 196–201.

Gupta V, Sharma S, Sasode DP, Joshi E, Kasana BS and Joshi N. 2019. Efficacy of herbicides on weeds and yield of greengram. *Indian Journal of Weed Science* **51**(3): 262–265.

Khairnar CB, Goud VV and Sethi HN. 2014. Pre- and post-emergence herbicides for weed management in greengram. *Indian Journal of Weed Science* **46**(4): 392–395.

Leva RL, Vaghasiya HY and Patel RV. 2018. Combined effect of herbicides and cultural methods of weed control on growth and yield of summer greengram [*Vigna radiata* (L.) Wilczek] under south Gujarat condition. *International Journal of Chemical Studies* **6**(4): 2348–2352.

Mishra JS, Rao AN, Singh VP. and Rakesh Kumar. 2016. Weed management in major field crops. Chapter 9. Pages 1-20 in: Advances in Weed Management (Eds. N.T. Yaduraju *et al*.). Indian Society of Weed Science, Jabalpur, M.P., India

Naidu KRK, Ramana AV, Veeraraghavaiah R and Ashoka Rani Y. 2011. Effect of pre and post emergence herbicides on the control of *Vicia sativa* in rice-fallow blackgram [*Vigna mungo* (L.) Hepper]. *The Andhra Agriculture Journal* **58**(1): 5–8.

Sahu R, Sharda K and Mandal SK 2019. Sowing date and weed management effects on weeds, nutrient uptake and productivity of summer greengram. *Indian Journal of Weed Science* **51**(3): 302–305.

Shilurenla ND, Singh AP and Yadav R 2022. Effect of integrated weed management on summer greengram (*Vigna radiata*). *The Pharma Innovation Journal* **11**(8): 1550–1552.

Shukla K, Dhankar A, Sharma S, Karki P, Thakur P, Abha, Sharma S, Thakur P and Diksha 2025. Bio-efficacy of pre-and post-emergence herbicides on weed dynamics, crop growth and yield in summer moong bean. *International Journal of Advanced Biochemistry Research* SP-9(10): 2133–2138.

Shweta and Singh VK 2005. Integrated weed management in greengram during Kharif season. *Indian Journal of Weed Science* **37**(1&2): 121–122.

Singh G, Aggarwal N and Ram H 2014. Efficacy of post-emergence herbicide imazethapyr for weed management in different greengram (*Vigna radiata*) cultivars. *Indian Journal of Agricultural Sciences* **84**(4): 540–543.

Snedecor GW and Cochran WG 1968. Statistical Methods, Oxford and IBH Publication Company, New Delhi.

Umrani NK and Boi PG 1982. Studies on weed control in bajra under dryland condition. *Journal of Maharashtra Agricultural University* **7**(2):145–147.

Yadav SL, Singh P, Yadav RK, Dhaked U, Yadav GN, Meena SN and Yadav DL 2022. Effective weed management for profitable Greengram [*Vigna radiata* (L.) Hepper] production in the rainy season in South Eastern Rajasthan. *The Pharma Innovation Journal* **11**(9): 1014–1017.