Environment and Ecology 40 (4A): 2183—2187, October—December 2022
ISSN 0970-0420

Effect of Pre and Post-Emergence Herbicide Applications on Growth, Yield and Economics of Black Gram (*Vigna mungo* L.) and Reduction in Weed Growth

Kurukunda Suresh Reddy, Dinesh Baboo Tyagi, Jai Dev Sharma, S. Prem Kumar, M. Sai Teja

Received 13 July 2022, Accepted 10 August 2022, Published on 4 November 2022

ABSTRACT

A field study was conducted during the kharif season of 2021-2022 in sandy loam soil at the Crop Research Center, School of Agriculture, ITM University, Gwalior (MP) to find out the impact of pre and post-emergence herbicide applications on black gram growth, yield and economics (*Vigna mungo* L.) and reduction in weed growth. The experiment consisted of twelve treatments with both pre and post-emergence application of herbicides, along with the weed-free and weedy check. Among the herbicide treatments lowest weed density, weed dry weight, and highest weed control efficiency, grain and straw yields, net returns and B:C ratio were recorded with the early post-emergence (EPOE) application of 294 g ha^{-1} of the ready mixture of Sodium acifluorfen 16% + Clodinafop propargyl 8% EC and remained at par with the EPOE application of Imazethapyr 35%+Imazamox 35% EC (ready mixture) at 70g ha^{-1} followed by pre-emergence (PE) application of Imazethapyr 2% + Pendimethalin 30% EC (ready mixture) at 870.4 g ha^{-1}. Sodium acifluorfen 16% + Clodinafop propargyl 8% EC (ready mixture) at 294 g ha^{-1} proved to be effective against weeds and led to high yield, and net return in black gram.

Keywords Black gram, Grain yield, Net return, Weed dry weight, Weed density.

INTRODUCTION

In India, one of the most significant pulse crops is the black gram (*Vigna mungo* L.). This crop also occupies a unique position as the main crop, green manuring crop, cover crop, catch crop and inter-crop. From 4.6 million hectares of land, it generates roughly 24.5 lakh tonnes of black gram yearly, with an average yield of 533 kg per hectare. Approximately 10% of India's total pulse production is the black gram. In terms of area, the three states that cultivate the most black gram in India are Madhya Pradesh, Uttar Pradesh, and Andhra Pradesh. The state of Bihar had the greatest yield (898 kg/ha), which was followed by the states of Sikkim (895 kg/ha) and Jharkhand (890 kg/ha). The national yield average is 585 kg/ha (Vikaspedia 2022). With a yield of 8.85 lakh tonnes and productivity of 975 kg/ha, black gram is farmed in Madhya Pradesh on an area of 17.52 lakh hectares. In the

Kurukunda Suresh Reddy, Dinesh Baboo Tyagi*[1], Jai Dev Sharma[2], S. Prem Kumar,, M Sai Teja
[1]Associate Professor, [2]Professor, School of Agriculture, ITM University Gwalior, MP 475001, India
Email : dineshtyagi.soag@itmuniversity.ac.in
*Corresponding author

Table 1. Effect of different weed control treatments on weed density (no. m^{-2}) and weed dry matter (g m^{-2}) and WCE (%) at 60 DAS. Note : Fig. in parenthesis are the original values, X = $\sqrt{(x+0.5)}$ transformation.

Treatments	Weed density of total weeds (no. m^{-2})	Weed dry weight (g m^{-2})	WCE (%)
T_1	10.97 (120)	10.11 (102)	57.2
T_2	10.66 (114)	9.48 (89.3)	62.4
T_3	8.00 (63.4)	6.03 (35.9)	84.9
T_4	11.24 (126)	9.86 (96.8)	59.3
T_5	11.56 (133)	10.95 (120)	49.8
T_6	11.82 (139)	11.21 (125)	47.3
T_7	10.89 (118)	9.12 (82.6)	65.3
T_8	10.11 (102)	8.99 (80.3)	66.2
T_9	11.66 (136)	11.04 (122)	48.9
T_{10}	10.08 (101)	6.49 (41.6)	82.5
T_{11}	14.04 (197)	15.44 (238)	0.00
T_{12}	8.71 (75.4)	6.87 (46.7)	80.4
SEm±	0.71	0.46	-
CD at 5%	2.08	1.35	-

Gwalior district, black gram occupies an area of 5.07 thousand hectares with production and productivity of 1.54 thousand tonnes and 303 kg ha^{-1}, respectively (Anonymous 2020). The yield of black gram is very low in Madhya Pradesh with special reference to the Gwalior region, which may be due to many factors such as being grown in rainfed areas, low fertile and marginal lands, non-availability of quality seeds as well as severe problems of weed invasion. With the plentiful rainfall received during the monsoon season, black gram is frequently accompanied by luxuriant weed growth during the *kharif* season, resulting in significant crop losses. Due to the slow growth rate of black gram in the initial stage, weeds compete with the crop very severely (Choudhary *et al.* 2012) ; hence the loss of seed yield of black gram reported ranges from 50–87% (Sukumar *et al.* 2018). The critical period of crop-weed competition has been reported in the range of 15 to 45 DAS (Khot *et al.* 2016). Weed control is very much vital during the critical period of crop-weed competition to avoid substantial yield losses. Without a doubt, manual weed management methods are effective, but they are tiresome, time-consuming and costly. Furthermore, labor is frequently unavailable during the critical weed-removal period. Furthermore, moist field conditions on account of the frequent rains in the *kharif* season do not allow the timely practice of manual weeding and intercultural operations. In such a situation, herbicides are the most appropriate, practical, effective and cost-efficient way to reduce early weed competition in the crops grown during the rainy season. Considering the above facts in view, the present study was undertaken to find out the effective and economic weed control in black gram by applying the new generation herbicides.

Table 2. Effect of treatments on yield attributes, yield and economics of black gram.

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	No. of pods per plant	Grains per pod	Test weight (g)	Net returns (INR ha^{-1})	B-C ratio (INR re^{-1} invested)
T_1	879	2436	24.7	6.89	36.9	68510	1.93
T_2	969	2520	28.7	7.25	37.3	76776	2.14
T_3	1105	2834	32.2	8.10	38.1	91687	2.53
T_4	943	2490	28.1	7.05	37.2	73128	1.98
T_5	781	2342	26.5	6.75	36.8	59621	1.71
T_6	610	2080	20.1	5.15	36.4	40981	1.14
T_7	972	2590	29.0	7.45	37.4	75917	2.01
T_8	998	2624	29.3	7.65	37.5	80361	2.23
T_9	772	2295	25.4	6.54	36.6	57380	1.60
T_{10}	1035	2735	31.6	7.96	37.8	85096	2.38
T_{11}	425	1510	18.1	4.95	35.0	20408	0.60
T_{12}	1027	2654	31.1	7.85	37.6	76255	1.78
SEm±	44.52	119.91	1.30	0.39	1.80	-	-
CD at 5%	130.57	351.70	3.81	1.16	NS	-	-

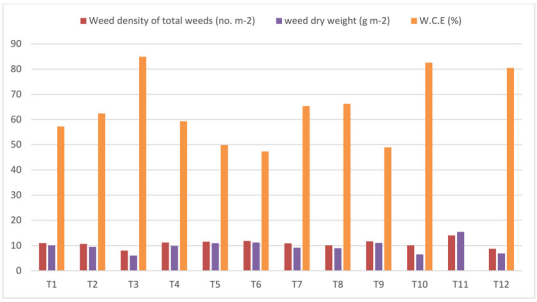

Fig. 1. Effect of various herbicide treatments on density and dry weight of weeds, and weed control efficiency at 60 DAS.

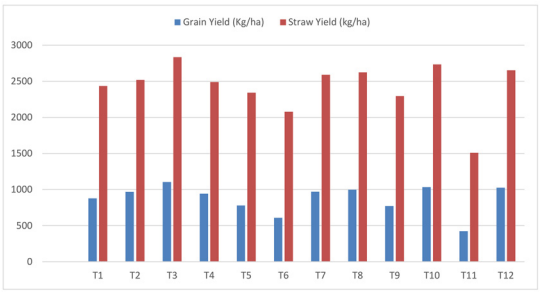

Fig. 2. Effect of various herbicide treatments on grain and straw yield (kg ha^{-1}) of black gram.

MATERIALS AND METHODS

The field trial was conducted at the crop research center, School of Agriculture, ITM University, Gwalior, MP, during the *kharif* season of 2021. Twelve treatments were included in the Randomized Block Design experiment, which were replicated thrice. The treatments were, T_1 : Sodium acifluorfen 16.5% EC + Clodinafop propargyl 8% EC (RM) (195.9 g $ha^{-1)}$ EPOE T_2 : Sodium acifluorfen 16.5% EC + Clodinafop propargyl 8% EC (RM) (244.8 g ha^{-1}) EPOE, T_3 : Sodium acifluorfen 16.5% EC + Clodinafop propargyl 8% EC (RM) (294 g ha^{-1}) EPOE, T_4 : Imazethapyr 10% EC + Quizalofop-b-ethyl 5% EC (70+50 g ha^{-1}) EPOE, T_5: Imazethapyr 10% EC (70 g ha^{-1}) EPOE, T_6: Quizalofop-b-ethyl 5% EC (50 g ha^{-1}) EPOE, T_7 : Pendimethalin 30% EC (100 g ha^{-1}) (PRE) fb Quizalofop-b-ethyl 5% EC (50 g ha^{-1}) (EPOE), T_8 : Imazethapyr 2% EC + Pendimethalin 30% EC (RM) (870.4 g ha^{-1}) PRE, T_9 : Pendimethalin 30% EC (1000 g ha^{-1}) PRE, T_{10} : Imazethapyr 35% EC + Imazamox 35% EC (RM) (70 g ha^{-1}) EPOE, T_{11} : Weedy Check, T_{12} : Two hand weedings at 20 and 40 DAS. Black gram variety "Vikral Plus" was used for the experiment and sown in August 2021, keeping 30 cm × 10 cm spacing. Pre-emergence herbicides were applied on the second day of sowing and post-emergence herbicides were on the 21st day of crop sowing using a knapsack sprayer with a flat-fan nozzle and a 500 L/ha spray volume. A common dose of 20 kg N, 60 kg P_2O_5 and 25 kg K_2O per hectare was applied as the basal dose of nutrients at the time of crop sowing. At 60 DAS, observations were made about the flora, density (no. m^{-2}), dry weight (g m^{-2}) of weeds, number of pods per plant, number of grains per pod, grain, and straw yield. Weed flora was categorized into broad-leaved, grasses, and sedges. Weed dry weight was assessed after two days of sun-drying and 48 hrs of oven drying at 70 ± 1°C. Category-wise weed density was initially evaluated by counting. Using a common equation, weed control efficiency (WCE) was calculated.

By deducting the particular treatment's cultivation costs from the gross return, the net return was computed. After dividing the net return by the cost of cultivation, the benefit-cost ratio was computed. The crop was harvested on 15th November 2021. Analysis of variance (ANOVA) methods for Randomized Block Designs were used to analyze statistical data on crops and weeds (Gomez and Gomez 1984). The square root transformed data $X= \sqrt{x} + 0.5$ on weed density and dry matter were used in an ANOVA.

RESULTS AND DISCUSSION

The experimental field was infested with grassy, broadleaf weeds and sedges (Table 1). The important weed species at 60 days stage were *Echinochloa crus-galli* (17.41%), *Commelina benghalensis* (7.23%), *Digera arvensis* (8.36%), *Dactyloctenium aegyptium* (7.80%), *Cyperus rotundus* (46.79%) and other weeds (12.37%). Other weeds (12.37%) include *Cynodon dactylon, Euphorbia hirta, Trianthema postulacastrum* and *Amaranthus viridis*. However, in Table 1 and Fig. 1, data on density and dry weight of total weeds and WCE recorded at 60 days stage of crop growth have been given. The occurrence of the above weeds differs significantly at varying popula-

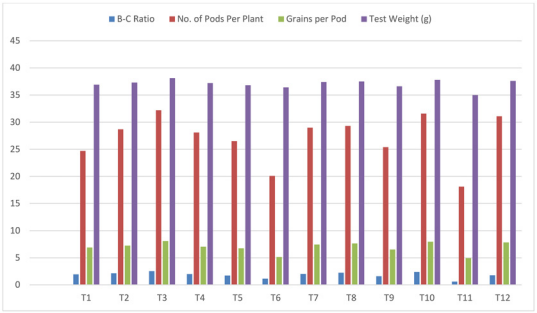

Fig. 3. Effect of various herbicide treatments on number of pods per plant, number of grains per pod, test weight (g) and B-C ratio (Rs re-1 invested).

tions under different treatments at various stages of observations recorded. The weed control efficiency (WCE) measured how effectively weed populations were reduced and how well weed control methods outperformed weedy checks. This was significantly impacted by various weed management methods. Among the several weed control methods, the highest WCE was recorded with T_3 : Sodium acifluorfen 16.5% + Clodinafop propargyl 8%EC (RM) at 294 g ha^{-1} applied at 3-4 leaf stage of weeds found more effective followed by T_{10} : EPOE application of Imazethapyr 35% EC + Imazamox 35% EC (RM) (70 g ha^{-1}) and T_8 : PE application of Imazethapyr 2% EC + Pendimethalin 30% EC (RM) (870.4 g ha^{-1}). The lowest WCE was recorded in the weedy check treatment. Similar results were also reported by (Caverzan *et al.* 2019). This might be due to the broad-spectrum activity of this post-emergence herbicide (T_3 : Sodium acifluorfen 16.5% + Clodinafop propargyl 8% EC (RM) at 294 g ha^{-1}) on different weed species and their greater efficiency to retard cell division of meristems as a result of which weeds died rapidly (Kalpana *et al.* 2004). The herbicides included in this ready mixture declined the total weed biomass at harvest, and the dense crop canopy may have restricted weed development, as seen by plant height and a larger number of branches per plant, which did not permit weeds to grow strongly owing to the smothering effect. Ultimately, the black gram crop grew quickly. Irrespective of Weed-free treatment (two hand weedings at 20 and 40 DAS), significantly lower weed density (no. m^{-2}) and weed biomass (g m^{-2}) at 60 DAS were recorded with the application of T_3 : Sodium acifluorfen 16.5% EC + Clodinafop propargyl 8% EC (RM) at 294 g ha^{-1} as EPOE applied at 3-4 leaf stage was found more effective and it was at par with the T_{10} : EPOE application of Imazethapyr 35 % EC + Imazamox 35% EC (RM) at 70 g ha^{-1} and then followed by T_8: PE application of Imazethapyr 2% EC + Pendimethalin 30 % EC (RM) at 870.4 g ha^{-1} as compared to the rest of the treatments. Significantly higher density and dry matter of weeds were recorded in the weedy check treatment. The present results confirmed the findings of Verma and Choudhary (2020). The yield characteristics, yield and economics of the black gram were significantly and favorably influenced by various weed control techniques (Table 2 and Figs. 2–3). A significantly higher number of pods, grains per pod, seed yield (1105.10 kg ha^{-1}) and straw yield (2834 kg ha^{-1}) were recorded in T_3 : EPOE application of Sodium acifluorfen 16.5% + Clodinafop propargyl 8% EC at 294 g ha^{-1} at 3-4 leaf stage followed by T_{10} : EPOE application of Imazethapyr 35%EC + Imazamox 35% EC (RM) (70 g ha^{-1}) and then followed by T_8– PE application of Imazethapyr 2% EC + Pendimethalin 30% EC (RM) (870.4 g ha^{-1}). A significantly lower yield was recorded with the T_{11} : Weedy check (425.20 kg ha^{-1}) due to heavy weed infestation. The results are analogous to those reported by (Harithavardhini *et al.* 2016).

Among all the herbicide treatments highest net return was recorded with the T_3 : EPOE application of Sodium acifluorfen 16.5% + Clodinafop propargyl 8% EC (RM) at 294 g ha^{-1} at 3-4 leaf stage (Rs 91687.61 ha^{-1}) followed by T_{10} : EPOE application of Imazethapyr 35% EC + Imazamox 35% EC (RM) (70 g ha^{-1}) (INR 85096.61 ha^{-1}) and T_8 : PE application of Imazethapyr 2% EC + Pendimethalin 30% EC (RM) (870.4 g ha^{-1}) (INR 80361.11 ha^{-1}). The lowest net return was recorded in the T_{11} : Weedy check (Rs 20408.11 ha^{-1}). The highest benefit-cost ratio was recorded in the T_3 : EPOE application of Sodium acifluorfen 16.5% + Clodinafop propargyl 8% EC at 294 g ha^{-1} at 3-4 leaf stage (INR 2.53) followed by T_{10} : EPOE application of Imazethapyr 35% EC + Imazamox 35% EC (70 g ha^{-1}) (INR 2.38) and then followed by T_8 : PE application of Imazethapyr 2% EC + Pendimethalin 30% EC (RM) (870.4 g ha^{-1}) (INR. 2.23 per rupee invested).

CONCLUSION

Thus, it can be concluded that the Sodium acifluorfen 16.5% + Clodinafop propargyl 8% EC (RM) at 294 g ha-1 applied at the 3-4 leaf stage of weeds resulted in higher seed yield and monetary returns and proved superior in respect of decreasing the density and dry weight of weeds over rest of the other treatments. It may be regarded as a suitable alternative for black gram's greater B-C ratio and broad-spectrum weed suppression.

ACKNOWLEDGEMENT

I express my indebtedness and deepest sense of gratitude to the School of Agriculture, ITM University Gwalior, Madhya Pradesh for giving me the opportunity and providing all necessary facilities to complete this research work.

REFERENCES

Anonymous (2020) Directorate of Economics and Statistics. Department of Agriculture and Co-operation, GOI, New Delhi.

Caverzan A, Piasecki CG, Chavarria CN, Stewart LV (2019) Defences against ROS in crops and weeds : The effects of interference and herbicides. *Int J Mol Sci* 20 : 1086.

Choudhary VK, Kumar PS, Bhagawati R (2012) Integrated weed management in black gram (*Vigna mungo*) under mid hills of Arunachal Pradesh. *Ind J Agron* 57 (4) : 382—385.

Gomez KA, Gomez AA (1984) Statistical Procedures for Agricultural Research. John Wiley and Sons.

Harithavardhini J, Jayalalitha K, Ashoka Rani Y, Krishnaveni B (2016) Efficacy of post-emergence herbicides on weed control efficiency, partitioning of dry matter and yield of black gram (*Vigna mungo* (L.) Hepper). *Int J Food, Agricult Veter Sci* 6 (2) : 39—44.

Kalpana R, Velayutham A (2004) Effect of herbicides on weed control and yield of soybean. *Ind J Weed Sci* 36 (1 and 2) : 138—140.

Khot AB, Sagvekar VV, Muthal YC, Panchal VV, Dhonde MB (2016) Effect on summer black gram (*Phaseolus mungo* L.) to different sowing time and weed management practices with respect to yield, quality and nutrient uptake. *Int J Trop Agricult* 34 (7) : 2155—2161.

Sukumar J, Pazhanivelan S, Kunjammal P (2018) Effect of pre-emergence and post-emergence herbicides on weed control in irrigated black gram. *J Pharmacog Phytochem* 1 : 3206—3209.

Verma A, Choudhary R (2020) Effect of weed management practices on weed growth and yield of green gram (*Vigna radiata* (L.) Wilczek) in Southern Rajasthan. *Int Res J Pure Appl Chem* 21 (20) : 12—19.

Vikaspedia (2022) Black gram. Retrieved from https://vikaspedia.in/agriculture/crop-production/package-of-practices/pulses/black gram-and-greengram.