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RESEARCH

EFFECT OF WEED CONTROL PRACTICES ON GROWTH AND YIELD OF BLACK GRAM(*VIGNA MUNGO* L.)

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Abstract: The investigation was undertaken at the Instructional Cum Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.) during the *kharif* season of 2023. The experiment was conducted using a randomized block design (RBD) with ten different treatments, each replicated three times. The treatments consisted of ten weed management practices *viz*., control (T_1), weed free (T_2), metribuzin (70 WP) 440 g ha^{-1} as pre-emergence (T_3), pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence (T_4), T_3 + hand weeding at 20 DAS (T_5), T_4 + hand weeding at 20 DAS (T_6), imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_7), T_3 + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_8), T_4 + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_9) and two hand weedings at 20 and 40 DAS (T_{10}). The black gram variety Mash 338 was grown as test crop on July 22, 2023 and harvesting was done on October 28, 2023. The results of the experiment indicated that the seed yield, stover yield and harvest index were maximum under weed free (T_2), followed by T_4 + hand weeding at 20 DAS (T_6) and T_3 + hand weeding at 20 DAS (T_5). T_4 + hand weeding at 20 DAS (T_6) and T_3 + hand weeding at 20 DAS (T_5) were most appropriate for reducing weed density and gave highest weed control efficiency. On July 22, 2023, the black gram variety Mash 338 was planted as a test crop and on October 28, 2023, it was harvested. According to the experiment's findings, weed free (T_2) had the highest seed yield, stover yield and harvest index. T_4 + hand weeding at 20 DAS (T_6) and T_3 + hand weeding at 20 DAS (T_5) were the next best treatments. The best treatments for lowering weed density and providing the highest weed control efficacy were T_4 + hand weeding at 20 DAS (T_6) and T_3 + hand weeding at 20 DAS (T_5). According to an economic analysis, treatment weed free (T_2) had the best net return (66350.50 ₹ ha^{-1}), which was followed by T_4 + hand weeding at 20 DAS (T_6) and T_3 + hand weeding at 20 DAS (T_5). In contrast, the B:C ratio reached its maximum with T_4 + hand weeding at 20 DAS (T_6) and T_3 + hand weeding at 20 DAS (T_5).

Keywords: Black gram, Imazethapyr, Pendimethalin, Metribuzin, Economics, Yield

INTRODUCTION

Black gram is cultivated all over the world for grains, green manuring, fodder and forage as a lone crop, intercrop, mixed crop and sequential cropping systems. It is primarily planted in tropical and subtropical regions. Legume grain scarcity could be lessened by boosting yield in addition to reducing grain losses from weeds, both in terms of quantity and quality, by controlling them. The world's top producer and consumer of pulses is India. Pulses account for 22 per cent of global production and 33 per cent of the area in India, making them an almost indispensable part of the vegetarian diet. Currently, 28.78 million hectares are planted with pulses, with a production of 25.46 million tonnes (Anonymous, 2021). After grains, pulses constitute one of the most significant sectors of Indian agriculture.

Weed is one of the main production elements that affects black gram yield. When it comes to resources like light, space, moisture and nutrients, weeds are compete. High temperatures and frequent rains during the growth season cause weeds to significantly infest the crop, which has a negative impact on crop yield. For crop-weed competition, the first 20-40 days are crucial. Many types of weeds are infesting black gram. Among the grassy weeds are *Digera arvensis*, *Setaria glauca*, *Elusine indica* and *Echinochloa* spp., broad leaved weeds, *Parthenium hysterophorus*, *Phyllanthus niruri*, *Amaranthus viridis*, *Celosia argentea*, *Cleome viscosa*, *Trianthema portulacastrum* and *Cyperus rotundus* and *Cyperus difformis* are the most common sedge weeds. Black gram's initial slow growth provides weeds with plenty of time to suffocate the crop. During the first 45 days, cultural and mechanical weed control approaches are not always successful. The situation is made worse by regular rainfall and the damp soil. Weeds can reduce grain yield by 27 to 90%, depending on their type, density and duration of occurrence (Pankaj *et al*. 2020). Weeding by hand and machine requires a lot of work and is tiresome. Labours are frequently unavailable when weeding needs are at their highest. Even if they are, their options are further restricted by the rising cost of labour. The cultural methods of controlling weeds,

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such as using a stale seed bed technique, reducing tillage, soil solarizing and adopting an appropriate crop rotation, are long-term planning strategies. When used properly with the right herbicide at the right dose and application, the chemical approach of weed control can reduce infestations of weeds for extended periods of time while also being reasonably priced (Sasikala *et al*. 2014).

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season 2023 at the Instructional Cum Research Farm, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur (C.G.). The crop was sowed at a depth of 30 cm, utilising 20 kg of seed ha^{-1} and fertilised with the necessary ratio of nutrients (20:60:40 kg ha^{-1}). Black gram seeds were treated with bavistin and rhizobium culture prior to sowing. To guarantee even germination, the crop was irrigated as soon as it was sown. The following day after seeding, pre-emergence herbicides were sprayed into the soil and post-emergence spraying was carried out at 20 DAS. Using a knapsack sprayer with a flat fan nozzle and 500 litres of water ha^{-1}, all herbicides were administered to the crop. Hand weeding was carried out in accordance with the treatment plan. Two hand weedings at 20 and 40 DAS were administered as part of the manual weeding practice. During the crop growing phase, the cultural methods advised for black gram were implemented. The Gomez and Gomez method was used to perform the statistical analysis. Critical difference (CD) at the 5% probability level was calculated for comparison whenever statistical significance was noted.

RESULTS AND DISCUSSION

Effect on crop

The treatment with weed free (T_2) followed by pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6) was found to have the highest plant height, number of leaves, number of primary and secondary branches, leaf area index and dry matter accumulation at 20 DAS, significantly more than any other treatment, with the exception of treatment with two hand weedings at 20 and 40 DAS (T_{10}), imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_7) and control plot (T_1).

However, at 40, 60 DAS and at harvest, significantly the highest plant height, number of leaves, number of primary and secondary branches, leaf area index and dry matter accumulation were recorded under weed free (T_2) followed by pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6) which was at par with treatments metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5). Treatment pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_9) next superior treatment and which was at par with metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_8) and were significantly superior over the treatments pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence (T_4), metribuzin (70 WP) 850 g ha^{-1} as pre-emergence (T_3), two hand weedings at 20 and 40 DAS (T_{10}) and imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_7). The lowest was recorded under control plot (T_1).

Data related to number of pods, number of seeds, test weight, grain yield and stover yield as affected by various weed management practices on black gram are presented in Table 4.4 and 4.5 reveals that amongst weed management practices, maximum under weed free (T_2), followed by pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6), which was at par with metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5). Treatment pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_9) next superior treatment and which was at par with metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_8) and were significantly superior over the treatments pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence (T_4) and metribuzin (70 WP) 850 g ha^{-1} as pre-emergence (T_3). All The above treatments were significantly superior over the treatments of control plot (T_1), imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_7) and two hand weedings at 20 and 40 DAS (T_{10}). Similar findings also reported by Bhowmick *et al*. (2015).

The number of pods, seeds, test weight, grain yield and stover yield that plants are able to produce is dependent on a variety of factors, including the size, efficiency and duration of their photosynthetic systems as well as the translocation of dry matter into economic sinks. The cumulative function of the yield components results in the final build-up of yield.

The black gram crop may have used moisture, nutrients, light and space more efficiently in the absence of weed competition, as evidenced by the higher number of pods, number of seeds, test weight, seed yield and stover yield under the conditions mentioned above. Comparable results were noted by Mishra *et al*. (2017).

Table 1. Effect of weed control practices on plant height and number of leaves of black gram (*Vigna mungo* L.).

Treatments	Plant height (cm)				Number of leaves plant^{-1}			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	15.23	27.16	36.93	40.06	4.78	6.68	11.13	7.21
T_2 - Weed free	19.04	34.96	46.23	49.83	6.81	9.61	17.5	10.8
T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	16.8	30.64	41.41	43.42	6.16	7.73	13.53	6.8
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	16.93	30.91	41.51	43.79	6.33	7.67	13.69	6.92
T_5 - T_3 + Hand weeding at 20 DAS	17.94	33.78	44.14	47.75	6.19	8.66	16.43	9.21
T_6 - T_4 + Hand weeding at 20 DAS	17.97	33.91	44.66	47.78	6.24	8.77	16.51	9.26
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	16.16	29.12	39.75	42.02	5.55	7.32	12.82	6.12
T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	17.15	31.64	43.26	46.4	6.2	8.11	15.41	8.04
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	17.37	31.96	43.42	46.51	6.37	8.15	15.52	8.11
T_{10} - Two hand weedings at 20 and 40 DAS	16.14	29.58	40.76	45.09	5.59	7.88	14.3	7.64
SEm (±)	**0.53**	**1.46**	**1.71**	**1.86**	**0.31**	**0.42**	**0.79**	**0.42**
CD (5%)	**1.58**	**4.34**	**5.08**	**5.53**	**0.94**	**1.27**	**2.35**	**1.26**

Table 2. Effect of weed control practices on number of primary and secondary branches of black gram (*Vigna mungo* L.).

Treatments	Number of primary branches plant^{-1}				Number of secondary branches plant^{-1}			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	2.21	4.02	6.34	6.76	6.26	8.27	15.1	15.54
T_2 - Weed free	2.8	6.05	9.37	9.48	9.35	14.16	23.56	24.13
T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	2.48	4.71	7.5	7.28	7.85	10.35	18.2	18.24
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	2.49	4.74	7.52	7.25	7.87	10.38	18.22	18.29
T_5 - T_3 + Hand weeding at 20 DAS	2.54	5.54	8.84	8.6	8.08	12.91	21.79	21.9
T_6 - T_4 + Hand weeding at 20 DAS	2.56	5.62	8.86	8.63	8.11	12.95	21.83	21.94
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	2.23	4.41	7.02	7.2	6.3	9.64	17.54	17.27
T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	2.49	5.4	8.3	8.14	7.9	11.71	20.61	20.81
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	2.51	5.47	8.34	8.17	7.94	11.77	20.66	20.84
T_{10} - Two hand weedings at 20 and 40 DAS	2.29	5.21	8	7.84	6.33	11.2	19.54	19.66
SEm (±)	**0.11**	**0.26**	**0.44**	**0.42**	**0.35**	**0.53**	**0.92**	**0.92**
CD (5%)	**0.33**	**0.80**	**1.31**	**1.25**	**1.05**	**1.57**	**2.74**	**2.75**

Table 3. Effect of weed control practices on dry matter accumulation and leaf area index of black gram (*Vigna mungo* L.).

Treatments	Dry matter accumulation (g plat^{-1})				Leaf area index			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	1.3	4.17	6.78	7.08	0.67	0.85	1.15	1.24
T_2 - Weed free	1.59	7.18	8.39	8.96	1.03	1.23	1.62	1.77

T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	1.42	5.04	7.35	7.5	0.94	0.95	1.34	1.48
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	1.44	5.07	7.36	7.53	0.95	0.96	1.36	1.49
T_5 - T_3 + Hand weeding at 20 DAS	1.46	6.11	8.14	8.32	0.95	1.12	1.53	1.69
T_6 - T_4 + Hand weeding at 20 DAS	1.48	6.15	8.17	8.34	0.98	1.14	1.55	1.71
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	1.33	4.58	7.04	7.25	0.86	0.96	1.29	1.41
T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	1.44	5.32	7.9	8.06	0.93	1.06	1.48	1.62
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	1.45	5.35	7.95	8.16	0.94	1.08	1.49	1.64
T_{10} - Two hand weedings at 20 and 40 DAS	1.34	5.08	7.7	7.86	0.88	1.01	1.41	1.53
SEm (±)	**0.04**	**0.28**	**0.31**	**0.35**	**0.04**	**0.05**	**0.07**	**0.08**
CD (5%)	**0.14**	**0.83**	**0.92**	**1.05**	**0.14**	**0.16**	**0.23**	**0.24**

Table 4. Effect of weed control practices on number of pods, number of seeds and test weight of black gram (*Vigna mungo* L.).

Treatments	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	Test weight (g)
T_1 - Control	23.09	3.66	4.05
T_2 - Weed free	32.94	5.96	4.94
T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	25.75	4.51	4.26
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	25.72	4.55	4.27
T_5 - T_3 + Hand weeding at 20 DAS	30.21	5.38	4.64
T_6 - T_4 + Hand weeding at 20 DAS	30.57	5.42	4.68
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	24.84	4.04	4.13
T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	29.08	5.02	4.48
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	29.12	5.06	4.49
T_{10} - Two hand weedings at 20 and 40 DAS	27.99	4.9	4.41
SEm (±)	**1.59**	**0.27**	**0.17**
CD (5%)	**4.75**	**0.82**	**0.51**

Table 5. Effect of weed control practices on grain yield, stover yield, biological yield and harvest index of black gram (*Vigna mungo* L.).

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T_1 - Control	539.54	1865.18	2404.72	22.44
T_2 - Weed free	1090.67	2766.54	3857.21	28.28
T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	711.32	2204.40	2915.72	24.40
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	717.90	2208.71	2926.61	24.53
T_5 - T_3 + Hand weeding at 20 DAS	945.24	2633.22	3578.46	26.41
T_6 - T_4 + Hand weeding at 20 DAS	951.76	2665.28	3617.04	26.31
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	635.00	2100.81	2735.81	23.21

T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	890.80	2521.28	3412.08	26.11
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	894.20	2531.19	3425.39	26.11
T_{10} - Two hand weedings at 20 and 40 DAS	806.22	2308.36	3114.58	25.89
SEm (±)	**46.15**	**125.91**	**131.39**	**0.55**
CD (5%)	**145.28**	**374.04**	**390.32**	**2.10**

Effect on weeds

At 20, 40, 60 DAS and at harvest the percentage composition of *Cyperus* spp. (46.28%, 42.45%, 42.51%, 41.92%, respectively) was recorded highest followed by *Cynodon dactylon* (40.71%, 23.46%, 23.22%, 23.69%, respectively) and *Parthenium hysterophorus* (2.06%, 1.97%, 6.24%, 5.09%, respectively). Other weed species like *Trianthema* spp., *Phyllanthus* spp. and *Euphorbia geniculata* etc. were also observed in the experiment field in negligible quantum.

Weed control efficiency and weed management index of different weed species at 20, 40, 60 DAS and at harvest are presented in Table 7. The results show that the treatment weed free (T_2) had the significantly highest weed control efficiency and weed management index at 20 DAS, followed by pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6). This was comparable to metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5), pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_9), metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_8), pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence (T_4) and metribuzin (70 WP) 850 g ha^{-1} as pre-emergence (T_3). The minimum were recorded in imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_7), followed by two hand weedings at 20 and 40 DAS (T_{10}).

However, weed free (T_2) had by far the highest weed control efficiency and weed management index at 40, 60 and at harvest. Pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6), followed closely behind and was on at par with metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5). The next best treatment was pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_9), which was comparable to metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_8). These treatments were significantly better than pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence (T_4) and metribuzin (70 WP) 850 g ha^{-1} as pre-emergence (T_3). The minimum were recorded under imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS (T_7), followed by two hand weedings at 20 and 40 DAS (T_{10}). The findings of Singh *et al*. (2017) are consistent with these results.

Table 6. Effect of weed control practices on weed density and weed dry matter production of black gram (*Vigna mungo* L.).

Treatments	Weed density (m^{-2})				Weed dry matter production (g m^{-2})			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
T_1 - Control	15.16	17.24	10.02	9.81	79.69	92.1	122.55	134.23
T_2 - Weed free	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	8.26	7.38	7.26	4.34	38.42	44.69	57.07	65.13
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	8.11	7.31	7.22	4.31	39.38	43.48	56.16	64.57
T_5 - T_3 + Hand weeding at 20 DAS	8.68	6.59	5.53	3.07	33.92	7.06	7.19	13.24
T_6 - T_4 + Hand weeding at 20 DAS	8.62	6.5	5.51	3.04	38.07	6.98	6.7	12.76
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	14.65	8.83	8.28	5.13	66.6	48.59	57.12	69.44
T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	8.28	7.24	6.77	3.85	38.07	12.08	19.22	28.34
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	8.26	7.22	6.71	3.81	35.04	12.14	18.33	26.95
T_{10} - Two hand weedings at 20 and 40 DAS	13.62	8.68	6.81	4.04	57.22	32.59	34.78	53.65
SEm (±)	**0.65**	**0.57**	**0.42**	**0.27**	**3.03**	**2.13**	**2.70**	**3.33**
CD (5%)	**1.96**	**1.69**	**1.26**	**0.82**	**9.09**	**6.33**	**8.02**	**9.91**

Table 7. Effect of weed control practices on weed control efficiency, weed management index and weed index of black gram (*Vigna mungo* L.).

Treatments	Weed control efficiency (%)				Weed management index (%)				Weed index (%)
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest	
T_1 - Control	0	0	0	0	0	0	0	0	50.53
T_2 - Weed free	100	100	100	100	100	100	100	100	0
T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	51.75	51.43	53.38	51.43	38.57	61.85	59.59	61.85	34.78
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	50.55	52.74	54.12	51.85	41	62.62	61.02	63.7	34.18
T_5 - T_3 + Hand weeding at 20 DAS	57.4	92.28	94.08	90.09	82.14	81.44	79.88	83.42	13.33
T_6 - T_4 + Hand weeding at 20 DAS	52.19	92.37	94.48	90.44	91.79	82.67	80.82	84.43	12.74
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	16.39	47.19	53.34	48.22	67.58	37.45	33.14	36.66	41.78
T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	52.19	86.83	84.27	78.84	78.21	74.93	77.21	82.53	18.33
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	56	86.77	84.99	79.87	73.61	75.71	77.29	82.25	18.01
T_{10} - Two hand weedings at 20 and 40 DAS	28.16	64.56	71.57	59.98	68.99	76.5	69.01	82.34	26.08
SEm (±)	**1.93**	**2.81**	**2.87**	**2.70**	**3.41**	**3.48**	**3.40**	**3.63**	-
CD (5%)	**5.76**	**8.36**	**8.53**	**8.04**	**10.15**	**10.35**	**10.13**	**10.77**	-

Table 8. Cost of cultivation, gross return, net return and B:C ratio of treatments.

Treatments	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B : C ratio
T_1 - Control	25097.80	50523.85	25426.05	2.0:1
T_2 - Weed free	33272.80	99623.30	66350.50	2.9:1
T_3 - Metribuzin (70 WP) 440 g ha^{-1} as pre-emergence	26882.80	65973.20	39090.40	2.5:1
T_4 - Pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence	27451.80	66543.28	39091.48	2.4:1
T_5 - T_3 + Hand weeding at 20 DAS	28844.80	86928.45	58083.65	3.0:1
T_6 - T_4 + Hand weeding at 20 DAS	29413.80	87562.80	58149.00	3.0:1
T_7 - Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	26951.80	59227.03	32275.23	2.2:1
T_8 - T_3 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	28736.80	82021.20	53284.40	2.9:1
T_9 - T_4 + Imazethapyr (10 SL) 75 g ha^{-1} at 20 DAS	29305.80	82334.98	53029.18	2.8:1
T_{10} - Two hand weedings at 20 and 40 DAS	29675.80	74299.60	44623.80	2.5:1

Weed index had remarkably influenced by weed management practices. Maximum weed index was noticed under control plot (T_1), which was 50.53%. Similar results confirm the findings of Tiwari *et al*. (2017) and Yassin *et al*. (2023). Whereas, minimum weed index was registered under pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6), followed by metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5).

Effect on crop economics

Table no. 8 presents information on the cost of cultivation, gross return, net return and benefit: cost ratio from black gram as impacted by various weed management techniques. Due to greater labour costs, the weed free (T_2) treatment had the highest cultivation costs (33272.80 ₹ ha^{-1}) followed by pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6), while the control plot (T_1) had the lowest costs. The treatments weed free (T_2) recorded the highest gross return (99623.30

₹ ha^{-1}) and net return (66350.50 ₹ ha^{-1}) followed by pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6) and metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5).

The highest benefit: cost ratio (3.0:1) recorded under the treatment of pendimethalin (30 EC) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6), which was equal to treatment metribuzin (70 WP) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5). However, minimum gross return, net returns and benefit: cost ratio was obtained under control plot (T_1). The higher B:C ratio under above treatments might be due to higher seed yield coupled with lower cost of chemical treatments.

CONCLUSIONS

Weed free plot (T_2) have registered higher growth, yield attributes and yield as well as gross return, followed by pendimethalin (30 EC) 850 g ha^{-1} as PE + hand weeding at 20 DAS (T_6) of *kharif* black gram as compared to other weed management practices. Two hand weedings at 20 and 40 DAS (T_{10}) and pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6) were next best performing treatments, it had the potential to control broad spectrum of weeds *i.e.* broad, narrow leaved weeds and sedges. Weed control efficiency and weed management index at harvest also recorded higher values in both the treatments. The benefit: cost ratio was higher under pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6), followed by metribuzin (70 WP) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5). Minimum weed index was recorded under pendimethalin (30 EC) 850 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_6) *i.e.* 12.74%, followed by metribuzin (70 WP) 440 g ha^{-1} as pre-emergence + hand weeding at 20 DAS (T_5) *i.e.* 13.33%.

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