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RESPONSE OF BLACK GRAM (*VIGNA MUNGO* L.) TO INTEGRATED WEED MANAGEMENT AND ITS EFFECT ON WEED DYNAMICS

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ABSTRACT

A field experiment was conducted during the *rabi* season of 2020-21 in Kurnool district of Andhra Pradesh in a farmers's field to access the efficacy of integrated weed management on weed dynamics in blackgram (*Vigna mungo* L.). Data on weed dynamics revealed that significantly lesser weed density, weed dry weight and high weed control efficiency were obtained with application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence. The higher values of all the weed dynamics except weed control efficiency were registered with the treatment Weedy check. Growth and yield parameters of blackgram *viz.,* plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$, LAI, CGR, RGR, number of pods $plant^{-1}$, length of pods, number of seeds pod^{-1}, test weight, grain yield, stover yield and harvest index were significantly higher with the application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence. The highest net returns and benefit-cost ratio were also recorded with the application of Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence.

Keywords **:** *Blackgram, Integrated weed management, yield, economics.*

Introduction

Black gram (*Vigna mungo* L.) is a remunerative legume crop grown in India, Myanmar, Pakistan and parts of Southern Asia, Africa and America. It is an important *Kharif* pulse crop in India which contains protein almost thrice that of cereals (Kanade, 2006). Urd bean is the fourth most important pulse crop in India after chickpea, pigeon pea, and green gram and second most important in Andhra Pradesh in terms of extent of cultivation. It is extensively grown in *Kharif* and summer seasons, while in South India it is grown in Rabi season also. It is consumed in the form of dal (whole or split, husked and unhusked and parched). Urd grain contains 24% protein, 60% CHO, 1.3% fat and is richest source of phosphoric acid among pulses (5-6% richer than others), vitamins like thiamine (B_1), riboflavin (B_2) and niacin (B_3). It is used as a nutritive fodder specially for milch cattle. It is also used as a green manuring crop, helps in binding soil particles and thus prevent soil erosion. It fixes atmospheric nitrogen (42 kg ha^{-1} $year^{-1}$) to the soil through symbiosis and improves fertility of soil. Black gram being initially slow growing and short duration crop suffers heavily due to infestation of weeds. Depending upon nature and intensity of weed flora, an average yield loss of 30-50 per cent has been reported (Mishra, 1997) and removal of weeds at appropriate time is essential to achieve higher yields. Control of weeds during critical period of crop weed competition (15-45 DAS), is very essential to avoid severe yield losses. In black gram weeds are controlled by hand weeding (Chand *et al.,* 2004). However, many times hand weeding is costly, time consuming, laborious and tedious. Moreover, several times labour is not available for weed removal during critical period of crop growth and weather conditions (rain) do not permit timely hand weeding during *Kharif* due to wet field conditions. In such situations, herbicides offer most ideal, effective, practical and economical means of reducing early weed competition and crop production losses. Integrated weed management (IWM) approach is an important aspect of weed management because it prevents weed shift towards perennial nature, prevents resistance of weeds to herbicides. In this system two or more weed control techniques are selected from five general categories *viz.,* cultural, mechanical, preventive, chemical and biological and designed in a well-planned sequence so that it would not affect the ecosystem. This technique achieves complete and effective control of all weeds during crop season and even a relatively few surviving weeds can produce sufficient number of seeds to perpetuate the species.

Materials and Methods

During the *rabi* season of 2020-21, a field experiment was conducted at farmer's field located in Tartur village, Kurnool district of Andhra Pradesh. The farm is geographically situated at 15.84^0N latitude and 78.31^0 E longitude with an altitude of 297 meters above the mean sea

level (MSL) in Scarce Rainfall Zone of Andhra Pradesh and falls under Semi-Arid Tropics (SAT) according to Troll's classification. The soil of experimental site was sandy loam in texture having pH 7.21, medium in organic carbon (0.62%), available P and K (18 and 185.73 kg/ha) and low in available N (214.3 kg/ha). The experiment comprised of 10 treatments, *viz.* Weedy check, Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence, Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1}as pre-emergence, Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post emergence, Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + one hand weeding at 30 DAS, Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + one hand weeding at 30 DAS, Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence, Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence, one hand weeding at 30 DAS and Two hand weedings at 20 and 40 DAS. The experiment was laid out in a randomized block design with 3 replications. On 19 December 2020, certified seeds of blackgram (var. 'PU-31') were sown with a spacing of 30 cm between the rows and 10 cm within the row by dibbling two seeds per hill. Recommended dose of P2O5 and K2O (40 kg/ha) were applied before sowing of the crop. Herbicides were applied as per treatments by using knapsack sprayer fitted with a flat fan nozzle at spray volume of 500 lit ha^{-1}.The data on weed population and weed biomass were taken at harvest with the help of random quadrate (1 m ×1 m) at 2 places. The weed-control efficiency (WCE) was calculated using formulae.

$$WCE\ (\%) = (WDc - WDt)/WDc \times 100$$

where, WCE, weed-control efficiency;

WDc, weed dry biomass (g/m^2) in control plot;

WDt, weed dry biomass (g/m2) in treated plot.

The data were subjected to square root transformation ($\sqrt{X+0.5}$) before subjecting to statistical analysis as suggested by Gomez and Gomez (1976).

Results and Discussion

Weed flora

During the whole crop season weed flora belonging to five taxonomic families were observed which comprised of 3 grass species, 5 broad leaved species and 2 species belonging to sedge (Table 1). *Cynodon dactyon*, *Dactylactenium aegyptium, Cyperus rotundus, Cyperus iria, Amaranthus viridis, Digera arvensis* and *Parthenium hysterophorus* were Predominant weed species. The observations on these weed species during the investigation followed similar trend with those reported by Jakhar *et al.* (2015) and Patel *et al.* (2017).

Weed density, weed dry weight and weed control efficiency

The data on effect of different weed management practices on weed density, weed dry weight and weed control efficiency were recorded at harvest and is presented in the Table 2. The data revealed that significantly lower density of grasses (1.54), broadleaf (1.71), sedges (1.85) and total density of weeds (2.60) was observed with the treatment two hand weeding at 20 and 40 DAS while the higher grassy weed density (6.92), broadleaf density (8.37) and sedges (8.84) and total density of weeds (13.94) was observed under weedy check. Two hand weedings at 20 and 40 DAS recorded lower weed density of all types of weeds. This is in line with the findings of Yadav *et al.* (2015), Teja *et al.* (2016) and Susmitha *et al.* (2019) because of complete removal of all types of weeds during early crop growth stages. Among the chemical weed management practices the treatment Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence application recorded lower weed density because the combination of both pre and post emergence herbicides have longer effect on controlling of weed population and brought significant reduction in weed density. Similar results of weed control under combination of herbicides were also reported by Jha et al. (2014) and Devaraju and Senthivel (2017).

Two hand weedings at 20 and 40 DAS (2.17 g m^{-2}) recorded significantly lower dry weight of total weeds than the other weed management practices. Among the different chemical weed management practices Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence application (2.65 g m^{-2}) recorded lower dry weight of total weeds while statistically higher dry weight of total weeds was observed in the Weedy check (11.97 g m^{-2}). Weed dry weight is considered as the most important parameter to assess the competitiveness of weed and the effect on crop growth and productivity. Because of complete removal of all types of weeds during early stages of crop growth the treatment; Two hand weedings at 20 and 40 DAS registered lower dry weight of weeds. Similar results were notedby Mansoori *et al.* (2015), Patel *et al.,* (2015). Among the chemical weed control treatments the lowest weed dry weight was observed with the treatment Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence application. Similar reports were noted by Devaraju and Senthivel (2017). The higher weed control efficiency was reported with the treatment Two hand weedings at 20 and 40 DAS (97.36 %) while the lower weed control efficiency was recorded with T_9-One hand weeding at 30 DAS (81.93 %). The results were in line with the findings of Kumar *et al.* (2017) and Sahoo *et al.* (2017). Among the chemical weed treatments Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence application recorded higher weed control efficiency. The crop yield is directly proportional to weed control efficiency (WCE). Higher WCE in the above mentioned treatment may be due to reduction in the weed dry weight as a result of effective weed control in this treatment. These findings are in line with Devaraju and Senthivel (2017).

Growth attributing characters

The data on growth attributing characters varied significantly and is presented in the Table 3. Significantly highest value of all the growth attributing characters i.e. Plant height (44.77 cm), no. of branches $plant^{-1}$ (7.96), no. of leaves $plant^{-1}$ (28.38), leaf area index (2.35), Crop growth rate (3.08) was observed with the treatment; hand weeding at 20 and 40 DAS. Highest value of relative growth rate (0.0089) was also noticed with the same treatment although the value was non-significant. However, the lower value of all the growth attributing characters was recorded with the treatment Weedy check. Maximum plant height with the noted treatment might be due to less weed population, which reduced crop weed competition for soil moisture, solar radiation, plant nutrients and space during active growth

period resulting in better nutrient availability which helped in rapid cell development and facilitated luxurious crop growth. Similar results were also reported by Susmitha *et al.* (2019). Higher number of branches and leaves plant^{-1} obtained could be due to better control of all types of weeds like grasses, broadleaved and sedges during early crop growth period. Similar results were also reported by Yadav *et al*. (2015). The lowest leaf area index under weedy check could be due to higher density of weed population leading to poor crop growth parameters. These results were in accordance with the findings of Das *et al.* (2014).

Yield and yield attributing characteristics

The data pertaining to yield and yield attributing characteristics varied significantly due to different weed management practices and is presented in the Table 4. Data reveals that the higher number of pods plant^{-1} (34.38), length of pods (5.02), no. of seeds pod^{-1} (5.48), text weight (4.86 g), grain yield (1095.30 kg ha^{-1}), stover yield (2564 kg ha^{-1}) and harvest index (29.93)were registered with the treatment; Hand weeding twice at 20 and 40 DAS which was statistically similar with the treatment; Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence application for all the parameters noted above while weedy check observed the lowest values for all the observations recorded. It could be possibly due to the reason that lower weed population had provided favourable environment to the crop and least crop weed competition, which resulted in higher photosynthetic accumulation rate and better translocation to the sink as compared. The above weed management practices were responsible for not only the reduction of weed growth but also to reduce the nutrient depletion by weeds and thereby increasing the nutrient uptake by crop throughout its life period. These findings are in line with that of Chaudhry *et al*. (2014), Das *et al.* (2014), Harithavardhini *et al.* (2016), Nirala *et al.* (2016), Raju *et al.* (2017) and Sakthi *et al.* (2018).

Economics

On the basis of current market price of various common and variable agro-inputs used were computed for the cost of cultivation. The data on economics is presented in the Table 5 and it clearly depicted that the highest cost of cultivation was recorded under treatment Hand weeding twice at 20 and 40 DAS (Rs. 31286.4 ha^{-1}) followed by Hand weeding at 30 DAS (Rs. 25686.4 ha^{-1}) and was found to be at par with treatment, Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + one hand weeding at 30 DAS (Rs. 25284.4 ha^{-1}). Significantly lower cost of cultivation were observed in the Weedy check (Rs. 20086.4 ha^{-1}). The higher gross returns were observed with the treatment, Hand weeding twice at 20 and 40 DAS (Rs. 84024.88 ha^{-1}) followed by treatment Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence application (Rs. 79354.58 ha^{-1}). The higher net returns (Rs. 55270.18 ha^{-1}) and B:C ratio (2.29) were realized with the treatment Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence application + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence application. The lowest value of gross return (Rs. 43999.36), net return (Rs. 43999.36) and B:C Ratio (1.19) was registered in weedy check. The results are in conformity with that of Malliswari *et al*. (2008) and Teja *et al*. (2016), Raju *et al.* (2017) and Sakthi *et al.* (2018).

Conclusion

It can be concluded from the present investigation that the treatment T_7 -Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence significantly lowered the weed density, weed dry weight and increased weed control efficiency. The higher values of all the weed dynamics except weed control efficiency were registered with the treatment T_1 -Weedy check. Data on growth and yield parameters of blackgram *viz.,* plant height, number of branches plant^{-1}, number of leaves plant^{-1}, LAI, CGR, RGR, number of pods plant^{-1}, length of pods, number of seeds pod^{-1}, test weight, grain yield, stover yield and harvest index were significantly higher with the treatment T_7-Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.*ha^{-1} at 25 DAS as post-emergence. The lower values of all the growth and yield parameters were registered with the treatment T_1-Weedy check. The highest net returns and benefit-cost ratio were recorded with the treatment T_7-Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence

Table 1 : Weed flora in the experimental area

A	**Grasses**			
1	*Brachiaria ramose* (L.)	Brown top millet	Perennial	Poaceae
2	*Cynodondactylon*(L.)	Bermuda grass	Perennial	Poaceae
3	*Dactylocteniumaegyptium*(L.)	Crow foot grass	Perennial	Poaceae
B	**Sedges**			
1	*Cyperus rotundus*(L.)	Yellow nutsedge	Perennial	Cyperaceae
2	*Cyperus iria*(L.)	Rice field flat sedge	Perennial	Cyperaceae
C	**Broad Leaved Weeds**			
1	*Amaranthus viridis*(L.)	Slender amaranth	Annual	Amaranthaceae
2	*Celosia argentia*	Silver cock's comb	Annual	Amaranthaceae
3	*Parthenium hysterophorus*(L.)	Congress grass/Carrot grass	Annual	Asteraceae
4	*Portulaca oleracea*	Common purslane	Annual	Portulaceae
5	*Tridax procumbens*	Coat buttons	Annual	Asteraceae

Table 2 : Weed density, Total weed dry weight and weed control efficiency as influenced by different weed management practices in blackgram.

Treatments	Weed density (no. m^{-2})				Total weed dry weight (g m^{-2})	Weed control efficiency (%)
	Grass	Broadleaf	Sedges	Total		
T_1: Weedy check	6.92 (47.04)	8.37 (69.15)	8.84 (77.28)	13.94 (193.47)	11.97 (142.33)	0.00
T_2: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1}as pre-emergence	2.42 (4.90)	3.99 (15.05)	3.17 (9.10)	5.47 (29.05)	4.45 (18.93)	86.70
T_3: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as pre-emergence	3.19 (9.24)	4.24 (17.06)	3.65 (12.33)	6.29 (38.63)	4.90 (23.20)	83.69
T_4: Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	2.68 (6.24)	2.74 (6.54)	3.68 (12.64)	5.13 (25.42)	4.17 (16.54)	88.37
T_5: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Hand weeding at 30 DAS	2.01 (3.05)	2.43 (5.00)	2.61 (5.87)	3.86 (13.92)	2.83 (7.12)	94.99
T_6: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Hand weeding at 30 DAS	2.02 (3.10)	2.38 (4.69)	2.91 (7.54)	4.03 (15.33)	2.99 (8.06)	94.33
T_7: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	1.97 (2.91)	2.11 (3.48)	2.30 (4.33)	3.41 (10.71)	2.65 (6.15)	95.67
T_8: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	1.98 (2.96)	2.15 (3.67)	2.32 (4.45)	3.46 (11.08)	2.75 (6.67)	95.31
T_9: Hand weeding at 30 DAS	3.27 (9.80)	3.60 (12.05)	3.90 (14.30)	6.09 (36.15)	4.31 (17.72)	81.93
T_{10}: Hand weeding at 20 and 40 DAS	1.54 (1.40)	1.71 (1.93)	1.85 (2.47)	2.60 (5.80)	2.17 (3.75)	97.36
S. Em ±	**0.97**	**1.02**	**1.05**	**2.35**	**1.67**	**1.22**
CD (P=0.05)	**2.90**	**3.07**	**3.14**	**7.03**	**5.02**	**3.65**

Table 3 : Growth attributes as influenced by different weed management practices in blackgram.

Treatments	Plant height (cm)	No. of branches $plant^{-1}$	Leaves $plant^{-1}$	Leaf area index (LAI)	Crop growth rate(gm^{-2} day^{-1}) 60 DAS - Harvest	Relative growth rate ($gg^{-1}day^{-1}$) 60 DAS-Harvest
T_1: Weedy check	29.20	5.33	15.07	1.85	0.97	0.0048
T_2: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence	35.27	6.64	20.76	1.92	2.02	0.0064
T_3: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as pre-emergence	33.67	6.52	20.07	1.87	1.93	0.0056
T_4: Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	37.95	6.87	22.78	2.13	2.09	0.0064
T_5: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Hand weeding at 30 DAS	38.98	7.01	24.98	2.16	2.14	0.0078
T_6: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Hand weeding at 30 DAS	38.73	6.90	24.20	2.09	2.10	0.0072
T_7: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	39.83	7.24	27.54	2.22	2.93	0.0081
T_8: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	39.00	7.04	25.83	2.20	2.47	0.0078
T_9: Hand weeding at 30 DAS	37.62	6.85	21.48	2.03	2.04	0.0070
T_{10}: Hand weeding at 20 and 40 DAS	44.77	7.96	28.38	2.35	3.08	0.0089
S. Em ±	**0.49**	**0.12**	**0.57**	**0.03**	**0.07**	**0.0000**
CD (P=0.05)	**1.47**	**0.37**	**1.68**	**0.09**	**0.21**	**NS**

Table 4 : Yield attributes and yield of blackgram as influenced by different weed management practices.

Treatments	Number of pods plant^{-1}	Length of pods (cm)	Number of seeds pod^{-1}	Test weight (g)	Grain Yield	Stover Yield	Harvest Index
T_1: Weedy check	18.20	4.25	4.02	4.10	564.63	1673.00	25.23
T_2: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence	22.80	4.41	4.46	4.36	828.00	2192.67	27.41
T_3: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as pre-emergence	21.53	4.37	4.38	4.33	793.60	2143.33	27.04
T_4: Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	26.85	4.67	4.71	4.44	907.68	2305.67	28.24
T_5: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Hand weeding at 30 DAS	28.50	4.73	4.96	4.63	985.81	2423.00	28.92
T_6: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Hand weeding at 30 DAS	27.73	4.70	4.85	4.58	968.29	2411.68	28.64
T_7: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	33.42	4.86	5.40	4.77	1033.11	2485.33	29.36
T_8: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	30.50	4.78	5.31	4.73	1002.05	2425.00	29.23
T_9: Hand weeding at 30 DAS	26.67	4.62	4.50	4.57	884.36	2269.67	28.03
T_{10}: Hand weeding at 20 and 40 DAS	34.38	5.02	5.48	4.86	1095.30	2564.00	29.93
S. Em ±	**1.39**	**0.10**	**0.29**	**0.13**	**7.52**	**51.67**	**0.46**
CD (P=0.05)	**4.13**	**0.29**	**0.87**	NS	**22.35**	**153.51**	**1.38**

Table 5 : Economics of treatments as influenced by different weed management practices in blackgram

Treatments	Cost of cultivation	Gross return	Net return	B:C ratio
T_1: Weedy check	20086.4	43999.36	23912.96	1.19
T_2: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as pre-emergence	22484.4	64001.34	41516.94	1.84
T_3: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as pre-emergence	21926.4	61425.86	39499.46	1.80
T_4: Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	21686.4	69964.3	48277.9	2.26
T_5: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Hand weeding at 30 DAS	25284.4	75824.32	50539.92	1.99
T_6: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.*ha^{-1}as PE + Hand weeding at 30 DAS	24726.4	74540.24	49813.84	2.01
T_7: Pendimethalin 30% EC @ 1.0 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	24084.4	79354.58	55270.18	2.29
T_8: Oxyfluorfen 23.5% EC @ 0.18 kg *a.i.* ha^{-1} as PE + Imazethapyr 10% SL @ 50 g *a.i.* ha^{-1} at 25 DAS as post-emergence	23526.4	76997.6	53471.2	2.27
T_9: Hand weeding at 30 DAS	25686.4	68213.26	42526.86	1.65
T_{10}: Hand weeding at 20 and 40 DAS	31286.4	84024.88	52738.48	1.68

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