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EVALUATION OF RELATIVE EFFICACY OF DIFFERENT ORGANIC WEED MANAGEMENT PRACTICES ON GROWTH, YIELD AND ECONOMICS OF URDBEAN (*VIGNA MUNGO* L. HEPPER)

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ABSTRACT

A field experiment was carried out at Research Institute of Organic Farming (RIOF) field unit, University of Agricultural Sciences, G.K.V.K., Bengaluru during *Rabi* season of 2025. It was laid out in randomized block design with twelve treatments *viz.*, T_1: Inter cultivation at 25 DAS+1 hand weeding at 45 DAS, T_2: Stale seed bed technique+ inter cultivation twice at 25 & 45 DAS, T_3: Straw mulching 5 t ha^{-1} at 10-15 DAS, T_4: Black gram+ fodder cowpea as an intercrop (multi-cut)+1 inter cultivation at 40 DAS, T_5: Black gram+ fodder cowpea as smothering crop in between rows of black gram, T_6: Black gram+ fodder cowpea as an intercrop with in-situ incorporation on 35 DAS + 1 inter cultivation at 40 DAS, T_7: Mechanical (cycle weeder) weeding at 35 DAS, T_8: Two mechanical weeding at 20 and 40 DAS, T_9: Cucumber leaf extract 100ml l^{-1} @ 2-4 leaf stage, T_{10}: *Ageratum conyzoides* leaf extract 100ml l^{-1} @ 2-4 leaf stage, T_{11}: Hand weeding at 20 & 40 DAS and T_{12}: Un weeded check with three replications. The results indicated that the plots with twice hand weeding at 20 & 40 DAS had significantly lower weed population, weed dry matter and weed control efficiency followed by those where stale seed bed technique + inter cultivation twice at 25 & 45 DAS and inter cultivation at 25 DAS +1 hand weeding at 45 DAS at 60 DAS were carried out. Significantly higher seed and haulm yield, and growth attributes, like plant height, leaf area and dry weight were recorded in hand weeded plots. Hand weeding at 20 and 40 DAS is the best efficient method for the control of weeds. Since, the labour availability is a problem besides high cost involved in the hand weeding, stale seed bed technique + inter cultivation twice at 25 & 45 DAS (T_2), inter cultivation at 25 DAS + 1 hand weeding at 45 DAS (T_1) and two mechanical (cycle weeder) at 20 & 40 DAS (T_8) weeding would be a viable alternative for weed management.

Keywords **:** Cycle weeder, Inter cultivation, Hand weeding, Stale seed bed.

Introduction

Grains and legumes are inseparable ingredients of vegetarian diet, and one of the cheapest source for combating the malnutrition by supplying dietary protein to the people. India contributes 27.6 per cent to the global grain legume production and holds 35.2 per cent of the world's pulse acreage (Kundu *et al*., 2025). Surprisingly, about 80 per cent of the areas under pulses are currently grown in rainfed land of the country. Urdbean [*Vigna mungo* (L.) Hepper] is one of the important grain legumes grown throughout the country during both in summer and rainy season. It is a self-pollinated leguminous crop fits well in various multiple and intercropping systems due to its rapid growth, shorter duration and nitrogen fixing capacity. The crop can be grown on all types of soils ranging from sandy loam to heavy clay except the alkaline and saline soil. Urd bean contributes about 13 per cent of total area in pulses and 10 per cent of their total production in our country. This crop was

cultivated on an area of about 5.44 M ha (rainy + winter season) and recorded a production of 3.56 mt at a productivity level of 655 kg/ha. This was the highest ever area, production and productivity in this crop (Anon., 2024). It is extensively grown in the states of Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu and Uttar Pradesh.

Urdbean is susceptible to weed competition (Balyan *et al*., 2016) with yield reduction of 42 -51 per cent (Malliswari *et al*., 2008; Begum and Rao 2006). Thus weed management has become very much imperative to sustain productivity in crops like urdbean (Kumar et. al., 2018). Higher weed density is seen mainly in the rainy season due to ample presence of moisture in the soil and limited field work days (Ramamoorthy *et al*., 2004). The most intensive period for weed competition is around 3 and 6 weeks after sowing which needs control measures for achieving yield targets (Asaduzzaman *et al*., 2010). Many potential weed problems can be avoided by diversifying the agricultural system and the weed environment through management actions and agronomic approaches. Stale seedbed method, inter-cultural operations, crop rotation, use of green manures, cover crops, mulching, intercropping, use of highly competitive crops and crop cultivars, and use of allelopathic crops, among other weed management techniques, would all have a place in organic farming. Weeding by hand is always impossible due to the high demand for and cost of human labour. As a result, awareness is being raised about the use of environmental friendly weed management strategies such as cultural and biological methods. There is a need to begin research on novel weed control tactics that include the use of naturally occurring pesticides, allelopathic effects, and the cultivation of smother crops, which are becoming increasingly popular in the field of organic weed management.

Adopting cost-effective weed management strategies is a crucial challenge for maintaining sustainable production levels in any organic agriculture system. Weed management in organic agriculture should follow the principles of biological processes to achieve the desired weed suppression. Weeding with non-chemical methods must be done during the crop's critical period. The critical period of crop–weed competition for the crop varies from 30-45 days after sowing. Weed control during early stages of crop growth period assumes important as it reveals the significant decrease in yield due to delay in weeding. The costly and laborious nature of manual weeding has made chemical weed control popular among farmers. Intensive adoption of weed control measures should be optimized by organic method of weed control methods to increase the soil health and fertility of soil. As a result, the current study was started in order to discover practical and cost-effective weed management strategies in organic black gram. Thus keeping these points in view, an experiment was conducted with the objective of evaluating the relative efficacy of different weed control practices in urdbean.

Material and Methods

A field experiment was conducted during Rabi season of 2025-26 at the Research Institute of Organic Farming (RIOF) field unit, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka (latitude of 13° 05' N, longitude 77° 34' E with an altitude of 924 m above MSL). The soil of the experimental site comes under sandy loam texture having neutral pH of 6.69, low electrical conductivity (0.25 dSm^{-1}) with medium organic carbon content (0.6 %). The soil was low in available nitrogen (310 kg ha^{-1}), medium in available phosphorus (48.5 kg ha^{-1}) and available potassium (196 kg ha^{-1}).

The experiment comprised of twelve treatments laid out in RCBD design in three replications with the gross plot size of 25.92 m^2 and 50cm buffer area was maintained between two plots within the replication, while the block border size was 0.75 meter. Treatments comprised of inter cultivation at 25 DAS + 1 hand weeding at 45 DAS (T_1), stale seed bed technique + inter cultivation twice at 25 & 45 DAS (T_2), straw mulching 5 t ha^{-1} at 10-15 DAS (T_3), black gram + fodder cowpea as an intercrop (multi-cut) + 1 inter cultivation at 40 DAS (T_4), black gram + fodder cowpea as smothering crop in between rows of black gram (T_5), black gram + fodder cowpea as an intercrop with in-situ incorporation on 35 DAS + 1 inter cultivation at 40 DAS (T_6), mechanical (cycle weeder) weeding at 35 DAS (T_7), two mechanical weeding at 20 and 40 DAS (T_8), cucumber leaf extract 100ml/l @ 2-4 leaf stage (T_9), *Ageratum conyzoides* leaf extract 100 ml l^{-1} @ 2-4 leaf stage (T_{10}), hand weeding at 20 & 40 DAS (T_{11}) and un weeded check (T_{12}). The urd bean variety LBG 791 having duration of around 70-80 days was sown with 30 cm spacing using seed rate of 20 kg/ha. Recommended fertilizer dose of 25:50:25 kg N, P_2O_5, K_2O per ha was supplied using FYM on N equivalent basis. Stale seedbed treatment was initiated 15 days before sowing of the crop by giving irrigation to stale seedbed plots and weeds were allowed to germinate. The germinated weeds were removed one day before sowing of the crop by passing cultivator in cris-cross manner. Inter cultivation was done with the help of hand gudli. Straw mulching was done with crop residues (Kodo millet straw @ 10 t ha^{-1}) at 10-15 DAS.

In T_4, T_5, T_6, plots, the seed of cowpea was sown in between rows of black gram. These cover crops in T_6 were mulched between rows at 35 DAS and inter cultivation done @ 40 DAS, in T_4 plots cowpea was multi-cut at 45 DAS and one inter cultivation was done at 40 DAS and in T_5 plot cowpea act as smothering crop and variety used was MFC 09-1. Mechanical weeding was done by passing cycle weeder in between the rows of black gram. In T_9 and T_{10}, cucumber and *Ageratum conyzoides* leaf extracts were sprayed at 2-4 leaf spray @ 15-20 DAS. The plant samples were collected and taken to the laboratory where they were washed thoroughly with tap water to remove the dirt. A 10 g of plant sample was weighed and blended by slowly adding 100 ml of distilled water. The blended solution was first filtered through a double layered muslin cloth and then through Whatman No. 1 filters paper. The obtained 10 % (w/v) aqueous allelochemical extract was used for spraying onto the weeds grown in pots (Javaid *et al.*, 2006). Statistical analysis of the data was done as per the Fisher's analysis of variance technique for the experimental designs and treatment means were compared using least significant difference test at 5 per cent probability level using t-test.

Results and Discussion

Weed flora: The common weeds in the experimental site were *Cyperus rotundus* L. (among sedges), *Digitaria marginata* (Retz.), *Echinochloa crusgalli* (L), *Dactyloctenium aegyptium* (L), P. Beauv, *Elucina indica* (L), *Cynodon dactylon* (L) Pers, *Chloris barbata* (L.) (among grasses) and among broad leaved weeds *Borreria hispida* (L), K. schum, *Emilia sonchifolia* (L), *Spilanthus acmella* (L), *Ageratum conyzoides* (L), *Alternanthera sessilie* (Br), *Commelina benghalensis* (L), *Ionaidium supfruiticesum* (L) Ging, *Cleome viscose* (L), *Amaranthus viridis* (L), *Portulaca oleracia* (L), *Sida acuta* (Burm f), *Acanthospermum hispida* DC, *Celosia argentea* (L) Similar weed species in urdbean crop was also reported by Chaudhary *et al.* (2000), Bhowmick and Gupta (2005), Jakhar *et al*. (2015) and Balyan *et al*. (2016) (Table 1). The weed density was in the order of broad leaved weeds > grasses > sedges during crop growth period. The emergence of different weed species is mainly attributed to initial soil weed seed bank, difference in tillage intensity during land preparation, earlier cropping system, and weather parameters during crop growth with favourable soil environment. Similar results were observed by Tomar (2011) and Nirala *et al*. (2012).

Weed density : Among different weed management practices, hand weeding at 20 & 40 DAS recorded significantly lower density of sedges, grasses, broad leaved weeds and total weeds (5.33, 0.00, 14.00 and 19.33 m^{-2}, respectively) (Table 2) followed by stale seed bed technique + inter cultivation twice at 25 & 45 DAS (6.00, 0.00, 16.00, 22.00 m^{-2}, respectively) and Inter cultivation at 25 DAS + 1 hand weeding at 45 DAS (6.00, 0.00, 16.67 and 22.67 m^{-2}, respectively) at 60 DAS. Significantly higher weed density of sedges, grasses, broad leaved weeds and total weeds was noticed in un weeded check (50.00, 20.00, 40.00 and 110.00 m^{-2}, respectively) at 60 DAS which attributed to initial deposition of weed seeds in the soil from the previous seasons has led to increased weed seed bank in the soil which is undisturbed for any activity after sowing and also no weed management measure is taken in these plots. These circumstances have led to higher weed density in the weedy check. These findings are in accordance with Nazma *et al*. (2015) in black gram and Dhanapal *et al*. (2018) in rice.

All weed control treatments significantly reduced the weed density over un weeded check (T_{12}). Further, total weed density and that of all categories of weeds were significantly low in hand weeding at 20 & 40 DAS (T_{11}). This could be due to physical removal of weeds at 20 & 40 DAS in comparison to other treatments. Similar results were also reported in earlier studies by Nazma *et al*. (2015) in Black gram. Further, stale seed bed technique + inter cultivation twice at 25 & 45 DAS (T_2) when it was effective in reducing weed density of all weeds category. This might be due to removal of the early emerged weeds through stale seedbed technique which provides weed free condition for crop growth and later on control of weeds could have been achieved through inter cultivation at 25 and 45 DAS. This helps not only to reduce the weed population but also provides better soil condition for crop growth and development. Effective stale seedbed should minimize the soil disturbance and the movement of the seeds from deeper soil profile to the germination zone (Boyd *et al*., 2006). Further, Caldwell and Mohler (2001) reported that grasses and sedges are not easy to manage in comparison to broad leaved weed with stale seedbed.

Weed dry weight (g m^{-2}): Hand weeding at 20 & 40 DAS recorded significantly lower dry weight of sedges, grasses, broad leaved weeds and total weeds (0.45, 0.00, 3.85 and 4.31 g m^{-2}, respectively) followed by stale seed bed technique + inter cultivation twice at 25 & 45 (0.51, 0.00, 4.21 and 4.73 g m^{-2}, respectively) and inter cultivation at 25 DAS + 1 hand weeding at 45 DAS (0.52, 0.00, 4.37 and 4.89 g m^{-2}, respectively) at 60 DAS. Significantly higher weed dry weight of sedges, grasses, broad leaved weeds and total weeds

was noticed in un weeded check (6.65, 3.37, 8.13 and 18.15 g m^{-2}, respectively) at 60 DAS (Table 2) attributed to higher weed dry weight compared to other weed management treatments. These findings are in accordance with Nazma *et al*. (2015) in Black gram and Dhanapal *et al*. (2018) in rice. Weed dry weight is a critical parameter for assessing the weed competitiveness with the crop growth and yield. The weed dry weight showed negative and significant correlation with crop yield in the present study indicating negative effect of weed composition on crop yield, as also stated by Basavaraj (2012) in groundnut and Khot *et al*. (2016) in Black gram. Concurrent findings were observed by Nazma *et al*. (2015), Kandasamy and Chandrashekar (1998), Gopinath *et al*. (2012), Bhuvaneshwari *et al*. (2010), Gaganpreet *et al*. (2010) and Sindhu *et al*. (2011). It is evident from the above discussion that two mechanical weeding at 20 and 40 DAS (T_8) could restrict the weed biomass to the minimum. Whereas, T_6, T_{10}, T_9, T_7, T_3, T_4 and T_5 for weed control did not result in satisfactory weed control but there was a considerable reduction in weed density and dry weight from the beginning of crop with these treatments. This made the provision for black gram to establish vigorously. This was due to effective control of weeds either manually or mechanically in these treatments, which has directly removal of emerged weed seedlings in the soil. As the initially vigorous crop stand could provide spatial advantage in suppressing the weeds below threshold level even at later stages. This can be further substantiated with higher ground coverage of the crops in the initial stages.

Crop growth components: At 60 DAS, plant height, leaf area and dry weight of the crop varied significantly (Table 3). Highest plant height, leaf area and dry weight of 33.67cm, 823.25 cm^2 $plant^{-1}$and 14.33 g $plant^{-1}$, respectively was recorded in hand weeding at 20 & 40 DAS (T_{11}) compared to other treatments. However, it was on par with T_2 (32.39 cm, 811.66 cm^2 $plant^{-1}$and 13.56 g $plant^{-1}$, respectively), T_1 (31.32 cm, 796.96 cm^2 $plant^{-1}$and 13.28 g $plant^{-1}$, respectively) and T_8 (31.07 cm, 793.56 cm^2 $plant^{-1}$ and 12.99 g $plant^{-1}$, respectively). This increase in plant height of the crop is mainly due to reduced competition of weeds, weed density and dry weight assisted the black gram crop to record higher plant height. Increased leaf area and dry weight of the crop in the treatment T_{11} is mainly due to increase in the plant height, more number of leaves, branches with reduced competition by weeds. While the lowest plant height, leaf area and dry weight of 28.27 cm, 400.13 cm^2 $plant^{-1}$ and 5.33 g $plant^{-1}$, respectively was recorded in un weeded check (T_{12}) due to severe weed density have affected the growth of the crop to a greater extent.

Yield components : Seed and haulm yield was significantly influenced by weed control practices (Table 3). Higher seed yield of 1129 kg ha^{-1} and haulm yield of 4622 kg ha^{-1} was recorded in the treatment receiving hand weeding at 20 & 40 DAS (T_{11}). However, stale seed bed technique + inter cultivation twice at 25 & 45 DAS (1089 and 4514 kg ha^{-1}, respectively), inter cultivation at 25 DAS + 1 hand weeding at 45 DAS (1076 and 4435 kg ha^{-1}, respectively) and two mechanical weeding at 20 and 40 DAS (1045 and 4324 kg ha^{-1}, respectively) were found to be on par with T_{11}. This might be due to better control of weeds at early stage of the crop resulted in higher number of productive branches and other yield components and yield of the crop. This efficiency might be attributed to effective control of weed density and weed biomass during critical stage of crop-weed competition period which leads to increased availability of nutrients, moisture, light and space for the crop. Similar results were also reported by Nazma *et al*. (2015) and Gaganpreet *et al*. (2010).

Among the treatments, significantly lowest seed and haulm yield was recorded in unweeded check (615 and 2709 kg ha^{-1}, respectively). This reduction in yield and yield components might be due to highest competition for space, light, moisture and nutrients with the black gram throughout the crop growth period which resulted in lower yield components ultimately leads to lower yield of black gram. It is evident from the results that higher weed population and biomass in Un weeded check (T_{12}) plot reduced the number of productive branches and other yield parameters. The research findings of Nazma *et al*. (2015) and Gaganpreet *et al*. (2010) are in concomitant with the present study, where in Un weeded check (T_{12}) accounted for lowest seed and haulm yields.

Weed control efficiency (WCE) and Weed index (WI): Weed control efficiency and weed index varied among different weed control practices at different crop growth stages (Table 4).

At 30 DAS, 60 DAS and at harvest higher weed control efficiency was observed in hand weeding at 20 & 40 DAS (82.81, 76.28 and 65.12 %, respectively) followed by stale seed bed technique + inter cultivation twice at 25 &45 DAS (80.04, 73.69 and 57.27 %, respectively), inter cultivation at 25 DAS + 1 hand weeding at 45 DAS (78.64, 73.04 and 56.60 %, respectively), two mechanical weeding at 20 and 40 DAS (75.86, 69.24 and 51.14%, respectively). Weed control efficiency (WCE) gives the magnitude of

reduction in weed dry matter by weed control treatments. The WCE was higher with hand weeding at 20 & 40 DAS owing to the fact that it produced lesser weed dry weight. Similar findings were observed by Nazma *et al*. (2015) in Black gram. Kumar (2004) in groundnut-finger millet cropping system, who observed hand weeding twice to be the best treatment having the lowest WI, highest WCE and higher yield.

While, weed index is an index to quantify the per cent reduction of yield due to treatment in comparison to the treatment with the least weed competition. Significantly lowest weed index was recorded in stale seed bed technique + inter cultivation twice at 25 & 45 DAS (3.49 %) and was succeeded by inter cultivation at 25 DAS + 1 hand weeding at 45 DAS, two mechanical weeding at 20 and 40 DAS accounted for 4.67 and 7.44 per cent, respectively. While the highest weed index of 45.52 per cent was noticed in un weeded check. Weed index shows the extent of yield reduction due to weed interference. So the lower the value better is the weed control practices.

Economics : Among the weed control practices, higher cost of weed control was obtained in hand weeding at 20 & 40 DAS (Rs. 8250 ha^{-1}). While, lowest cost of weed control was recorded in black gram + fodder cowpea as smothering crop in between rows of black gram (Rs. 987 ha^{-1}). Lower cost of cultivation was observed in un weeded check (Rs.13375 ha^{-1}) with lowest gross (Rs. 24596 ha^{-1}) and net returns (Rs.11221). While, hand weeding at 20 & 40 DAS recorded highest cost of cultivation of Rs. 21625 ha^{-1} with high gross returns of Rs. 45150 ha^{-1} and highest net returns of Rs. 25698 ha^{-1} was observed in stale seed bed technique + inter cultivation twice at 25 & 45 DAS. Among the weed control practices the highest benefit to cost ratio of 2.44 was observed in stale seed bed technique + inter cultivation twice at 25 & 45 DAS followed by two mechanical weeding at 20 and 40 DAS, inter cultivation at 25 DAS + 1 hand weeding at 45 DAS accounted for 2.43 and 2.41, respectively. Whereas, black gram + fodder cowpea as an intercrop (multi-cut) + 1 inter cultivation at 40 DAS recorded lowest benefit to cost ratio of 1.62 (Table 5). Similar results obtained in Sindhu *et al*. (2011) in rice, Pankaj *et al*. (2018), Naik *et al*. (2000) and Ashok *et al*. (2003).

Conclusion

Hand weeding at 20 and 40 DAS is the best efficient method for the control of weeds which produces significantly highest yield and weed control efficiency. Since, the labour availability is a problem besides high cost involved in the hand weeding, Stale seed bed technique + Inter cultivation twice at 25 & 45 DAS (T_2), Inter cultivation at 25 DAS + 1 Hand weeding at 45 DAS (T_1) and Two mechanical (cycle weeder) at 20 & 40 DAS (T_8). weedingwould be a viable alternative for weed management in organic black gram production as it gave higher weed control efficiency, better crop growth and yield parameters, higher grain yield, higher net returns and B:C ratio.

Table 1 : Major weeds species density (number m^{-2}) at 60 DAS in black gram as influenced by organic weed management practices.

Treatments	Sedges	Grasses						Broad leaved weeds												
	Cr	Cd	Da	Dm	Ec	Ei	Total	Alt	Is	Bh	Cv	Av	Cb	Ac	Po	Spa	Es	Sa	Ah	Total
T_1	6.00	0.00	0.00	0.00	0.00	0.00	0.00	4.67	0.67	5.33	0.00	2.67	1.33	1.33	0.00	0.67	0.00	0.00	0.00	16.67
T_2	6.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	0.67	2.00	0.00	2.67	0.67	4.00	0.00	0.00	0.00	0.00	0.00	16.00
T_3	32.00	1.33	0.67	2.00	1.33	2.67	8.00	7.33	0.00	5.33	0.67	2.00	0.67	5.33	0.00	6.67	0.00	2.00	0.00	30.00
T_4	38.00	5.33	0.00	2.00	2.00	2.67	12.00	10.00	1.33	6.00	2.67	3.33	1.33	2.67	1.33	4.67	0.00	0.00	0.00	33.33
T_5	43.33	4.00	0.00	3.33	3.33	4.67	15.33	9.33	2.00	3.33	0.00	9.33	2.00	6.00	0.00	4.00	0.00	0.00	1.33	37.33
T_6	18.00	0.00	0.00	1.33	2.67	1.33	5.33	9.33	2.67	4.67	0.67	0.67	0.00	2.67	0.00	1.33	0.00	0.00	0.00	22.00
T_7	36.67	4.00	0.00	1.33	2.00	4.00	11.33	4.00	0.00	4.00	0.00	4.00	0.00	13.33	0.67	4.67	0.67	0.00	0.00	31.33
T_8	8.00	0.00	0.00	0.67	0.00	0.67	1.33	4.00	0.67	6.67	0.00	1.33	0.00	2.00	0.67	2.67	0.00	0.67	0.00	18.67
T_9	22.00	4.67	0.00	0.00	0.67	0.67	6.00	9.33	0.00	5.33	0.00	5.33	1.33	2.67	0.00	2.00	0.00	0.00	0.00	26.00
T_{10}	23.33	2.00	0.00	0.00	2.67	2.67	7.33	8.00	2.00	4.00	0.67	1.33	0.00	10.00	0.00	2.00	0.00	0.00	0.00	28.00
T_{11}	5.33	0.00	0.00	0.00	0.00	0.00	0.00	4.67	0.67	2.67	0.00	2.00	0.00	0.67	0.00	3.33	0.00	0.00	0.00	14.00
T_{12}	50.00	1.33	0.00	2.00	6.67	10.00	20.00	8.67	2.00	10.67	0.00	2.67	0.67	11.33	0.00	4.00	0.00	0.00	0.00	40.00

Cr- *Cyperus rotundus*, **Dm**- *Digitaria marginata*, **Ec**- *Echinochloa crusgalli*, **Da**- *Dactyloctenium aegyptium*, **Ei**- *Elucina indica*, **Cd**- *Cynodon dactylon*, **Bh**- *Borreria hispida*, **Es**- *Emilia sonchifolia*, **Spa**- *Spilanthus acmella*, **Ac**- *Ageratum conyzoides*, **Alt**- *Alternanthera sessilie*, **Cb**- *Commelina benghalensis*, **Is**- *Ionaidium supfruiticesum*, **Cv**- *Cleome viscose*, Av- *Amaranthus viridis*, **Po**- *Portulaca oleracia*, **Sa**- *Sida acuta*, **Ah**- *Acanthospermum hispida*

T_1 - Inter cultivation at 25 DAS + 1 hand weeding at 45 DAS

T_2 - Stale seed bed technique + inter cultivation twice at 25 & 45 DAS

T_3 - Straw mulching 5 t ha^{-1} at 10-15 DAS

T_4 - Black gram + fodder cowpea as an intercrop (multi-cut) +1 inter cultivation at 40 DAS

T_5 - Black gram + fodder cowpea as smothering crop in between rows of black gram

T_6 - Black gram + fodder cowpea as an intercrop with in-situ incorporation on 35 DAS + 1 inter cultivation at 40 DAS

T_7 - Mechanical (cycle weeder) weeding at 35 DAS

T_8 - Two mechanical weeding at 20 and 40 DAS

T_9 - Cucumber leaf extract 100ml l^{-1} @ 2-4 leaf stage

T_{10} - *Ageratum conyzoides* leaf extract 100ml l^{-1} @ 2-4 leaf stage

T_{11} - Hand weeding at 20 & 40 DAS

T_{12} - Unweeded check

Table 2 : Effect of organic weed management practices on weed density and dry weight of the weeds (sedges, grasses and broad leaf weeds m^{-2}) at 60 DAS in black gram.

Treatments	Weed density				Weed dry weight (g m^{-2})			
	Sedge	**Grasses**	**BLW**	**Total**	**Sedge**	**Grasses**	**BLW**	**Total**
T_1: Inter cultivation at 25 DAS + 1 hand weeding at 45 DAS	2.58 (6.00)	1.00 (0.00)	4.18 (16.67)	4.82 (22.67)	1.23 (0.52)	1.00 (0.00)	2.31 (4.37)	2.42 (4.89)
T_2 : Stale seed bed technique + inter cultivation twice at 25 & 45 DAS	2.58 (6.00)	1.00 (0.00)	4.09 (16.00)	4.73 (22.00)	1.23 (0.51)	1.00 (0.00)	2.27 (4.21)	2.38 (4.73)
T_3: Straw mulching 5 t ha^{-1} at 10-15 DAS	5.72 (32.00)	2.99 (8.00)	5.57 (30.00)	8.42 (70.00)	2.15 (3.66)	1.36 (0.85)	2.70 (6.27)	3.43 (10.79)
T_4: Black gram + fodder cowpea as an intercrop + 1 inter cultivation at 40 DAS	6.24 (38.00)	3.60 (12.00)	5.86 (33.33)	9.18 (83.33)	2.33 (4.42)	1.51 (1.28)	2.79 (6.80)	3.67 (12.49)
T_5: Black gram + fodder cowpea as smothering crop in between rows of black gram	6.66 (43.33)	4.04 (15.33)	6.18 (37.33)	9.85 (96.00)	2.52 (5.33)	1.66 (1.74)	2.85 (7.12)	3.90 (14.19)
T_6: Black gram + fodder cowpea as an intercrop with in-situ incorporation on 35 DAS + 1 inter cultivation at 40 DAS	4.35 (18.00)	2.49 (5.33)	4.79 (22.00)	6.81 (45.33)	1.60 (1.57)	1.24 (0.54)	2.49 (5.21)	2.88 (7.31)
T_7: Mechanical (cycle weeder) weeding at 35 DAS	6.13 (36.67)	3.51 (11.33)	5.68 (31.33)	8.96 (79.33)	2.26 (4.14)	1.47 (1.17)	2.73 (6.46)	3.57 (11.77)
T_8: Two mechanical (cycle weeder) weeding at 20 & 40 DAS	2.96 (8.00)	1.49 (1.33)	4.43 (18.67)	5.37 (28.00)	1.29 (0.68)	1.06 (0.13)	2.40 (4.77)	2.56 (5.58)
T_9: Cucumber leaf extract 100ml l^{-1} @ 2-4 leaf stage	4.79 (22.00)	2.60 (6.00)	5.19 (26.00)	7.42 (54.00)	1.77 (2.15)	1.27 (0.62)	2.55 (5.52)	3.05 (8.29)
T_{10}:*Ageratum conyzoides* leaf extract 100ml l^{-1} @ 2-4 leaf stage	4.93 (23.33)	2.87 (7.33)	5.38 (28.00)	7.72 (58.67)	1.81 (2.30)	1.32 (0.74)	2.64 (6.00)	3.17 (9.04)
T_{11}: Hand weeding at 20 & 40 DAS	2.46 (5.33)	1.00 (0.00)	3.83 (14.00)	4.44 (19.33)	1.20 (0.45)	1.00 (0.00)	2.19 (3.85)	2.29 (4.31)
T_{12}: Unweeded check	7.14 (50.00)	4.57 (20.00)	6.40 (40.00)	10.53 (110.0)	2.77 (6.65)	2.08 (3.37)	3.02 (8.13)	4.38 (18.15)
F test	*	*	*	*	*	*	*	*
S.Em±	**0.19**	**0.16**	**0.21**	**0.27**	**0.05**	**0.05**	**0.07**	**0.08**
CD (P=0.05)	**0.57**	**0.47**	**0.61**	**0.79**	**0.14**	**0.15**	**0.19**	**0.23**

DAS- Days after sowing, BLW- Broad leaved weed, *- Significant.
Figures in the parenthesis are original values; data analysed after square root (X+1) transformation.

Table 3 : Effect of organic weed management practices on plant height(cm), leaf area(cm^2/plant), plant dry weight(g/plant), crop growth rate, CGR (Between 30 DAS to 60 DAS), seed yield (kg/ha), haulm yield (kg/ ha) and harvest index at 60 DAS in black gram.

Treatments	Plant height	Leaf area	Dry weight	CGR	Seed yield	Haulm yield	Harvest Index
T_1: Inter cultivation at 25 DAS + 1 hand weeding at 45 DAS	31.32	796.96	13.28	13.05	6.53	4435	0.20
T_2 : Stale seed bed technique + inter cultivation twice at 25 & 45 DAS	32.39	811.66	13.56	13.32	6.71	4514	0.19
T_3: Straw mulching 5 t ha^{-1} at 10-15 DAS	30.51	528.88	8.00	7.59	5.18	3233	0.18
T_4: Black gram + fodder cowpea as an intercrop + 1 inter cultivation at 40 DAS	29.13	453.52	6.00	5.59	2.65	2763	0.19
T_5: Black gram + fodder cowpea as smothering crop in between rows of black gram	28.42	403.98	5.33	4.96	2.27	2737	0.19
T_6: Black gram + fodder cowpea as an intercrop with in-situ incorporation on 35 DAS + 1 inter cultivation at 40 DAS	30.51	746.90	10.33	10.04	5.73	4135	0.19
T_7: Mechanical (cycle weeder) weeding at 35 DAS	29.64	525.87	7.33	7.00	5.03	3207	0.20
T_8: Two mechanical (cycle weeder) weeding at 20 & 40 DAS	31.07	793.56	12.99	12.88	6.21	4324	0.19
T_9: Cucumber leaf extract 100ml l^{-1} @ 2-4 leaf stage	30.31	601.00	9.33	9.01	5.65	3831	0.18
T_{10}:*Ageratum conyzoides* leaf extract 100ml l^{-1} @ 2-4 leaf stage	30.11	598.72	9.00	8.65	5.64	3867	0.17
T_{11}: Hand weeding at 20 & 40 DAS	33.67	823.25	14.33	14.07	7.27	4622	0.20
T_{12}: Unweeded check	28.27	400.13	5.33	4.99	2.27	2709	0.19
F test	*	*	*	*	*	*	NS
S.Em±	**0.93**	**19.90**	**0.51**	**0.57**	**0.25**	**133.02**	**0.01**
CD (P=0.05)	**2.73**	**58.26**	**1.50**	**1.66**	**0.74**	**389.47**	**NS**

DAS- Days after sowing, *- Significant. NS- Non significant

Table 4 : Influence of weed management practices on weed control efficiency (WCE) and weed index (WI)

	Treatments	WCE (%) 30 DAS	WCE (%) 60 DAS	WCE (%) at harvest	WI (%)
T_1	Inter cultivation at 25 DAS + 1 hand weeding at 45 DAS	78.63	73.04	56.60	4.67
T_2	Stale seed bed technique + inter cultivation twice at 25 & 45 DAS	80.04	73.96	57.27	3.49
T_3	Straw mulching 5 t ha^{-1} at 10-15 DAS	24.46	40.56	26.80	35.13
T_4	Black gram + fodder cowpea as an intercrop (multi-cut) + 1 inter cultivation at 40 DAS	37.67	31.18	16.37	42.10
T_5	Black gram + fodder cowpea as smothering crop in between rows of black gram	34.70	21.83	15.73	44.81
T_6	Black gram + fodder cowpea as an intercrop with in-situ incorporation on 35 DAS + 1 inter cultivation at 40 DAS	46.14	59.71	46.67	12.33
T_7	Mechanical (cycle weeder) weeding at 35 DAS	17.75	35.15	24.40	28.22
T_8	Two mechanical weeding at 20 and 40 DAS	75.86	69.24	51.14	7.44
T_9	Cucumber leaf extract 100ml l^{-1} @ 2-4 leaf stage	44.18	54.35	38.12	27.65
T_{10}	*Ageratum conyzoides* leaf extract 100ml l^{-1} @ 2-4 leaf stage	42.69	50.22	33.92	28.52
T_{11}	Hand weeding at 20 & 40 DAS	82.81	76.28	65.12	-
T_{12}	Unweeded check	-	-	-	45.52

DAS- Days after sowing

Table 5 : Influence of weed management practices on economics of black gram

	Treatments	Cost of weed control practices Rs. ha^{-1}	Cost of cultivation Rs. ha^{-1}	Gross returns Rs. ha^{-1}	Net returns Rs. ha^{-1}	B:C ratio
T_1	Inter cultivation at 25 DAS + 1 hand weeding at 45 DAS	4500	17875	43040	25165	2.41
T_2	Stale seed bed technique + inter cultivation twice at 25 & 45 DAS	4500	17875	43573	25698	2.44
T_3	Straw mulching 5 t ha^{-1} at 10-15 DAS	2400	15775	29289	13514	1.86
T_4	Black gram + fodder cowpea as an intercrop (multi-cut) + 1 inter cultivation at 40 DAS	2767	16142	26140	9998	1.62
T_5	Black gram + fodder cowpea as smothering crop in between rows of black gram	987	14362	24918	10556	1.74
T_6	Black gram + fodder cowpea as an intercrop with in-situ incorporation on 35 DAS + 1 inter cultivation at 40 DAS	4487	17862	39583	21721	2.22
T_7	Mechanical (cycle weeder) weeding at 35 DAS	1900	15275	32407	17132	2.12
T_8	Two mechanical weeding at 20 and 40 DAS	3800	17175	41791	24616	2.43
T_9	Cucumber leaf extract 100ml l^{-1} @ 2-4 leaf stage	2900	16275	32665	16390	2.01
T_{10}	*Ageratum conyzoides* leaf extract 100ml l^{-1} @ 2-4 leaf stage	2900	16275	32272	15997	1.98
T_{11}	Hand weeding at 20 & 40 DAS	8250	21625	45150	23525	2.09
T_{12}	Unweeded check	-	13375	24596	11221	1.84

DAS- Days after sowing

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