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Effect of Non-Chemical Weed Management Practices on Weed Dynamics and Yield in Blackgram (*Vigna mungo*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was conducted at wetlands farms of Tamil Nadu Agricultural University during summer 2022 with an objective of evaluating the non-chemical weed management practices in blackgram (*vigna mungo*). The experiment was laid out in randomized block design with ten treatments and replicated thrice. Treatments included leaf extracts of sorghum, castor and papaya @ 30% concentration, citric acid 5% + garlic 0.2%, dust mulching, mechanical and hand weeding

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along with weed free, weedy check and chemical check. The results revealed that among the various non-chemical weed management practices pre-emergence application of sorghum leaf extract @ 30% concentration resulted in lower weed density (56.33 No.m^{-2}) and dry weight (3.28 g m^{-2}) at 15 DAS which is higher than chemical check (32 No. m^{-2} and 2.11 g m^{-2} respectively). On 30 DAS dust mulching recorded lowest density (73.67 No. m^{-2}) which was on par with sorghum leaf extract (81.33 No.m^{-2}) while weedy check recorded highest density (326.67 No.m^{-2}). PE application of sorghum leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS gave a comparative yield of 875 kg ha^{-1} which was highest among other non-chemical treatments. Thus, using 30% sorghum leaf extracts can aid in cost-effective non-chemical weed control in summer irrigated blackgram.

Keywords: Blackgram; dust mulching; leaf extracts; non-chemical; pre-emergence; weed management.

1. INTRODUCTION

Blackgram (*Vigna mungo* L.), a legume crop which belongs to the family Fabaceae, it is the fourth important pulse crop after chickpea, pigeon pea and green gram. In India it is grown in 4.633 million ha area with 2.776 million tonnes production with a productivity of 599 kg ha^{-1} [1]. The productivity of blackgram in India is lower as compared to the world average (1808 kg ha^{-1}). It is a short duration crop with an initial slow growth. Therefore, it experiences a severe weed infestation upto 45 days after sowing. In both developed and developing countries weeds are the most important biotic constraints to crop production. Among different biotic factors like weeds, insects, pathogens, nematodes, rodents and birds, *etc*., weeds have highest potential for yield loss as they compete for sunlight, water, nutrient and space with crops apart from that, they also act as host plants for insects and pathogens. Based on the nature and density of weed flora, the average yield loss reported was 30-50% [2]. Management of weeds during critical period of crop weed competition (15-45 DAS) is very important to avoid severe yield loss. The use of herbicides for controlling weeds can be highly accepted by farmers for rapid and effective weed control. But non-judicious use of herbicides set down negative impacts like herbicide resistant weeds. At present 266 weed species have developed resistance against 164 herbicides in 96 crops [3]. Alternative weed management strategies have been investigated to achieve a cost-effective weed control strategy. There is a need for increased awareness within the farmer's community, for an assured focus on the non-chemical methods for safe and successful weed control in agriculture. Hence, an attempt has been made to find the suitable, cost effective and efficient non-chemical weed management practices in blackgram.

2. MATERIALS AND METHODS

The field experiment was conducted at Wetlands farm of Tamil Nadu Agricultural University, Coimbatore during summer 2022. The field is located at latitude of 11˚ 00'09.9" N, longitude of 76˚ 55'41.4" E and at an altitude of 429 m MSL. The field experiment was laid out in randomized block design with ten treatments and replicated thrice. The treatment details were mentioned in Table 1. The seeds are sown at 30 × 10 cm spacing with VBN 11 blackgram variety.

Table 1. Treatment details

T_1	PE application of sorghum leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS
T_2	PE application of castor leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS
T_3	PE application of papaya leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS
T_4	PE application of citric acid @ 5% + Garlic @ 0.2% on 3 DAS *fb* hand weeding on 30 DAS
T_5	Dust mulching* on 15 DAS and 30 DAS
T_6	TNAU improved weeder on 15 DAS and 30 DAS
T_7	Hand weeding twice on 15 DAS and 30 DAS
T_8	PE application of pendimethalin @ 1.0 lit ha^{-1} on 3 DAS *fb* hand weeding on 30 DAS (chemical check)
T_9	Weed free check
T_{10}	Weedy check

***** *Pulverizing the soil to create dust mulch*

PE- Pre-emergence; DAS- Days after sowing; fb- followed by

2.1 Preparation of Extracts

2.1.1 Preparation of leaf extracts

The pest and disease-free leaves of sorghum, castor and papaya were collected in and around the experimental farm of TNAU, Coimbatore. The collected leaves were washed and cut into small pieces and soaked in 1:1 ratio of water: leaves for overnight (12 h). Separately each species of soaked leaves with water were ground into paste and filtered through Whatman no.1 filter paper which makes stock solution. From the stock solution 30% concentration was prepared [4,5].

2.1.2 Preparation of citric acid + garlic

Lemons were peeled off and juice was extracted then filtered through muslin cloth and centrifuged for 15 min at 3,000 rpm. From the supernatant 5% citric acid were prepared [6]. Garlic cloves were ground and juice was homogenized in 100 ml of 0.9% cold salt solution at higher speed for 15 minutes. Homogenized mixture was filtered through muslin cloth and 0.2% solution was made from the stock [7] then 5% concentration of citric acid and 0.2% garlic extracts were mixed thoroughly [8].

2.2 Weed Observations

Weed count was taken by using 0.25 m^2 quadrant which is placed randomly in four places in the plot. The counted weeds were collected shade dried and oven dried for 72˚C until constant weight attained. The data obtained from weeds subjected to variations hence data were square root transformed $\sqrt{X + 0.5}$ before analysis statistically as per methods proposed by Gomez and Gomez [9].

2.2.1 Weed Control Efficiency (WCE)

Weed control efficiency was calculated using the weed density of each treatment at 15, 30 and 45 DAS by using the formula suggested by Mani et al. [10].

$$WCE\ (\%) = \frac{WDc - WDt}{WDc} \times 100$$

WCE (%) - Weed Control Efficiency

WD_c - Weed density in unweeded control (No. m^{-2})

WD_t - Weed density in treated plot (No. m^{-2})

3. RESULTS AND DISCUSSION

3.1 Weed Flora

The predominant weed species occured in the experiment field were *Echinochola colona* in grasses, while in broad leaved weeds, *Amaranthus retroflexus*, *Cleome viscosa*, *Convolvulus arvensis, Corchorus olitorius, Marsilea quadrifolia, Portulaca oleracea* and *Trianthema protulacastrum* were observed. Similar, weed flora was reported in blackgram at western zone of Tamil Nadu by Vikram et al., [11] and Richardsan et al., [12].

3.2 Weed Density and Dry Weight

All the non-chemical weed management practices had significant influence on grass and broad-leaved weeds density (Table 2). The leaf extracts of sorghum, castor, papaya at 30 % concentration and citric acid (5%) + garlic (0.2%) showed no phytotoxicity in blackgram. Broad leaved weed density was lower in the experimental field than grass density.

On 15 DAS, chemical check recorded lower weed density (32 No. m^{-2}) followed by sorghum leaf extract performed well with a weed density of 56.33 No. m^{-2}. These results are fitted with the findings of Cheema *et al*. [13] who reported lower weed density was due to herbicidal effect and allelopathic effect of sorghum on the weeds. At 30 DAS chemical check (32.0 No. m^{-2}) was on par with dust mulching (73.67 No. m^{-2}) and hand weeding (78.33 No. m^{-2}) followed by sorghum leaf extract (81.33 No. m^{-2}). Highest weed density was recorded in weedy check (281.67 and 326.67 No. m^{-2}) at 15 and 30 DAS respectively because no weed control measures were taken in weedy check. On 45 DAS, dust mulching recorded lower weed density (26.33 No. m^{-2}) due to repeated pulverizing of soil and the primary effect of dust mulching is controlling of weeds [14]. Among the treatments, weedy check recorded higher weed density (153.67 No. m^{-2}) at 45 DAS.

The reduction in dry weight of weeds (Table 3) was highest in chemical check (2.11 g m^{-2}) followed by sorghum leaf extract (3.28 g m^{-2}) at 15 DAS, which was also reported by Yarnia *et al*. [15] were 5, 10, 15 and 20% sorghum extracts decreased the dry weight of *Amaranthus retroflexus* with 68.92, 85.87, 86.30 and 88.91%, respectively. At 30 DAS, chemical check recorded lowest weed dry weight (22.28 g m^{-2})

which was on par with dust mulching (41.98 g m^{-2}) and hand weeding (43.76 g m^{-2}). The highest dry weight was recorded in weedy check (9.63 g m^{-2} at 15 DAS and 178.62 at 30 DAS g m^{-2}). The minimum dry weight was observed in chemical check (20.96 g m^{-2}) which was on par with dust mulching (24.46 g m^{-2}) and sorghum leaf extract (26.30 g m^{-2}) at 45 DAS.

Table 2. Effect of non-chemical weed management practices on weed density (No m^{-2})

Treatment	15 DAS	30 DAS	45 DAS
T_1 -PE Application of Sorghum leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	7.53 (56.33)	9.04 (81.33)	5.57 (30.67)
T_2 - PE Application of Castor leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	8.94 (79.67)	10.49 (109.67)	5.84 (33.67)
T_3 - PE Application of Papaya leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	8.14 (66)	9.8 (95.67)	5.7 (32)
T_4 - PE Application of Citric acid @ 5% + Garlic @ 0.2% on 3DAS *fb* hand weeding on 30 DAS	9 (80.67)	10.74 (115)	5.9 (34.33)
T_5 -Dust mulching on 15 DAS and 30 DAS	16.19 (261.67)	8.61 (73.67)	5.17 (26.33)
T_6 - TNAU improved weeder on 15 DAS and 30 DAS	16.25 (263.67)	9.62 (92.33)	7.43 (54.67)
T_7 - Hand weeding twice on 15 DAS and 30 DAS	16.31 (265.67)	8.87 (78.33)	6.03 (36)
T_8 - PE application of Pendimethalin @ 1.0 lit ha^{-1} on 3 DAS *fb* hand weeding on 30 DAS (chemical check)	5.69 (32.00)	8.22 (67.33)	5.27 (27.33)
T_9 - Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_{10} - Weedy check	16.79 (281.67)	18.08 (326.67)	12.4 (153.67)
SEd	0.38	0.38	0.32
CD (P=0.05)	0.80	0.80	0.67

PE- Pre- emergence; DAS- Days After Sowing; fb- followed by
Data present in the table is square root transformed value and parentheses are original value

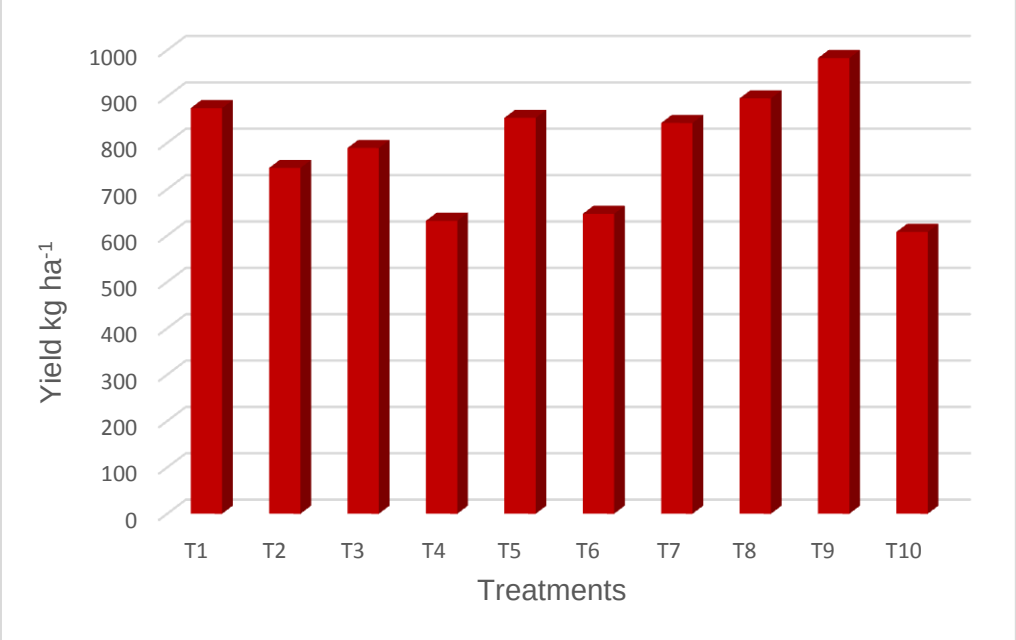

Fig. 1. Effect of non-chemical weed management practices on seed yield (kg ha^{-1})

Table 3. Effect of non-chemical weed management practices on weed dry weight (g m^{-2})

Treatment	15 DAS	30 DAS	45 DAS
T_1 - PE Application of Sorghum leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	1.94 (3.28)	7.55 (56.81)	5.14 (26.30)
T_2 - PE Application of Castor leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	2.32 (4.92)	8.41 (70.27)	5.75 (32.70)
T_3 - PE Application of Papaya leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	2.3 (4.83)	7.98 (63.43)	5.83 (33.62)
T_4 - PE Application of Citric acid @ 5% + Garlic @ 0.2% on 3DAS *fb* hand weeding on 30 DAS	2.46 (5.56)	8.65 (74.74)	5.82 (33.65)
T_5 - Dust mulching on 15 DAS and 30 DAS	3.09 (9.08)	6.51 (41.95)	4.99 (24.46)
T_6 - TNAU improved weeder on 15 DAS and 30 DAS	3.16 (9.47)	7.12 (50.39)	6.78 (45.53)
T_7 - Hand weeding twice on 15 DAS and 30 DAS	3.13 (9.32)	6.65 (43.76)	5.48 (29.61)
T_8 - PE application of Pendimethalin @ 1.0 lit ha^{-1} on 3 DAS *fb* hand weeding on 30 DAS (chemical check)	1.62 (2.11)	4.77 (22.28)	4.62 (20.96)
T_9 - Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_{10} - Weedy check	3.18 (9.63)	13.37 (178.62)	14.51 (210.75)
SEd	0.10	0.41	0.39
CD (P=0.05)	0.21	0.87	0.82

PE- Pre- emergence; DAS – Days After sowing; fb- followed by
Data present in the table is square root transformed value and parentheses are original value

Table 4. Effect of non-chemical weed management practices on weed control efficiency (%) in blackgram

Treatment	15 DAS	30 DAS	45 DAS
T_1 - PE Application of Sorghum leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	79.93	75.05	79.79
T_2 - PE Application of Castor leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	71.68	66.13	77.86
T_3 - PE Application of Papaya leaf extract @ 30% on 3 DAS *fb* hand weeding on 30 DAS	76.56	70.54	78.88
T_4 - PE Application of Citric acid @ 5% + Garlic @ 0.2% on 3DAS *fb* hand weeding on 30 DAS	71.39	64.64	77.42
T_5 - Dust mulching on 15 DAS and 30 DAS	6.94	77.32	82.66
T_6 - TNAU improved weeder on 15 DAS and 30 DAS	6.39	71.42	64.14
T_7 - Hand weeding twice on 15 DAS and 30 DAS	5.72	76.02	76.14
T_8 - PE application of Pendimethalin @ 1.0 lit ha^{-1} on 3 DAS *fb* hand weeding on 30 DAS (chemical check)	88.58	79.13	82.00
T_9 - Weed free check	100.00	100.00	100.00
T_{10} -Weedy check	0.00	0.00	0.00

PE- Pre- Emergence application; DAS- Days after sowing; fb- followed by

3.3 Weed Control Efficiency

Weed control efficiency was calculated at 15, 30 and 45 DAS and presented in Table 4. Higher weed control efficiency was found in chemical check (88.58 % on 15 DAS and 79.13% on 30 DAS) followed by sorghum leaf extract (79.93%) on 15 DAS and dust mulching (77.32%) on 30 DAS. At 45 DAS TNAU improved weeder recorded lowest weed control efficiency (64.14%) because weeds present in intra rows were less affected by TNAU improved weeder.

3.4 Yield

Higher seed yield was obtained in weed free check (983 kg ha^{-1}) followed by chemical check

(896 kg ha^{-1}) due to less weed incidence, which offers less competition to utilize all the inputs to produce higher yield. Among the non-chemical treatments 30% sorghum leaf extract (875 kg ha^{-1}) recorded higher yield which is on par with chemical check (Fig. 1). Similarly, Safi et al., [16] reported yield of sorghum leaf extract sprayed treatment (21.67 capsules plant^{-1}) is closely related with the herbicidal treatment (24.57 capsules plant^{-1}) in flax.

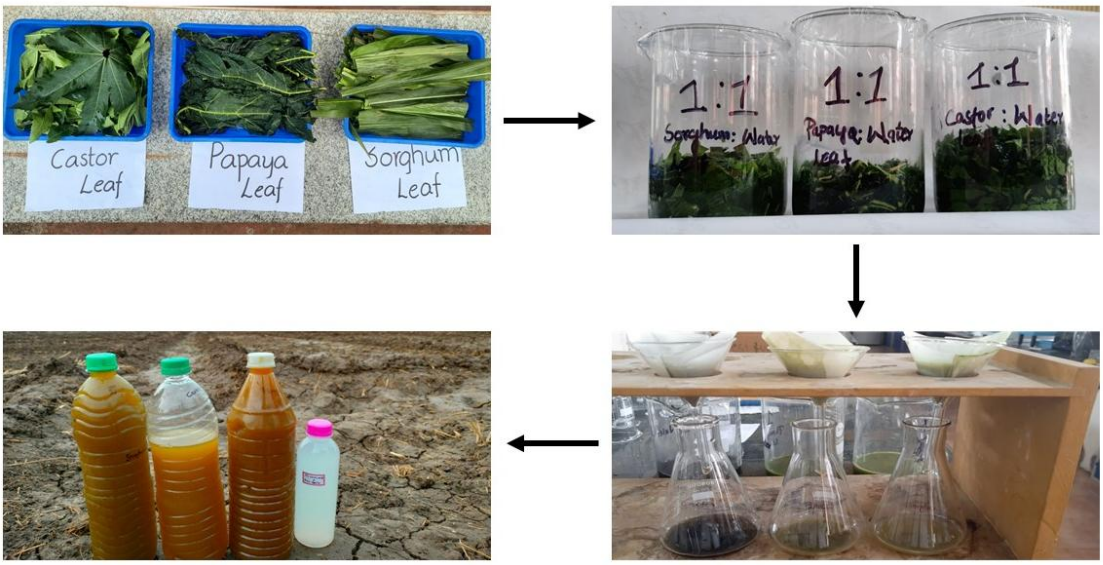

Fig. 2. Preparation of leaf extracts

Fig. 3. T_1 - PE Application of Sorghum leaf extract @ 30%

Fig. 4. T_{10} -Weedy check

Fig. 5. T_7- Hand weeding twice on 15 DAS and 30 DAS

4. CONCLUSION

Among the treatments, sorghum leaf extract @ 30% as pre-emergence performed well in suppressing weeds at 15 DAS due to the presence of allelochemicals like sorgoleone, gallic acid, caffeic acids, protocateuic acid, p-hydroxybenzaldehyde, syringic acid, vanillic acid, p-hydroxybenzoic acid, p-coumaric acid, benzoic acid, ferulic acid and m-coumaric acid [17]. The treatments hand weeding and dust mulching were best on 15 DAS and 30 DAS but manual methods like hand weeding and dust mulching involve more labour [18,19], hence it is uneconomical. From the experimental results, it could be concluded that the sorghum leaf extracts were effective in controlling weeds at earlier stages and further research in use of leaf extracts at different intervals can help in effective screening of leaf extracts for effective and efficient weed management.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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