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Effect of stale seedbed technique and herbicide integration on weed dynamics and yield of *rabi* Blackgram (*Vigna mungo* L.)

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Abstract

Weeds often emerge along with blackgram and compete for nutrients, water, light and space during the early growth stages addressed by de campos *et al.* (2023) [3]. This competition suppresses crop growth and reduces productivity. Since blackgram is highly sensitive to weed interference, effective weed management is essential. Failure to control weeds throughout the crop growth period can cause yield losses of up to 70% reported by Marimuthu *et al.* (2024) [9]. To address this issue, a field experiment was conducted during the *rabi* season of 2025-26 at the Regional Agricultural Research Station (RARS), Palem. The experiment was laid out in a randomized block design comprising 13 treatments with 3 replications to evaluate the effect of stale seedbed technique and herbicide integration on weed dynamics and yield of *rabi* blackgram. The results revealed that the stale seedbed practice combined with shallow tillage followed by application of fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha⁻¹ (PoE) at 20-25 DAS recorded the lowest weed count 1.22 (1.00) No. m⁻², weed biomass 1.15 (2.67) g m⁻² and the highest weed control efficiency (99.4%) at 60 DAS, resulting in superior seed yield (1395 kg ha⁻¹). This treatment was statistically comparable with T₉, stale seedbed (paraquat spray @ 500 g a.i. ha⁻¹ before sowing) followed by application of fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha⁻¹ (PoE) at 20-25 DAS, while T₈ and T₉ were found to be on par with the weed-free check maintained through hand weeding at 20 and 40 DAS (T₁₂).

Keywords: Blackgram, stale seedbed, Shallow Tillage, paraquat, weed control efficiency

1. Introduction

Blackgram is widely grown throughout South and Southeast Asia. In India, it is popularly known as urdbean, whereas in Bangladesh it is referred to as mashkalai addressed by Kaewwongwal *et al.* (2015) [7]. Due to its significant contribution to vegetarian diets, blackgram is highly valued for its protein content (24-26%) and for being a rich source of essential minerals such as calcium and iron reported by Asaduzzaman *et al.* (2010) [1]. In Telangana, blackgram occupied an area of 0.30 lakh ha with a production of 0.43 lakh tonnes and an average productivity of 1462 kg ha⁻¹ (Indiastat, 2024-2025) [5]. Despite its nutritional and agronomic importance, blackgram productivity is affected by several constraints, among which weed infestation is one of the most serious, Marimuthu *et al.* (2024) [9]. Weeds adversely affect crop growth by emerging vigorously and competing with the crop for vital resources such as nutrients, moisture, sunlight and space, particularly during the early stages of crop development reported by Teja *et al.* (2017) [12]. Significant yield reductions due to unchecked weed growth have been reported in India, with losses reaching up to 79% in Hisar, Sharma *et al.* (2024) and 42% in coastal Odisha, Dash *et al.* (2024) [2]. Hence, minimizing crop-weed competition during the critical period of 15-45 DAS is essential for realizing higher crop yields, Reddy *et al.* (2023) [11]. However, timely manual weeding is often constrained by adverse weather conditions and labour shortages, posing a major challenge to effective weed management in blackgram. Therefore, the integration of the stale seedbed technique with herbicide application has been advocated as an efficient approach for suppressing weeds and maintaining their population below the economic threshold level in blackgram cultivation.

2. Materials and Methods

A field experiment was conducted during *rabi* 2025-26 at the Regional Agricultural Research Station, Palem to evaluate the effect of stale seedbed technique and herbicide integration on weed dynamics and yield of *rabi* blackgram. The present investigation was conducted with 13 weed management treatments (T₁ to T₁₃), T₁-Normal sowing + pendimethalin 38.7% CS @ 677.25 g a.i. ha⁻¹ (PE), T₂- Normal sowing + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha⁻¹ (PoE) at 20-25 DAS, T₃- Normal sowing + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha⁻¹ (PoE) at 20-25 DAS, T₄- Stale seedbed (shallow tillage), T₅- Stale seedbed (paraquat spray @ 500 g a.i. ha⁻¹ before sowing), T₆- Stale seedbed (shallow tillage) + pendimethalin 38.7% CS @ 677.25 g a.i. ha⁻¹ (PE), T₇- Stale seedbed (paraquat spray @ 500 g a.i. ha⁻¹ before sowing) + pendimethalin 38.7% CS @ 677.25 g a.i. ha⁻¹ (PE), T₈- Stale seedbed (shallow tillage) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha⁻¹ (PoE) at 20-25 DAS, T₉-Stale seedbed (paraquat spray @ 500 g a.i. ha⁻¹ before sowing) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha⁻¹ (PoE) at 20-25 DAS, T₁₀- Stale seedbed (shallow tillage) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha⁻¹ (PoE) at 20-25DAS, T₁₁- Stale seedbed (paraquat spray @ 500 g a.i. ha⁻¹ before sowing) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha⁻¹ (PoE) at 20-25 DAS, T₁₂- Weed free check (Hand Weeding at 20 & 40 DAS), T₁₃- Weedy check laid out in a Randomized Block Design (RBD) with three replications. The experimental field comprised well drained sandy loam soil containing 70.0% sand, 16.3% silt and 12.5% clay. The soil was slightly alkaline in reaction with a pH of 7.8, non-saline with an electrical conductivity (EC) of 0.23 dS m⁻¹ and low in organic carbon content (0.35%). Prior to sowing, the soil nutrient status indicated low available nitrogen (220 kg ha⁻¹), high available phosphorus (45 kg ha⁻¹) and high available potassium (322 kg ha⁻¹). During the crop growth period, the mean weekly maximum temperature reached 35.9 °C, while the minimum temperature dropped to 11.9°C. The black gram variety MBG-1070, having a crop duration of 80-85 days was sown at a seed rate of 20-25 kg ha⁻¹ with a spacing of 30 × 10 cm. The stale seedbed was prepared after the layout of the experimental field. Pre-sowing irrigation was applied only to the stale seedbed plots. Two flushes of weeds were allowed to emerge and were removed before sowing. The stale seedbed was maintained for 14 days with an interval of 7 days between successive weed flushes. At sowing, fertilizers were applied at the rate of 20:50:0 kg N:P₂O₅:K₂O ha⁻¹ through urea and single super phosphate. The weed management treatments were imposed according to the treatment schedule. Herbicides were applied using a knapsack sprayer fitted with a flat-fan nozzle, utilizing a spray volume of 500 L water ha⁻¹. The crop was raised by following the recommended package of practices for black gram cultivation. Weed density of grasses, sedges and broad-leaved weeds was recorded at 15 day intervals up to 60 DAS using a 0.5 × 0.5 m quadrat (0.25 m²) placed randomly within each plot. Data on weed population and weed dry matter were subjected to square root transformation $\sqrt{(X + 0.5)}$ to normalize their distribution before statistical analysis, following the procedure described by Gomez and Gomez (1984) [4]. The weeds collected from the quadrats were oven dried at 65 °C for 24 hours until a constant weight was attained and the dry weight was expressed in g m⁻². Weed control efficiency (WCE) was calculated using the formula proposed by Mani *et al.* (1973) [8].

$$WCE (\%) = \frac{WDC - WDT}{WDC} \times 100$$

WDC- Dry matter production of weeds in control plot (g m⁻²)

WDT- Dry matter production of weeds in treated plot (g m⁻²)

The experimental data were statistically analyzed using Fisher's analysis of variance (ANOVA) technique. Treatment effects were tested for significance using the F-test at the 5% probability level. Analysis of variance was carried out on all the observations recorded during the course of the investigation.

3. Results and Discussion

3.1 Weed flora

The predominant weed flora observed in the experimental field comprised *Echinochloa colona*, *Digitaria sanguinalis* and *Dactyloctenium aegyptium* among grasses, *Cyperus rotundus* among sedges and *Parthenium hysterophorus*, *Amaranthus viridis*, *Euphorbia hirta*, *Phyllanthus niruri*, *Digera arvensis*, *Trianthema portulacastrum* and *Mollugo verticillata* among broad-leaved weeds. Among the different weed groups, broad-leaved weeds were dominant followed by sedges and grasses.

3.2 Weed count (No. m⁻²), weed biomass (g m⁻²) and weed control efficiency (%)

Different weed management practices significantly influenced weed count, weed biomass and weed control efficiency, as presented in Tables 1 and 2. Among all the treatments, T₁₂ recorded the lowest weed count 1.05 (0.67) No. m⁻² and weed biomass 1.00 (0.53) g m⁻², along with the highest weed control efficiency (99.6%) and was statistically on par with T₈ and T₉. The superior performance of T₁₂ may be attributed to the weed free conditions maintained during the critical period of crop-weed competition through hand weeding at 20 and 40 DAS. In the case of T₈ and T₉, the effective control of weeds could be due to the combined effect of the stale seedbed technique and herbicide application. The stale seedbed practice reduced the initial flush of germinating weeds through shallow cultivation in T₈ and through the application of paraquat, a non-selective contact herbicide, in T₉. Similar findings were reported by Johnson and Mullinix (1995) [6], observed that the stale seedbed technique was effective in reducing weed density in peanut cultivation. This was followed by the post-emergence application of the ready-mix herbicide fluazifop-p-butyl + fomesafen, which provided broad-spectrum weed control. Fluazifop-p-butyl effectively controlled grassy weeds by inhibiting the ACCase enzyme, whereas fomesafen controlled sedges and broad-leaved weeds through inhibition of the PPO enzyme. Similar findings were recorded by Pallerla *et al.* (2024) [10]. Among all the treatments weedy check recorded the highest weed count 14.14 (199.67) No. m⁻², weed biomass 11.82 (139.55) g m⁻² and lowest weed control efficiency (0.00%).

3.3 Yield (kg ha⁻¹) and harvest index (%)

Significantly higher seed yield (1415 kg ha⁻¹) and haulm yield (2731 kg ha⁻¹) were recorded with T₁₂ (weed free check maintained by hand weeding twice at 20 and 40 DAS) represented in Table 3. This could be attributed to the lower weed count, reduced weed biomass and higher weed control efficiency maintained throughout the crop growth period under weed-free conditions, which minimized crop-weed competition. The yields (seed yield and haulm yield) recorded under T₁₂ were statistically comparable with those obtained under T₈ (1395 and 2668 kg ha⁻¹, respectively) and T₉ (1349 and 2655 kg ha⁻¹,

respectively). Higher harvest index reported with weed free check (hand weeding at 20 and 40 DAS) which was statically on par with T₈ and T₉. This may be attributed to the stale seedbed technique, which effectively reduced the initial flush of emerging weeds through shallow tillage in T₈ and paraquat application before sowing in T₉. The subsequent post-emergence application of fluazifop-p-butyl + fomesafen provided broad-

spectrum and season long weed control. Effective weed suppression during the critical stages of crop growth minimized competition for light, water and nutrients, creating favourable conditions for crop development and assimilate translocation, which ultimately resulted in higher seed yield. These results are in accordance with those reported by Yadav *et al.* (2022)^[13].

Table 1: Influence of weed management practices on weed count (No.m⁻²) at 60 DAS of blackgram

Treatment details		At 60 DAS			
		Grasses	Sedges	BLW	Total
T ₁	Normal sowing + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	3.43 (11.33)	6.71 (44.67)	7.15 (50.67)	10.34 (106.67)
T ₂	Normal sowing + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1.22 (1.00)	3.03 (8.67)	1.35 (1.67)	3.43 (11.33)
T ₃	Normal sowing + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (Ready mix) (PoE) at 20-25 DAS	1.58 (2.00)	4.23 (17.67)	2.35 (5.00)	5.00 (24.67)
T ₄	SSB (shallow tillage)	2.80 (7.33)	5.33 (28.00)	3.85 (14.33)	7.08 (49.67)
T ₅	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing)	3.12 (9.33)	6.04 (36.00)	4.05 (16.00)	7.86 (61.33)
T ₆	SSB (shallow tillage) + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	2.53 (6.00)	5.38 (28.67)	3.85 (14.33)	7.03 (49.00)
T ₇	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	2.27 (4.67)	6.15 (37.67)	3.56 (12.33)	7.40 (54.67)
T ₈	SSB (shallow tillage) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	0.88 (0.33)	1.05 (0.67)	0.71 (0.00)	1.22 (1.00)
T ₉	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	0.88 (0.33)	1.68 (2.33)	0.71 (0.00)	1.77 (2.67)
T ₁₀	SSB (shallow tillage) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1.22 (1.00)	2.26 (4.67)	0.88 (0.33)	2.53 (6.00)
T ₁₁	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1.34 (1.33)	2.41 (5.33)	0.88 (0.33)	2.73 (7.00)
T ₁₂	Weed free check (Hand Weeding at 20 & 40 DAS)	0.71 (0.00)	1.05 (0.67)	0.71 (0.00)	1.05 (0.67)
T ₁₃	Weedy check	5.60 (31.00)	9.31 (87.00)	9.06 (81.67)	14.14 (199.67)
	SEm±	0.14	0.29	0.17	0.23
	CD (P=0.05)	0.42	0.84	0.51	0.68

Note: Values in parenthesis are original observations. Data were subjected to square root transformation ($\sqrt{x+0.5}$) prior to statistical analysis. BLW- Broad-leaved weeds, SSB- Stale seedbed, a.i.- Active ingredient, CS- capsule suspension ME- Micro emulsion, SL- soluble liquid, PE- pre-emergence, PoE- Post-emergence

Table 2: Influence of weed management practices on weed biomass (g m⁻²) and weed control efficiency (%) at 60 DAS of blackgram

Treatment details		At 60 DAS				WCE (%)
		Grasses	Sedges	BLW	Total	
T ₁	Normal sowing + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	3.20 (9.82)	6.02 (35.90)	5.19 (26.49)	8.52 (72.21)	48.3
T ₂	Normal sowing + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1.16 (0.84)	2.73 (6.93)	1.13 (0.88)	3.02 (8.66)	93.8
T ₃	Normal sowing + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (Ready mix) (PoE) at 20-25 DAS	1.49 (1.73)	3.83(14.43)	1.75 (2.56)	4.37 (18.72)	86.6
T ₄	SSB (shallow tillage)	2.54 (5.96)	4.64 (21.08)	2.59 (6.22)	5.81 (33.27)	76.2
T ₅	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing)	2.90 (8.02)	5.40 (28.73)	2.87 (7.80)	6.70 (44.55)	68.1
T ₆	SSB (shallow tillage) + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	2.38 (5.29)	4.83 (22.92)	2.82 (7.49)	6.02 (35.70)	74.4
T ₇	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	2.12 (3.99)	5.50 (30.03)	2.58 (6.24)	6.36 (40.26)	71.2
T ₈	SSB (shallow tillage) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	0.86 (0.28)	1.00 (0.54)	0.71 (0.00)	1.15 (0.82)	99.4
T ₉	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	0.86 (0.30)	1.26 (1.11)	0.71 (0.00)	1.37 (1.40)	99.0
T ₁₀	SSB (shallow tillage) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1.16 (0.85)	2.05 (3.74)	0.86 (0.28)	2.30 (4.87)	96.5

T ₁₁	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1.26 (1.11)	2.17 (4.25)	0.86 (0.28)	2.48 (5.65)	96.0
T ₁₂	Weed free check (Hand Weeding at 20 & 40 DAS)	0.71 (0.00)	1.00 (0.53)	0.71 (0.00)	1.00 (0.53)	99.6
T ₁₃	Weedy check	5.24 (26.99)	8.39 (70.60)	6.51 (41.95)	11.82 (139.55)	0.00
	SEm±	0.14	0.26	0.13	0.22	48.3
	CD (P=0.05)	0.42	0.75	0.39	0.65	93.8

Note: Values in parenthesis are original observations. Data were subjected to square root transformation $\sqrt{X + 0.5}$ prior to statistical analysis. BLW- Broad-leaved weeds, SSB- Stale seedbed, a.i.- Active ingredient, CS- capsule suspension, ME- Micro emulsion, SL- soluble liquid, PE- pre-emergence, PoE- Post-emergence

Table 3: Influence of weed management practices on yield (kg ha⁻¹) and harvest index (%) of blackgram

Treatment details		Yield (kg ha ⁻¹)		Harvest index (%)
		Seed yield	Haulm yield	
T ₁	Normal sowing + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	714	1740	29.1
T ₂	Normal sowing + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1117	2383	31.9
T ₃	Normal sowing + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (Ready mix) (PoE) at 20-25 DAS	817	1974	29.3
T ₄	SSB (shallow tillage)	901	2103	30.0
T ₅	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing)	865	2082	29.6
T ₆	SSB (shallow tillage) + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	1039	2306	30.9
T ₇	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + pendimethalin 38.7% CS @ 677.25 g a.i. ha ⁻¹ (PE)	969	2234	30.2
T ₈	SSB (shallow tillage) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1395	2668	34.3
T ₉	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1349	2655	33.7
T ₁₀	SSB (shallow tillage) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1228	2491	32.9
T ₁₁	SSB (paraquat spray @ 500 g a.i. ha ⁻¹ before sowing) + propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 50+75 g a.i. ha ⁻¹ (PoE) at 20-25 DAS	1203	2463	32.7
T ₁₂	Weed free check (Hand Weeding at 20 & 40 DAS)	1415	2731	34.0
T ₁₃	Weedy check	401	1345	23.1
	SEm±	77	95	1.7
	CD (P=0.05)	224	279	5.0

Note: SSB- Stale seedbed, a.i.- Active ingredient, CS- capsule suspension, ME- Micro emulsion, SL- soluble liquid, PE- pre-emergence, PoE- Post-emergence

4. Conclusion

Among the different weed management practices, T₁₂ (hand weeding at 20 and 40 DAS) was found to be superior, recording the lowest weed count and weed biomass, along with the highest weed control efficiency, yield and harvest index. However, its performance was statistically comparable with T₈, SSB (shallow tillage) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha⁻¹ (PoE) at 20-25 DAS and T₉, SSB (paraquat spray @ 500 g a.i. ha⁻¹ before sowing) + fluazifop-p-butyl 11.1% w/w + fomesafen 11.1% w/w SL @ 250 g a.i. ha⁻¹ (PoE) at 20-25 DAS.

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