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Response of summer irrigated black gram (*Vigna mungo* L.) to planting method and weed management methods under western agro-climatic zones of Tamil Nadu

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Abstract

To assess the effect of sowing methods and weed management on summer irrigated black gram yield, a field experiment was conducted during the summer season of 2024 in the Department of Pulses at Tamil Nadu Agricultural University, Coimbatore. The treatments were employed in the Split plot design and replicated thrice. The sowing methods and weed management treatments were allotted in the main and subplots, respectively. The findings showed that, among the sowing methods, furrow-irrigated raised beds recorded a lower weed density and concerning weed management, the pre-emergence (PE) application of Pendimethalin 30 % + Imazethapyr 2 % EC (ready mix) and weeding with power-operated weeder at 20 DAS resulted in lesser weeds which leads to higher weed control efficiency (79.88 %) and higher seed yield in both furrow-irrigated raised beds and pre-emergence (PE) application of Pendimethalin 30 % + Imazethapyr 2 % EC (ready mix) and weeding with power-operated weeder at 20 DAS.

Keywords

blackgram; sowing methods; weed density; weed dry weight; yield

Introduction

Pulses are crucial in Indian farming systems as primary crops, catch crops, cover crops, green manure and intercrops (1). Monoculture cereals can be diversified by incorporating legumes, especially pulses, to achieve nutritional security. Including legumes in cropping systems promotes soil sustainability and nutritional security (2). India is the world's leading producer and consumer of pulses, accounting for 25.5 % of the global production (3). Blackgram (*Vigna mungo* L.) is a major pulse crop in India, cultivated over 45.83 lakh hectares, with an annual production of 25.55 lakh tonnes and a 558 kg/ha productivity. Among Indian states, Andhra Pradesh has the highest productivity of 1057 kg/ha (4). In Tamil Nadu, black gram is grown on over 3.97 lakh hectares, with a total production of 2.68 lakh tonnes and productivity of 675 kg/ha (5). Low production of pulse crops can be attributed to several factors, including inappropriate sowing techniques and timing, poor crop stand management, over-irrigation, delays in weed management and inadequate intercultural operations like thinning, gap filling, hoeing, etc. (6).

The sowing technique significantly impacts yield and production in pulses. Planting pulses in the furrow irrigated raised bed (FIRB) system is viable for

minimizing water losses while offering several benefits (7). These include maximizing productivity, preventing waterlogging, serving as a drainage channel, increasing nitrogen (N) use efficiency and reducing lodging (8). Raised bed planting also enhances crop establishment, reduces soil compaction and improves the availability of nutrients to crops due to lesser dry matter accumulation by weeds and avoids water stagnation, etc. (9).

Among the *kharif* pulses, black gram is a significant crop typically produced on marginal and submarginal fields without proper weed management. Weeds may reduce seed yield by up to 78 %. The application of pre-emergence herbicide Pendimethalin 30 % + Imazethapyr 2 % EC was chosen for its complementary effectiveness in managing a broad spectrum of weeds (10). Manual weeding is typically more expensive, time-consuming and labour-intensive (11). In light of this, the current study looked into the combined effects of weed management practices and sowing methods on black gram productivity.

Materials and Methods

A field experiment was conducted in the summer of 2024 at a pulse farm, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (11° 1'N, 76° 55'E, altitude 434 m). The red sandy loam soil at the experimental site had a composition of 55.45 % sand, 24.25 % silt and 9.40 % clay. Its pH is 8.61, its organic carbon content is 0.36 % and the available N, P and K contents are 334 kg/ha, 17.3 kg/ha and 611 kg/ha, respectively.

The field experiment was laid out in a split-plot design with three methods of sowing in the main plot and five weed management practices in the subplot, and it was replicated three times. Treatments comprised in main plots are M_1- Line sowing (Fig 2), M_2 - Sowing in Furrow Irrigated Raised Bed (FIRB) (Fig 3), M_3 - Seed drill sowing (Fig 1) and subplots are S_1 - PE (Pre-emergence) application of Pendimethalin 30 % + Imazethapyr 2 % EC (Ready mix) on 3 DAS (Days After Sowing) *fb* (followed by) one hand weeding on 20 DAS, S_2 - PE application of Pendimethalin 30 % + Imazethapyr 2 % EC (Ready mix) on 3 DAS *fb* Power Operated weeder on 20 DAS, S_3 - PE application of Pendimethalin 30% + Imazethapyr 2 % EC (Ready mix) on 3 DAS *fb* EPoE (Early post-emergence) application of Sodium Acifluorfen 16.5 % + Clodinafop-Propargyl 8 % EC (Ready-mix) on 20 DAS, S_4- Weed free, S_5- Weedy check. FIRB was formed using a raised bed formerly. The width of the raised bed was 60 cm. Seeds were dibbled manually in M_1 and M_2 treatment. Meanwhile, in M_3, an inclined plate seed drill was used for sowing. Row spacing of 30 cm and a plant spacing of 10 cm was maintained in all plots. Pendimethalin 30 % + Imazethapyr 2 % EC was sprayed as PE on 3 DAS of the crop, whereas Sodium Acifluorfen 16.5 % + Clodinafop-Propargyl 8 % EC was sprayed on 20 DAS as Early post-emergence. Blackgram variety VBN-11 was used with a 20 kg/ha seed rate. The basal recommended doses of N (25 kg/ha), P_2O_5 (50 kg/ha) and K_2O (25 kg/ha) were applied through the use of urea, single super phosphate and muriate of potash, respectively.

Fig. 1. Seed drill sowing.

Fig. 2. Line sowing.

Fig. 3. Furrow irrigated raised bed former.

Weed density and dry weight were recorded 30 and 45 days after sowing (DAS). This was done randomly using a 0.5 m × 0.5 m (0.25 m^2) quadrant placed in four locations within each plot. Weeds within the quadrant frame were counted and the average weed count was expressed as the number per square meter (No./m^2). At 30 and 45 DAS, the dry weights of the weeds were measured by placing them in a hot air oven after taking the weed count. The dry weight was determined using the formula given in Equation 1 :

$$WCE = \frac{\text{Dry weight of weeds in weedy check-Dry weight of weeds in treatment plot}}{\text{Dry weight of weeds in weedy check}} \times 100$$

Data was collected on plant characteristics, including plant height, branches/plant and pods/plant, from five randomly chosen plants in each experimental plot. Additionally, seeds/pod count was recorded for twenty randomly selected pods/plots. The weight of a hundred seeds was recorded. Seed yield and haulm yield were measured for each entire plot. These measurements were then converted into kg/ha. The collected data was analyzed using standard statistical methods.

Results and Discussion

Weed dynamics

Grasses like *Cynodon dactylon* and *Echinichloa colona*, sedges like *Cyperus rotundus* and broad-leaved weeds *viz Parthenium hysterophorus, Trianthema portulacastrum* and *Boerhavia diffusa* were prominent weed flora that observed throughout the experimental period.

The experiment results showed that the sowing techniques and weed management significantly affected the weed density and dry weight (Table 1). Among the sowing methods, furrow irrigated raised bed (M_2) recorded the lowest weed count and weed dry weight, followed by the line sowing method (M_1), but it was significantly on par with seed drill sowing (M_3). This could be attributed to the enhanced suppression of weeds by more vigorous crop growth, reduced space for weeds and greater availability of nutrients and moisture for the crops in the Brod Bed Furrow sowing compared to other sowing methods. Similar results were obtained in black gram when sown under the Broad Bed and Furrow (BBF) system and a similar reduction in weed population was noted in pigeonpea cultivated using the BBF method (11, 12). With respect to weed management practices, S_2 - PE application of Pendimethalin 30 % + Imazethapyr 2 % EC *fb* Power operated weeder showed lower weed density of 25.78, 29.67 No./m^2 and weed dry weight of 11.85, 15.59 g/m^2 on 30 and 45 DAS, respectively and it was comparable with S_1 - PE application of Pendimethalin 30 % + Imazethapyr 2 % EC *fb* One Hand weeding. Likewise, increased Weed Control Efficiency of 79.88 and 75.76 were also noted in the same treatments (S_2). This might be due to the application of herbicide as pre-emergence controls the weeds at the early growth stage of the crop and power–operated weeding at a later stage. These results correspond with another study, which also opined lesser weed density, lesser weed dry weight, and higher weed control efficiency (13).

Table 1. Effect of sowing methods and weed management on weed density, weed dry weight and weed control efficiency at 30 and 45 days after sowing (DAS)

Treatment	Weed density (No/m^2)		Weed dry weight (g/m^2)		Weed control efficiency (%)	
	30 DAS	45 DAS	30 DAS	45 DAS	30 DAS	45 DAS
Sowing methods						
M_1	8.80 (158.73)	8.58 (136.66)	6.01 (72.80)	6.18 (68.75)	–	–
M_2	7.80 (126.60)	7.62 (109.67)	5.32 (57.64)	5.52 (55.19)	–	–
M_3	9.08 (162.73)	8.75 (139.73)	6.22 (74.45)	6.35 (71.27)	–	–
CD (P =0.05)	0.62	0.63	0.44	0.44	–	–
S_1	5.56 (30.89)	5.90 (34.67)	3.79 (14.13)	4.31 (18.24)	78.09	73.82
S_2	5.07 (25.78)	5.46 (29.67)	3.48 (11.85)	3.99 (15.59)	79.88	75.76
S_3	5.92 (35.00)	6.33 (40.00)	3.98 (15.54)	4.63 (21.10)	76.99	71.87
S_4	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	100.00	100.00
S_5	25.56 (655.11)	23.182 (539.11)	17.30 (293.97)	16.46 (271.62)	–	–
CD (P =0.05)	0.68	0.64	0.46	0.47	–	–

(The values in the table are square root transformed values; original values are represented in parentheses)

Growth parameters

Different treatments of sowing methods and weed management significantly affected plant height and No of-branches/plants (Table 2). The furrow irrigated raised bed method of sowing significantly surpassed the line sowing method regarding plant height (46.53 cm) and number of branches/plant (6.5). Line sowing method and seed drill sowing are significantly on par. Better crop growth and development in furrow-irrigated raised beds might be due to increased crop availability of nutrients and moisture and less competition for natural resources. Similar results of increased plant height and branches/plants in green gram under the raised bed were also found in another study (9). Among the weed management practices, the maximum plant height of 50.35 cm was observed in the weed-free plot. This height was significantly higher than that of the other weed management approaches. It was statistically comparable to the height achieved with the PE application of Pendimethalin 30 % + Imazethapyr 2 % EC at 3 DAS, followed by a power-operated weeder. The highest number of branches/plant (6.78) was observed in the weed-free plots, which was statistically comparable to the PE application of Pendimethalin 30 % + Imazethapyr 2 % EC at 3 DAS, followed by power-operated weeder and the PE application of Pendimethalin 30 % + Imazethapyr 2 % EC at 3 DAS, followed by one hand weeding. The weedy check (control) recorded the lowest number of branches. The higher plant height and branches were attributed to the timely removal of weeds and the utilization of a power-operated weeder, which potentially enhanced the root aeration and positively influenced root parameters, contributing to superior plant height and branches. These findings are consistent with those of another study conducted on rice, which resulted in exceptional growth parameters like plant height and number of shoots (14)

Yield attributes and yield

Table 2 provides information on pods/plant, seeds/pod, test weight, seed yield and haulm yield. Sowing methods and weed management significantly influenced the number of pods/ plant, seed yield and haulm yield. However, seeds/pod and test

Table 2. Effect of sowing methods and weed management on plant height, yield and yield attributes of black gram

Treatment	Plant height at 45 DAS	Branches/plant	Pods/ plant	Seeds/ Pod	Test weight (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)
Sowing methods							
M_1	40.72	5.96	31.26	5.72	4.47	773	1776
M_2	46.53	6.50	33.31	5.77	4.52	833	2285
M_3	39.00	5.38	29.06	5.73	4.50	744	1757
CD (P =0.05)	4.63	0.72	1.93	NS	NS	49.30	119.98
Weed management							
S_1	44.38	6.15	33.94	5.77	4.50	838	2038
S_2	45.82	6.30	35.40	5.80	4.53	850	2116
S_3	40.85	5.48	30.36	5.76	4.50	782	1782
S_4	50.35	6.64	37.28	5.89	4.53	900	2261
S_5	29.01	5.14	19.06	5.47	4.43	544	1500
CD (P =0.05)	4.80	0.63	2.62	NS	NS	50.59	126.07

weight were not significantly affected by either sowing methods or weed management. Sowing black gram on the furrow irrigated raised bed (FIRB) resulted in more pods/plant (33.31) compared to line sowing and seed drill sowing. Similar results were reported in black gram (15). Concerning weed management, the highest number of pods/plants (37.28) was observed in the weed-free plot, significantly more significant than in the other treatments. This was comparable to the PE application of Pendimethalin 30 % + Imazethapyr 2 % EC at 3 DAS, followed by a power-operated weeder. This increase in pods/plants can be attributed to the lower weed density, reduced weed dry weight and higher weed control efficiency.

Significantly higher seed yield (833 kg/ha) and haulm yield (2270 kg/ha) were recorded in furrow irrigated raised bed method of sowing followed by line sowing. This could be due to favourable soil conditions like reduced soil compaction and increasing moisture availability. The plant collects and translocates photosynthates from source to sink more effectively, increasing all growth and yield qualities. In cowpeas, the superior yield was recorded under the broad bed and furrow method of sowing (16). Concerning weed management, the highest seed yield (900 kg/ha) and haulm yield (2261 kg/ha) was obtained in the weed-free plot, which was comparable to the pre-emergence (PE) application of Pendimethalin 30 % + Imazethapyr 2 % EC at 3 DAS, followed by power-operated weeder (850 kg/ha and 2116 kg/ha, respectively). Among all the weed management techniques, the unmanaged weedy check resulted in the lowest seed yield (544 kg/ha) and haulm yield (1500 kg/ha) compared to the other weed management practices.

Similarly, higher seed and haulm yields in pigeonpea were reported (12). The increased seed and haulm yields observed in weed management practices can be attributed to timely and efficient weed management. These treatments reduced the dry weight and density of weeds, allowing the crop plants to access adequate light, space, nutrients and moisture. Consequently, this led to increased pods per plant and higher seed yield.

Interpretation of Pearson Correlation Analysis of weed, growth, yield and yield parameters.

Weed density and dry matter exhibited a highly significant negative correlation with the growth and yield attributes. However, growth and yield characteristics such as plant height, branches per plant, pods per plant and seeds per pod were positively correlated with yield (Fig. 4.). This indicates that as weed interference increased, black gram's growth and yield attributes decreased accordingly.

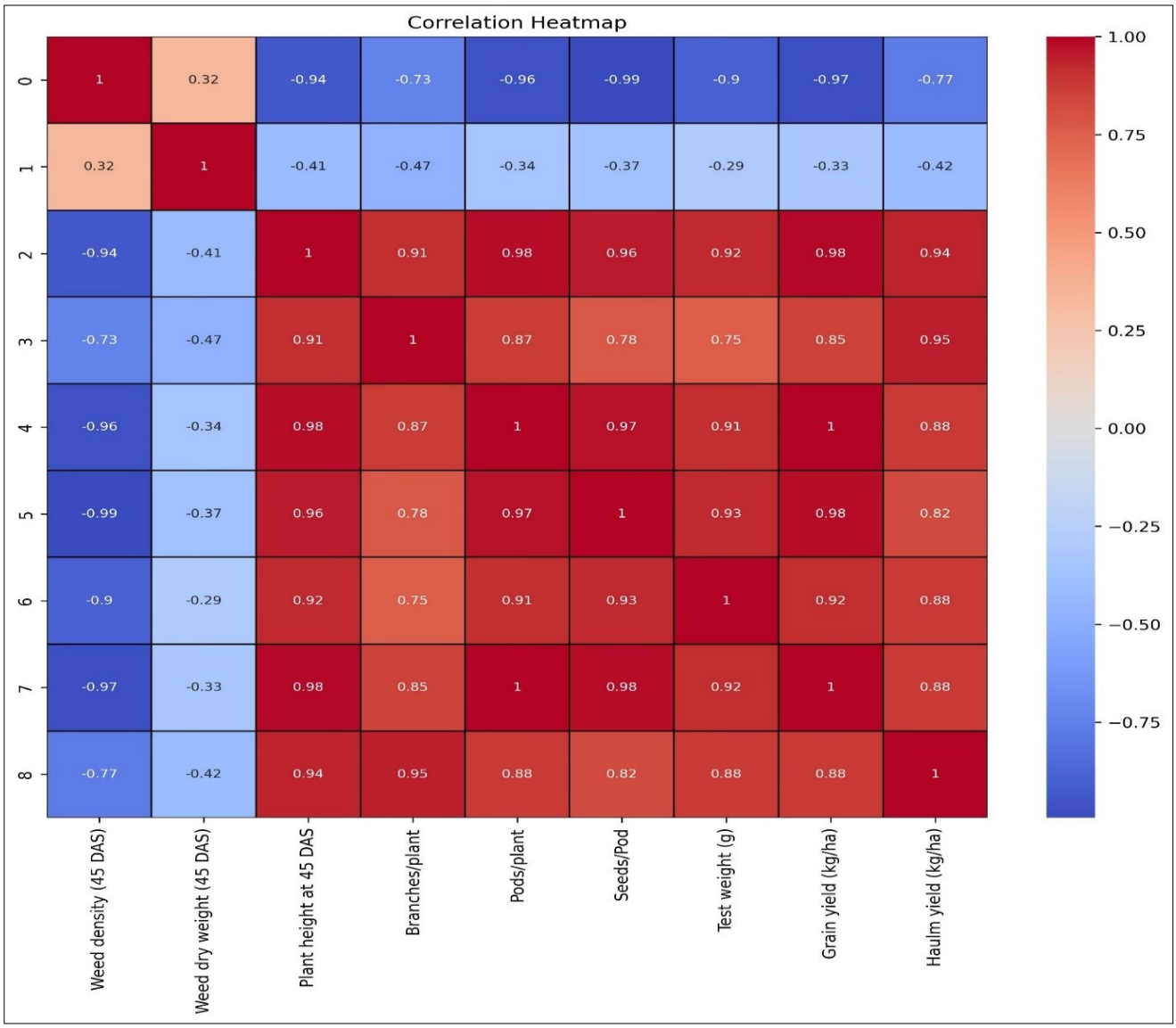

Fig. 4. Pearson correlation analysis heatmap for different variables.

Conclusion

Thus, it can be enunciated that the furrow irrigated raised bed along with weed management through the application of Pendimethalin 30 % + Imazethapyr 2 % EC on 3 DAS, followed by weeding by power-operated weeder on 20 DAS could reduce the weed density effectively in summer irrigated black gram under western agro-climatic zones of Tamil Nadu to get higher seed yield with higher weed control efficiency by reducing the competition between crop and plants.

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Authors' contributions

SS was responsible for carrying out the work, preparing the manuscript and communicating. AFS reviewed the manuscript and RM, BRP and MKAP provided guidance and helped throughout the process.

Compliance with ethical standards

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While preparing this work, the author(s) used a quill bot to improve language and readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the publication's content.

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