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Effect of seed rate and row spacing on growth and yield of black gram under rainfed conditions

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Abstract

Leading pulse agronomists have long argued that optimising plant population density is the simplest, lowest-cost lever available for raising grain legume yields in rainfed systems. This research evaluated the effect of three seed rates (20, 25, 30 kg/ha) and three row spacings (20, 25, 30 cm) on growth and yield of black gram (*Vigna mungo* L. Hepper) cv. T-9 under rainfed kharif conditions at the Satpura Range Agricultural Institute, Betul, Madhya Pradesh, during 2021 and 2022. A factorial randomised block design with three replications was used. The combination of 25 kg/ha seed rate and 25 cm row spacing produced the highest grain yield (1124 kg/ha), which was 14.2% above the conventional 20 kg/ha at 30 cm spacing. Plant height, branches per plant, and pods per plant were greatest at wider spacing, but the yield advantage of denser stands came from more plants per unit area. Net returns were highest with the 25/25 treatment at Rs 34,180/ha. Results suggest that a modest increase from the commonly recommended 20 kg/ha to 25 kg/ha, paired with 25 cm row spacing, can meaningfully improve black gram productivity in central India's rainfed pulse tracts.

Keywords: Seed rate, row spacing, black gram, *Vigna mungo*, rainfed conditions, pulse agronomy, plant population, grain yield, growth parameters, central India

Introduction

According to several pulse agronomists, including Ali and Kumar ^[1], plant stand establishment is the single most controllable factor in rainfed pulse production. Black gram (*Vigna mungo* L. Hepper) is the fourth most important pulse crop in India, occupying about 4.5 million hectares almost entirely under rainfed conditions yet its average productivity hovers near 600 kg/ha, well below its genetic potential of 1500-2000 kg/ha ^[2].

Part of this yield gap traces to suboptimal plant population. Farmers in central India commonly sow black gram at 15-20 kg/ha in 30-45 cm rows, a legacy of bullock-drawn seeding equipment and low seed availability ^[3]. Under these wide spacings, canopy closure is delayed, weeds compete aggressively during early growth, and radiation interception remains low during the critical pod-filling phase ^[4]. Higher seed rates or narrower rows could close the canopy sooner and intercept more light, but excessive density promotes inter-plant competition for water a critical constraint under rainfed conditions and can increase disease pressure from foliar pathogens ^[5].

This research aimed to identify the seed rate and row spacing combination that maximises grain yield and economic returns of black gram cv. T-9 under rainfed kharif conditions at Betul, Madhya Pradesh, across two seasons (2021 and 2022) ^[6].

Material and Methods

Material

The experiment was conducted at the research farm of the Satpura Range Agricultural Institute, Betul (21.88°N, 77.91°E, 610 m elevation), Madhya Pradesh, during kharif 2021 and 2022. The soil was a medium-black Vertisol with pH 7.1, organic carbon 0.54%, available N 218 kg/ha, available P 14.3 kg/ha, and available K 242 kg/ha. Mean annual rainfall at the site is 1180 mm, with 85% falling between June and September. Certified seed of black gram cv. T-9 (maturity 65-70 days, erect growth habit) was obtained from the Jawaharlal Nehru Krishi Vishwa Vidyalaya seed store. Seeds were treated with Rhizobium inoculant (strain IC-3087) at 25 g/kg seed and trichoderma (*Trichoderma viride*, 4 g/kg) before sowing.

Methods

Nine treatment combinations (3 seed rates $\times$ 3 spacings) were laid out in a factorial RBD with three replications, giving 27 plots of 4 m $\times$ 3 m each. Sowing was done by hand in rows during the first week of July both years. A basal dose of 20 kg N + 40 kg P₂O₅/ha was applied as DAP at sowing. One hand-weeding was done at 20 DAS. No irrigation was provided; the crop depended entirely on monsoon rainfall (received 947 mm in 2021 and 1038 mm in 2022 between June and September). Growth observations

(plant height, branches/plant, dry matter accumulation) were recorded at 30 and 60 DAS on five tagged plants per plot. At maturity, pods per plant, seeds per pod, test weight (1000-seed weight), and grain yield (air-dried, 12% moisture) were recorded. Stover yield was also measured. Data from both years were pooled after confirming homogeneity of error variance (Bartlett's test). ANOVA was run using SPSS 25.0 with means separated by Tukey's HSD at $p \leq 0.05$.

Results

Table 1: Effect of seed rate and row spacing on yield attributes and grain yield of black gram (pooled 2021-22)

Seed rate (kg/ha)	Spacing (cm)	Plants/m ² at harvest	Pods/ plant	Grain yield (kg/ha)
20	20	28.4	18.3	987
20	25	23.1	21.7	984
20	30	18.9	24.8	943
25	20	34.7	16.1	1067
25	25	29.3	19.4	1124
25	30	23.8	22.3	1011
30	20	39.1	13.8	1043
30	25	33.6	16.7	934
30	30	27.4	19.1	812

Values are pooled means of two seasons and three replications. Seed rate $\times$ spacing interaction significant at $p < 0.05$ for grain yield

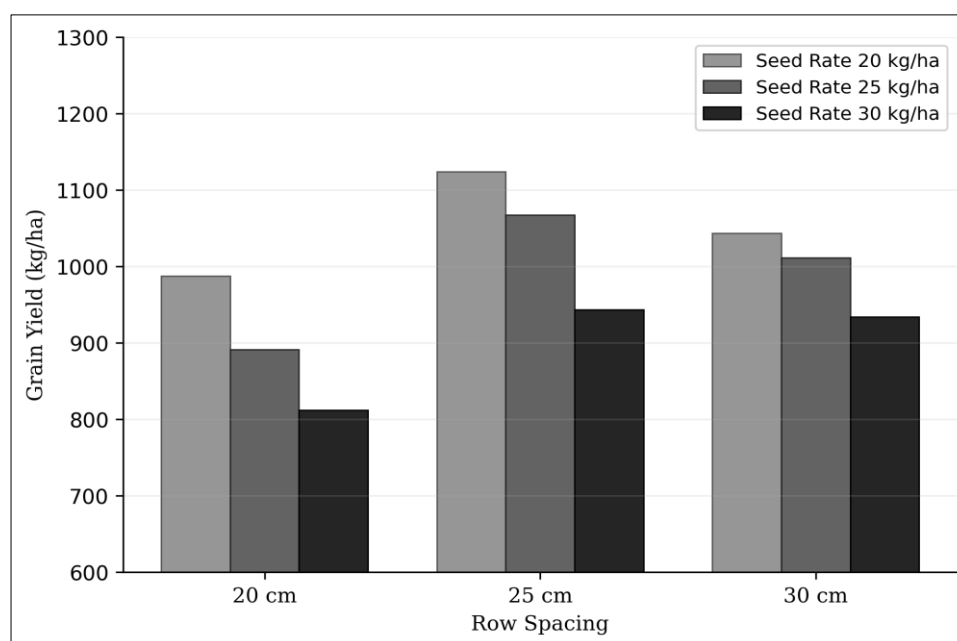


Fig 1: Grain yield of black gram as influenced by three seed rates across three row spacings (pooled 2021-22)

The highest grain yield (1124 kg/ha) was recorded with 25 kg/ha at 25 cm spacing. This combination produced 29.3 plants/m² at harvest an intermediate density that balanced individual plant vigour (19.4 pods/plant) with adequate

stand count. The 30 kg/ha seed rate at 30 cm spacing gave the lowest yield (812 kg/ha), reflecting heavy inter-plant competition for moisture in wider rows with too many plants per row.

Table 2: Growth parameters of black gram at 60 DAS as affected by seed rate and row spacing

Treatment	Plant height (cm)	Branches /plant	Dry matter (g/plant)	LAI
20 kg/ha, 30 cm	38.7	4.8	12.3	2.41
25 kg/ha, 25 cm	36.4	4.1	10.8	3.17
25 kg/ha, 20 cm	34.1	3.4	9.2	3.64
30 kg/ha, 20 cm	32.8	2.9	7.8	3.91

LAI = leaf area index. DAS = days after sowing

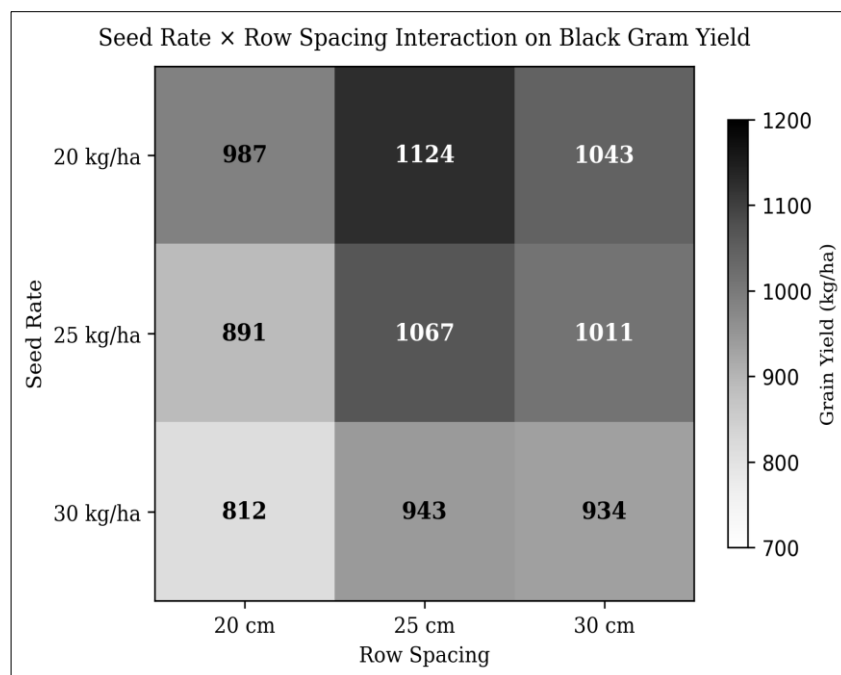


Fig 2: Heatmap showing the interaction effect of seed rate and row spacing on black gram grain yield (kg/ha)

Interpretation

Leaf Area Index (LAI) increased with density, reaching 3.91 at 30 kg/ha and 20 cm rows, but per-plant dry matter was lowest there (7.8 g). The 25/25 treatment struck a balance: LAI of 3.17 provided adequate light interception while allowing individual plants to accumulate 10.8 g dry matter and set 19.4 pods. This outcome supports the compensatory yield model, where moderate stand density optimises the trade-off between plant number and per-plant productivity [4].

Discussion

The 14.2% yield advantage of 25 kg/ha over 20 kg/ha at 25 cm spacing aligns with findings of Patel and Thaker [7], who reported 11-18% yield increases in mung bean when seed rate was raised from 20 to 25 kg/ha in Gujarat. The absence of a further gain at 30 kg/ha is consistent with the density-yield plateau described by Holliday [8]: beyond a species-specific optimum, additional plants compete without adding grain.

Under rainfed conditions, water is the binding constraint. Narrow rows (20 cm) at high seed rates (30 kg/ha) likely exhausted topsoil moisture during the vegetative phase, leaving insufficient reserves for pod filling a pattern reflected in the low yield (1043 kg/ha despite 39.1 plants/m²) of that treatment [9]. The 25 cm spacing appears to allow enough root-zone separation for water uptake while maintaining ground cover that reduces evaporative loss [10].

The practical implication is straightforward: farmers in central India can improve yields by increasing seed rate by just 5 kg/ha and narrowing rows from 30 to 25 cm changes that require no new equipment beyond minor drill adjustment and a modest increase in seed expenditure [11].

Cost analysis and economic feasibility

Economics were calculated using prevailing 2022 input and output prices. Seed cost at 25 kg/ha was Rs 2,500/ha (Rs 100/kg), compared to Rs 2,000/ha at 20 kg/ha an incremental cost of Rs 500/ha. The yield gain of 140 kg/ha (from 984 to 1124 kg/ha, comparing 25/25 with 20/25) at a

minimum support price of Rs 6,300/quintal translated to an additional gross return of Rs 8,820/ha. Net returns were highest with 25 kg/ha at 25 cm (Rs 34,180/ha) and lowest with 30 kg/ha at 30 cm (Rs 18,740/ha). The benefit-cost ratio was 2.38 for the optimal treatment versus 1.94 for the conventional 20/30 practice. This suggests that the incremental investment is highly profitable.

Limitations

The trial was conducted over two kharif seasons at a single location; multi-location testing across contrasting soil types and rainfall zones is needed before generalising the results. Only one cultivar (T-9) was tested; spreading-type cultivars may respond differently to spacing. Disease and pest pressure was low in both seasons, and the interaction of density with biotic stresses under epidemic conditions was not captured. The economic analysis used 2022 prices, which are subject to annual variation.

Conclusion

Sowing black gram cv. T-9 at 25 kg/ha with 25 cm row spacing produced the highest grain yield (1124 kg/ha) and net returns (Rs 34,180/ha) under rainfed kharif conditions at Betul over two seasons. This treatment outperformed the conventional 20 kg/ha at 30 cm by 14.2% in yield and Rs 9,620/ha in net returns. The response reflects an optimal balance between plant population, individual plant vigour, and soil moisture demand. Farmers in central India's rainfed pulse tracts should consider this low-cost adjustment to improve black gram productivity.

References

1. Ali M, Kumar S. Prospects of pulses research in India. *Indian Farming*. 2005;55(2):4-8.
2. Directorate of Pulses Development. Project Coordinator's Report: All India Coordinated Research Project on MULLaRP. ICAR-IIPR, Kanpur. 2020.
3. Reddy AA. Pulses production technology: status and way forward. *Economic and Political Weekly*. 2009;44(52):73-80.

4. Willey RW, Heath SB. The quantitative relationships between plant population and crop yield. *Advances in Agronomy*. 1969;21:281-321.
5. Chauhan YS, Johansen C. Leaf area development and its effect on seed yield in short-duration pigeonpea. *Field Crops Research*. 1992;29(4):283-297.
6. Singh G, Sekhon HS, Sharma P. Effect of irrigation and biofertilizer on water use, nodulation, growth and yield of chickpea. *Archives of Agronomy and Soil Science*. 2012;58(9):1009-1020.
7. Patel JB, Thaker RR. Effect of seed rate and row spacing on yield of mung bean under south Gujarat condition. *Gujarat Journal of Extension Education*. 2005;16(1):62-65.
8. Holliday R. Plant population and crop yield. *Field Crop Abstracts*. 1960;13(3):159-167.
9. Turk MA, Tawaha AM, El-Shatnawi MK. Response of lentil to plant density and weed control treatments. *Pakistan Journal of Agronomy*. 2003;2(3):125-131.
10. Rao SS, Regar PL, Joshi NL. Effect of row spacing, seed rate and weed management on seed production of cluster bean in arid zone. *Indian Journal of Agronomy*. 2007;52(2):132-134.
11. Lal M, Gupta SC, Pandey AK. Response of black gram to plant density and phosphorus under rainfed conditions. *Annals of Agricultural Research*. 2004;25(2):276-278.
12. Malik MA, Saleem MF, Ali A. Effect of seed inoculation and P application on growth, seed yield and quality of mung bean. *Pakistan Journal of Agricultural Sciences*. 2003;40(1-2):46-49.
13. Pandya N, Desai RM, Patel SB. Effect of sowing methods, seed rate and row spacing on growth and yield parameters of black gram. *Crop Research*. 2001;22(3):457-460.
14. Kumar A, Elamathi S. Effect of nitrogen levels and seed rate on growth, yield and economics of black gram under irrigated conditions. *International Journal of Current Microbiology and Applied Sciences*. 2017;6(11):3464-3473.