



Influence of Seed Priming, Plant Geometry and Conjunctive Use of Fertilizers, FYM and Vermicompost on Productivity and Economics of Green Gram (*Vigna radiata* L.)

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ABSTRACT

Background: Nutrients requirement of crops can easily be met by the application various fertilizers alone but in long run their continuous use deteriorate soil health and may retard the productivity of crops also. Further cost escalation and timely availability of fertilizers and other inputs lead to uneconomic production. Integrated nutrient management (INM) practices including reduced levels of fertilizers with locally available organic sources of plant nutrients, low cost and no cost inputs may be answer to the problems. Very meagre work has been done in past on different aspects on green gram crop. Present study aimed at evaluating and quantify the performance of summer green gram (*Vigna radiata* L.) crop as affected by seed hydropriming, plant geometry and nutrient applications through fertilizers, FYM, vermicompost and their combinations for maximizing the productivity and economic viability.

Methods: The low cost seed hydropriming, no cost treatments of 2 plant geometries of (i) G₁ (30×10 cm) and (ii) G₂ (30×20 cm) and 5 treatments of integrated nutrient management (INM) practices (N) viz; (i) N₁ (20+40+20 kg NPK/ha (RDF), (ii) N₂ (100% RDF equivalent FYM), (iii) N₃ (100% RDF equivalent vermicompost) (iv) N₄ (50% RDF from fertilizer+50% RDF equivalent FYM) and (v) N₅ (50% RDF from fertilizer+50% RDF equivalent vermicompost) were evaluated in field experiments using split-split plot design having 3 replications.

Result: The main conclusion is that practices of seed hydropriming and planting geometry of 30×10 cm proved superior for realizing maximum productivity and profitability. Integrated application of fertilizer equivalent to 50% of recommended dose of fertilizers (RDF) coupled with 50% nutrients through organic sources like farmyard manure and or vermicompost (treatments N₄ and N₅) proved most effective over organic sources alone (FYM and vermicompost through treatments N₂ and N₃) and 100% RDF through fertilizers (N₁) for summer green gram cultivation on sustainable basis. The results of the present work will be useful for majority of farmers particularly pulse crops growers to bridge the gap between present level of productivity and potentially realizable productivity of moong bean crop on cost effective and sustainable basis.

Key words: FYM, Green gram, Nutrient management, Plant geometry, Productivity, Profitability, Seed hydropriming, Vermicompost.

INTRODUCTION

Green gram (*Vigna radiata* L.) is grown in the countries of India, Burma, Srilanka, Pakistan, China, Fiji, Queens land and Africa. It is commonly known as *moong*, golden gram, *mung*, etc. Being a leguminous crop, it is capable of fixing atmospheric N to the tune of 38 kg/ha through symbiosis and improves the fertility and health of soil (Gupta and Prasad, 1982). It is cultivated throughout India for its multipurpose uses as vegetable, pulse, fodder and green manure crop. The seeds of green gram are more palatable, nutritive, digestible and nonflatulent than other pulses (Kumar *et al.*, 2009).

In India, green gram occupies about 6.12 lakh hectares area producing 13.45 lakh tones with yield level of 593 kg/ha (Anonymous, 2022). The main green gram growing states are U.P. and Andhra Pradesh being in the top two positions, contributing over 40%. Maharashtra contributes about 14% while Tamil Nadu and Madhya Pradesh contribute about 10% and 8.5% respectively of total production in India. There exists a vast gap between potential productivity present level of productivity realized by farmers. The yield potential of green gram in research plot is 10-12 quintals

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per hectare as against 8-9 quintals per hectare in farmers' fields. The national average yield is still low at 4-5 quintals per hectare. This yield gap needs to be addressed by improving seed production packages including good quality seed (Marimuthu and Surendran, 2015) and other low-cost technology.

Among several crop production factor viz., selection of variety, spacing, sowing time, dose of fertilizer, method and time of fertilizer application and irrigation etc., play

important role to exploit full genetic potential and maximizing productivity of green gram (Yadav and Singh, 2014). Plants spacing being an important non-monetary input, can be manipulated to attain the maximum production per unit area. Integrated nutrients management (INM) using fertilizers along with organic sources of nutrients help increasing yield and also maintaining soil fertility.

Although, the use of fertilizers alone can lead to higher productivity of crops but their continuous application over the years has been reported to result in deleterious effects on soil health (Endris and Dawid, 2015). Further, use of organics alone cannot compensate the productivity of crops obtained due to inorganic chemical fertilizers (Ahmad *et al.*, 2013). The lack of successful germination and establishment of green gram was largely due to the use of seeds of poor quality, sowing in a rain-fed condition, reduced plant stand, inadequate crop management and cultivation in inhospitable soils (Sathiya *et al.*, 2017). Integrated use of reduced levels of chemical fertilizers in conjunction with organics has been considered as a sustainable approach for enhanced productivity and profitability of various crops on a sustainable basis. Very meagre work has been done in past on different aspects on green gram crop. Thus, keeping above points in view a study was under taken to evaluate and quantify the performance of summer green gram crop as affected by seed priming, plant geometry and nutrient applications through fertilizers, FYM, vermicompost and their combinations.

MATERIALS AND METHODS

Experiments at Bundelkhand University Jhansi (UP), during Summer 2020-21 and -2021-22 were carried out in split plot design having 3 replications. The treatments comprised combination of main plot treatments *viz*; 2 seed treatments (1) P_1 (Without seed priming) and (2) P_2 (With seed priming) $\times$ 2 plant geometry treatments *viz*; (1) G_1 (30 $\times$ 10 cm apart rows $\times$ plants) and G_2 (30 $\times$ 20 cm apart rows $\times$ plants), 5 Sub plot treatments of integrated nutrient management (INM) practices (N) *viz*; (1) N_1 (20+40+20 kg NPK/ ha (RDF), (2) N_2 (100% RDF through FYM), (3) N_3 (100 % RDF through Vermicompost) (4) N_4 (50% RDF through chemical fertilizer+50% RDF through FYM) and (5) N_5 (50% RDF through chemical fertilizer+50% RDF through Vermicompost). The broad objectives of the experiment were to evaluate the impact of seed hydropriming under different plant population and INM treatments on growth, productivity and economics of different treatments given to summer green gram crop. Observations on growth parameters *viz*; plants /m², height of plants (cm), branches/ plants, root nodules/ plant, weight of dry root nodules per plant, dry matter/ plant and crop growth rate were recorded in 2 consecutive summer seasons. The data on grain and straw yield were recorded at harvesting time from net plots in both the years of experimentation and mean values were worked out. The economics of treatments was calculated

using prevailing market rates of different inputs, labour charges and price of produce. The benefit cost ratio (BCR) was computed treatment wise by dividing gross income with total cost of cultivation. Results were analysed statistically as per the procedure suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth attributors

Plant population (15 DAS and at harvest)

The results (Table 1) on green gram plant population due to seed hydropriming and nutrient levels from different sources varied from 22.19 to 22.33 plants/m²) and 21.61 and 23.00 plants/ m², differences being negligible and statistically non-significant. Closer row to row spacing in the treatment of G_1 (30 $\times$ 10 cm) facilitated significantly higher mean plant population (29.35 plants /m²) as compared to wider row spacing (15.17 plants/m²) of the treatment of G_2 (30 $\times$ 20 cm). The results lead to conclude that for the realization of higher productivity of green gram plant geometry of G_1 (30 $\times$ 10 cm) is optimum. Gurjar *et al.* (2018) also reported similar finding.

Plant height (cm)

Mean plant height of 36.93 cm due to without seed hydropriming (P_1) was enhanced significantly to 40.15 cm by seed hydropriming (P_2 : seed priming). Plant geometry treatment of G_1 (30 $\times$ 10 cm) resulted in optimum plants elongation up to 39.45 cm height as compared to G_2 (30 $\times$ 20 cm) which showed significant decline of plant height (37.63 cm). Thus, the plant geometry of 30 $\times$ 10 cm (treatment G_1) is considered as optimum over plant geometry of 30 $\times$ 20 cm (treatment G_2). Results indicated that the treatment N_5 (50% RDF through chemical fertilizer+50% RDF through Vermicompost) proved superior and recorded tallest plants of 39.35 cm height. Farmyard manure alone (treatment N_2) or combined with fertilizer (treatment N_4) resulted in better vegetative growth than sole use of FYM. Seed treatments, plant geometry and INM treatments were found individually effective but their interactions were nonsignificant. The results corroborate the earlier findings of Chaudhari *et al.* (2023) and Tyagi *et al.* (2014).

Green gram branches per plant

The seed hydropriming treatment P_2 enhanced branching to a significant level from 3.27 to 3.75 per plant. The treatment G_1 (30 $\times$ 10 cm) produced 3.61 branches/ plant (Table 1) which were decreased significantly to 3.41 branches due to G_2 (30 $\times$ 20 cm). Results indicated that the treatment N_5 resulted in highest of 3.61 branches/ plant over rest of the treatments. Next in descending order were the treatments N_4 , N_1 , N_3 and N_2 as these recorded final mean number of 3.57, 3.51, 3.46 and 3.41 branches per plant. The difference in mean number of branches due to the treatments N_5 , N_4 and N_1 were statistically nonsignificant.

Table 1: Growth of summer green gram as affected by seed hydropriming, planting geometry and INM practices in Bundelkhand region of U. P., India (Mean of 2020-21 and 2021-22).

Growth characters									
Treatments	Plants /m ²	Plant height (cm)	Branches/ plant	Root nodules/ plant (35 DAS)	Root nodules dry weight/ plant (mg)	Dry matter/ plant (g)	Crop growth rate (CGR) (gm ² day ⁻¹)		
							15-35 DAS	35-55 DAS	55 DAS - harvest
A = Seed treatment (P)									
P ₁ : Without seed hydropriming	22.33	36.93	3.27	20.19	23.45	13.40	0.169	1.351	0.287
P ₂ : With seed hydropriming	22.19	40.15	3.75	23.47	27.97	17.82	0.242	2.229	0.372
S.E.m±	0.21	0.03	0.04	0.00	0.31	0.10	0.005	0.042	0.007
CD (P=0.05)	NS	0.18	0.24	0.01	1.86	0.61	0.031	0.253	0.040
B = Geometry (G)									
G ₁ : 30 cm×10 cm	29.35	39.45	3.61	22.59	26.97	16.65	0.222	2.014	0.346
G ₂ : 30cm×20cm	15.17	37.63	3.41	21.07	24.45	14.56	0.189	1.566	0.312
S.E.m±	0.14	0.28	0.04	0.16	0.35	0.16	0.005	0.064	0.004
CD (P=0.05)	0.56	1.11	0.15	0.64	1.39	0.64	0.018	0.252	0.014
C = Nutrient Management (N)									
N ₁ : 20+40+20 kg NPK ha ⁻¹ (RDF)	21.61	38.43	3.51	21.84	25.82	15.67	0.204	1.792	0.330
N ₂ : 100% RDF through FYM	21.62	37.79	3.41	21.21	24.54	14.74	0.192	1.630	0.309
N ₃ : 100% RDF through vermicompost	22.54	38.14	3.46	21.46	25.41	15.16	0.199	1.705	0.319
N ₄ : 50% RDF through chemical fertilizer +50% RDF through FYM	22.54	38.97	3.57	22.19	26.25	16.07	0.212	1.868	0.340
N ₅ : 50% RDF through chemical fertilizer +50% RDF through vermicompost	23.00	39.35	3.61	22.44	26.54	16.40	0.221	1.957	0.348
S.E.m.±	0.60	0.36	0.04	0.24	0.45	0.34	0.007	0.056	0.015
CD (P=0.05)	NS	1.03	0.11	0.69	1.29	0.97	0.019	0.161	0.044
S.E.m± (P×G×N)	1.20	0.71	0.08	0.48	0.90	0.67	0.0135	0.112	0.030
CD (P=0.05) (P×G×N)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Patel *et al.* (2022) have also reported similar results. Application of FYM or Vermicompost alone through treatments N_2 and N_3 could not cope up the nutrients requirements of the crop and resulted in significantly poor growth with respect to number of branching as compared to the treatments N_4 and N_5 .

Number of root nodules at 35 DAS

Seed hydropriming proved beneficial and increased root nodules by 16.24% compared to unprimed seeds. Treatment P_2 (seed hydropriming) produced significantly a greater number of 23.47 root nodules/ plant compared to the treatment P_1 (without seed priming) resulting in the lowest number of root nodules of 20.19. Closer spacing of the treatment G_1 (30×10 cm) recorded significantly a greater number of root nodules of 22.59 which were significantly decreased to 21.07 nodules per plant, respectively as a result of the treatment G_2 (30×20 cm). The INM treatment N_5 (50% RDF through chemical fertilizer+50% RDF through Vermicompost) produced highest number of root nodules of 22.44 per plant. The treatments N_2 and N_3 , being at par in between them, but recorded significantly less nodules in comparison to treatments N_5 , N_4 and N_1 . The results confirm earlier reports by Mir *et al.* (2013). This emphasized that use of FYM and/ or vermicompost alone even equivalent to 100% of RDF is not sufficient or optimum to cope up the nutrient requirement of green gram crop (Table 1).

Weight of dry root nodules per plant (mg) at 35 DAS

The data (Table 1) indicated that the trend of variation of weight of dry root nodules because of different treatment under consideration commensurate the trend of root nodules numbers in these treatments. The treatment P_1 (without seed priming) recorded minimum weight of as 23.45 mg per plant and increased to significant level by seed priming treatment P_2 by 19.27%. The increase in nodules dry weight due to seed priming treatment is ascribed to significantly high number of root nodules due to this treatment. Nutrient management, treatment N_5 (50% RDF through chemical fertilizer+50% RDF through Vermicompost) showed the highest dry weight, while the treatment N_2 resulted in significantly less weight of nodules per plant.

Dry matter (g/ plant) at harvest

The average dry matter of plants due to the treatment P_1 (Without seed hydropriming) was 13.40 g per plant which increased significantly to 17.82 g per plant, respectively due to seed hydropriming treatment. The mean increase in final dry matter accumulation in green gram plants due to the treatment P_2 (with seed priming) was 32.98% over unprimed seeds because of early start of enhanced growth rate and photosynthesis. The mean dry matter accumulation due to wider plant to plant spacing in the treatment G_2 :30×20 cm was recorded as 14.56 g per plant and increased significantly to 16.65 g per plant at harvest due to treatment of G_1 (30×10 cm). The increase of dry matter because of

treatment G_1 (30×10 cm) recorded at harvest was 14.35% over the treatment of G_2 (30 cm × 20 cm). Similar results have been reported earlier by Kachare *et al.* (2009) and Patel *et al.*, (2022).

Significantly high amount of dry matter of 16.40 g per plant at harvest was observed in the treatment N_5 (50% RDF through chemical fertilizer+50% RDF through Vermicompost) followed by the treatment N_4 (50% RDF through chemical fertilizer+50% RDF through FYM) both being at par in between them (T5 Versus T4). The nutrient management practices involving 50% of RDF through chemical fertilizers in conjunction with 50% of RDF through organic sources (treatments N_5 and N_4) were found more effective to RDF alone or 100% of RDF through organics alone i.e. FYM and/ or vermicompost. Relative superiority of the treatments with respect to dry matter accumulation was as $N_5 > N_4 > N_1 > N_3 > N_2$, respectively.

Crop growth rate (CGR) ($\text{gm}^{-2} \text{day}^{-1}$) 15, 35 and 55 DAS

In general, the crop growth rate gradually increased up to 55 DAS and severely declined later on up to harvesting regardless of different treatment. Decrease of CGR after 55 DAS was due to senescence of plant leaves and gradual reduction in green leaf area and thereby decreased photosynthesis. The treatment P_2 seed hydropriming) resulted in significantly higher CGR compared to P_1 (Without seed priming) recorded at various growth stages (Table 1). The mean CGR during of 15-35, 35-55 DAS and 55 DAS- harvest due to treatment P_1 (without seed priming) was recorded as 0.169, 1.351 and 0.287 $\text{gm}^{-2} \text{day}^{-1}$ which increased significantly to 0.242, 2.229, and 0.372 $\text{gm}^{-2} \text{day}^{-1}$ by seed priming treatment P_2 (with seed priming). The mean CGR during 15-35, 35-55 DAS and 55 DAS- harvest period due to treatment G_1 (30×10 cm) was recorded as 0.222, 2.014 and 0.346 $\text{gm}^{-2} \text{day}^{-1}$ which decreased significantly to 0.189, 1.566, and 0.312 $\text{gm}^{-2} \text{day}^{-1}$, respectively due to the treatment G_2 (30×20 cm). The treatment N_5 recorded highest crop growth rate (CGR) of 0.221, 1.957 and 0.348 $\text{gm}^{-2} \text{day}^{-1}$ during the period of 15-35, 35-55 DAS and 55 DAS- harvesting, respectively. This was followed by the treatment N_4 , being statistically at par. Results emphasized that conjunctive use of chemical fertilizers equivalent to 50% of RDF along with organics (FYM and / or vermicompost) equivalent to 50% of RDF resulted in highest CGR. It is well known fact that inclusion of organic sources of nutrients favour release of nutrients from soil and their availability to plants and thereby increased use efficiency by crop plants.

Seed and stover yield

Green gram seed yield

The results (Table 2) revealed that seed hydropriming of green gram showed significantly high mean seed yield of 858.61 kg/ha due to treatment of P_2 (with seed priming). The treatment P_1 (without seed priming) recorded seed yield of 554.97 kg/ha. The mean increase in seed yield of

green gram due to seed priming was 54.71% over without seed priming, which is attributed to better growth and yield contributory characters. Planting geometry of $G_1(30 \times 10 \text{ cm})$ was found optimum as it resulted in significantly more mean seed yield of 995.70 kg/ha. Closer plant spacing in the treatment $G_1(30 \times 10 \text{ cm})$ witnessed 138.27% increased yield of 995.70 kg/ha over wider plant spacing in the treatment of $G_2(30 \times 20 \text{ cm})$ yielding 417.88 kg/ha. Ali *et al.* (2001) reported that seed yield and yield parameters of mung bean were affected significantly by different row spacings and maximum seed yield was resulted in 30 cm apart rows.

Results showed that INM treatment of N_5 (50% RDF from fertilizer+50% RDF through Vermicompost) produced significantly higher grain yield 800.96 kg/ha, followed by the treatment N_4 (50% RDF from fertilizer+50% RDF through FYM) which recorded seed yield of 753.91 kg/ha, being at par with treatment N_5 . The efficiency of INM treatments regarding seed yield of green gram crop was in order of $N_5 > N_4 > N_3 > N_1 > N_2$, respectively. The minimum yield of 617.49 kg/ha was resulted from the treatment N_2 which was increased by 7.89 %, 12.61%, 22.09% and 29.71% due to N_1 , N_3 , N_4 and N_5 . Results indicated that seed priming, closer plant geometry of $30 \times 10 \text{ cm}$ (G_1) and nutrient management of conjunctive use of chemical fertilizers coupled with organic sources of FYM and/ or Vermicompost yielded best results in terms of seed yield. The results are

consistent with findings of Chaudhary *et al.* (2015); Kalsaria *et al.* (2017) and Bhise *et al.* (2011).

Stover yield (kg/ ha)

Seed Priming treatment of P_2 (with seed hydropriming) resulted in significantly high mean stover production of 1020.35 kg/ha in comparison to treatment P_1 (without seed priming) which recorded mean stover of 871.00 kg/ha. The increase in stover yield of green gram as result of seed hydropriming was 17.14% over without seed priming treatment (Table 2).

Significantly high mean stover yield 989.03 kg/ha was recorded due to planting geometry of $G_1(30 \times 10 \text{ cm})$, which was significantly decreased to 902.32 kg/ha due to seed priming treatment $G_2(30 \times 20 \text{ cm})$. The decrease in stover yield due to wider plant spacing in the treatment $G_2(30 \times 20 \text{ cm})$ was 9.61% over planting geometry of $G_1(30 \times 10 \text{ cm})$. Highest mean stover yield of green gram was shown by the treatment N_5 (970.88 kg/ha) while the minimum of 912.25 kg/ha due to the treatment N_2 (100% RDF through FYM). The increase in stover yield due to the treatments N_3 , N_1 , N_4 and N_5 over N_2 was by 2.38%, 4.40%, 5.11% and 6.43%, respectively. The superiority of treatments as regards to stover yield affected by different nutrient treatments was in order of $N_5 > N_4 > N_1 > N_3 > N_2$, respectively. The results (Table 2) indicated that seed hydropriming (P_2). Plant geometry of $30 \times 10 \text{ cm}$ (G_1) and nutrient treatments

Table 2: Yield and economics of summer green gram cultivation as in relation to treatments of seed priming, planting geometry and INM practices (Mean of 2020-21 and 2021-22).

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)	Cost of cultivation (Rs. /ha)	Gross return (Rs. /ha)	Net return (Rs. /ha)	B:C ratio
A = Seed treatment (P)						
P_1 : Without seed priming	554.97	871.00	24558	46139.4	21581.6	0.89
P_2 : With seed priming	858.61	1020.35	24558	70729.6	46171.8	1.89
S.E.m $\pm$	16.36	9.18	-	1326.4	1326.4	0.05
CD (P=0.05):	99.53	55.89	-	8071.1	8071.1	0.30
B = Geometry (G)						
G_1 : 30cm $\times$ 10 cm	995.70	989.03	24508	81634.4	57126.6	2.35
G_2 : 30cm $\times$ 20 cm	417.88	902.32	24608	35234.6	10626.8	0.43
S.E.m $\pm$	16.90	6.62	-	1362.4	1362.4	0.06
CD (P=0.05)	66.35	25.98	-	5349.5	5349.5	0.22
C = Nutrient Management (N)						
N_1 : 20+40+20 kg NPK ha $^{-1}$ (RDF)	666.24	952.42	22361	55203.2	32842.8	1.48
N_2 : 100% RDF through FYM	617.49	912.25	25022	51224.1	26202.1	1.04
N_3 : 100% RDF through vermicompost	695.35	933.96	27022	57496.1	30474.1	1.14
N_4 : 50% RDF through chemical fertilizer + 50% RDF through FYM	753.91	958.88	23692	62230.3	38538.3	1.62
N_5 : 50% RDF through chemical fertilizer + 50% RDF through vermicompost	800.96	970.88	24692	66018.3	41326.3	1.68
S.E.m $\pm$	34.75	8.30	-	2785.9	2785.9	0.11
CD (P=0.05)	100.09	23.92	-	8025.1	8025.1	0.32
S.E.m $\pm$ (P $\times$ G $\times$ N)	69.49	16.61	-	5571.7	5571.7	0.22
CD (P=0.05) (P $\times$ G $\times$ N)	NS	NS	-	NS	NS	NS

($N_5 > N_4 > N_1$) were observed more effective for realizing higher seed and stover yield of summer green gram. Organic sources of nutrients either FYM or vermicompost were relatively less effective as for as stover yield of green gram crop was concerned. Earlier reports of Theeshnavi and Dawson (2022); Chaudhari *et al.* (2023) and Paul *et al.* (2023) also reported similar results.

Economics of treatments

The cost on each of the seed hydropriming and unprimed seed treatments was Rs 24558 /ha, respectively (Table 2). The monetary returns and BCR from treatment P_1 (Without seed priming) were Rs 46139 /ha, Rs 21582/ha, and 0.89 which were significantly increased to Rs 70729.6 /ha, Rs 46171.8 /ha and 1.89, respectively due to seed hydropriming treatment of P_2 . The treatment P_2 (seed hydropriming) proved superior over the treatment P_1 (without seed priming) as the increase in net returns and B:C ratio was more than double due to seed hydropriming treatment (P_2). Additional net return of Rs 24590 /ha (114%) and B: C ratio of 1.89 fetched due to the treatment of seed hydropriming. Plant geometry treatment G_1 (30 × 10 cm) fetched significantly more gross returns (Rs 81634.4/ha), net returns (Rs 57126.6 /ha), and B:C ratio (2.35) over the treatment G_2 (30 × 20 cm). The total returns, net returns and B:C ratio due to treatment G_2 (30 × 20 cm) was recorded as Rs 35234.6/ha, Rs 10626.8/ha, and 0.43, respectively. The increase in net return and B: C ratio due to plant geometry treatment G_1 (30 cm × 10 cm) was 436.56% (Rs 46499.8 /ha) and 446.5 % (1.92) over the treatment G_2 (30×20 cm) which was due to significantly high seed yield because of the treatment G_1 (30 × 10 cm). Keerthi *et al.* (2015) also reported similar trend of economics. The treatment N_5 registered highest net returns of Rs 41326.3 /ha and B:C ratio of 1.68 which were gradually decreased due to other treatments. The overall superiority of the INM treatments regarding net returns and B: C ratio was as $N_5 > N_4 > N_1 > N_3 > N_2$, respectively which recorded net returns of Rs 41326.3 /ha, > Rs 38538.3 /ha, > Rs 32842.8 ha, >Rs 30474.1 /ha, > Rs 26202.1 /ha, respectively and B: C ratio of 1.68, > 1.62, > 1.48, > 1.14 and > 1.04 respectively. Higher returns and BCR due to the treatment N_5 were due to highest biological yield. The treatments N_3 and N_2 fetched significantly low net returns of Rs 30474.1 /ha and Rs 26202.1 /ha and benefit-cost ratio (BCR) of 1.14 and 1.04, respectively.

CONCLUSION

Green gram seed hydropriming resulted significantly high yield of 858.61 kg/ha which was 54.71% more over untreated seeds. Additional net return of Rs 24590 /ha (114%) and B:C ratio of 1.89 was also fetched due to the treatment of seed hydropriming. The plant geometry treatment of G_1 (30×10 cm) witnessed 138.272% increased seed yield of 995.70 kg/ha over the treatment of G_2 (30×20 cm) yielding 417.88 kg/ha. It fetched significantly more gross returns (Rs 81634.40/ha), net returns (Rs 57126.60 /ha), and B:C ratio (2.35) compared to the treatment G_2 .

Increased net return and BCR because of treatment G_1 was 436.56% (Rs 46499.76 /ha) and 446.51% (1.92) over the treatment G_2 . Combined application of fertilizers and vermicompost through the treatment N_5 (50% RDF from fertilizers and 50% RDF equivalent vermicompost) proved better for growth, yield, monetary returns and BCR. Next in order was the treatment N_4 (50% RDF through chemical fertilizer+50% RDF through FYM) in this respect. The minimum green gram grain yield of 617.49 kg/ha as a result of the treatment N_2 (100% RDF equivalent FYM) was increased by 7.89%, 12.61%, 22.09 %, and 29.71% due to treatments N_1 (20+40+20 kg NPK ha⁻¹ (RDF), N_3 (100% RDF equivalent Vermicompost), N_4 (50% RDF from fertilizer+50% RDF through FYM) and N_5 (50% RDF through fertilizer+50% RDF equivalent Vermicompost), respectively. The treatment N_5 recorded maximum net monetary income of Rs 41326.31 /ha and benefit-cost ratio of 1.68.

It is concluded that maximum productivity of green gram and profitability can be realised from a combination of seed hydropriming, planting geometry of 30×10 cm and conjunctive use of fertilizer equivalent to 50% of recommended dose of fertilizers (10:20:10 kg/ha N: P: K) coupled with 50% nutrients through farmyard manure (treatment N_5). Next option may combined use of 50% of recommended dose of fertilizers (10:20:10 kg/ha N:P: K) along with vermicompost equivalent to ½ of RDF (50% of recommended dose of fertilizers (RDF i.e. 10:20:10 kg/ha N:P: K) treatment N_4). Organic sources alone (FYM and vermicompost treatments N_2 and N_3) and 100% RDF alone (N_1) were found significantly inferior for green gram.

Conflict of interest

There are no conflicts of any kind. including financial, personal, or other relationships with other people or organizations The Synopsis and all the detailed plans for the experiments were approved by the committee formed by the University.

REFERENCES

- Anonymous. (2022). Department of Agriculture and Farmers Welfare, Department of Agriculture and Farmers Welfare Crops and Post Harvest Management of Foodgrains Division, Ministry of Agriculture, Government of India.
- Ahmad, M., Afzal, M., Ahmad, A., Ahmad, A.U.H. and Azeem, M.I. (2013). Role of organic and inorganic nutrient sources in improving wheat crop production. *Cercetari Agronomice in Moldova*. 4: 15-23.
- Ali, A., Nadeem, M.A., Tayyab, M., Tahir, M. and Sohail, R. (2001). Determining suitable planting geometry for two mung bean (*Vigna radiata* L.) cultivars under Faisalabad conditions. *Pakistan Journal of Biological Science*. 4: 344-345.
- Bhise, A.B, Pawar, S.U, Solunke, S.S, Alse, U.N. and Kadam, G.T. (2011). Effects of varieties and plant geometry on yield attributes and yield of summer green gram (*Vigna radiata* L.). *Advance Research Journal of Crop Improvement*. 2: 221-223.

- Chaudhary, A.N., Vihol, K.J., Chaudhary, J.H., Mor, V.B. and Desai, L.J. (2015). Influence of spacing and scheduling of irrigation on growth, yield, yield attributes and economics of summer green gram (*Vigna radiata* L.). Journal of Ecology Environment and Conservation. pp 357-361.
- Chaudhari, P.R., Patel, K.I., Talaviya, P.L., Patel, P.D. and Patel, P.M. (2023). Effect of different spacings under varying fertility levels on summer green gram (*Vigna radiata* L.). The Pharma Innovation Journal. 12(2): 1027-1032.
- Endris, S. and Dawid, J. (2015). Yield response of maize to integrated soil fertility management on acidic nitosol of south-western Ethiopia. J. Agron. 14: 152-57.
- Gupta, R.B. and Prasad, S.N. (1982). Rhizobium culture and its role in kharif pulses. Farm Parliament. 17(3): 15-16.
- Gurjar, R., Patel, K.V., Patel, H.P. and Mistry, C.R. (2018). Effect of sowing dates and spacing on semi rabi green gram. International Journal of Chemical Studies. 6(5): 2850-2853.
- Kachare, G.S., Pol, K.M., Anju, A., Bhagat. and Bhoge, R.S. (2009). Effect of spacing and sowing direction on growth, yield and yield attributes of green gram. BIOINFOLET. 6(3): 251-252.
- Kalsaria, R.N., Vekariya, P.D., Hadiyal, J.G. and Ichchhuda, P.K. (2017). Effect of spacing, fertility levels and bio-fertilizers on growth and yield of summer green gram (*Vigna radiata* L. Wilczek). Journal of Pharmacognosy and Phytochemistry. 6(5): 934-937.
- Keerthi, M.M., Babu, R., Joseph, M. and Amutha, R. (2015). Optimizing plant geometry and nutrient management for grain yield and economics in irrigated green gram. American Journal of Plant Sciences. 6: 1144-1150.
- Kumar, R., Nandan, R., Kumar, V., Prasad, S. and Singh. (2009). Response of summer mung bean (*Vigna radiata*) cultivars. Ind. J. Agril. Sci. 79 (4): 309-312.
- Marimuthu, S. and Surendran, U. (2015). Effect of nutrients and plant growth regulators on growth and yield of black gram in sandy loam soils of Cauvery new delta zone, India. Cogent Food and Agriculture. 1(1): 143-147.
- Panse, V.G. and Sukhatme, P.V. (1985). Statistical Methods for Agricultural workers. 4th edn., ICAR Publication, New Delhi, India.
- Patel, V., Singh, D., Kumar, A., Verma, V.K., Kumar, P., Maurya, N.K. and Naresh, R. (2022). The Pharma Innovation Journal. 11(10): 729-733.
- Tyagi, P.K., Upadhyay, A.K. and Raikwar, R.S. (2014). Integrated approach in nutrient management of summer green gram. The Bioscan. 9(4): 1529-1533.
- Theeshnavi, V. and Dawson, J. (2022). Effect of spacing, farm yard manure and neem cake on growth and yield of green gram (*Vigna radiata* L.). The Pharma Innovation Journal. 11(4): 1685-1687.
- Yadav, S. and Singh, B.N. (2014). Effect of irrigation schedules and planting methods on growth, productivity and WUE of green gram (*Phaseolus mungo* L.) under rice- wheat-green gram cropping system. Plant Archives. 14(1): 211-213.