*Full Length Research Article*

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Research Journal of Agricultural Sciences
Volume 15; Issue 02 (Mar–Apr 2024); pp 539–544

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

# Effect of Seed Hydropriming, Plant Geometry and Nutrients Management Using Fertilizers, FYM and Vermicompost on Soil Fertility, Protein and Productivity of Mung Bean (*Vigna radiata* L.)

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Received: 02 Feb 2024; Revised accepted: 31 Mar 2024; Published online: 16 Apr 2024

## Abstract

The impact of seed hydropriming, plant geometry and integrated nutrient management treatments on soil fertility and protein content and yield green gram crop was studied in field trials. Seed hydropriming resulted significant increase in grain yield of mung bean by 54.71% over untreated seeds. Plant spacing of 30x10 cm (treatment $G_1$) witnessed 138.272% increased yield of 995.70 kg/ha over the treatment $G_2$ (30 x 20 cm) yielding 417.88 kg/ha. The treatment $N_2$(FYM equivalent to RDF) produced minimum yield of 617.49 kg/ha which was enhanced by 7.89%, 12.61%, 22.09%, and 29.71% due to $N_1$(20:40:20 kg NPK/ha (RDF), $N_3$ (Vermicompost equivalent to RDF), $N_4$ (½ RDF + FYM equivalent to ½ RDF) and $N_5$ (½ RDF + Vermicompost equivalent to ½ RDF), respectively. Minimum stover production of 912.25 kg/ha as a result of treatment $N_2$ (FYM equivalent to RDF) was increased by 2.38%, 4.40%, 5.11%, and 6.43% due to treatments $N_3$, $N_1$, $N_4$ and $N_5$. Significantly more depletion of available N, P and K from soil was observed due to the treatment $P_2$ (seed hydropriming) compared to $P_1$ (untreated seeds). The plant geometry treatment $G_2$ (30 × 20 cm) removed significantly more amount of available nutrients than $G_1$ (30 × 10 cm) which caused more residual nutrients in soil at harvesting time. The removal of nitrogen was significantly more due to nutrient treatments of $N_5 > N_4 > N_1 > N_3 > N_2$. The residual amount of available P and K in soil was due to treatments $N_3 > N_2 > N_1 > N_4 > N_5$, indicating significantly more depletion of P and exchangeable K due to treatments of $N_5 > N_4 > N_1 > N_2 > N_3$, respectively. The residual amount of nutrients had direct inverse relationship with the total production of grain and biomass of crop. Significantly high crude protein of 20.97% and protein yield of 180.84 kg/ha, respectively was due to treatment of $P_2$ (seed hydropriming) compared to treatment $P_1$ (untreated seeds). The treatment $P_1$ recorded 20.33% protein in mung bean grains and protein yield of 113.21 kg/ha, respectively. The enhancement of protein content and protein yield due to seed hydropriming was 3.14% and 59.73%, respectively over untreated seeds. Significantly high protein (20.82%) and protein yield (208.19 kg/ha), respectively was due to treatment $G_1$ and increase was 1.66% and 142.50%, respectively over the treatment $G_2$. Nutrient management of $N_5$ (½ RDF + Vermicompost equivalent to ½ RDF) led to significantly high of 20.81% protein and protein yield of 167.84 kg/ha, respectively. Next in order was the treatment $N_4$ (½ RDF + FYM equivalent to ½ RDF) resulted 20.74% crude protein and protein yield of 157.38 kg/ha, being on par with $N_5$. Results lead to conclude that seed hydropriming, 30 x 10 cm plant geometry and combined application of $N_5$ (½ RDF + Vermicompost equivalent to ½ RDF) followed by $N_4$ (½ RDF + FYM equivalent to ½ RDF) were assessed to enhance productivity of crop, quality of soil, protein per cent in seeds and protein yield significantly.

***Key words*: Green gram, Seed yield, FYM, Vermicompost, Nutrient content, Protein yield**

India is the major producer of green gram (*Vigna radiata* L.) and it is grown almost in all the States. It is the important amongst pulse crops ranking third after chickpea and pigeonpea crops. During the year 2020-21, in India this crop was grown on 5.13 million hectares area and produced 3.09 million tonnes with the productivity level of 601 kg/ha, respectively [1]. The states of Uttar Pradesh and Andhra Pradesh are the main states producing green gram crop and occupy 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 country. 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 per hectare against 8-9 quintals/ ha on farmers' fields [2]. The national average productivity of the crop is still less of about 5 to 6 quintals per hectare. This yield gap can be bridged by improving seed production packages and including good quality seeds [3] and other low-cost technology.

Although, chemical fertilizers can lead to increase the productivity but its continuous application over the years is known to lead deleterious effects on soil health [4]. Further, use

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**Citation:** Birla J, Pandey S. 2024. Effect of seed hydropriming, plant geometry and nutrients management using fertilizers, FYM and vermicompost on soil fertility, protein and productivity of Mung bean (*Vigna radiata* L.). *Res. Jr. Agril. Sci*. 15(2): 539-544.

of organics alone cannot compensate total production of crops as obtained due to inorganic chemical fertilizers [5]. Integrated use of reduced levels of fertilizers in conjunction with organics has been a sustainable approach for enhancing the yield per unit area and economics of various crops on sustainable basis. Simultaneously it is essential to reduce the use of fertilizers and supplementing the same through cheaper organics sources of nutrients like FYM, compost, vermicompost, etc. This would help improving the productivity and profits from crops and also reduce depletion of plant nutrients from soil and maintain soil health also [6]. In view of the referred facts as above field studies were conducted for 2 consecutive years of 2021 and 2022 at Bundelkhand University, Uttar Pradesh, India to evaluate the influence of seed hydropriming, plant geometries and nutrient management practices involving reduced levels of fertilizers combined with FYM and vermicompost on summer green gram. Present paper reports the effects of different treatments on the performance of green gam production, primary nutrients left in soil after harvesting of crop, nutrient content in green gram seeds and straw, protein content and protein yield, respectively.

## MATERIALS AND METHODS

The experiments were conducted at Bundelkhand University Jhansi (UP), India during Summer season of the year 2021 and 2022. Bundelkhand region is located at 25.44°N 78.57°E and is a historic region in Central India that is now part of northern Madhya Pradesh. It has an average elevation of 250-300 m (730 ft) above MSL and the land is undulating. The region has a hot, semi-humid climate. The mean ambient maximum temperatures range in between 6 - 12°C during winter season and maximum temperatures from 38 - 43°C during summer season. The average annual rainfall varies in between 657.7 - 1146.4 mm, most of which occurs during June to September. The rainfall during crop growing period in the years of 2020-21 and 2021-22 was 36.2 mm and 83.0 mm, respectively. The experimental soil was neutral in reaction (pH 7.3, EC 0.21 dS/m) having 0.53% organic carbon, 160.05 kg/ha available N, 30.10 kg/ha available phosphorus and 260 kg/ha K content in plough layer of soil.

The experimentation was done in split-split plot design having with three replications. The treatments were combination of main plot treatments viz; 2 seed treatments (1) $P_1$(Untreated seeds) and (2) $P_2$(seed hydropriming) x 2 plant geometry treatments viz; (1) $G_1$(30×10 cm) and $G_2$ (30×20 cm), 5 sub plot treatments of nutrient levels and sources (N) viz; (1) $N_1$(20:40:20 kg NPK/ha (RDF), (2) $N_2$(FYM equivalent to RDF), (3) $N_3$(Vermicompost equivalent to RDF) (4) $N_4$(½ RDF+FYM equivalent to ½ RDF) and (5) $N_5$(½ RDF + Vermicompost equivalent to ½ RDF). In all there were 20 treatment combinations of 2 seed treatments x 2 plant geometry treatments x 5 nutrients management treatments. At present the prevailing RDF comprises of 20 kg N, 40 kg $P_2O_5$ and potassium 20 kg /ha, respectively which were applied at sowing time as per treatments. Application of FYM and vermicompost in required amount in the treatments was done through broadcasting during last ploughing and split application was 30 days after sowing. Harvesting of crop was done from net plots when the pods of green gram turned green to dark brown or blackish in colour. The borders rows were harvested separately. The harvest was tied up in bundles and then tagged. The bundles were allowed for sun drying in the respective plots for about a week time.

The weight of each dry bundle was recorded to know biological yield, and then threshed manually and winnowed, cleaned and weighed separately to record yield and finally seed, straw yield was computed and expressed as kg/ha. Soil samples were taken before sowing of the crop in initial year and after harvest of the crop each year. Chemical analysis was performed for available N [7] and expressed as kg/ha. Available P and K were estimated by the standard methods as described by Jackson [8] and expressed as kg/ha. Total N in plant material was determined by Micro-Kjeldahl method [9], total P content by the method described by Olsen *et al*. [10] and total K content by the Flame Photometer method (Jackson, 1973). The protein content in seeds was computed by multiplying the nitrogen percentage with 6.25 for each treatment and protein yield was calculated the seed yield and expressed as kg/ha. Statistical analysis of results was done as per the procedure of Panse and Sukhatme [11].

## RESULTS AND DISCUSSION

*Seed and stover yield*

The treatment of seed hydropriming of green gram produced significantly high seed yield of 858.61 kg/ha as against yield of 554.97 kg/ha by the treatment $P_1$(Untreated seeds), the mean increase being 54.71% over without seed priming (Table 1) which is attributed to improved growth and development of yield contributory characters. Planting geometry of $G_1$(30×10 cm) caused significantly more mean seed yield of 995.70 kg/ha, which was significantly decreased to 417.88 kg/ha due to wider plant spacing in the treatment $G_2$ (30×20 cm). Closer $G_1$ spacing of 30x10 cm witnessed 138.272% increased yield of 995.70 kg/ha over wider plant spacing in of treatment $G_2$(30x20 cm) [12]. Nutrient management of $N_5$(½ RDF + Vermicompost equivalent to ½ RDF) showed significantly higher grain yield of 800.96 kg/ha. The minimum seed yield of 617.49 kg/ha was recorded as a result of the treatment $N_2$(FYM equivalent to RDF), which increased by 7.89%, 12.61%, 22.09%, and 29.71% due to treatments $N_1$(20:40:20 kg NPK/ha (RDF), $N_3$(Vermicompost equivalent to RDF), $N_4$(½ RDF+FYM equivalent to ½ RDF) and $N_5$ (½ RDF + Vermicompost equivalent to ½ RDF). The interactions of seed priming, plant geometry and nutrient management were observed non-significant [13-15].

The trend of stover yield in relation to different treatments of seed treatment, plant geometry and nutrient management treatments commensurate with the trend of seed yield. Seed hydropriming treatment of $P_2$ resulted in significantly high mean stover yield of 1020.35 kg/ha compared to treatment $P_1$(Untreated seeds) which recorded mean stover yield of 871.00 kg/ha. The increase in stover yield due to seed hydropriming was 17.14 % over without seed priming treatment. Planting geometry of $G_1$(30×10m) produced significantly high mean stover yield 989.03 kg/ha which was significantly decreased to 902.32 kg/ha in seed priming treatment $G_2$(30×20 cm). The decrease in stover yield of moong bean due to wider plant spacing in the treatment $G_2$(30× 20 cm) was 9.61% over planting geometry of $G_1$(30×10 cm).

The minimum mean stover yield of 912.25 kg/ha received from treatment $N_2$(FYM equivalent to RDF) was increased by 2.38%, 4.40%, 5.11%, and 6.43% due to $N_3$(Vermicompost equivalent to RDF). Vermicompost, $N_1$(20:40:20 kg NPK/ha (RDF), $N_4$(½ RDF+FYM equivalent to ½ RDF) and $N_5$(½ RDF + Vermicompost equivalent to ½ RDF), respectively (Table 1). This study led to conclude that seed hydropriming ($P_2$), closer plant spacing of 30×10 cm ($G_1$) and nutrient treatments ($N_5 > N_4 > N_1$) were most effective for realizing maximum seed and stover yield of summer green gram (Table 1) [16-17].

Table 1 Influence of seed hydropriming, plant geometry and INM treatments on green gram seed and straw production and residual available nutrients in soil (Mean of 2021-2022)

| Treatments | Seed yield (kg/ha) | Stover yield (kg/ha) | Available nutrients in soil at harvesting time crop (Kg/ha) | | |
|---|---|---|---|---|---|
| | | | N | $P_2O_5$ | K |
| A = Seed treatment (P) | | | | | |
| $P_1$: Untreated seeds | 554.97 | 871.00 | 147.53 | 72.46 | 266.60 |
| $P_2$: Seed hydropriming | 858.61 | 1020.35 | 126.91 | 68.27 | 257.95 |
| S.Em± | 16.36 | 9.18 | 1.02 | 0.19 | 0.49 |
| CD (P=0.05) | 99.53 | 55.89 | 6.23 | 1.18 | 2.96 |
| B = Geometry (G) | | | | | |
| $G_1$: 30 × 10 cm | 995.70 | 989.03 | 121.21 | 67.37 | 257.29 |
| $G_2$: 30 × 20 cm | 417.88 | 902.32 | 153.23 | 73.37 | 267.25 |
| S.Em± | 16.90 | 6.62 | 1.11 | 0.18 | 0.39 |
| CD (P=0.05) | 66.35 | 25.98 | 4.38 | 0.70 | 1.52 |
| C = Nutrient management (N) | | | | | |
| $N_1$: 20:40:20 kg NPK/ha RDF | 666.24 | 952.42 | 136.42 | 68.65 | 261.22 |
| $N_2$: FYM equivalent to RDF | 617.49 | 912.25 | 147.30 | 73.84 | 265.93 |
| $N_3$: Vermicompost equivalent to RDF | 695.35 | 933.96 | 142.77 | 74.58 | 265.98 |
| $N_4$: ½ RDF + FYM equivalent to ½ RDF | 753.91 | 958.88 | 131.33 | 67.69 | 259.71 |
| $N_5$: ½ RDF + Vermicompost equivalent to ½ RDF | 800.96 | 970.88 | 128.28 | 67.06 | 258.52 |
| S.Em± | 34.75 | 8.30 | 1.85 | 0.35 | 0.57 |
| CD (P=0.05) | 100.09 | 23.92 | 5.33 | 0.99 | 1.65 |
| S.Em± (P × G × N) | 69.49 | 16.61 | 3.70 | 0.69 | 1.15 |
| CD (P=0.05) (P × G × N) | NS | NS | NS | NS | NS |

*Residual NPK in soil*

The data (Table 1) indicated that available nutrient contents in soil at harvest because the treatment $P_1$(Untreated seeds) was 147.53 kg/ha N, 72.46 kg/ha P, and 266.60 kg/ha K, respectively while the same as a result of treatment $P_2$(seed hydropriming) was as 126.91 kg/ha N, 68.27 kg/ha P, and 257.95 kg/ha K, respectively. Results indicated that the depletion of all these nutrients was significantly more from the treatment $P_2$(seed hydropriming) in comparison to $P_1$(untreated seeds) resulting in relatively less amount of these nutrients left in soil after harvesting of crop.

After harvesting of the crop, the plant geometry treatment of treatment $G_1$ (30×10 cm) recorded residual nutrient contents in soil as 121.21 kg/ha N, 67.37 kg/ha P, and 257.29 kg/ha K, while the same due to the treatment $G_2$(30×10 cm) was as 153.23 kg/ha N, 73.37 kg/ha P and 267.25 kg/ha K), respectively. The results indicated the treatment $G_2$(30×20 cm) led significantly less depletion of available N, P and K from soil in comparison of the plant geometry $G_1$(30×10 cm) which caused significantly more amount of residual available nutrients at harvesting stage. Residual nutrients status of soil at harvesting stage due to different nutrient management practices (Table 1) indicated that the mean amount of available N in soil varied from 128.28 to 147.30 kg/ha because of treatment $N_5$(½ RDF+ Vermicompost equivalent to ½ RDF) and $N_2$(FYM equivalent to RDF); available P from 67.06 to 74.58 kg/ha in $N_5$(½ RDF+ Vermicompost equivalent to ½ RDF) and $N_3$(Vermicompost equivalent to RDF), and exchangeable potassium from 258.52 to 265.93 kg/ha, respectively due to the treatments $N_5$ and $N_2$. Available N present in soil recorded after harvesting of crop due to different treatments was of the order of $N_2 > N_3 > N_1 > N_4 > N_5$, respectively. This emphasized that N removal from soil was significantly more due to nutrient management treatment of $N_5 > N_4 > N_1 > N_3 > N_2$. Similarly, the amount of available phosphorus and exchangeable K left in soil due to treatments $N_3 > N_2 > N_1 > N_4 > N_5$, respectively. This indicated that removal of available P and exchangeable K from soil was significantly high due to nutrient management treatments of $N_5 > N_4 > N_1 > N_2 > N_3$, respectively. This emphasized that there was direct inverse relationship between total production of stover and grain of the crop and available nutrients left in soil at harvesting time of crop [18].

*Nutrient content in seeds and stover*

Significantly high mean nutrients content in seeds of green gram was noticed due to seed hydropriming. The treatment $P_1$(untreated seeds) recorded 3.25% N, 0.567% P and 0.783% K which increased significantly to 3.36% N, 0.602% P and 0.857% K, respectively by $P_2$(seed hydropriming) (Table 2, Fig 1). Plant geometry of $G_1$(30×10 cm) resulted in highest content of nutrients in seeds of green gram as 3.33% N, 0.594 % P and 0.841% K), respectively. Significant reduction in nutrient contents was caused by the treatment $G_2$(30×20 cm) which recorded 3.28% N, 0.575% P, and 0.799% K, respectively. The treatment $N_5$(½ RDF+ Vermicompost equivalent to ½ RDF) registered highest 3.33% N 0.592% P and 0.836% K, respectively. The treatment $N_4$(½ RDF+FYM equivalent to ½ RDF) although recorded relatively less nutrients are seeds in comparison of treatment $N_5$, but both were at par which is attributed to relatively better availability and absorption of nutrients to plants and their translocation from vegetative parts to seeds. The minimum mean of content of nutrients in green gram seeds was observed as 3.28% N, 0.578% P and 0.805 K in the treatment $N_2$(FYM equivalent to RDF). The variations of the mean nutrients contents in seeds were not significant because of nutrient management treatments of $N_1$, $N_2$ and $N_3$ while it was significantly less than the treatments $N_5$ and $N_4$ [19].

The treatment $P_1$(untreated seeds) recorded a mean 1.434% N, 0.225% P and 1.400% K in green gran straw which significantly increased to 1.528% N, 0.264% P and 1.462% K, respectively due to the treatment $P_2$ (seed hydropriming) (Table 2). Seed hydropriming increased N content in straw by 6.55% (1.528% vs 1.434%), P content by 17.3% (0.7264% vs 0.225%) and K content by 4.42% (1.462% vs 1.400%) over no priming. In stover, the treatment $G_1$(30×10 cm) recorded significantly higher amount of 1.501% N, 0.256% P and 1.448% K which significantly decreased to 1.460% N, 0.233% P and 1.414% K, respectively because of treatment $G_2$(30×20 cm). The green gram under $N_5$(½ RDF + Vermicompost equivalent to ½ RDF resulted in significantly high N of 1.499%, P 0.255%, and K 1.446%. The treatment $N_4$(½ RDF + FYM equivalent to ½ RDF) although recorded relatively less nutrients in straw compared with the treatment $N_5$, but both were statistically at par. FYM alone ($N_2$: FYM equivalent to recommended dose of fertilizers) showed a minimum of 1.464%, 0.235%, and 1.415% N, P and K in green gram straw. The differences in nutrient contents in stover of green gram due to different treatments were governed by the variations of stover yield and translocation from stover to seeds.

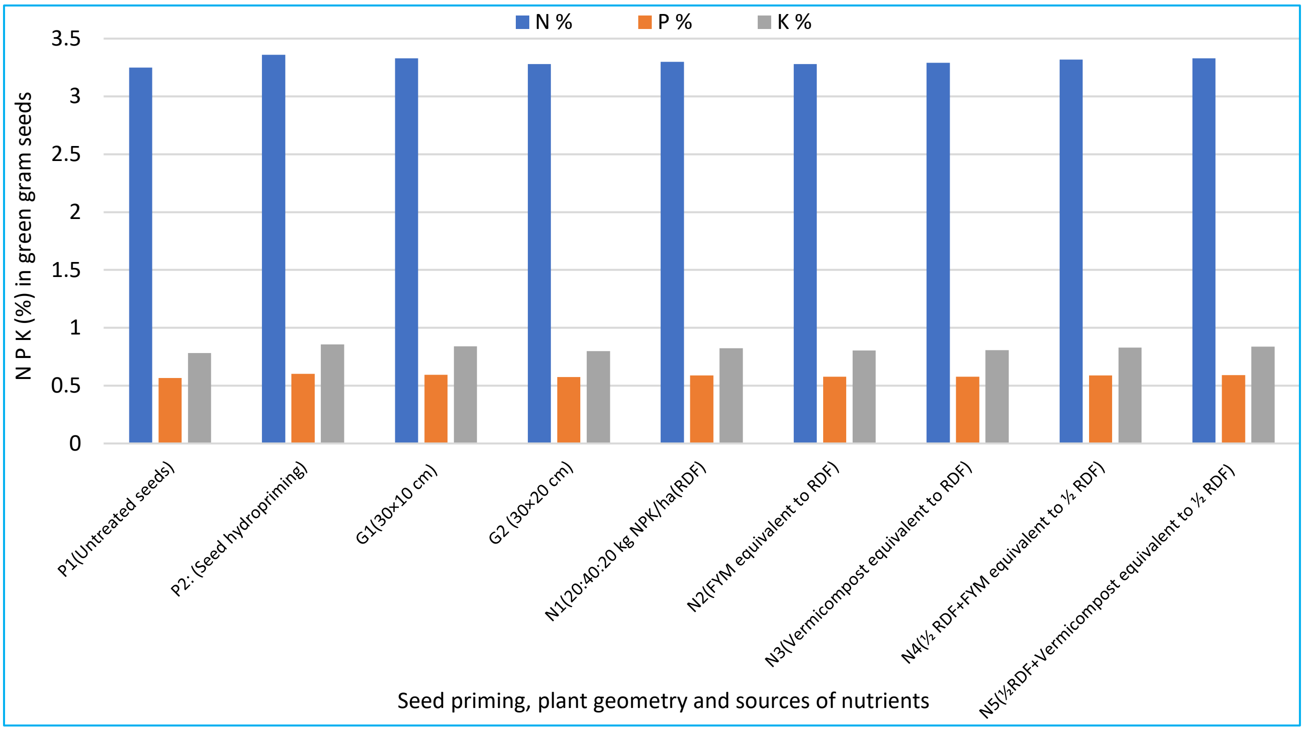


Fig 1 N, P and K content in green gram seeds as affected by seed hydropriming, plant geometry and INM treatments of fertilizers, FYM and vermicompost

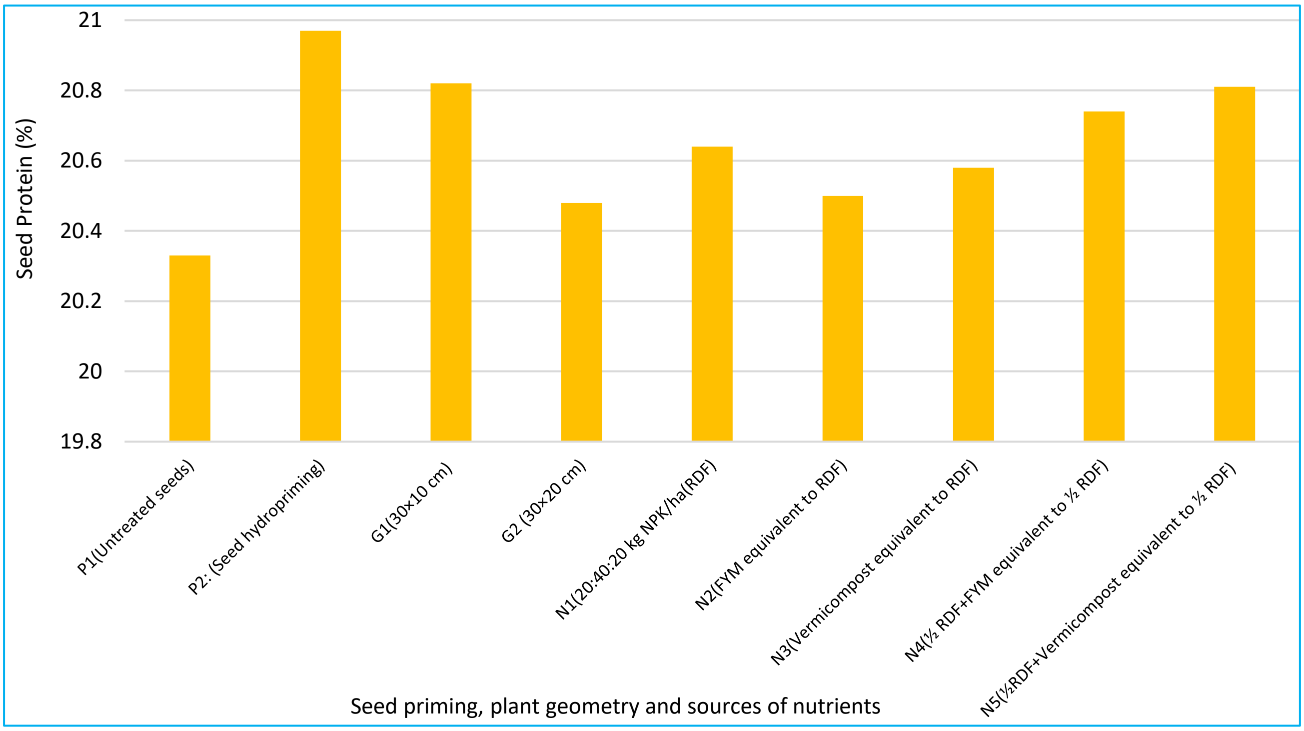


Fig 2 Effect of seed hydropriming, plant geometry and INM treatments of fertilizer, FYM and vermicompost on seed protein (%)

*Protein content and protein yield*

Results (Table 2, Fig 2-3) indicated that significantly higher crude protein of 20.97% and estimated protein yield of 180.84 kg/ha was resulted from treatment of $P_2$ over the $P_1$(untreated seeds). The treatment $P_1$ recorded mean 20.33% protein and estimated crude protein yield of 113.21 kg/ha, respectively. The enhancement of crude protein per cent and estimated protein yield due to seed priming was 3.14% and 59.73%, respectively over without seed priming treatment. A significantly high protein content of 20.82% and protein yield of 208.19 kg/ha, respectively due to treatment of $G_1$(30×10 cm) over plant spacing treatment $G_2$(30×20 cm). The treatment of

$G_1$ increased protein content and protein yield by 1.66% and 142.50%, respectively over treatment $G_2$. Results revealed that treatment $N_5$ led to significantly high crude protein per cent of 20.81% and estimated protein yield of 167.84 kg/ha, respectively. Next in order was the treatment $N_4$ resulting in 20.74% protein in mung grains and protein yield of 157.38 kg/ha, being at par with treatment $N_5$.

The superiority of treatments with regards to crude protein content and protein yield due to nutrient treatments was of the order of $N_5 > N_4 > N_3 > N_1 > N_2$, respectively which commensurate with the trend of N in seeds (%) and seed yield, respectively. The treatment $N_2$(FYM equivalent to RDF) resulted minimum protein of 20.50% and protein yield of 127.48 kg/ha, respectively which was increased by 0.68%, 0.68%, 1.17%, 1.51% and by 8.64%, 12.90%, 23.45%, 31.66%, due to $N_1$(20:40:20 kg NPK/ha (RDF), $N_4$(½ RDF + FYM equivalent to ½ RDF) and $N_5$(½ RDF + Vermicompost equivalent to ½ RDF), respectively. It is apparent that N content (%) and seed yield (kg/ha) had direct bearing on protein % and crude protein yield for obvious reasons [20]. The interaction of seed hydropriming, plant geometry and nutrient management treatments was found non-significant.

Table 2 Nutrient content in seeds, straw, protein content and estimated protein yield influenced by different treatments (Mean of 2021-2022)

| Treatments | Nutrient content in seeds | | | Nutrient content in straw | | | Protein content in seed (%) | Protein yield (kg /ha) |
|---|---|---|---|---|---|---|---|---|
| | N % | P % | K % | N % | P % | K % | | |
| | | | | A = Seed treatment (P) | | | | |
| $P_1$: Untreated seeds | 3.25 | 0.567 | 0.783 | 1.434 | 0.225 | 1.400 | 20.33 | 113.21 |
| $P_2$: Seed hydropriming | 3.36 | 0.602 | 0.857 | 1.528 | 0.264 | 1.462 | 20.97 | 180.84 |
| S.Em± | 0.010 | 0.0028 | 0.006 | 0.0041 | 0.0013 | 0.0011 | 0.061 | 3.03 |
| CD (P=0.05) | 0.060 | 0.0168 | 0.037 | 0.0249 | 0.0081 | 0.0068 | 0.373 | 18.42 |
| | | | | B = Geometry (G) | | | | |
| $G_1$: 30 × 10 cm | 3.33 | 0.594 | 0.841 | 1.501 | 0.256 | 1.448 | 20.82 | 208.19 |
| $G_2$: 30 × 20 cm | 3.28 | 0.575 | 0.799 | 1.460 | 0.233 | 1.414 | 20.48 | 85.85 |
| S.Em± | 0.0006 | 0.0015 | 0.006 | 0.0056 | 0.0011 | 0.0016 | 0.004 | 3.58 |
| CD (P=0.05) | 0.0022 | 0.0059 | 0.025 | 0.0218 | 0.0042 | 0.0063 | 0.014 | 14.07 |
| | | | | C = Nutrient management (N) | | | | |
| $N_1$: 20:40:20 kg NPK/ha RDF | 3.30 | 0.587 | 0.823 | 1.479 | 0.244 | 1.433 | 20.64 | 138.49 |
| $N_2$: FYM equivalent to RDF | 3.28 | 0.578 | 0.805 | 1.464 | 0.235 | 1.415 | 20.50 | 127.48 |
| $N_3$: Vermicompost equivalent to RDF | 3.29 | 0.577 | 0.808 | 1.473 | 0.239 | 1.423 | 20.58 | 143.93 |
| $N_4$: ½ RDF + FYM equivalent to ½ RDF | 3.32 | 0.587 | 0.828 | 1.489 | 0.249 | 1.438 | 20.74 | 157.38 |
| $N_5$: ½ RDF + Vermicompost equivalent to ½ RDF | 3.33 | 0.592 | 0.836 | 1.499 | 0.255 | 1.446 | 20.81 | 167.84 |
| S.Em± | 0.006 | 0.0036 | 0.008 | 0.0082 | 0.0013 | 0.0073 | 0.036 | 7.20 |
| CD (P=0.05) | 0.017 | 0.0104 | 0.022 | 0.0237 | 0.0039 | 0.0210 | 0.105 | 20.74 |
| S.Em± (P × G × N) | 0.0117 | 0.0072 | 0.016 | 0.0164 | 0.0027 | 0.0146 | 0.073 | 14.40 |
| CD (P=0.05) (P × G × N) | N.S. | N.S. | N.S. | N.S. | 0.0077 | N.S. | N.S. | N.S. |

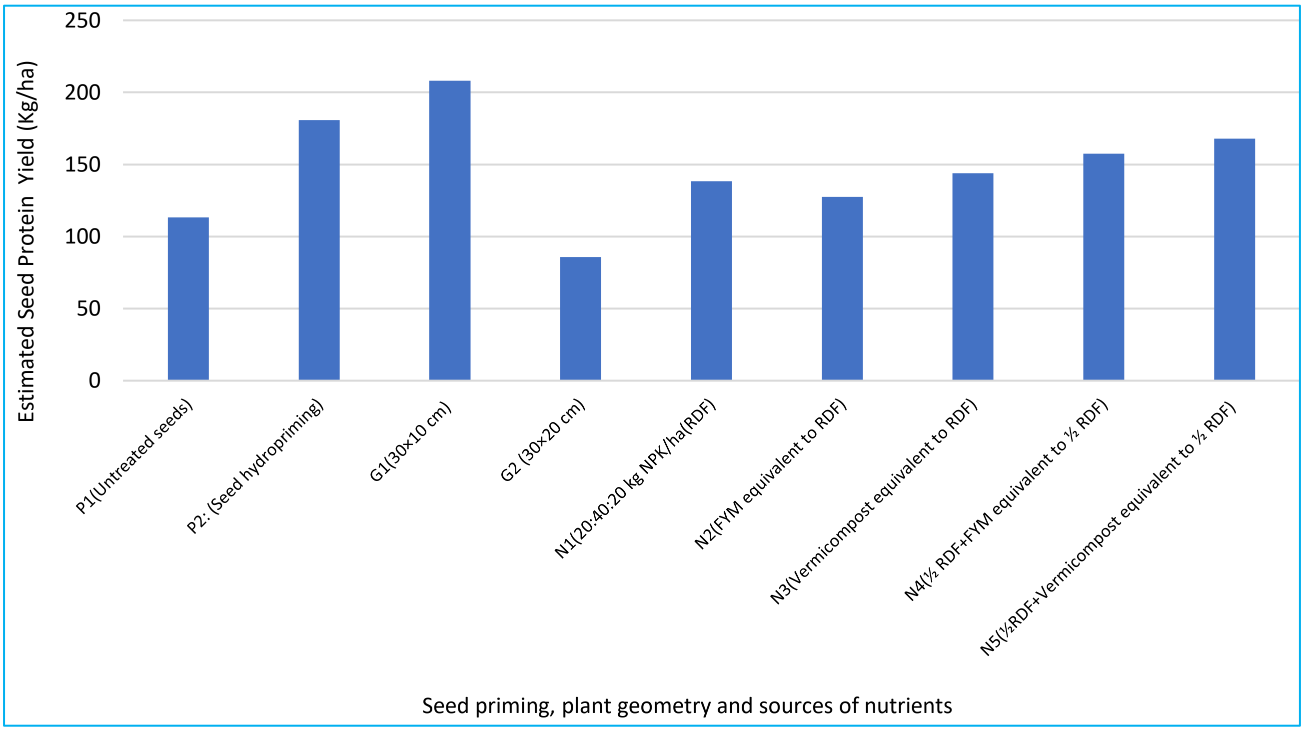


Fig 3 Estimated seed protein yield (Kg/ha) as influenced by seed hydropriming, plant geometry and sources and levels of nutrients through organic and inorganic sources

## CONCLUSION

Results lead to conclude that seed hydropriming, plant geometry of 30x10 cm spacing and combined application of $N_5$ (½ RDF + Vermicompost equivalent to ½ RDF) followed by $N_4$ (½ RDF + FYM equivalent to ½ RDF) were assessed to enhance productivity of crop, quality of soil, protein per cent in seeds and protein yield significantly. Seed hydropriming resulted significant increase in grain yield of mung bean by 54.71% over untreated seeds. Plant spacing of 30 × 10 cm (Treatment $G_1$) witnessed 138.272% increased yield of 995.70 kg/ha over the treatment $G_2$(30 × 20 cm) yielding 417.88 kg/ha. Significantly high crude protein of 20.97% and protein yield of 180.84 kg/ha, respectively was due to treatment of $P_2$ (seed hydropriming). The treatment $P_1$ recorded 20.33% protein in mung bean grains and protein yield of 113.21 kg/ha, respectively. The enhancement of protein content and protein yield due to seed hydropriming was 3.14% and 59.73%, respectively over untreated seeds. The study suggests that seed hydropriming, optimal plant spacing (30x10 cm), and combined nutrient application can significantly improve mung bean productivity, soil quality, and protein content and yield.

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