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Performance of Mung Bean Varieties with New Generation Fertilizers and Organic Manures

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ABSTRACT: The field experiment took place at the research farm of Chandra Shekhar Azad University of Agriculture and Technology in Kanpur, Uttar Pradesh, during the consecutive summer seasons of 2021 and 2022. The research included twelve unique treatment combinations, featuring two varieties of mung bean (Pusa-1431 and Virat) and six different nutrient management treatments (100% NPK, 75% NPK + 5 t ha^{-1} FYM, 75% NPK + 5 t ha^{-1}FYM + NPK Consortia, 75% NPK + 5 t ha^{-1} FYM + Nano-P Spray at 25 DAS, 75% NPK + NPK Consortia + Nano-P Spray at 25 DAS, and 75% NPK + 5 t ha^{-1} FYM + NPK Consortia + Nano-P Spray at 25 DAS). The experimental design was a factorial randomized block with three replications. The study's focus was to evaluate the impact of various nutrient management practices on factors such as plant height, dry matter accumulation, and soil physical and chemical characteristics, across the two distinct crop varieties, IPM 205-7 (VIRAT) and PUSA: - 1431. The study was conducted over two years, 2021 and 2022, and the results were pooled to observe trends. In the domain of plant height, nutrient management practices involving 75% NPK combined with FYM, NPK Consortia, and Nano-P Spray at 25 DAS showed the highest growth, reaching an average height of 59.1 cm at harvest. For dry matter accumulation, the same combination yielded the maximum accumulation of 11.2 at harvest, indicating the robustness of this treatment. In terms of soil physical and chemical properties, the study found that a combination of 75% NPK, FYM at 5 t ha^{-1}, NPK Consortia, and Nano – P Spray at 25 DAS enhanced organic carbon content (0.54%), available nitrogen (193.9 Kg ha^{-1}), available phosphorus (17.4 Kg ha^{-1}), and available potassium (205.9 Kg ha^{-1}). The research importantly concluded that variations in nutrient management could lead to differences in plant growth and soil quality. The application of organic and inorganic components together, such as NPK Consortia with FYM, demonstrated synergy in enhancing both plant and soil health. The study's results highlight the importance of precise nutrient management in sustainable agricultural practices. They pave the way for further research and development of tailor-made nutrient solutions that can meet specific crop requirements, contributing to higher yields, and improved soil health.

Keywords: Soil, Growth, NPK Consortia, Nano P, FYM.

INTRODUCTION

Protein is a crucial ingredient in human food, and its deficiency can lead to significant health issues, such as poor growth and development. In India, a country where the protein content in the average diet is far below the recommended 80 g /day by the Indian Council of Medical Research (ICMR), the situation is dire. With a population that is mostly vegetarian and dependent on pulses for their protein intake, the importance of pulses like mung bean is immense. Pulses are beneficial not only as a source of protein but also for their ability to fix atmospheric nitrogen, contributing to soil amelioration. They are drought tolerant and prevent soil erosion due to their deep roots and good ground cover, earning the title "Marvel of Nature" (Shah *et al.*, 2019). The total global area for pulse cultivation is around 85.40 m ha, with India leading the way, covering 29.99 m ha, constituting 34% of the area and 6% of the production. Among the pulses, mung bean (*Vigna radiata* L.) ranks third after chickpea and pigeon pea, with a cultivation area of 4.26 m/ha, and production of 2.01 m tonnes (Manoharan *et al*., 2020). It lags behind in productivity, as against an average yield of 835 kg /ha for pulses in general. Essential nutrients like nitrogen, phosphorus, and potassium play a vital role in plant growth and development, forming a part of crucial biological macromolecules. Pulses are mostly grown on residual fertility and face nitrogen deficiency during certain growth phases, which can lead to poor pod setting and grain filling (Ainsworth & Long 2021). A holistic approach is essential for balanced nutrient management, involving the integration of organic and inorganic sources, bio-fertilizers, and bio-stimulants. Farmyard manure (FYM), for instance, supplies major and micronutrients but needs to be used in conjunction with inorganic fertilizers for optimal soil health. Bio-fertilizers also play a crucial role in boosting nitrogen and phosphorus availability, with Rhizobium culture inoculation proving beneficial for nitrogen fertilization in legumes. Recently, strains of phosphate-solubilizing bacteria and fungi have been isolated to enhance phosphorus availability. NPK Consortia, a liquid biofertilizer, and nano-fertilizers are also making headway in ensuring increased nutrient use efficiency. India's Green Revolution of the 1970s paved the way for food security but led to macro and micronutrient deficiencies and negatively affected soil health (Yadav *et al*., 2019). The application of urea, DAP, and MOP has shown lower fertilizer efficiency, contributing to greenhouse gases and other health hazards. Nano technology is emerging as a solution that can enhance the effectiveness of conventional mineral fertilizers. Foliar nutrition is another critical method, as it allows for rapid nutrient utilization, reducing wastage and fertilizer requirements (Elemike *et al*., 2019).

MATERIAL AND METHOD

The field experiment was conducted at research farm, Chandra Shekhar Azad university of Agriculture and technology Kanpur Uttar Pradesh for two consecutive years during Summer seasons 2021 and 2022. The twelve treatment combinations consisting of two varieties (Pusa-1431 and Virat) and six nutrient management practices (100 %NPK, 75 % NPK + FYM @ 5 t ha^{-1}, 75% NPK + FYM @ 5 t ha^{-1} + NPK Consortia, 75% NPK + FYM @ 5 t ha^{-1} + Nano – P Spray at 25 DAS, 75% NPK + NPK Consortia + Nano – P Spray at 25 DAS and 75 % NPK+ FYM @ 5 t ha^{-1} + NPK Consortia + Nano – P Spray at 25 DAS) were tested in factorial randomized block design with three replications. The treatments were randomly allotted to different plots using random number table of Fisher and Yates (1963). For Plant height three plants were randomly tagged in net plot area to record their height at successive growth stages. Height of all the tagged plants was recorded in centimeters with the help of meter scale from the base of the plant i.e. ground surface to the top/ upper most part of the plant in cm. Height of all the 3 plants was summed and averaged to express plant height in cm. For Dry matter three plants were randomly picked from the sampling area and their above ground fresh weight was recorded. The plants were chopped and then sun dried. Sundried plant material, whole or 200 g whichever is less was taken and kept in oven at a temperature of 70° C ± 2° C till a constant dry weight was achieved. Estimation of total organic carbon was done to assess the amount of organic matter in the soil. To determine the organic carbon content, soil sample of 0.5-1 gm was taken and treated with chromic acid as given by Walkley and Black using wet oxidation method (Jackson, 1973). Available Nitrogen was estimated by alkaline potassium permanganate ($KMnO_4$) method given by Subbiah and Asija (1956). Before estimation of available phosphorous, pH of soil sample was determined using pH meter. The pH of soil sample was 7.9 which is in alkaline range so, 0.5M $NaHCO_3$ extractable method was used given by Olsen (1954). The available potassium content of soil was determined by extracting soil with neutral ammonium acetate as described by Hanway and Heidel (1952).

RESULT AND DISCUSSION

A. Plant Height

Table 1 highlights the results of an experiment to study the effect of different treatment combinations on plant height at different stages: 25 DAS (days after sowing), 40 DAS, and at harvest for two consecutive years, 2021 and 2022, along with the pooled data. Among the two varieties tested, IPM 205-7 (VIRAT) and PUSA: - 1431, the data showed a consistent growth pattern in plant height over time. Both varieties exhibited comparable plant height, with PUSA: - 1431 showing slightly higher height at harvest however the difference between the varieties was not statistically significant at the tested levels. The experiment investigated the effect of various nutrient management practices on plant height. Utilizing 100% NPK (20 N_2, 40 P_2O_5, 20 K_2O kg ha^{-1}), a steady growth pattern was observed with an average height of 46.1 cm at harvest. A different treatment, 75% NPK + FYM @ 5 t ha^{-1}, exhibited balanced growth and reached an average height of 50.2 cm at harvest. When combined with NPK Consortia, this 75% NPK treatment resulted in an average height of 53.9 cm. Moreover, the 75% NPK + FYM @ 5 t ha^{-1} combined with Nano – P Spray at 25 DAS achieved the second-highest average height of 55.82 cm at harvest. Consistent growth was seen with 75% NPK, NPK Consortia, and Nano – P Spray at 25 DAS, culminating in an average height of 51.3 cm at harvest. Lastly, the combination of 75% NPK, FYM @ 5 t ha^{-1}, NPK Consortia, and Nano – P Spray at 25 DAS demonstrated the highest growth, with an average height of 59.1 cm at harvest. These results highlight the significant impact of nutrient management practices on plant height and growth dynamics, suggesting the importance of selecting the appropriate combination for optimal crop performance. The experiment studied two plant varieties, IPM 205-7 (VIRAT) and PUSA: - 1431, and various nutrient combinations. Both varieties showed similar growth, and the difference in height was not significant (Pratap *et al*., 2021). Different nutrient treatments, including combinations of 75% NPK with other elements, resulted in varied plant heights. The combination with FYM, NPK Consortia, and Nano – P Spray reached the highest growth at 59.1 cm (Gul *et al*., 2015). These results underscore the importance of selecting specific nutrient combinations rather than relying solely on full concentrations, reflecting a complex interplay that can optimize crop performance (Rolhauser *et al*., 2022).

B. Dry matter

The effect of nutrient management practices on dry matter accumulation for the two varieties, IPM 205-7 (VIRAT) and PUSA: - 1431, was evident (Table 2). The VIRAT variety showed a steady increase in dry matter accumulation, averaging 3.5 at 20 DAS, 6.4 at 40 DAS, and 8.6 at harvest. The PUSA variety had a more pronounced accumulation, with averages of 4.35, 7.4, and 10.6 for the corresponding periods. In terms of nutrient management practices, using 100% NPK led to an average accumulation of 2.3, 5.3, and 7.2 across the three periods. A combination of 75% NPK with FYM at 5 t ha^{-1} showed balanced growth, with averages of 3.2, 6.1, and 8.6. Adding NPK Consortia to this combination further increased the accumulation to 4.1, 7.3, and 10.2. Incorporating Nano – P Spray at 25 DAS with 75% NPK and FYM led to one of the highest accumulations, averaging 4.7, 7.7, and 10.9. The combination of 75% NPK, NPK Consortia, and Nano – P Spray led to steady growth, with averages of 3.8, 6.8, and 9.6. The practice of integrating 75% NPK, FYM, NPK Consortia, and Nano – P Spray resulted in the maximum accumulation, with averages of 5.6, 8.2, and 11.2. The steady increase in the VIRAT variety contrasted with the more pronounced accumulation in PUSA, pointing to intrinsic differences between the varieties. While full NPK concentrations led to moderate growth, combinations of 75% NPK with other treatments, such as FYM, NPK Consortia, and Nano – P Spray, provided more significant results. The combination of all elements yielded the highest accumulation, suggesting that an understanding of specific plant needs and a more nuanced application of nutrients could be more effective. These findings could have practical applications for farmers seeking to optimize dry matter accumulation and may pave the way for further research into more sustainable and efficient agricultural practices (Pratap *et al*., 2021; Pratap & Gupta 2020; Saini *et al*., 2022).

C. Available Nutrient

In Table 3 effect of nutrient management practices on soil physical and chemical analysis over the years 2021 and 2022. In two varieties, IPM 205-7 (VIRAT) and PUSA: - 1431, showing marginal differences in organic carbon, available N, P, and K, with no significant differences recorded. Different nutrient management practices were assessed, including combinations of 100% NPK, 75% NPK with FYM, and the incorporation of NPK Consortia and Nano-P Spray. The highest organic carbon percentage (0.54) and available N (193.9 Kg ha^{-1}), P (17.4 Kg ha^{-1}), and K (205.9 Kg ha^{-1}) were observed in the treatment containing 75% NPK with FYM, NPK Consortia, and Nano-P Spray at 25 DAS. It two varieties, IPM 205-7 (VIRAT) and PUSA: - 1431, and finds only minor differences in organic carbon, N, P, and K, a finding that has been supported by research conducted by Pratap *et al*. (2021). The table also explores various nutrient management practices, such as combinations of 75% NPK with FYM, NPK Consortia, and Nano-P Spray. The highest values for organic carbon and available N, P, and K were found in the treatment with 75% NPK, corroborated by the studies of Tiwari *et al.* (2002). The results add to the existing body of knowledge, aligning with earlier research by Wu *et al.* (2022), that demonstrates how the precise combination of nutrients can profoundly influence soil characteristics.

Table 1: Effect of nutrient management practices on plant height.

Sr. No.	Treatment Combinations	25 DAS			40 DAS			At Harvest		
		2021	2022	Pooled Data	2021	2022	Pooled Data	2021	2022	Pooled Data
	(A) Variety (2)									
1.	IPM 205-7 (VIRAT)	25.8	26.0	25.9	39.9	42.6	41.2	50.2	53.4	51.8
2.	PUSA: - 1431	26.1	26.5	26.3	42.5	44.3	43.1	52.5	54.9	53.7
	SE(m)	**0.3**	**0.4**	**0.4**	**0.6**	**0.6**	**0.6**	**0.7**	**0.80**	0.8
	CD	**NS**	**NS**	**NS**	**1.8**	**NS**	**1.9**	**2.2**	**NS**	NS
	(B) Nutrient Management (6)									
1.	100 % NPK (20 N_2, 40 P_2O_5, 20 K_2O kg ha^{-1})	25.9	26.2	25.6	31.3	36.1	33.7	43.9	48.3	46.1
2	75 % NPK + FYM @ 5 t ha^{-1}	26.8	24.4	24.1	39.1	41.7	40.0	49.1	51.2	50.2
3.	75% NPK + FYM @ 5 t ha^{-1} + NPK Consortia	26.1	26.9	27.1	43.0	44.7	43.8	52.3	55.6	53.9
4.	75% NPK + FYM @ 5 t ha^{-1} + Nano – P Spray at 25 DAS	25.8	26.1	25.9	44.8	47.1	46.5	54.8	56.8	55.82
5.	75% NPK + NPK Consortia + Nano – P Spray at 25 DAS	27.9	26.7	26.4	41.1	44.1	42.6	50.2	52.4	51.3
6.	75 % NPK+ FYM @ 5 t ha^{-1} + NPK Consortia + Nano – P Spray at 25 DAS	27.1	27.4	27.2	46.3	48.2	47.2	57.7	60.5	59.1
	SE(m)	**0.6**	**0.7**	**0.7**	**1.1**	**1.12**	**1.0**	**1.3**	**1.3**	**1.3**
	CD	**NS**	**NS**	**NS**	**2.1**	**2.5**	**2.3**	**3.9**	**4.1**	**4.0**

Table 2: Effect of nutrient management practices on dry matter accumulation.

Sr. No.	Treatment Combinations	20 DAS			40 DAS			At Harvest		
		2021	2022	Pooled Data	2021	2022	Pooled Data	2021	2022	Pooled Data
(A) Variety (2)										
1	IPM 205-7 (VIRAT)	3.3	3.7	3.5	6.1	6.6	6.4	8.3	8.8	8.6
2	PUSA: - 1431	4.1	4.6	4.35	7.1	7.6	7.4	10.2	10.9	10.6
SE(m)		0.06	0.07	**0.7**	0.065	0.11	0.09	0.15	0.15	0.15
CD		**0.18**	0.20	**0.19**	0.19	0.32	0.26	**0.43**	**0.45**	0.44
(B) Nutrient Management (6)										
1	100 % NPK (20 N_2, 40 P_2O_5, 20 K_2O kg ha^{-1})	2.1	2.4	2.3	5.0	5.5	5.3	6.9	7.5	7.2
2	75 % NPK + FYM @ 5 t ha^{-1}	2.9	3.5	3.2	5.8	6.4	6.1	8.2	8.9	8.6
3	75% NPK + FYM @ 5 t ha^{-1} + NPK Consortia	3.8	4.3	4.1	7.0	7.5	7.3	9.8	10.5	10.2
4	75% NPK + FYM @ 5 t ha^{-1} + Nano – P Spray at 25 DAS	4.6	4.8	4.7	7.4	7.9	7.7	10.6	11.1	10.9
5	75% NPK + NPK Consortia + Nano – P Spray at 25 DAS	3.5	4.0	3.8	6.7	6.9	6.8	9.2	9.9	9.6
6	75 % NPK+ FYM @ 5 t ha^{-1} + NPK Consortia + Nano – P Spray at 25 DAS	5.4	5.8	5.6	7.9	8.4	8.2	10.9	11.5	11.2
SE(m)		**0.11**	**0.12**	**0.12**	**0.1**	**0.19**	**0.15**	**0.25**	**0.27**	**0.26**
CD		**0.31**	**0.34**	**0.33**	**0.3**	**0.19**	**0.25**	**0.74**	**0.79**	**0.77**

Table 3: Effect of nutrient management practices on soil physical and chemical analysis.

Sr. No.	Treatment Combinations	Organic Carbon (%)			Available N (Kg ha^{-1})			Available P (Kg ha^{-1})			Available K (Kg ha^{-1})		
		2021	2022	Pooled Data	2021	2022	Pooled Data	2021	2022	Pooled Data	2021	2022	Pooled Data
(A) Variety (2)													
1	IPM 205-7 (VIRAT)	0.45	0.49	0.47	185.3	188.0	186.7	14.8	15.6	15.2	187.4	194.1	192.12
2	PUSA: - 1431	0.47	0.51	0.49	186.0	189.1	187.6	15.3	16.2	15.8	192.5	195.9	193.9
	SE(m)	0.007	**0.008**	**0.007**	**2.7**	**2.8**	**2.7**	**0.22**	**0.23**	**0.23**	**2.8**	**2.9**	2.8
	CD	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	NS
(B) Nutrient Management (6)													
1	100 % NPK (20 N_2, 40 P_2O_5, 20 K_2O kg ha^{-1})	0.41	0.44	0.43	171.6	173.9	172.7	13.8	14.0	13.9	180.70	184.8	185.8
2	75 % NPK + FYM @ 5 t ha^{-1}	0.44	0.50	0.47	188.0	191.9	189.9	15.0	15.3	15.1	183.4	187.6	185.4
3	75% NPK + FYM @ 5 t ha^{-1} + NPK Consortia	0.48	0.52	0.50	192.6	195.2	193.9	15.9	16.4	16.3	195.6	201.4	198.4
4	75% NPK + FYM @ 5 t ha^{-1} + Nano – P Spray at 25 DAS	0.46	0.51	0.49	191.5	139.6	192.6	15.3	16.8	16.0	191.2	196.4	193.8
5	75% NPK + NPK Consortia + Nano – P Spray at 25 DAS	0.45	0.50	0.48	177.9	181.9	179.9	13.8	14.9	14.3	186.7	190.7	188.7
6	75 % NPK+ FYM @ 5 t ha^{-1} + NPK Consortia + Nano – P Spray at 25 DAS	0.53	0.55	0.54	192.8	195.0	193.9	16.8	18.0	17.4	202.6	209.1	205.9
	SE(m)	**0.012**	**0.013**	**0.012**	**4.7**	**4.8**	**4.7**	**0.38**	**0.41**	**0.40**	**4.8**	**4.9**	**4.9**
	CD	**0.035**	**0.037**	**0.035**	**NS**	**14.19**	**14.03**	**1.1**	**1.2**	**1.1**	**14.2**	**14.7**	**14.4**

CONCLUSIONS

The research's findings reveal that the integration of organic manures with new-generation fertilizers has a substantial impact on the growth and health of the mung bean crops. Specific combinations, such as 75% NPK + 5 t ha^{-1} FYM + NPK Consortia + Nano-P Spray at 25 DAS, demonstrated the highest growth, pointing to the potential benefits of innovative nutrient management in sustainable agriculture. The observed differences between the two mung bean varieties, IPM 205-7 (VIRAT) and PUSA: - 1431, offer valuable information for tailored agricultural practices. The results of this study have broad implications for the development of optimized fertilization strategies, and they contribute to the broader understanding of sustainable farming practices. Continued research in this area is essential to validate these findings and to explore further the long-term effects of these nutrient management practices on crop yield, soil health, and environmental sustainability.

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