Plant Archives Vol. 25, Supplement 2, 2025 pp. 1321-1326 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.163

ZINC AND PHOSPHORUS DOSE MODULATION FOR OPTIMIZING PERFORMANCE OF GREEN GRAM (*VIGNA MUNGO* L.)

Vishal Kumar, Akhil Bharti*, Aaina Sharma, Brajesh Kumar Mishra, Arushi Padiyal and Yuvraj Rana
Faculty of Agriculture Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala 133207, India
*Corresponding author E-mail: abharti.bharti@gmail.com
(Date of Receiving : 22-03-2025; Date of Acceptance : 30-05-2025)

ABSTRACT

A field experiment was conducted during the *Kharif* season of 2024 at the Research Farm of Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, to study the effect of varying phosphorus levels and foliar zinc on green gram. The experiment was carried out in split plot design with three replications. Main plots included four phosphorus levels: M_1-control, M_2-75% recommended dose of phosphorus (RDP), M_3-100% RDP, and M_4-125% RDP while the sub-plots had three foliar zinc treatments: S_1-control, S_2-1.0% foliar zinc and S_3-1.5% foliar zinc. Among different phosphorus levels, the results showed that 125% RDP significantly improved plant height (68.3 cm), branches/plant (6.0), leaf area index (3.09), and dry matter accumulation (16.46 g/plant) at harvest. It also produced significantly higher number of pods/plant (22.5), seeds/pod (8.8), pod length (7.9 cm), seed yield (1089 kg/ha), and stover yield (2806 kg/ha). It was also observed that 100% RDP application recorded statistically at par results in all the parameters. Among zinc treatments, 1.5% foliar zinc significantly enhanced plant height (64.9 cm), leaf area index (2.98), dry matter accumulation (14.87 g/plant), pods/plant (8.3), seeds/pod (8.3), pod length (7.6 cm), seed yield (969 kg/ha), and stover yield (2451 kg/ha), which was statistically at par with 1.0% foliar zinc application. Economic analysis revealed maximum gross returns, net returns, and B:C ratio with 125% RDP application and 1.5% foliar zinc spray. Further, interaction of both the factors showed that 100% RDP application with 1.0% foliar zinc spray resulted in seed and stover yield statistically similar to 125% RDP application with 1.5% foliar zinc spray. Thus, 100% RDP combined with 1.0% foliar zinc was identified as a promising and economical practice for enhancing green gram productivity and profitability.
Keywords**:** Zinc, Phosphorus, Green gram, Growth, Yield and Economics.

Introduction

Pulses serve as a valuable dietary protein source and contribute significantly towards meeting the food security of the world's constantly growing population. Green gram, locally known as moong (*Vigna radiate* L.), belongs to *leguminaceae* family. Being a short duration crop and having wider adaptability, it can be grown in *Kharif* as well as in summer season. Green gram is an excellent source of energy (334 Kcal), protein (24%), fat (1%), carbohydrates (57%), minerals (3%), fibre (4%), calcium (124 mg/100g), phosphorus (326 mg/100g), iron (4 mg/100g) (Kumar *et al*., 2022). Fertilizer management is one of the key agronomic techniques for boosting crop yield and preserving soil fertility among other production techniques. Among nutrients, phosphorus is one of the three crucial primary macronutrients that plant needs for optimal growth and development. Phosphorus is critical nutrient in pulse crop which plays important role in root proliferation, photosynthesis, energy transfer, signal transduction, macromolecular biosynthesis, respiration and atmospheric nitrogen fixation, and ultimately plays a vital role in higher yield of pulses (Rashmitha *et al*., 2021). Besides macronutrients, micronutrients are also necessary for the growth and development of plants. Zinc is an energy source for production of auxin and increases plant metabolic and enzymatic process (Rathod *et al*., 2020). Zinc contributes to several aspects of auxin metabolism, including the production of tryptophan, proteins, and nucleic acids (Saini *et al*., 2022). Zinc also aids in the plant's uptake of phosphate and nitrogen. Additionally, it encourages nodulation and nitrogen fixation in leguminous crops (Naz *et al*., 2022). Foliar application of zinc has a significant impact on crop yield and plant growth. Zinc has a significant favourable impact on green gram seed and straw yields as well as the percentage of crude protein in the seeds (Movalia *et al*. 2020). Therefore, this study was conducted to evaluate the performance of zinc foliar application in green gram under different phosphorus regimes with the objective to optimise dose of foliar zinc while enhancing the growth and productivity of green gram in irrigated conditions.

Materials and Methods

A field experiment was conducted during the *Kharif* season of the year 2024 at research farm of Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana. The experimental site was located at an altitude of 264 meter above mean sea level with geographical coordinates of 30° 17'0" N latitude and 77° 3'0" E longitude and average rainfall of approximately 700 mm annually. The soil of the experimental field was sandy loam in texture having 54% sand, 32% silt and 11% clay content. Soil was found to be low in organic carbon (0.30%) and available N (169.34 kg/ha), on the other hand it was medium in available P_2O_5 (13.43 kg/ha) and available K_2O (208.59 kg/ha). The experiment was carried out in split plot design with four treatments of varying doses of phosphorus in main plot *viz*. M_1-control, M_2-75% recommended dose of phosphorus (RDP), M_3-100% RDP and M_4-125% RDP while the sub plots comprised of three treatments of foliar application of zinc *viz*. S_1-control, S_2-1.0% foliar zinc and S_3-1.5% foliar zinc. The recommended dose of nitrogen was applied @ 20 kg/ha uniformly as basal dose through urea. The recommended dose of phosphorus (RDP) was 40 kg/ha for green gram. The phosphorus dose was calculated and applied as per treatments details using single super phosphate while zinc sulphate was used for foliar spray of zinc. Green gram variety MH-1142 was sown on 19th July 2024 using seed rate of 20 kg/ha at row spacing of 30 cm. The data pertaining to biometric observations like plant height, number of branches/plant and leaf area index as well as yield attributes including number of pods/plants, number of seeds/pod and pod length were recorded from five tagged plants selected randomly from each plot while the dry matter accumulation/plant, was recorded periodically from five plants selected randomly in the second outermost row in each plot. The seed yield (kg/ha) was determined by weighing seeds from each net plot while the biological yield (kg/ha) was determined by weighing bundle weight from each net plot. The straw yield (kg/ha) was calculated after deducting seed yield from biological yield. The cost of cultivation of each treatment was computed using current market prices and benefit-cost ratio was determined as ratio of gross return to cost of cultivation using the given equation

$$B:C = \frac{\text{Gross returns}}{\text{Cost of cultivation}}$$

The crop data collected in the field, encompassing various parameters, underwent statistical analysis following the methodology outline by Cochran and Cox (1967).

Result and Discussion

Growth parameters

The growth parameters of green gram including plant height, branches/plant, leaf area index and dry matter accumulation/plant have been presented in the Table 1. The data revealed that among different levels of phosphorus fertilization, application of 125% RDP (M_4) recorded significantly higher plant height (68.3 cm), branches/plant (6.0), leaf area index (3.09) and dry matter accumulation (16.46 g/plant) at harvest and it was found statistically at par with application of 100% RDP (M_3). The increment in growth parameters might be attributed to proper availability of phosphorus which plays an important role in improving nutritional status of plant through increased photosynthetic activity and increased root nodulation (Kumari *et al*., 2022). The increase in plant height might be due to enhanced photosynthetic activity, efficient translocation and utilization of photosynthates causing rapid cell elongation, cell expansion and cell division (Kumawat *et al.,* 2022). Efficient utilization of nutrients might have resulted in attaining better crop canopy which further increased the absorption and utilization of radiant energy resulting in higher leaf area index, dry matter accumulation and number of branches/plant (Patel *et al*., 2017). These results are in agreement with Masih *et al*. (2020). Similarly, among different doses of zinc foliar spray application, 1.5% foliar zinc application (S_3) recorded significantly higher plant height (64.9 cm), leaf area index (2.98) and dry matter accumulation (14.87 g/plant) at harvest and further it was found statistically at par with application of 1.0% foliar zinc (S_2). However, foliar application of zinc did not have any significant effect on number of branches/plant. The enhancement in growth parameters could be attributed to increased availability of zinc which had a beneficial effect on raising the enzymatic activity of plants which ultimately enhanced photosynthetic activity, chlorophyll synthesis and overall plant metabolism. Similar results were also reported by Todawat *et al.* (2018) and Dhinagaran *et al.* (2021).

Yield attributes

The yield attributes of green gram including number of pods/plants, pod length (cm), number of seeds/pod and 1000-seed weight (g) have been presented in the Table 2. The data revealed that among different levels of phosphorus fertilization, application of 125% RDP (M_4) recorded significantly higher number of pods/plant (22.5), pod length (7.9 cm), number of seeds/pod (8.8) and this treatment was found statistically at par with application of 100% RDP (M_3). This might be due to higher dose of phosphorus application. Due to its significant involvement in root multiplication, nodule formation and subsequent atmospheric nitrogen fixation, phosphorus played an important role in better partitioning of photosynthates which ultimately increased the yield attributes of green gram in terms of number of pods/plant and number of seeds/pods. Similar findings were also reported by Kumar and Debbarma (2023) and Gorai and Mondal (2023). Likewise, among different doses of zinc foliar spray, 1.5% foliar zinc application (S_3) recorded significantly higher number of pods/plant (21.2), pod length (7.6 cm), number of seeds/pod (8.3) which was statistically at par with 1.0% foliar zinc application (S_2). However, data pertaining to 1000-seed weight remained non-significant under varying doses of phosphorus and zinc foliar spray application. The application of zinc to green gram crop improved fruit growth by synthesizing tryptophan and auxin. The enhanced yield attributes of green gram might be attributed to the favourable influence of the zinc application on nutrient metabolism, biological activity and growth parameters and hence, applied zinc resulted in higher enzyme activity which in turn encouraged higher number of seeds/pod and pods/plant. Similar findings have been reported earlier by Shekhawat and Shivay (2012) and Dhinagaran *et al*. (2021).

Yield

The yield of green gram including seed yield (kg/ha), stover yield (kg/ha) is presented in Table 3. The data revealed that among different levels of phosphorus fertilization, application of 125% RDP (M_4) recorded significantly higher seed yield (1089 kg/ha) and stover yield (2806 kg/ha) and it was found statistically at par with 100% RDP (M_3). The higher dose of phosphorus application increased the yield attributes such as number of pods/plant, number of seeds/pod, and 1000-seed weight due to superior source sink relationship and increased nitrogen fixation, consequently leading to higher seed and stover yields of green gram. Similar findings were reported by Hossain *et al.* (2016). Among different doses of zinc foliar spray, 1.5% foliar zinc (S_3) recorded significantly higher seed yield (969 kg/ha), stover yield (2451 kg/ha) which was statistically at par with application of 1.0% foliar zinc (S_2). The increase in seed and straw yield due to foliar application of zinc might be due to the concomitant increase in number of pods/plant, number of seeds/pod, and 1000-seed weight. These results are in conformity to those of Tak *et al*. (2014). Further it was revealed that the seed and stover yield of green gram recorded significant interaction between varying doses of phosphorus and foliar zinc application presented in Table 4. The data presented in Table 4 revealed application of 125% RDP (M_4) along with 1.5% foliar zinc application (S_3) recorded significantly higher seed and stover yield which was statistically at par with application of 100% RDP (M_3) along with 1.0% foliar zinc application (S_2).

Relative economics

The relative economics of green gram calculated in terms of gross returns (Rs./ha), net returns (Rs./ha) and benefit-cost ratio (B:C) have been presented in the Table 3. The data revealed that among different levels of phosphorus fertilization, application of 125% RDP (M_4) recorded numerically higher gross returns (Rs. 94547/ha) and net returns (Rs. 60795/ha). However, maximum value of B-C ratio was recorded with the application of 100% RDP (M_3) (2.81) which was closely followed by application of 125% RDP (M_4) (2.80). Similarly, among different doses of zinc foliar spray, application of 1.5% foliar zinc application (S_3) recorded maximum gross returns (Rs. 84157/ha), net returns (Rs. 50360/ha) and benefit-cost ratio (2.48) which were followed by application of 1.0% foliar zinc (S_2). The increase in B-C ratio is attributed to increased seed yield of green gram. Almost similar findings were supported Gupta *et al*. (2022) and Omran *et al.* (2020).

Conclusion

The results of the experiment revealed that there was significant effect of both phosphorus and zinc on performance of green gram. Although 125% phosphorus and 1.5% foliar zinc application was significantly superior in almost all the parameters but 100% phosphorus and 1.0% foliar zinc application were statistically similar to these treatments. Further interaction effect on yield revealed that application of 100% phosphorus along with 1.0% foliar zinc application resulted in statistically similar yield as of treatments with higher doses of nutrients making it ideal treatment for obtaining higher yield without substantially increasing cost of cultivation.

Table 1: Effect of phosphorus and foliar spray of zinc on growth parameters of green gram

Treatments	Plant height (cm)	Number of branches /plants	Leaf area index	Dry matter accumulation (g/plant)
Main plot (Phosphorus)				
Control (M_1)	51.6	5.3	2.65	10.92
75% RDP (M_2)	61.0	5.6	2.68	14.17
100% RDP (M_3)	65.8	5.8	3.01	16.07
125% RDP (M_4)	68.3	6.0	3.09	16.46
S.Em ±	1.70	0.1	0.07	0.29
LSD (p=0.05)	5.0	0.3	0.21	0.85
Sub plot (Foliar zinc)				
Control (S_1)	58.1	5.5	2.72	13.74
1.0% foliar zinc (S_2)	62.0	5.7	2.87	14.61
1.5% foliar zinc (S_3)	64.9	5.8	2.98	14.87
S.Em ±	1.48	0.1	0.06	0.25
LSD (p=0.05)	4.3	NS	0.18	0.74
Interaction LSD (p=0.05)				
M x S	NS	NS	NS	NS

Table 2: Effect of phosphorus and foliar spray of zinc on yield attributes of green gram

Treatments	Number of pods/plant	Pod length (cm)	Number of seeds/pod	1000-seed weight (g)
Main plot (Phosphorus)				
Control (M_1)	17.8	6.6	6.8	42.3
75% RDP (M_2)	20.6	7.1	7.5	42.7
100% RDP (M_3)	21.4	7.8	8.2	43.6
125% RDP (M_4)	22.5	7.9	8.8	43.8
S.Em ±	0.5	0.1	0.2	0.6
LSD (p=0.05)	1.4	0.4	0.6	NS
Sub plot (Foliar zinc)				
Control (S_1)	19.7	7.0	7.4	43.6
1.0% foliar zinc (S_2)	20.8	7.4	7.8	42.4
1.5% foliar zinc (S_3)	21.2	7.6	8.3	43.3
S.Em ±	0.4	0.1	0.2	0.5
LSD (p=0.05)	1.2	0.4	0.5	NS
Interaction LSD (p=0.05)				
M x S	NS	NS	NS	NS

Table 3: Effect of phosphorus and foliar spray of zinc on yield and relative economics of green gram

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C
Main plot (Phosphorus)					
Control (M_1)	645	1592	56013	25011	1.81
75% RDP (M_2)	870	2193	75549	42897	2.32
100% RDP (M_3)	1076	2746	93450	60248	2.81
125% RDP (M_4)	1089	2806	94547	60795	2.80
S.Em ±	16	47	-	-	-
LSD (p=0.05)	47	139	-	-	-

Sub plot (Foliar zinc)					
Control (S_1)	847	2137	73579	42457	2.35
1.0% foliar zinc (S_2)	944	2415	81934	48897	2.47
1.5% foliar zinc (S_3)	969	2451	84157	50360	2.48
S.Em ±	14	41	-	-	-
LSD (p=0.05)	41	121	-	-	-
Interaction LSD (p=0.05)					
M x S	82	241	-	-	-

Table 4: Interaction effect of phosphorus and foliar spray of zinc on seed and stover yield of green gram

Treatments	**Seed yield (kg/ha)**			**Stover yield (kg/ha)**		
	Control (S_1)	1.0% foliar zinc (S_2)	1.5% foliar zinc (S_3)	Control (S_1)	1.0% foliar zinc (S_2)	1.5% foliar zinc (S_3)
Control (M_1)	607	644	684	1552	1574	1649
75% RDP (M_2)	854	866	890	2155	2202	2223
100% RDP (M_3)	958	1123	1148	2418	2889	2930
125% RDP (M_4)	970	1142	1155	2425	2994	3000
LSD (p=0.05)	82			241		

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

Acknowledgments

Authors greatly appreciate support provided by Head, Agronomy section, Director, Faculty of Agriculture, MMDU Mullana and MMDU Administration for smooth conduct of the study.

References

Cochran, W. G. and Cox, G. M. (1967). *Experimental Designs*, John Willey and Sons. Inc., New York.

Dhinagaran, M., Indirani, R., Pandian, P. S., Gurusamy, A. and Kannan, P. (2021). Effect of organic fortified zinc on growth and yield of green gram (*Vigna radiata* (L). Wilczek) in typic chromustert. *J. Appl. Nat. Sci*. **13**, 1166-1171.

Gorai, M. S. and Mondal, R. (2023). Effect of date of sowing and level of phosphorus on growth and yield of summer mung bean (*Vigna radiata* L.) in Red and Lateritic soils of West Bengal. *J. Food Legumes*. **36**, 164-168.

Gupta, S. P., Singh, P. K., Vivek, R. K., Chandra, M. S., Verma, S. K., Kumar, A., Mourya, D. K. and Gupta, S. (2022). Effect of micronutrients application on productivity and profitability of moong bean (*Vigna radiata* L.) *J. Pharm. Innov*. **11**, 1660-1665

Hossain, M. L. (2016). Effect of phosphorous on growth and yield of mung bean under different row spacings (MSc dissertation, Department of Agronomy) Sher-e-Bangla Agricultural University, Dhaka.

Kumar, Y., Basu, S., Goswami, D., Devi, M., Shivhare, U. S. and Vishwakarma, R. K. (2022). Anti‐nutritional compounds in pulses, Implications and alleviation methods. *Legume Science*. **4**, 111.

Kumari V. V. Banerjee P., Verma V. C., Sukumaran S., Chandran M .A. S., Gopinath K. A., Venkatesh G., Yadav S. K., Singh V. K. and Awasthi N. K. (2022). Plant nutrition, An effective way to alleviate abiotic stress in agricultural crops. *Int. J. Mol. Sci*. **23**, 8519.

Kumawat R., Ram B., Singh P., Tetarwal J. P., Yadav R. K., Gupta A. K. and Bijarnia A. (2022). Response of summer mung bean (*Vigna radiata*) to phosphorus levels, biophos liquid biofertilizer and growth-regulator. *Indian J. Agron.* **67**, 170-174.

Kumar S., and Debbarma V., (2023). Effects of Phosphorus and Boron on Growth, Yield and Economics of Green Gram (*Vigna radiata* L.). *Int. J. Plant Soil Sci.* **35**, 1-8.

Masih, A., Dawson, J. and Singh, R.E. (2020). Effect of levels of phosphorus and zinc on growth and yield of green gram (*Vigna radiata* L.). *Int. J. Curr. Microbiol. Appl. Sci*. **9**, 3106-3112.

Muniswamy, R. S., Singh, V. and Mithare, P. (2018). Response of nitrogen, Sulphur and foliar application of zinc on yield and quality of green gram (*Vigna radiata* L.). *J. pharmacogn. phytochem*. **7**, 517-522.

Movalia, D. J., Donga, S., & Parmar, K. B. (2020). Effect of boron and molybdenum on summer green gram (*Vigna radiata* L.)(GM-4) under medium black calcareous soils, A review. In *Proceedings of the National Conference on Innovations in Biological Sciences.*

Naz, R., Khan, M. K., Hafeez, A., Fazil, M., Khan, M .N., Ali, B., Javed, M. A., Imran, M., Shati, A. A., Alfaifi, M. Y., Elbehairi, S .E. I., Ahmed, A. E., 2022. Assessment of phytoremediation potential of native plant species naturally growing in a heavy metal-polluted industrial soils. *Braz. J. Biol*. **84**, 264473.

Omran, A. H., Dass, A., Rajanna, G. A., Dhar, S., Choudhary, A. K., Meena, S. L. and Rathore, S. S. (2020). Root-shoot characteristics, yield and economics of mung bean (*Vigna radiata* L.) under variable rates of phosphorus and nitrogen. *Bangladesh J. Bot*. **49**, 13-19.

Patel, H. B., Shah, K. A., Barvaliya, M. M. and Patel, S. A. (2017). Response of green gram (Vigna radiata L.) to different level of phosphorus and organic liquid fertilizer. *Int. J. Curr. Microbiol. Appl. Sci.* **6**, 3443-3451.

Rashmitha, B., Umesha, C. and Meshram, M. R. (2021). Influence of spacing and phosphorus levels on growth and yield of black gram (*Vigna mungo* L.). *Biol. Forum*. **13**, 82-85.

Rathod, S., Channakeshava, S., Basavaraja, B., and Shashidhara, K. S. (2020). Effect of soil and foliar application of zinc and boron on growth, yield and micro nutrient uptake of Chickpea. *J. pharmacogn. phytochem*. **9**, 3356-3360.

Saini, A., Manuja, S., Kumar, S., Hafeez, A., Ali, B. and Poczai, P. (2022). Impact of cultivation practices and varieties on productivity, profitability, and nutrient uptake of rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.) cropping system in India. *Agriculture*. **12**, 1678.

Shekhawat K., Shivay Y. S. (2012). Residual effects of nitrogen sources, sulphur and boron levels on mung bean (*Vigna radiata*) in a sunflower (*Helianthus annuus*) – mung bean system. *Arch. Agron. Soil Sci*. **58**, 765-776.

Sitaram Tak, S. T., Sharma, S. K. and Reager, M. L. (2014). Effect of vermicompost and zinc on yield attributes, yield and quality of green gram [*Vigna radiata* var. aureus (L.) Wilczek] in arid western Rajasthan. *Int. J. Agric. Sci***. 10**, 138-141.

Todawat, A., Jat, G., Lakhran, H. and Aechra, S. (2018). Response of green gram [*Vigna radiata* (L.)] to levels of vermicompost and zinc under loamy sand soil. *Int J Agric Sci.* **8**, 33-38.