Annals of Arid Zone 64(4): 695-700, 2025

Short Communication

Productivity and Profitability of Mung bean (*Vigna radiata L.*) as Influenced by Foliar Application of Nutrients under Hot Arid Conditions of Rajasthan

Rohitash Bajiya[1*], Hansa Lakhran[2], Moola Ram[2], Shiv Singh Meena[2], Manju Kumari[2] and Rekha Sodani[2]

[1]*Agricultural Research Sub-Station, Nagaur 341 001 (Agriculture University, Jodhpur), India*

[2]*College of Agriculture, Nagaur 341001 (Agriculture University, Jodhpur), India*

Received: May 20, 2025 Accepted: November 27, 2025

****Correspondence***
Rohitash Bajiya
bajiyarohitash@gmail.com

Citation
Bajiya, R., Lakhran, H., Ram, M., Meena, S.S., Kumari, M and Sodani, R. 2025. Productivity and profitability of mung bean (Vigna radiata L.) as influenced by foliar application of nutrients under hot arid conditions of Rajasthan. Annals of Arid Zone 64(4): 695-700

https://doi.org/10.56093/aaz.v64i4.166917

https://epubs.icar.org.in/index.php/AAZ/article/view/166917

Mung bean (*Vigna radiata* L.), also known as green gram or moong bean, is an important pulse crop in India and is believed to have originated in the country. It is cultivated on 3.19 m ha, accounting for 10% of the total pulse acreage, with a production of 1.51 mt (ICAR-IIPR, 2023-24[a]). Rajasthan leads the nation in mung bean area (2.21 m ha), production (1.06 mt), and yield (477 kg ha^{-1}) (ICAR-IIPR, 2023-24[b]), contributing 46% of the total area and 45% of national production. Other major producing states include Madhya Pradesh, Maharashtra, Karnataka, Odisha, Bihar, Tamil Nadu, Gujarat, Andhra Pradesh, and Telangana. Within Rajasthan, the districts of Nagaur (27%), Jodhpur (13.57%), and Pali (12.18%) together account for more than 50% of the mung bean cultivation area (Sharma *et al*., 2017).

Mung bean is valued for its adaptability to arid and semi-arid climates and for its high nutritional content (Khaket *et al*., 2015; Moriyama and Oba, 2008; Muchomba *et al*., 2023). Its grains typically contain 25-28% protein, 60-65% carbohydrates, 3.5-4.5% fibre, and essential minerals such as iron (7.3 mg kg^{-1}), calcium (124 mg kg^{-1}), and magnesium (189 mg kg^{-1}). It also provides key vitamins including folate (549 µg 100 g^{-1}), vitamin A (94 µg 100 g^{-1}), and vitamin C (8 mg 100 g^{-1}). Beyond its role as a food crop, mung bean enhances soil fertility through biological nitrogen fixation, adding 30-40 kg N ha^{-1} per season, while its residues serve as a valuable fodder source. Its short growth cycle and resilience to environmental stress make it suitable as both a cover crop and a rotation crop (Dhakal *et al*., 2016).

With the global population expected to surpass 10 billion by 2050, food demand is projected to rise by 50% (FAO, 2017). Yet, widespread micronutrient deficiencies affect over 30% of the global population, particularly pregnant women and children (Dogra *et al*., 2024). In India, soils exhibit substantial micronutrient deficiencies- zinc (48%), sulphur (41%), boron (33%), iron (12%), molybdenum (13%), manganese (5%), and copper (4%) - which significantly constrain crop productivity (Boradkar *et al*., 2023). Despite the crucial role of micronutrients in photosynthesis, nitrogen fixation, and overall plant development, they remain underutilized in crop fertilization (Bashir *et al.*, 2022).

In western Rajasthan, mung bean cultivation faces challenges such as high temperatures, limited water, poor soil fertility, and salinity, which hinder nutrient uptake through roots. Under such conditions, foliar nutrient application is an effective alternative, ensuring direct nutrient absorption and improving efficiency, especially in short-duration crops like mung bean (Pochampally *et al.*, 2021; Danga *et al.*, 2020). Considering these factors, the present study was undertaken to evaluate the growth, yield, and profitability of mung bean under hot arid conditions of Rajasthan, and to examine the effectiveness of foliar nutrient application at the flower initiation and pod formation stages in mitigating the effects of dry spells.

The field experiment was conducted during the kharif (rainy) season of 2022 at the Research Farm of Agricultural Research Sub-Station, Nagaur, affiliated with Agriculture University, Jodhpur, Rajasthan. The experimental site is geographically located at 27°12′7.24″ N latitude and 73°44′2.18″ E longitude, at an altitude of 302 m above mean sea level. This location falls under Agro-climatic Zone II-A, classified as the arid and semi-arid transitional plain of inland drainage in Rajasthan. The region experiences a distinctly arid and semi-arid climate, characterized by extreme temperature variations and an average annual rainfall of 385 mm, approximately 80% of which is received during July to September through the southwest monsoon. During the experimental period (July to September) the mean maximum temperature ranged from 33 to 36°C and the minimum from 26 to 27°C. Total rainfall in July, August and September was 270, 216 and 54 mm respectively.

Prior to sowing, soil samples were collected from a 0 to15 cm depth and analysed for physico-chemical properties and nutrient status. The soil was classified as sandy loam with an alkaline reaction (pH 8.2), low organic carbon (0.15%), and non-saline in nature (EC: 0.35 dS m^{-1}). Available N P_2O_5 and K_2O were 219, 15 and 217 kg ha^{-1}. Fe, Zn, Cu, Mn, B and Mo content were 2.56, 0.5040.178, 2.21, 2.34, and 0.64 mg kg^{-1} respectively. Except Mn, B and Mo content of all nutrients in soil was low.

The experiment comprised eleven treatments (T1 to T11) involving foliar application of macronutrients and micronutrients at different crop growth stages, and was laid out in a Randomized Block Design (RBD) with three replications. The gross plot size was 4 × 3 m², and net plot size was 3 × 2.6 m².

The experiment consisted of eleven treatments. T_1 served as the absolute control with no foliar spray. T_2 involved applying 1% urea (N) at the flower initiation (FI) stage, while T_3 included the same 1% urea spray at both FI and pod formation (PF). T_4 consisted of a 1% NPK (19:19:19) spray at FI, and T_5 applied the same NPK solution at both FI and PF. In T_6, a 0.5% KNO_3 solution was sprayed at FI, whereas T_7 received the 0.5% KNO_3 spray at both FI and PF. T_8 involved applying 0.5% borate at FI, and T_9 applied 0.5% borate at both FI and PF. T_{10} included a 0.5% micronutrient mix (containing six elements) applied at FI, while T_{11} applied the same micronutrient mix at both FI and PF.

Micronutrient formulation consisted of Zn (5%), Fe (2%), Mn (2%), Cu (0.5%), B (0.5%), Mo (0.05%) are typically minimum percentages by weight basis and micronutrient fertilizer sources are mostly sulphates for Zn, Fe, Cu, and Mn, but borate and ammonium molybdate are used for B and Mo, respectively. Borate source was Disodium tetraborate pentahydrate (20%). N was added as a mixture of KNO_3 and urea. DAP containing 46% P_2O_5 and 18% Nitrogen. Spray solutions were prepared at recommended concentrations using 500 L water ha^{-1} and applied using a knapsack sprayer with flat-fan nozzle.

The mung bean variety 'GM-4' was sown on 8th July 2022 using a spacing of 30 × 10 cm and a seed rate of 15 kg ha^{-1}. The crop was grown under rainfed conditions, receiving a basal dose of 40:20 kg N:P_2O_5 ha^{-1} supplied through urea and DAP, as per regional recommendations. All standard agronomic practices (thinning, weeding, mulching, pest management) were followed uniformly across treatments. No additional irrigation was applied. The crop was harvested at the maturity stage on 24 September, 2022 from the designated area within each individual plot. The harvested material was then bundled separately, tagged, and left for

Table 1. Effect of foliar application of nutrients on the growth and yield attributes of mung bean

Treatments	Plant height at maturity (cm)	Number of branches/ plants Plant^{-1}	Number of active nodules at flowering	Number of pods/ plants	Number of seeds/ pods.	1000 -grain weight (gm)	Seed yield (t ha^{-1})	Stalk yield (t ha^{-1})	Biological yield (t ha^{-1})
T1: Absolute control (Without foliar application)	63.3	6.7	21.9	46.6	10.9	39.4	1.01	2.07	3.08
T2: Foliar spray of nitrogen Urea @ 1% at FI stage	72.6	7.8	23.7	50.4	11.4	39.6	1.05	1.92	2.97
T3: Foliar spray of nitrogen Urea @ 1% at FI and PF stage	73.4	7.9	24.0	51.4	11.6	40.8	1.06	1.92	2.98
T4: Foliar spray soluble NPK (19:19:19) @ 1% at FI stage	73.0	7.9	24.4	50.2	11.7	41.0	1.07	2.03	3.1
T5: Foliar spray soluble NPK (19:19:19) @ 1% at FI and PF stage	75.6	8.0	24.4	51.8	12.1	40.6	1.09	2.04	3.13
T6: Foliar spray of soluble KNO_3 @ 0.5% at FI stage	71.0	8.0	24.5	51.1	12.2	40.8	1.15	2.09	3.24
T7: Foliar spray of soluble KNO_3 @ 0.5% at FI and PF stage	72.0	8.0	24.6	52.9	11.9	41.3	1.19	2.03	3.22
T8: Foliar spray of borate @ 0.5% at FI stage	73.6	8.0	24.7	53.5	12.1	43.3	1.2	2.07	3.27
T9: Foliar spray of borate @ 0.5% at FI and PF stage	74.7	8.0	24.7	53.8	12.3	42.2	1.24	2.08	3.32
T10: Foliar spray of combined six micronutrients (Fe, Zn, Mn, Cu, Mo, B) @ 0.5% at FI stage	72.8	8.1	25.0	54.1	12.4	42.5	1.24	2.01	3.25
T11: Foliar spray of micronutrient 6'S element (Fe, Zn, Mn, Cu, Mo, B) @ 0.5 % at FI and PF stage	78.0	8.2	24.7	61.6	13.2	42.7	1.32	2.06	3.38
SEm±	2.5	0.35	0.7	2	0.2	0.3	0.03	0.05	0.06
CD (P=0.05)	7.6	1.06	2.1	6.1	0.6	1.0	0.10	0.15	0.18

FI: Flower initiation and PF: Pod formation

sun drying in the field. Following thorough sun drying, the bundles were weighed to document the biological yield. The important growth parameters, yield attributes and yield were recorded as per standard procedures. In order to calculate the net returns for each treatment, total cost of cultivation was subtracted from the gross returns. Total cost of cultivation calculated as per input and labor requirement at the time of experiment conducted. Gross returns were estimated as per the minimum support price of prevailing at the time of conduct of experiment of and benefit-cost ratio was calculated from gross return to cost of cultivation.

Harvest index (HI) was calculated by Gardner *et al*. (1985) and production and economic efficiency was were recorded by mean yield (t ha^{-1}) and crop duration (days) as per standard procedure.

All data were analysed using the Analysis of Variance (ANOVA) technique suitable for RBD as described by Gomez and Gomez (1984). Treatment means were compared using the Critical Difference (CD) at 5% significance level (P = 0.05).

Growth and Yield: Foliar application of nutrients at the flower initiation and pod formation stages significantly enhanced the growth, yield attributes, and yield of mung bean (Table 1). Among all treatments, the combined foliar application of all six micronutrient (Fe, Zn, Mn, Cu, Mo, B) at 0.5% concentration was most effective and lead to highest plant height (78.0 cm), maximum branches plant^{-1} (8.2) and most active nodules at flowering (24.7). This treatment also led to maximum pods plant^{-1} (61.6), maximum seeds pod^{-1} (13.2), maximum 1000-grain weight (42.7 g), maximum seed yield (1.32 t ha^{-1}), stalk yield (2.06 t ha^{-1}), biological yield (3.38 t ha^{-1}) and harvest index (39.1%).

Table 2. Effect of foliar application of nutrients on harvest index, economics production and monetary efficiency the yield in mung bean

Treatments	Harvest index	Cost of cultivation (Rs. ha^{-1})	*Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Benefit cost ratio	Production efficiency (kg ha^{-1} d^{-1})	Monetary efficiency (Rs. ha^{-1} d^{-1})
T1: Absolute control (without foliar application)	32.8	26800	78326	51526	1.92	14.9	758
T2: Foliar spray of nitrogen urea @ 1% at FI stage	35.4	28800	81428	52628	1.83	15.4	774
T3: Foliar spray of nitrogen urea @ 1% at FI and PF stage	35.6	29800	82203	52403	1.76	15.6	771
T4: Foliar spray soluble NPK (19:19:19) @ 1% at FI stage	34.5	28800	82979	54179	1.88	15.7	797
T5: Foliar spray soluble NPK (19:19:19) @ 1% at FI and PF stage	34.8	29800	84530	54730	1.84	16.0	805
T6: Foliar spray of soluble KNO_3 @ 0.5% at FI stage	35.5	28600	89183	60583	2.12	16.9	891
T7: Foliar spray of soluble KNO_3 @ 0.5% at FI and PF stage	37.0	29700	92285	62585	2.11	17.5	920
T8: Foliar spray of borate @ 0.5% at FI stage	36.7	28700	93060	64360	2.24	17.6	946
T9: Foliar spray of borate @ 0.5% at FI and PF stage	37.3	31000	96162	65162	2.10	18.2	958
T10: Foliar spray of combined six micronutrients (Fe, Zn, Mn, Cu, Mo, B) @ 0.5% at FI stage	38.2	29600	96162	66562	2.25	18.2	979
T11: Foliar spray of combined six micronutrients (Fe, Zn, Mn, Cu, Mo, B) @ 0.5% at FI and PF stage	39.1	31400	102366	70966	2.26	19.4	1044
SEm±	0.85	-	-	-	-	0.41	29.2
CD (P=0.05)	2.55	-	-	-	-	1.27	87.9

*Gross return computed based on MSP of Kharif 2022.

Borate @ 0.5% was the second-best treatment producing a seed yield of 1.24 t ha^{-1}, biological yield of 3.32 t ha^{-1} with harvest index of 37.3%. In contrast, the control (no foliar spray) had the lowest values across all parameters. Combined application of all six micronutrients recorded higher number of branches plant^{-1} (22.3%), number of pods plant^{-1} (32.8%), number of seeds plant^{-1} (21.1%), number of active nodules (12.7%), Seed yield (30.6%) and harvest index (19.2%) over control. Foliar nutrition provides direct and immediate nutrient availability, promotes leaf area expansion, chlorophyll content, photosynthesis, metabolic processes, hormonal and enzymatic activity (Saini *et al.,* 2023 and Selim *et al*., 2023). Thus, the improvement is attributed to enhanced nutrient availability, root growth, photosynthesis, and enzymatic activity due to foliar feeding. These findings are consistent with earlier studies by Zafar *et al*. (2023), who reported significant improvements in growth and yield parameters of mung bean with foliar application of Zn at 0.3%. Similarly, Dhaliwal *et al*. (2023) found that combined foliar application of $ZnSO_4$, $FeSO_4$, and borax significantly enhanced yield, economic returns, and nutrient uptake in mung bean. Additionally, the role of Zn and Fe in mobilizing native soil nutrients and activating plant metabolism has been well documented (Ali *et al*., 2014; Bahadari *et al*., 2020), further supporting the observed yield improvements through foliar application, suggesting similar benefit in legumes.

*Economics and efficiency***:** The highest cost of cultivation was recorded with the foliar application of combined six micronutrients at Rs. 31,400 ha^{-1}, followed closely by borate application at Rs. 31,000 ha^{-1} (Table 2). In contrast, the lowest cost of cultivation was observed in the control treatment (no foliar application), which stood at Rs. 26,800 ha^{-1}. In terms of economic returns, the combined application of six micronutrient at 0.5% concentration applied at flowering and pod formation stages provided the maximum gross return of Rs. 1,02,366 ha^{-1} and net return of Rs. 70,966 ha^{-1}. On the other hand, the control treatment resulted in a comparatively lower gross return of Rs. 78,326 and net return of Rs. 51,526 ha^{-1}. The benefit-cost (B:C) ratio followed a similar trend. The highest B:C ratio of 2.26 was observed with the application of the combined six micronutrients, clearly indicating the economic advantage of using a balanced micronutrient foliar spray during key growth stages of the crop.

With regard to efficiency indicators, the micronutrient treatment also resulted in the highest production efficiency, measured at 19.4 kg ha^{-1} d^{-1}, and monetary efficiency of Rs. 1,044 ha^{-1} d^{-1}. These parameters reflect the effectiveness of the crop in timely utilization of resources under the influence of micronutrient foliar application. The second-best performance in terms of production (18.2 kg ha^{-1} d^{-1}) and monetary efficiency (Rs. 958 ha^{-1} d^{-1}) was observed with borate application. In contrast, the lowest efficiencies were recorded in the control treatment, with production efficiency of 14.9 kg ha^{-1} $d^{-1}$and monetary efficiency of Rs. 758 ha^{-1} d^{-1}. These findings are in agreement with previous studies by Diwedi *et al*. (2024) and Dhaliwal *et al*. (2023), who also reported improved yield and economic returns with the foliar application of balanced micronutrients in mung bean and other pulses.

Conclusion

Foliar application of all six micronutrient elements combined (Fe, Zn, Mn, Cu, Mo, B) at 0.5% concentration, applied at flower initiation and pod formation stages significantly enhanced the productivity, profitability, and efficiency of mung bean cultivation. Therefore, this practice can be recommended as a profitable and efficient nutrient management strategy for mung bean farmers aiming to maximize returns and resource use.

Acknowledgments

The author is grateful to the ARSS, Nagaur, ARS, Fathpur and ARS, Mandor for providing necessary facilities and technical support to carrying out research.

Conflict of Interest

This research is conducted ethically and in compliance with relevant guidelines and regulations. We, all the authors have declared that no conflict of interest exists that could have appeared to influence the work reported in this paper.

References

Ali, B. Ali, A., Tahir, M. and Shafaqat, A.L. 2014. Growth, Seed Yield and Quality of Mung bean as Influenced by Foliar Application of Iron Sulfate. *Pakistan Journal of Life and Social Sciences* 12(1): 20-25.

Bahadari, S., Singh Y.V., Baray S. M., Shivay Y. S, and Parsad R. 2020. Influence of foliar application of nitrogen on growth and yield of mung bean (*Vigna radiata*) varieties in Kandahar region of Afghanistan. *Indian Journal of Agronomy* 65(1): 111-115.

Bashir, M., Bahar, F.A., Bhat, M.A., Singh, L., Mahdi, S.S., Palmo, T., Rehman, U. and Raheeba, T.N. 2022. Review: Nanotechnology in Agriculture: Prospects and Problems. Biological Forum – *An International Journal* 14(1): 519-528.

Boradkar, S.G., Adsul, P.B. and Adsul, V.B. 2023. Effect of iron and zinc application on growth, yield and quality of green gram (*Vigna radiata* L.) in Inceptisol. *The Pharma Innovation Journal* 12: 211-215.

Danga, M., Mehriya, M.L., Shukla, U.N., Mali, G.R. and Yadav V.L. 2020. Effect of weed management on growth and yield of mung bean [*Vigna radiata* (L.) Wilczek]. *International Journal of chemical Studies* 8(4): 3430-3432.

Dhakal, Y., Meena, R.S. and Kumar, S. 2016. Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of green gram. *Legume Research* 39(4): 590-594.

Dhaliwal, S.S., Sharma, V., Shukla, A.K., Kaur, M., Kaur, J., Verma, V., Singh, P., Barek, V., Gaber, A. and Hossain, A. 2023. Biofortifcation of mung bean (*Vigna radiata* L. (Wilczek)) with boron, zinc and iron alters its grain yield and nutrition. *Scientifc Reports* 13: 3506.

Diwedi, N., Singh S. Pandey D., Singh P. K., Chanda S.S., Tiwari H. N., Singh D.K. and Singh G. 2024. The effect of integrated nutrient management on growth, yield attributes and yield of transplanted rice under irrigated condition (*Oryza sativa* L.). *Journal of Experimental Agriculture International* 46(1): 27-36.

FAO 2017. The Future of Food and Agriculture "*Trends and Challenges*".

Gardner, F.P., Pearce, R.B. and Mistechell, R.L. 1985. *Physiology of Crop Plants*. Iowa State Univ. Press, Powa. 66.

Gomez, K.A. and Gomez, A. 1984. *Statistical Procedures for Agricultural Research*, 2nd edn. John Willey and Sons. Singapore.

ICAR-IIPR-2023-24[a]. 1st estimates of production of major crops, *Economic Survey*. *Government of India, Ministry of Finance and Company Affairs*, Economic Division, New Delhi. 2023-24.

ICAR-IIPR-2023-24[b]. 3rd Advance Estimate, *Ministry of Agriculture and Farmers Welfare Department of Agriculture*, Cooperation and Farmers Welfare.

Khaket, T., Dhaka, K.S. and Singh, R. 2015. Genetic variability and association analysis for yield and its component traits in mung bean (*Vigna radiata* L. Wilczek). *Journal of Agricultural Sciences* 60(1): 83-88.

Moriyama, M. and Oba, K. 2008. Comparative study on the vitamin C contents of the food legume seeds. *Journal of Nutritional Science Vitaminology* 54(1): 1-6. doi: 10.3177/jnsv.54.1. PMID: 18388400.

Muchomba, M.K., Muindi, E.M. and Mulinge, J.M. 2023. Overview of green gram (*Vigna radiata* L.) crop, its economic importance, ecological requirements and production constraints in Kenya. *Journal of Agriculture and Ecology Research International* 24(2): 1-11. Doi: 10.9734/jaeri/2023/v24i2520

Pochampally, K., Singh, S., Hinduja, N., Tiwari, D. and Sruthi, S. 2021. Effect of foliar application of micronutrients on growth and yield of green gram (*Vigna radiata* L.). *Legume Research- An International Journal* 44(12): 1460-1464.

Saini, L., Singh, R., Kumhar, B.L. and Meena, R.S. 2023. Effect of foliar application of zinc and boron on growth and yield of primed mung bean (*Vigna radiata L.*). *Nature Environment and Pollution Technology Journal* 3(1): 112-118.

Selim, M.S.R., Adhikary, S., Mondal, M.A., Nadim, K.A. and Akter, B. 2023. Foliar application of different levels of zinc and boron on the growth and yield of mung bean (*Vigna radiata L.*). *Turkish Journal of Agriculture – Food Science and Technology* 11(8): 1415-1421. https://doi.org/10.24925/turjaf.v11i8.1415-1421

Sharma, N.K., Panwar, P. K. and Kumawat, N. 2017. Evaluation of mung bean varieties and production technologies at farmer's fields in western Rajasthan. *Annals of Arid Zone* 56(1&2): 43-45.

Zafar, M., Ahmed, S., Munir, M.K., Zafar, N., Saqib, M., Sarwar, M.A., Iqbal, S., Ali, B., Akhtar, N., Ali, B. and Hussain S. 2023. Application of zinc, iron and boron enhances productivity and grain biofortification of mung bean. *Phyton* 92(4): 983-999.

Printed in December 2025