PLANT SCIENCE TODAY
Vol 12(3): 1-8
https://doi.org/10.14719/pst.7712

eISSN 2348-1900

RESEARCH ARTICLE

Assessing the effect of various nutrient management practices on Mungbean (*Vigna radiata*) production in Guava (*Psidium guajava*) based agri-horti system

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Received: 12 February 2025; Accepted: 04 June 2025; Available online: Version 1.0: 01 August 2025; Version 2.0: 16 August 2025

Cite this article: Visha J, Chandra B, Ayushi J, Shivam, Anjali T, Subhaprada B, Vikas K. Assessing the effect of various nutrient management practices on Mungbean (*Vigna radiata*) production in Guava (*Psidium guajava*) based agri-horti system. Plant Science Today. 2025; 12(3): 1-8. https://doi.org/10.14719/pst.7712

Abstract

The field experiment was conducted in the *Kharif* season spanning 2022-23 to determine the most effective nutrient management practice via foliar application in Mungbean (*Vigna radiata* L.) in a guava (*Psidium guajava* L.) *cv.* Lalit based agri-horti system. The studies were conducted at Agroforestry Research Farm, Banaras Hindu University campus in Randomized Block Design (RBD) with ten treatmentsand three replications. The guava fruit orchard of size 7x7 m was established in 2007. The orchard had an average height of 5.85 m, canopy diameter of 5.60 m, stem girth of 0.97 cm and crown length of 4.93 m. Mungbean cv. *Samrat,* a short duration (60-65 days) and yellow mosaic virus resistant variety were used for the study. The plot size was 9 m^2 (gross) and 4.80 m^2 (net) with an inter-row spacing of 30 cm and an intra-row spacing of 10 cm. The seeds were sown at the rate of 15 kg ha^{-1}. The plants were raised till 64 days and the treatments with different concentrations of recommended fertilizer foliar were given when most of the (80 %) pods turned brown. The results revealed that treatment T_{10} in which recommended fertilizer dose (18:48:24 kg ha^{-1} N:P_2O_5: K_2O) along with foliar applications of Nano urea (4 mL L^{-1}), 0.5 % $ZnSO_4$ and 0.2 % Boron at pre-flowering and pod development stages gave high yield. The plants subjected to this treatment showed significantly low mortality but increased plant height, branching, leaf production, yield and improved economic returns (gross return, net return and benefit-cost ratio). The second most effective treatment was T_9 in which recommended fertilizer dose was supplemented with 0.5 % $ZnSO_4$ and 0.2 % boron applied twice, at pre-flowering and pod development stages. Integrating optimized fertilization and foliar nutrient applications to enhance mungbean yield while maintaining sustainable practices in agri-horti systems.

Keywords: agri-horti system; boron; foliar nutrient; mungbean; nano urea; yield; zinc

Introduction

Agroforestry involves the intentional integration of trees and shrubs with agricultural crops and/or livestock, arranged spatially or temporally, to create diverse and sustainable land-use systems (1). The practice is widely accepted in low-income countries, where a large proportion of the populations depend on the agricultural sector and land is still underutilized (2-4). Complimentary nutrient sharing in agroforestry systems promotes high productivity, sustainable land use pattern and ecosystem services, making it a widely adopted practice globally (5-7). Interest in alley cropping and/ or hedge cropping systems is increasing due to the growing demand for food, fuel, fodder, energy (8-9) and others desirable goods and services that promote sustainable agriculture through the integration of trees and crops.

Monoculture practices have led to soil degeneration, decline in water tables, increased pests and diseases incidences and serious economic losses, decreased crop yield (10). The profitability of agroforestry systems depends on the selection of tree species, crops, interactions, site quality. These factors can positively influence arable crop yields, soil fertility (11, 12), microclimate, moisture levels (13), nutrient cycling (14), soil microbial biodiversity (15,16), climate change mitigation through carbon sequestration (17) and other ecosystem services (18) in tropics and subtropics, ultimately ensuring nutrition and food security.

The combination of arable crops, particularly legume crops and perennial horticultural crops can provide a profitable (19) and sustainable source of revenue for farmer's livelihoods. It can also promote yields and provide value added products, thereby creating an agri-horti system (20). Horticultural crops, especially fruit crops, are the preferred choice of farmers in any horticulture-based agroforestry systems (21, 22). This is due to their short gestation period, aesthetic value, nutritional content (23), nitrogen fixing capacity, ability to maintain nutrient levels in soil, sequester soil carbon, provide protection from wind and at the top provide regular income with low risk (24). In this era of shrinking agricultural land, Agri-Horti System acts an attractive farming system because of high yield and productivity, short juvenile period, seasonal flowering and good fruiting. This system can provide both direct benefits (economical status, employment opportunities, aesthetic value) and indirect benefits (ecological services, clean environment, greenly, beautification) to the agro based industry in the region.

Mungbean or green gram (*Vigna radiata* L.) is a vital legume crop grown worldwide across varied climates and geographies. It serves as an excellent source of high-quality protein and contributes to soil fertility through its nitrogen-fixing properties (25, 26). However, its production is severely constrained by heavy weed infestation (27-30). It is rich in protein, bioactive compounds, minerals and vitamins and is essential for a balanced vegetarian diet. As pulses are referred to as "poor man's meat" (31).

Guava (*Psidium guajava* L.), known as the 'Apple of the tropics', is native to Central America and southern Mexico, belonging to the family Myrtaceae. It is one of the predominant and fast-growing horticultural crops that grows well in India's alluvial plains and can be easily cultivated worldwide due to its broader adaptability (32, 33). Traditionally, guava is cultivated at a spacing of 6-8 m (156-278 plants ha^{-1}) to utilize the full potential of natural resources (light, moisture, space and nutrients) (34). In India, guava is cultivated by small and marginal farmers and on field bunds in the semi-arid eastern plain zone (35).

For enhanced crop productivity in various agroforestry systems, a combination of organic and inorganic fertilizers, mulching techniques (36-40) and liming (41) is strongly recommended. Healthy soil is crucial for interactions between biota and the physicochemical properties of soil (42, 43) to maintain or recover the integrity of agricultural lands and promote sustainable agricultural practices and profitability without environmental deterioration. Micronutrient deficiencies, particularly zinc and boron are prevalent in Indian soils and are mainly responsible for reduction in crop yields (44). Nitrogen fertilization enhances crop growth, while foliar application during reproductive stages improves yield and reduces flower drop (45). Boron and zinc play vital roles in starch metabolism, photosynthesis and enzyme activity, as well as flower development and seed yield (46). The foliar application of zinc promotes root and shoot growth (47) and boron affect leaf area and dry matter production in pulses (48). The study was aimed to investigate the impact of foliar nutrient application on the growth and yield attributes of Mungbean within a guava-based agri-horti system.

Materials and Methods

The experiment was carried out during the 2022-23 *Kharif* season at the Agroforestry Research Farm, Mirzapur (Uttar Pradesh), situated in the Vindhyan region (25°10′ N, 82°37′ E) at an elevation of 147 m above mean sea level. This region falls within the semi-arid eastern plain zone IIIA and is characterized by an annual rainfall of 1061 mm, with approximately 88 % of it concentrated between June and September. The average daily potential evapotranspiration was noted to be around 4.46 mm/day (Fig. 1). The soil of experimental site was slightly acidic (pH 6.4) and classified as silty sandy loam. The soil had low nutrient availability, including nitrogen (202.33 kg/ha), zinc (0.31 ppm) and boron (0.35 ppm). Additionally, the soil also exhibited low organic carbon content (0.37 %).

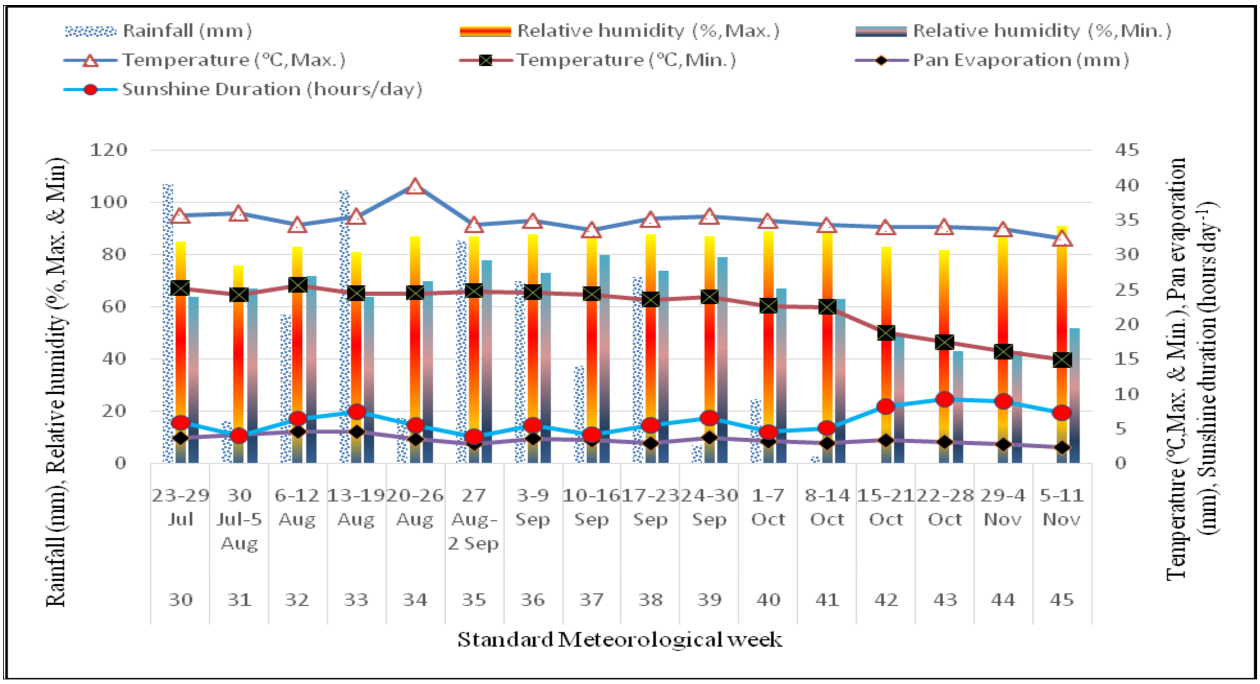

Fig. 1. Mean weekly meteorological observations recorded during the Mungbean cropping season under guava (*Psidium guajava*) based agri-horti system (July to November 2022).

Experimental details

The experiment was conducted in a 14-year-old guava (cv. Lucknow-49) orchard, established in 2007, using a RBD. The guava trees were planted at a spacing of 7 x 7 meters. The experiment consisted of three replications and ten treatments. The guava trees had an average height (5.85 m), canopy diameter (5.60 m), stem girth (0.97 cm) and crown length (4.93 m). Mungbean variety *Samrat* (a cross between ML-20/19 x ML-5), a short duration (60-65 days) and yellow mosaic virus resistant variety, was released by ICAR-IIPR, Kanpur in 2009. The experiment consisted of treatment plots with a gross size of 3 x 3 m (9 m^2) and a net plot size of 2 x 2.4 m (4.80 m^2). Mungbean was sown with an inter-row spacing of 30 cm and an intra-row spacing of 10 cm, using a seed rate of 15 kg ha^{-1}. Uniform application of NPK compound fertilizer of grade 12 N: 32 P_2O_5: 16 K_2O at rate of 150 kgha^{-1} was applied basally at time of sowing.

Weed management involved the application of pendimethalin as a pre-emergence herbicide (PRE) within 2 days of sowing, followed by imazethapyr as a post-emergence herbicide (POST) 20 days after sowing (DAS). Herbicides were dissolved in water at a rate of 500 L ha^{-1} and sprayed using a knapsack sprayer equipped with a flat-fan nozzle.

The treatments were consisted of absolute control (no fertilizer) (T_1); recommended dose of fertilizers (RDF) 18:48:24 kg ha^{-1} (T_2); RDF + 2 % neem coated urea twice at pre-flowering and pod development (T_3); RDF + foliar application of nano urea at 4 ml L^{-1} twice at pre-flowering and pod development (T_4); RDF + foliar application of 0.5 % $ZnSO_4$ + 0.25 % lime twice at pre-flowering and pod development (T_5); RDF + foliar application of 0.2 % B twice at pre-flowering and pod development (T_6); RDF + foliar application of nano urea at 4 mL/L^{-1} + 0.5 % Zn (T_7); RDF + foliar application of nano urea at 4 mL L^{-1} + 0.2 % B twice at pre-flowering and pod development (T_8); RDF + foliar application of 0.5 % $ZnSO_4$ + 0.2 % B twice at pre-flowering and pod development (T_9); and RDF + foliar application of nano urea at 4 mL L^{-1} + 0.5 % $ZnSO_4$ + 0.2 % B twice at pre-flowering and pod development (T_{10}). Observations were recorded on 20 DAS, 40 DAS and at harvest. The RDF consisted of N18:P48:K24 kg ha^{-1}, supplied through Diammonium Phosphate (DAP) and or Muriate of Potash (MOP). Micronutrients zinc (0.5 %) and boron (0.2 %) were supplied through Zinc Sulphate Monohydrate (containing 33 % zinc) and Di-Sodium Octa Borate Penta Hydrate (containing 20 % boron), respectively. Macronutrient N was supplied through neem coated urea and liquid nano urea, twice at pre-flowering (30 DAS) and pod development (45 DAS) stages.

Biometric observation

Five mungbean plants were randomly selected from each treatment to record various growths and yield attributes. The parameters such as plant height (cm), number of branches per plant, number of trifoliate leaves per plant, dry matter accumulation, days to 50 % flowering, days to 80 % maturity, nodules per plant, pods per plant, grains per pod, pod length, thousand grains weight, biological yield, grain yield, straw yield, grain: straw ratio, harvest index, net return, gross return and benefit: cost ratio were measured. These attributes were calculated using established formulas:

Plant (mungbean) mortality is calculated by (Eqn. 1-4):

$$\text{Mortality} = \frac{\text{Number of initial plants - Number of plants at harvest}}{\text{Number of initial plants}} \times 100 \quad \text{(Eqn. 1)}$$

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological Yield}} \times 100 \quad \text{(Eqn. 2)}$$

$$\text{Net return} = \text{Gross returns - Cost of cultivation (Rs)} \quad \text{(Eqn. 3)}$$

$$\text{B : C} = \frac{\text{Net return (Rs/ha)}}{\text{Cost of cultivation (Rs/ ha)}} \quad \text{(Eqn. 4)}$$

Gross return was calculated based on the mungbean seed yield and its prevailing market price, using the following equation (Eqn. 5).

$$\text{Gross returns} = \text{Yield of produce} \times \text{price of produce (Rs kg / ha)} \quad \text{(Eq. 5)}$$

Statistical analysis

The collected data were subjected to statistical analysis using R studio software, with a significance level set at $p < 0.05$. To compare treatment means and determine significant differences, Tukey's Honestly Significant Difference (HSD) test was applied, considering the experiment's three replicates.

Results and Discussion

Morphological growth attributes

In this study various growth attributes of mungbean such as plant height, branch number, trifoliate leaf count, dry matter accumulation and root nodule count were evaluated. The results showed significant variations in these attributes due to different foliar nutrient dosage. The highest values for all growth attributes were observed in treatment T_{10}, which was statistically at par with treatments T_9, T_7, T_8 and T_6 in terms of plant height and number of trifoliate leaves. All these treatments showed significant improvement over control (Table 1). The application of RDF + foliar application of Nano urea at 4 mL L^{-1} + 0.5 % $ZnSO_4$ + 0.2 % B twice at pre-flowering and pod development (T_{10}) significantly improved critical growth phases by enhancing essential physiological and metabolic activities such as auxin production, cell elongation and photosynthetic activity (26). This treatment promoted photosynthesis, respiration, chlorophyll biosynthesis and protein synthesis, while also stimulating critical enzymatic activities for plant growth (49, 50). The application of boron increased internode diameter by thickening the stem walls. Additionally, nano nutrients increase tryptophan levels in meristematic cells, stimulating auxin synthesis (51, 52). Enhanced nutrient availability promoted axillary bud growth, branching and plant height (53). The increased number of nodules caused by micronutrient application improves nitrogen fixation, promoting vegetative development (53). The increase in dry matter production could be attributed to the synergistic effects of macronutrients and micronutrients, which enhanced metabolic processes and stimulate crop

Table 1. Effect of various nutrient management practices on growth and morphological attributes of mungbean [*Vigna radiata* (L.)] under guava (*Psidium guajava*) based agri-horti system

Treatments	Plant height (cm)		No. of branches/ plant		No. of trifoliate leaves/plant		Dry matter (g/ plant)		No. of root nodules/plant		Plant population (1000 plants/ha)		Mortality %	50 % Flowering	80 % Maturity
	40 DAS	At harvest	40 DAS	At harvest	40 DAS	At harvest	40 DAS	At harvest	40 DAS	At harvest	At initial (15 DAS)	At harvest			
T1	29.3^{d}	38.3^{b}	3.0^{c}	4.5	12.0^{c}	4.6^{c}	30.0^{c}	35.0^{c}	15.3^{c}	3.9	128.7^{b}	121.3^{c}	5.7	30.33	57.67
T2	31.0^{abcd}	45.4^{a}	4.0^{ab}	5	13.0^{bc}	6.2^{b}	31.9^{bc}	37.6^{bc}	19.2^{b}	4.5	139.7^{a}	131.3^{b}	5.9	31	58.67
T3	30.2^{cd}	44.3^{a}	3.9^{b}	4.9	12.6^{bc}	6.0^{b}	33.8^{ab}	39.6^{ab}	19.1^{b}	4.3	146.7^{a}	138.7^{ab}	5.6	30.67	58.33
T4	32.9^{abc}	45.6^{a}	4.2^{ab}	5.1	13.6^{ab}	6.3^{b}	34.6^{ab}	40.3^{ab}	21.0^{ab}	4.5	142.3^{a}	134.3^{ab}	5.6	31.33	59
T5	30.4^{bcd}	44.3^{a}	3.9^{ab}	4.9	12.2^{c}	6.0^{b}	32.0^{bc}	40.4^{ab}	18.9^{b}	4.2	143.0^{a}	135.7^{ab}	5.1	30.67	58.33
T6	30.6^{bcd}	45.0^{a}	3.9^{b}	5	12.9^{bc}	6.1^{b}	33.4^{ab}	39.7^{ab}	19.7^{ab}	4.4	142.7^{a}	135.3^{ab}	5	31	58.33
T7	32.6^{abc}	45.6^{a}	4.2^{ab}	5.1	13.2^{abc}	6.3^{b}	34.2^{ab}	41.1^{ab}	21.5^{a}	4.6	146.7^{a}	140.3^{ab}	4.3	31.67	59.33
T8	32.6^{abc}	45.5^{a}	4.0^{ab}	5	13.4^{ab}	6.3^{b}	34.3^{ab}	40.3^{ab}	20.7^{ab}	4.5	148.3^{a}	141.7^{a}	4.5	31.33	58.67
T9	33.1^{ab}	45.7^{a}	4.4^{ab}	5.2	13.6^{ab}	6.5^{ab}	34.7^{ab}	42.1^{a}	21.6^{a}	4.6	145.7^{a}	140.0^{ab}	3.9	31.67	59.33
T10	33.6^{a}	46.4^{a}	4.5^{a}	5.3	14.2^{a}	6.9^{a}	34.9^{a}	42.3^{a}	21.9^{a}	4.7	147.3^{a}	141.7^{a}	3.8	32	59.67
C.D. (P=0.05)	1.63	2.66	0.32	NS	0.7	0.3	1.68	3.6	1.32	NS	6.18	5.45	NS	NS	NS

Values followed by same superscript in a column do not differ significantly

development (54). Furthermore, the addition of micronutrients increases chlorophyll content, leading to improved growth metrics (55). The lack of significant variations implies that the treatments may not be effective in altering these specific aspects of plant growth or development. However, 15 DAS, treatment T_{10} exhibited a significantly higher plant population, which was statistically at par with all treatments except T_1 (Table 1). This trend persisted at harvest, with treatment T_{10} maintaining a significantly higher plant population, comparable to treatment T_8, but surpassing the other treatments.

Premature flower and pod drop is a major constraint to pulse yields. Minimizing flower abscission can potentially lead to significant improvements in pulse productivity. Genotypes that produce a higher number of flowers over a shorter duration tend to have a greater capacity for pod set and retention until maturity. Furthermore, the application of zinc and boron has been shown to effectively reduce flower drop, potentially leading to improved yield outcomes (56).

Yield attributes and Yield

Treatment T_{10}, comprising RDF plus foliar spray of nano urea (4 mL L^{-1}), 0.5 % $ZnSO_4$ and 0.2 % B, applied twice at pre-flowering and pod development stages, resulted in significantly higher yield attributes in Mungbean. Pod number, pod length, test weight, grains per pod, grain yield, straw yield and biological yield noted a significant increase as compared to all other treatments. The other treatments showing good performance were T_9, T_7, T_4, T_8, T_2 and T_6. All these treatments also showed improved yield attributes compared to the control (Table 2). Foliar application of zinc at critical growth stages promotes cell elongation and enhances pollen grain function, contributing to flower and pod development and increasing protein content in grains (47, 52). Additionally, boron, applied as a foliar spray, significantly improved flower development, pollen tube growth, pollen viability and seed development in mungbean (53, 54).

Nutrient content and uptake attributes

The results revealed significant variations in nutrient content and uptake across treatments. Treatment T_{10}showed higher nitrogen, zinc and boron content and uptake in straw and zinc and boron in grains, comparable to T9 and T6, respectively (Table 3). Foliar application of balanced nutrition substantially impacted crop growth and development. The results are in accordance with the previous findings (44, 55, 56). Foliar application enhanced nutrient content and uptake in plants and thus can be an effective strategy for improving crop growth, optimizing nutrient availability and enhancing agricultural productivity (57).

Quality attributes

The treatment T_{10} showed significantly higher protein content and yield compared to other treatments (Table 3). This improvement is attributed to the application of foliar nutrients, which enhance metabolic and physiological functions, enzymatic processes and protein synthesis, ultimately boosting protein content and grain quality (58-62).

Table 2. Effect of various nutrient management practices on yield attributes of mungbean [*Vigna radiata* (L.)] under guava (*Psidium guajava*) based agri-horti system

Treatments	No. of pods plant^{-1}	Pod length (cm)	1000 grains weight (g)	No. of grains pod^{-1}	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index	Grain: Straw ratio
T1	21.33c	4.7^{c}	24.2^{e}	3.73^{f}	708^{e}	1123^{h}	1831^{h}	38.6^{a}	0.59
T2	25.67a	6.4^{ab}	31.1^{bcd}	6.93^{bc}	919^{d}	2114^{def}	3032^{ef}	31.0^{c}	0.43
T3	24.67ab	6.6^{ab}	29.2^{d}	5.80^{de}	1034^{cd}	2474^{bc}	2769^{fg}	37.3^{ab}	0.57
T4	26.33a	6.0^{b}	33.6^{b}	6.53^{c}	992^{d}	1670^{g}	3467^{d}	32.2^{c}	0.41
T5	22.67bc	6.0^{b}	28.6^{d}	5.47^{e}	1010^{cd}	1929^{efg}	2680^{g}	37.5^{ab}	0.57
T6	25.33ab	6.7^{ab}	30.1^{cd}	6.33^{cd}	1008^{d}	2426^{bcd}	2937^{efg}	34.3^{abc}	0.51
T7	26.67a	6.5^{ab}	33.7^{b}	7.50^{ab}	1203^{bc}	2139^{cde}	3759^{c}	35.4^{abc}	0.54
T8	26.00a	6.7^{ab}	33.4^{bc}	6.57^{c}	1040^{cd}	2727^{ab}	3179^{e}	32.7^{c}	0.48
T9	27.00a	6.9^{a}	37.9^{a}	7.60^{a}	1306^{b}	3043^{a}	4064^{b}	33.1^{bc}	0.48
T10	27.33a	6.0^{b}	40.2^{a}	8.13^{a}	1550^{a}	1735^{fg}	4402^{a}	31.7^{c}	0.44
C.D. (P=0.05)	1.7	0.4	1.9	0.3	112	155	174	NS	NS

Values followed by same superscript in a column do not differ significantly

Table 3. Effect of various nutrient management practices on economics, quality and nutrient content and uptake in grain and straw of mungbean [*Vigna radiata* (L.)] under guava (*Psidium guajava*) based agri-horti system

Treatment	Total cost of cultivation	Gross return (Rs/ha)	Net return (Rs)	B:C ratio	Protein content (%)	Protein yield (kg/ha)	N content in grain (%)	N content in straw (%)	Zn content in grain (ppm)	Zn content in straw (ppm)	B content in grain (ppm)	B content in straw (ppm)
T1	31452^{b}	152659^{d}	121207^{e}	3.8^{b}	21.4	152.0^{c}	3.4	1.4^{b}	20.4^{d}	172^{c}	20.2^{g}	16^{g}
T2	39361^{a}	170827^{c}	131466^{d}	3.3^{e}	22.0	202.4^{bc}	3.5	1.3^{b}	25.3^{cd}	145^{c}	26.7^{f}	17.8^{f}
T3	39505^{a}	180695^{c}	141190^{c}	3.5^{c}	21.9	227.0^{b}	3.4	1.5^{b}	40.3^{b}	175^{c}	26.8^{f}	21.8^{e}
T4	39901^{a}	177141^{c}	137240^{cd}	3.4^{de}	22.5	223.5^{b}	3.6	1.5^{b}	38.3^{b}	158^{c}	31.8^{e}	17.7^{f}
T5	39637^{a}	178631^{c}	138994^{c}	3.5^{cd}	22.6	228.5^{b}	3.5	1.4^{b}	46.0^{ab}	301^{b}	34.6^{d}	23.6^{d}
T6	39741^{a}	178488^{c}	138747^{c}	3.4^{cde}	21.2	213.7^{b}	3.6	1.5^{b}	37.3^{bc}	140^{c}	42.7^{b}	38.6^{b}
T7	40177^{a}	195251^{b}	155074^{b}	3.8^{b}	22.2	296.1^{a}	3.5	1.4^{b}	48.8^{ab}	310^{ab}	35.5^{d}	26.6^{c}
T8	40281^{a}	181234^{c}	140953^{c}	3.4^{cde}	22.4	232.9^{b}	3.6	1.5^{b}	41.2^{b}	295^{b}	39.9^{c}	44.6^{a}
T9	40017^{a}	204132^{ab}	164115^{a}	4.1^{a}	22.2	296.3^{a}	3.5	1.5^{b}	53.7^{a}	339^{ab}	39.4^{c}	44.4^{a}
T10	40557^{a}	208617^{a}	168060^{a}	4.1^{a}	23.8	323.2^{a}	3.8	2.0^{a}	54.0^{a}	345^{a}	46.7^{a}	45.8^{a}
C.D. (P=0.05)	1375	10878	5890	0.15	NS	27.2	NS	0.18	7.1	24	7.6	5.2

Values followed by same superscript in a column do not differ significantly

Economics

The Benefit-Cost (B:C) ratio indicates the economic viability of treatment. A higher B:C ratio suggests that the treatment generates more benefits (returns) compared to its costs, making it a more profitable option. The economic analysis showed that treatment T_{10} incurred the highest cultivation costs but generated the highest gross return, net return and benefit-cost ratio, with values statistically at par those of treatment T_9 (Table 3). Furthermore, the additional investment in T_{10} was justified by the increased returns, making it a potentially profitable option. These findings aligned with previous studies (63-66), which demonstrated that foliar nutrition in mungbean cultivation can lead to significant improvements in productivity and economic benefits.

Conclusion

The study showed that foliar application of nano urea, boron and zinc significantly improved mungbean's growth, yield, quality and nutrient uptake. The treatment where RDF was applied along with nano urea (4 mL/L) + 0.5 % zinc + 0.2 % boron (T_{10}) at pre-flowering and pod development stages proved to be very effective in boosting the overall growth of plants and productivity. The plants of T 10 treatment also showed superior economic returns and higher B:C ratio. The combined application of RDF with foliar sprays of nano urea, zinc and boron significantly enhanced mungbean's growth, yield and economic returns.

Acknowledgements

This work form part of the M Sc programme of the first author. The authors acknowledge the laboratory and other facilities provided by different institutions such as BHU, Banaras; Vivekananda Global University, Jaipur and ANDUAT, Kumarganj, Ayodhya (U P). We would like to thank R K Anand, Dr S K Verma (Professor, ANDUAT, Ayodhya) R K Jha (Professor, DRPCAU, Pusa), Pandey, S B S (Associate Professor, AU, Kota) and Kunhamu, T K (Professor, KAU, Thrissur) for their thoughtful comments and reviews of an early version of this manuscript.

Authors' contributions

VJ and CB have conducted the field experiment Mungbean (*Vigna radiata* L.) agri-horti system under guava (*Psidium guajava* L.) *cv.* Lalit and set up the experiment as per the treatment and replication. AJ and S recorded the data and critically analyzed the data. SB finalized dosage has applied the foliar spray in mungbean. AT and VK wrote the critically manuscript along with arrange journal format for submission. All authors reviewed properly before the submission.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

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