



RESEARCH ARTICLE

Influence of foliar application of urea and micronutrients on growth, yield attributes and nutrient uptake of green gram (*Vigna radiata* L.)

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Abstract

Pulses are inexpensive and widely consumed sources of protein in the human diet. They have enormous potential for enhancing human health, environmental protection, soil conservation and contributing to global food security. Currently in Indian agriculture, micronutrient deficiency is one of the major obstacles in crop production. Hence, a research trial was carried out to evaluate influence of foliar application of boron, urea and zinc on growth and yield of green gram during 2021 at Research Farm, Lovely Professional University, Punjab. This experiment was conducted in randomized block design (RBD) including 8 treatments with 3 replications. The treatments comprised of foliar application of urea at 2 %, single super phosphate (SSP) at 2 %, borax at 0.2 %, zinc ethylenediaminetetraacetic acid (EDTA) at 0.1 %, urea at 2 % + SSP at 2 %, urea at 2 % + borax at 0.2 %, urea at 2 % + zinc EDTA at 0.1 % and control (no foliar application). The results indicated that, significantly higher growth parameters, physiological parameters, yield parameters and seed yield (14.3 q ha⁻¹) were recorded in foliar application of urea at 2 % + borax at 0.2 % as compared with other treatments. However, foliar application of urea at 2 % + SSP at 2 % was statistically at par with foliar application of urea at 2 % + zinc EDTA at 0.1 %. Contrarily, control treatment produced significantly lower values as compared to foliar application treatments.

Keywords: borax; foliar spray; green gram; legume; micronutrient; nutrient uptake; urea; *Vigna radiata*; zinc

Introduction

Peas, beans and lentils are examples of pulses, which are edible seeds that grow in pods, belonging to legume family. Pulses are recognised for their nutrient density, long shelf life and affordable price (1). They are a great source of soluble and insoluble fibre, essential vitamins and plant-based protein and minerals. After chickpea and pigeonpea, green gram is the third most important pulse crop in India. Sometimes referred to as mung or mungbean. Among pulses, it is regarded as being healthful and free of heaviness and flatulence. Haulms are utilised as green manure and fodder in addition to being consumed in many ways as food. It can be used in a variety of multiple cropping systems due to its shorter life cycle (2). Like other pulse crops, the addition of green gram to cropping systems enhances the fertility and health of the soil. Green gram is rich source of potassium (K), magnesium (Mg), iron (Fe) and copper (Cu) etc. The green gram also contains fibre, folate and vitamin B6. India contributes about 45 % of global production of green gram which is cultivated on 3.8 million hectares of area with a total production of 1.56 million tonnes annually. The average productivity of green gram was 413 kg ha⁻¹. (3). Using innovative agricultural techniques, such as fertiliser application and growing high yielding cultivars, Indian agriculture has increased food output by a fourfold. This was initially made possible by utilising only

nitrogenous fertilisers because the earth was able to supply all other vital elements required by plants. But within a few years, the soil's nitrogen (N) reserves progressively ran out, making it impossible to maintain increased yields even when both N and phosphorus (P) were applied. Micronutrients (zinc (Zn), boron (B), Fe etc.) and secondary nutrients deficiency was regularly seen in oilseed, cereal and pulse crops in north regions of India, where high cropping intensity is reported. In addition, farmers are utilising unusual production practises like the excessive and careless application of chemical fertilisers, which has reduced factor productivity while also destroying biodiversity and creating environmental degradation (4). Furthermore, extensive fertiliser use on soil has revealed ineffective N utilisation as a result of significant nutrient loss by denitrification, volatilisation and leaching. Therefore, improving nutrient utilisation efficiency and reducing micronutrient deficits in the green gram crop are urgent needs. The foliar spray of nutrients has direct contact with the foliage of the plants which makes nutrients more readily available to crop, it is more advantageous than the soil application of nutrients. It is a tried-and-true method of applying fertiliser that is quite effective. It directly contacts with the crop's leaf, ensuring that the plants may quickly access the nutrition. Foliar treatment improves the plant's ability to utilise nutrients. It can accelerate root growth and regulate the crop's rate of expansion. It is more advantageous and simpler

for plants to absorb urea, single super phosphate (SSP), Zn and B when applied topically to the leaves of the plants (5). Hence, an essential crop management technique for raising crop yields is foliar spraying. By keeping all points in mind, this experiment was carried out to evaluate of foliar application of urea, SSP, Zn and B effect on growth and yield of green gram.

Materials and Methods

The field trial was conducted at research farm of Lovely Professional University, Phagwara, Punjab during kharif season, 2021. The farm is located at 234–280 m above mean sea level at 31.2690° N latitude and 75.7021° E longitude. The total rainfall received during crop period was 414.9 mm. Maximum temperature recorded during the crop period was 45 °C and minimum temperature was 16 °C. The soil was sandy loam with pH 8.3, electrical conductivity (EC) 0.121 dSm⁻¹, available N 188.2 kg ha⁻¹, available P 18.3 kg ha⁻¹, available K 170.2 kg ha⁻¹ and organic carbon 0.18 %. The trial was conducted in randomized complete block design (RCBD) including 8 treatments and 3 replications. The treatments included: control (T1-no foliar application), foliar application of urea at 2 % (T2), SSP 2 % (T3), borax at 0.2 % (T4), Zn EDTA at 0.1 % (T5), urea at 2 % + SSP at 2 % (T6), urea at 2 % + borax at 0.2 % (T7) and urea at 2 % + Zn EDTA at 0.1 % (T8).

Variety (PAU-911) was sown at 30 × 10 cm spacing in kharif season with seed rate of 15 kg ha⁻¹. A recommended basal dose of 25 kg N and 40 kg phosphorus pentoxide (P₂O₅) ha⁻¹ was applied through urea and diammonium phosphate (DAP) at sowing. Three foliar (500 L ha⁻¹) were done based on the treatments at 20, 40 and 60 days after sowing (DAS). Five plants were selected randomly and tagged for taking various observations on growth and yield components like plant height, leaf area index (Eqn. 1) and dry matter and yield parameters like number of pods / plant, number of seeds / pod, test weight, seed yield and biological yield.

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Ground area}}$$

The collected data was compiled and subjected to statistical analysis with analysis of variance (ANOVA) using OPSTAT software. The level of significance was set at $p = 0.05$ (6).

Results and Discussion

The research showed that green gram's foliar fertiliser treatment generated significant differences on its growth parameters, physiological parameters, yield parameters and yield.

Growth attributes of green gram

Foliar spray of nutrients significantly improved growth characters of green gram (Table 1, Fig. 1) such as significantly more plant height (62.6 cm), leaf area index (4.13) and crop dry weight (12.4 g plant⁻¹) was recorded in foliar treatment of urea at 2 % + borax at 0.2 % than other treatments. However, foliar treatment of urea at 2 % + SSP at 2 % and foliar treatment urea at 2 % + Zn EDTA at 0.1 % were statistically at par with each other. The increased plant height was mainly due to foliar application of macro and micronutrients. Boron helps in pollen formation. Nutrients are immediately and readily available to plants by foliar application which may have resulted in more nutrient absorption, which is necessary for cell elongation and multiplication (7). Additionally, greater K availability may have improved CO₂ fixation, decreased stomata resistance and enhanced photosynthetic transfer into phloem. It may have accelerated meristematic growth, which has improved the height and branch count of the plant (8). Leaf area index increased progressively up to flowering stage, after which it declined due to leaf senescence at maturity. Similar beneficial effect of micronutrients on leaf area index was reported previously in cotton (9), green gram (10) and soybean crop (11). The massive increase in dry matter was due to N's function is to maintain auxin levels, which had resulted in better leaf foliage and chlorophyll content. This may result in significant accumulation of photosynthates due to the improved infiltration, assimilation and consumption of radiant energy, resulting in increased accumulation of dry matter by the plants. The findings are consistent with previous study (12).

Yield parameters and yield of green gram

Foliar fertiliser treatment influenced yield parameters of green gram significantly (Table 2). Significantly better yield parameters such as a greater number of pods (30.7 plant⁻¹), number of seeds / pod (8.3) and 1000 seed weight (36.3 g) was found in foliar application of urea at 2 % + borax at 0.2 % treatment than other treatments. However, this treatment was statistically at par with foliar application of urea at 2 % + SSP at 2 % and foliar application of urea at 2 % + Zn EDTA at 0.1 %. Foliar spray of nutrients significantly influenced yield parameters of green gram, such as seed yield, biological yield differed significantly with foliar application. Significantly more seed yield (14.3 q ha⁻¹) and biological yield (39.8 q ha⁻¹) were observed with foliar application of urea at 2 % + borax at 0.2 % as compared with other treatments (Table 2). However, foliar application of urea at 2 % + SSP at 2 % and foliar application urea at 2 % + Zn EDTA at 0.1 % were statistically at par with each other. This could be because foliar nutrition administration improves fertilisation. Additionally, vegetative and

Table 1. Effect of foliar nutrition application on plant height (cm), leaf area index and total dry matter (g plant⁻¹) of green gram

Treatments		Plant height (cm)	Leaf area index	Total dry matter (g plant ⁻¹)
		60 DAS	60 DAS	At harvest
T ₁	Control (Only RDF)	50.3 ^e	3.1 ^e	11.0 ^d
T ₂	RDF + urea at 2 %	55.4 ^{c-d}	3.5 ^d	11.5 ^{c-d}
T ₃	RDF + SSP at 2 %	54.3 ^{d-e}	3.6 ^{c-d}	11.9 ^{a-c}
T ₄	RDF + borax at 0.2 %	57.0 ^{b-d}	3.7 ^{b-d}	11.6 ^{b-d}
T ₅	RDF + zinc EDTA at 0.1 %	57.2 ^{b-d}	3.9 ^{a-c}	11.7 ^{a-c}
T ₆	RDF + urea at 2 % + SSP at 2 %	61.3 ^{a-b}	4.0 ^{a-b}	12.3 ^{a-b}
T ₇	RDF + urea at 2 % + borax at 0.2 %	62.6 ^a	4.1 ^a	12.4 ^a
T ₈	RDF + urea at 2 % + zinc EDTA at 0.1 %	60.3 ^{a-c}	4.0 ^{a-b}	12.2 ^{a-c}
	SE(m) ±	0.97	0.06	0.13
	C.D. at 5 %	2.99	0.26	0.39

CD: critical difference; RDF: recommended dose of fertiliser; SSP: single super phosphate; EDTA: ethylenediaminetetraacetic acid. Means in the same column followed by the different letter are significantly different ($p > 0.05$).

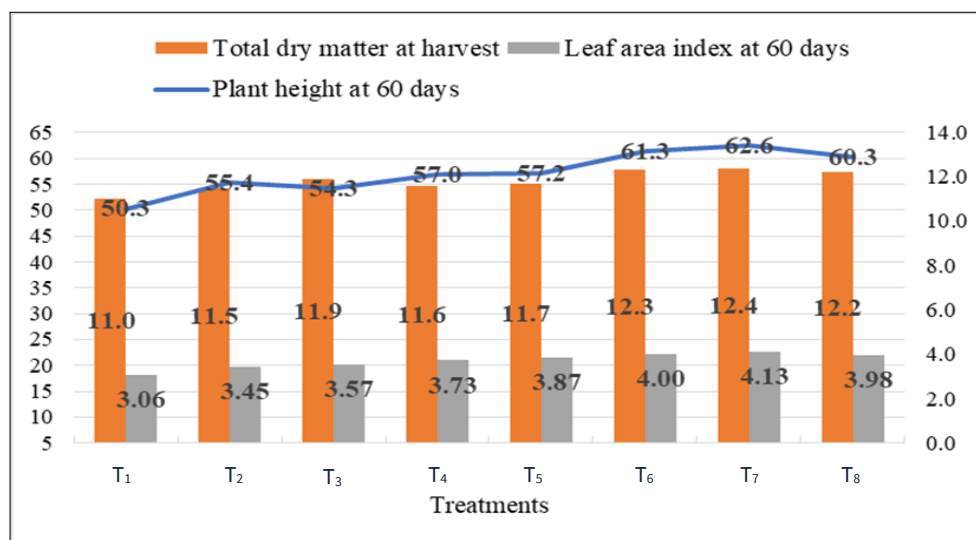


Fig. 1. Effect of foliar nutrition application on plant height (cm) at 60 days, leaf area index at 60 days and total dry matter (g plant⁻¹) at harvest of green gram

Table 2. Effect of foliar nutrition application on pod plant⁻¹, seeds per pod, 1000 seed weight, seed yield (q ha⁻¹) and biological yield (q ha⁻¹)

Tr. No.	Treatments	Pod plant ⁻¹	Seeds per pod	1000 seed weight	Seed yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)
T ₁	Control (Only RDF)	26.4 ^c	5.0 ^c	30.4 ^c	11.1 ^d	32.0 ^d
T ₂	RDF + urea at 2 %	27.7 ^{b-c}	6.0 ^{b-c}	30.9 ^c	13.3 ^{a-c}	36.1 ^{b-c}
T ₃	RDF + SSP at 2 %	27.5 ^{b-c}	6.7 ^{a-c}	32.7 ^{a-b}	13.0 ^{b-c}	35.2 ^c
T ₄	RDF + borax at 0.2 %	26.6 ^c	7.3 ^{a-b}	33.2 ^{a-b}	12.2 ^{c-d}	34.5 ^c
T ₅	RDF + zinc EDTA at 0.1 %	26.4 ^c	7.0 ^{a-b}	32.8 ^{a-b}	12.8 ^{b-c}	34.7 ^c
T ₆	RDF + urea at 2 % + SSP at 2 %	29.6 ^{a-b}	7.3 ^a	35.8 ^a	14.0 ^{a-b}	39.0 ^a
T ₇	RDF + urea at 2 % + borax at 0.2 %	30.7 ^a	8.3 ^a	36.3 ^a	14.3 ^a	39.8 ^a
T ₈	RDF + urea at 2 % + zinc EDTA at 0.1 %	29.4 ^{a-b}	8.0 ^a	35.4 ^a	13.9 ^{a-b}	38.3 ^{a-b}
	SE(m) ±	0.47	0.34	0.73	0.25	0.5
	C.D. at 5 %	1.44	1.04	2.25	0.76	1.4

CD: critical difference; RDF: recommended dose of fertiliser; SSP: single super phosphate; EDTA: ethylenediaminetetraacetic acid. Means in the same column followed by the different letter are significantly different ($p > 0.05$).

reproductive parts may have been enhanced by the nutrients' quick and direct availability as well as their balanced amounts (13, 14). Synergistic effect of N with borax and Zn can only be expected if supply of borax and Zn is adequate during vegetative and reproductive stage with foliar fertilisation (15, 16). The yield attributes of green gram may have increased as a result of early flowering and increased assimilation of photosynthesis in reproductive areas brought on by balanced fertilisation with higher macro and micronutrient doses (17–19).

Plant nutrient uptake content and nutrient use efficiency

The effect of foliar application on nutrient uptake of green gram such as N, P and K differed significantly with different nutrient sprays (Table 3). Significantly better nutrient uptake such as N, P and K were observed with foliar application of urea at 2 % + borax at 0.2 %, foliar application of urea at 2 % + SSP at 2 % and foliar

application of urea at 2 % + Zn EDTA at 0.1 %. Further, superiority of nutrient uptake of green gram was to an extent of 23.7 % with respect to N, 55.5 % with respect to P, 13.0 % with respect to K under urea at 2 % + borax at 0.2 % when compared to control. Increased uptake of nutrients is due to higher nutrients supplied through foliar application, which may have enhanced the nutrient diffusion to roots and increased nutrient content in crop plant (20, 21). Additionally, there may be no losses when nutrients are administered topically, so the plant absorbs and uses all of the nutrients. Increased dry matter accumulation in vegetative and reproductive sections at harvest is indicative of higher nutritional content, which further boosts nutrient intake. However, the nutrient use efficiency of green gram was non-significant which may be due to the uniform basal application of urea and DAP leading to limited variation in nutrient use efficiency. Similar results were reported previously (22, 23).

Table 3. Effect of foliar nutrition application on plant nutrient uptake content and nutrient use efficiency of green gram

Tr. No	Treatments	Nutrient uptake by crop			NUE
		Nitrogen (kg ha ⁻¹)	Phosphorus (kg ha ⁻¹)	Potassium (kg ha ⁻¹)	
T ₁	Control (only RDF)	16.0	3.42	16.8	17.1
T ₂	RDF + urea at 2 %	17.3	3.58	17.0	12.7
T ₃	RDF + SSP at 2 %	17.0	3.95	17.4	12.4
T ₄	RDF + borax at 0.2 %	17.7	4.25	18.0	17.7
T ₅	RDF + zinc EDTA at 0.1 %	18.7	4.69	17.2	19.1
T ₆	RDF + urea at 2 % + SSP at 2 %	19.5	4.95	18.1	9.81
T ₇	RDF + urea at 2 % + borax at 0.2 %	20.2	5.32	19.0	13.2
T ₈	RDF + urea at 2 % + zinc EDTA at 0.1 %	19.1	4.82	17.9	13.1
	SE(m) ±	0.16	0.05	0.17	0.33
	C.D. at 5 %	0.25	0.08	0.26	NS

CD: critical difference; RDF: recommended dose of fertiliser; SSP: single super phosphate; EDTA: ethylenediaminetetraacetic acid. Means in the same column followed by the different letter are significantly different ($p > 0.05$).

Contrarily, the reduced uptake of nutrients was observed under control treatment and is due to absence of foliar nutrition. Hence, lower concentration of nutrients in the plants and reduced biomass. Besides, this is mainly because of reduced availability of nutrient resources during various crop growth stages. Similar results were previously reported (24).

Conclusion

From this study it can be concluded that foliar spray of fertilisers either micro or macro nutrients has a positive impact on growth and yield of green gram. Foliar application of borax or zinc micronutrient improved the yield attributes as well as plant nutrient thereby enhancing crop productivity and nutrient status. Urea spray on green gram not only improves the crop productivity but also enhanced the crop quality. The combination of recommended dose of fertilisers along with foliar application of urea (2 %) + borax (0.2 %) was found to be beneficial for improving yield and nutrient uptake under the given experimental conditions.

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Authors' contributions

AR carried out the field experiment and data collection. MC carried out the data collection, analysis and drafted the manuscript. RS carried out the proof reading and drafting. SHT and MAD participated in the sequence alignment and data analysis. SDS participated in the design of the study and performed the statistical analysis. All authors have read and approved the final manuscript.

Compliance with ethical standards

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

Ethical issues: None

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