RESEARCH ARTICLE

EFFECT OF DIFFERENT MICRONUTRIENTSAPPLICATION ON GROWTH, YIELD AND QUALITY OF MOONG BEAN (*VIGNARADIATA* L.)

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Abstract: A field experiment was conducted at Crop Research Center, SardarVallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, with a view to compare the production potential under different micronutrients application and also to find out the economic viability of this cultivar for soil quality. The treatments comprised of *Control*,RDF (20:40:20) kg ha^{-1},RDF + Zn @ 5 kg ha^{-1},RDF + B @ 2.5 kg ha^{-1},RDF+ Mo @ 1 kg ha^{-1},RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1},RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1},RDF + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1} and RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}revealed that treatment T_9 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) and T_7(RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) exhibited significant influence on the growth, yield and quality of moong bean as compared to the application of RDF (20:40:20) kg ha^{-1}alone.Significant improvement in growth parameters *viz.* plant height, leaf area index, dry matter accumulation as well as crop growth rate, yield attributes and yields was recorded with the application of T_9 and T_7.Maximum protein content (25.0%) was found in T_9 which was on par with $T_{7,}$ T_6, T_8,T_3& T_4.The maximum protein yield (325.0 kg ha^{-1}) was obtained in treatment T_9followed by T_7, and $T_{6.}$

Keywords: Growth, Moong bean, Quality, Protein, Yield

INTRODUCTION

The pulses are an excellent source of dietary proteins and play an important role in fulfilling requirements of rapidly increasing population. Pulse production is very low and has become a challenging problem against the requirement of increasing population of our country. Its shortage in human diet leads to manifold problems, *viz.*, poor growth and development particularly of growing child. In India, the protein status of common man's diet is far less than the minimum recommendations (80 g day^{-1}) of Indian Council of Medical Research (ICMR).

Green gram locally called as moong (*Vigna radiate* L.) belongs to the family leguminaceae. Being a short duration crop and having wider adaptability, it can be grown in *kharif* as well as in summer season. It is an important ruling crop in summer season. The yield of summer green gram are comparatively more than that of *kharif* crop mainly because of controlled moisture conditions through irrigation, abundant sunshine and less pest and disease infestation.

Technical constraints such as lack of implementation of improved cultural practices, cultivation carried out in lands with low fertility status, Economical constraints like exploitation by middlemen and high market prices are some of the major constraints for moong bean production in India. Added to this is the use of high yielding varieties of moong bean which has led to increased depletion of nutrients from the soil. Consumption of nutrients have remained lower as compared to their removal. This imbalance between nutrient availability, supply and removal cannot be overcome by application of fertilizer alone. This can be achieved through balanced and integrative use of different nutrients.

Moong bean requires optimum weather conditions for its good growth and development. Since it is mostly grown after the harvest of rice and late recession of moisture from rice fields in Uttar Pradesh, the sowing of moong bean crop gets delayed and the growth and vigour of moong bean is not good as timely sown crop. It is important to increase the productivity of moong bean, which still has a greater scope to exploit the yield potential of existing cultivars with agronomic management.

All the major nutrient *viz.*, nitrogen, phosphorus, potassium, zinc, boron and molybdenum play an important role in increasing the yield and quality of moong bean. Nitrogen is known to activate most of metabolic activities and transformation of energy. Phosphorus has essential role of cell division and meristematic growth of tissue.Zinc is essential for increasing oil content (%) and oil yield. Iron application greatly influenced chlorophyll synthesis, carbohydrate as well as protein metabolism and synthesis of amino acids.Various nutrients and micronutrients are required for oilseed production, and Iron plays a crucial role in providing nutrition to oilseed crops, more importantly the crops of Cruciferae family.

Zinc plays an important role in various physiologicaland functions of the plant. Boron plays crucial role in cell differentiation and development,

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regulating membrane permeability, tissue differentiation, carbohydrates and protein metabolism.

There is a great scope for enhancing the production of moongbean by increasing the area under cultivation and improvising its productivity by the application of micronutrients with balanced fertilization keeping in view, the soil fertility status and soil health.

MATERIALS AND METHODS

The experiment was carried out at Crop Research Centre, SardarVallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) to study the influence of different micronutrients on productivity and profitability of Moong bean in Randomized Block Design with 09 treatments (Table 1), replicated three times. The maximum and minimum temperatures recorded were 35.9 ° C and 18.5 ° C during the crop growth period. Maximum temperature ranged from 18.5 ° C to 35.9 ° C during maturity phase of the crop. Relative humidity varied from 46.5% to 95.7% during crop growth period. The area receives mean annual rainfall of 845mm. The soil of the experimental field was sandy loam in texture, low in available nitrogen (180.5 kg ha^{-1}) and organic carbon (0.47%), medium in available phosphorous (13.5 kg ha^{-1}) and potassium (180.0 kg ha^{-1}), available zinc (16.1 ppm), available boron (0.6 ppm), available molybdenum (0.26 ppm) and slightly alkaline (pH 8.0) in reaction with electrical conductivity of 0.16 dS m^{-1}. The gross and net plot size were 5 m X 3.6 m and 4.0 m X 2.4 m respectively. The crop variety SML-1827 was sown on 01 August 2020 and harvested on 06 October 2020. The seed rate was 20 kg ha^{-1}. Seeding was done in the row to row spacing of 30 cm and plant to plant spacing of 10 cm. The recommended dose of nitrogen (120 kg ha^{-1}) was applied in two equal split, the half as basal and the remaining half was top dressed 2 times at the time of first and second irrigation. The whole quantity of potassium (40 kg ha^{-1}) was applied as basal dose through Murate of Potash at 8-10 cm depth along with half dose of nitrogen prior to sowing. Phosphorous was applied as basal dose (60 kg ha^{-1}) through DAP. Vermicompost (2t ha^{-1}) and FYM (6t ha^{-1}) were applied in the field as per treatments and was thoroughly mixed at the time of sowing. The sulphur was applied through Gypsum in the field as per treatments. Boron was applied through borax at the time of sowing. Zinc was applied at the time of sowing in the form of Zinc sulphate. The seed was treated with Azotobacter @200g / 10 kg seed which was applied as per treatments before the sowing. One thinning was done after 30 days of sowing to maintain a plant to plant distance of about 10 cm. Weeding and hoeing operation were performed manually after first and second irrigation at proper soil moisture condition of the soil. The observations recorded included Growth parameters [Plant height (cm), No. of primary, Plant dry weight (g $plant^{-1}$)], Leaf area index (LAI), Crop growth rate (g m^{-2} day^{-1}), yield (Grain and Straw yield), Protein content (%) and Protein yield (kg ha^{-1}).Protein content (%) was calculated by multiplying % N content with factor of 6.25. Protein yield was obtained by multiplying protein content (%) with seed yield divided by 100. Statistical analysis of the data was done as per the standard analysis of variance technique for the experimental designs following SPSS software based programme, and the treatment means were compared at $P<0.05$ level of probability using t-test and calculating CD values.

RESULTS AND DISCUSSION

Growth parameters

Data regarding Growth parameters *viz*., Plant height (cm), No. of branches and Plant dry weight (g $plant^{-1}$) is mentioned in Table 1.

At harvest, application ofT_9(RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) exhibited significantly taller plant 51.1 cm which was on par with T_7 (RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) and T_6 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1})whereas, the lowest plant height was recorded under control. On an average an increase in height of 53.45% was obtained in T_9 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) over T_1 (Control) respectively.

Highest value of number of branches $plant^{-1}$ were recorded in T_9(RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) and was statistically on par with T_6, T_7, T_3, $T_8$and T_2, respectively at harvest stage. In case of plant dry weight, treatment T_9 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) exhibited highest plant dry weight and was on par with T_6, and T_7 at harvest stage.

Crop Growth Rate and Leaf Area Index

The Crop Growth Rate was non- significant, however the maximum CGR (0.138 g m^{-2} day^{-1}) was obtained in $T_9$and minimum in Control. T_9 exhibited significantly higher leaf area index (3.9) respectively, which was on par with T_6,and T_7.

Table 1: Influence of different micronutrients on Growth parameters of moong beanat harvest

Treatments		Plant height (cm)	Number of branches $plant^{-1}$	Plant dry weight (g $plant^{-1}$)
T_1	Control	33.3	4.35	8.95
T_2	RDF (20:40:20) kg ha^{-1}	45.1	5.92	9.05

T_3	RDF + Zn @ 5 kg ha^{-1}	47.8	6.28	9.53
T_4	RDF + B @ 2.5 kg ha^{-1}	47.0	5.16	9.36
T_5	RDF+ Mo @ 1 kg ha^{-1}	46.0	5.04	9.15
T_6	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}	49.0	6.44	10.85
T_7	RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	50.5	6.63	11.60
T_8	RDF + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	46.9	6.16	10.72
T_9	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	51.1	6.69	11.55
		1.06	**0.46**	**0.24**
		3.20	**1.39**	**0.70**

This improvement in growth attributes could be assigned to better soil environment with nutrient management system. The beneficial effects might have been derived due to combined application of essential macronutrients, micronutrients, organic manure and biofertilizers which satisfied the immediate requirement of nutrients and also provided favourable soil environment for better plant growth. The results obtained from the present experiment are in near conformity with the findings.

Table 2: Influence of different micronutrients on CGR and LAI of moong bean

Treatments		**CGR ($g/m^2/day$)**	**LAI**
		90 DAS to Harvest	
T_1	Control	0.080	2.2
T_2	RDF (20:40:20) kg ha^{-1}	0.132	2.7
T_3	RDF + Zn @ 5 kg ha^{-1}	0.132	3.1
T_4	RDF + B @ 2.5 kg ha^{-1}	0.130	2.6
T_5	RDF+ Mo @ 1 kg ha^{-1}	0.124	2.5
T_6	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}	0.136	3.6
T_7	RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	0.137	3.8
T_8	RDF + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	0.130	3.2
T_9	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	0.138	3.9
SEm ±		**0.005**	**0.1**
C D (P=0.05)		**NS**	**0.4**

Influence on yield and quality parameters of moong bean

Data (Table 2 & Table 3) regarding the influence of different nutrients on yield and quality parameters of moong bean.

Among the various micronutrients, the treatment T_9 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}r) exhibited significantly higher grain yield (13.91 q ha^{-1}) followed by T_7 (RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}), T_6 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}) and T_8 (RDF + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}). Treatment T_1 (Control) with no application of any fertilizer recorded lowest grain yield of 5.83 q ha^{-1}. About 138.59%, 114.40%, 104.11%, 89.70% and 84.56% increase in grain yield was recorded by T_9 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}), T_7 (RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}), T_6 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}), T_8 (RDF + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) and T_3 (RDF + Zn @ 5 kg ha^{-1}), respectively over control treatment T_1. This might be due to slow release of nutrient and efficient use of micronutrients.

In the same way, straw yield of moong bean (Table 2) was significantly influenced by different micronutrients treatments. Results revealed that the differences in straw yield were found significant due to different treatments. Though significantly higher straw yield 30.74 q ha^{-1} was recorded under T_9, it was statistically on par with T_7, (RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}). The lowest straw yield (14.13 q ha^{-1}) was recorded in T_1 (control). Similar trend was observed in Biological yield, whereas maximum harvest index (31.25 %) was recorded in T_9 (RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) which was on par with T_7, T_6, T_8, T_3, T_4 and T_2. The increase in straw yield was mainly due to increased growth attributing characters like plant height and number of pod $plant^{-1}$. The use of micronutrients had profound effect on vegetative growth due to improved nutrients availability in the soil. These findings are in conformity with the results of **Khan, K. *et al.* (2014), Dhruw*et al*. (2017) and Malik *et al.* (2015).**

Table 3: Influence of different micronutrients on Yield of moong bean

Treatments		Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	HI (%)
T_1	Control	5.83	14.13	19.96	29.02
T_2	RDF (20:40:20) kg ha^{-1}	7.15	15.36	22.51	29.70
T_3	RDF + Zn @ 5 kg ha^{-1}	10.76	24.34	35.09	30.65
T_4	RDF + B @ 2.5 kg ha^{-1}	9.90	22.62	33.25	29.82
T_5	RDF+ Mo @ 1 kg ha^{-1}	7.96	19.59	27.55	28.91
T_6	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}	11.90	26.63	38.53	30.91
T_7	RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	12.50	27.75	40.25	31.09
T_8	RDF + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	11.06	25.06	36.12	30.65
T_9	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	13.91	30.74	44.65	31.25
SEm ±		**0.40**	**1.12**	**1.52**	**0.90**
C D (P=0.05)		**1.11**	**3.23**	**4.31**	**2.62**

Maximum protein content (25.0%) was obtained in treatment T_9 followed by T_6, T_7, T_8 T_3& T_4. Lowest protein content (20.45%) was obtained in treatment T_1. Significantly higher protein yield (325.0 kg ha^{-1}) was obtained in treatment T_9(RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}) followed by T_6 and T_7. The lowest protein yield (143.15 kg ha^{-1}) was recorded in T_1 which was significantly lower than the rest of the other treatments. Increase in protein content may be ascribed to the enhanced protein synthesis (acetyl-CoA carboxylase) and increased oil accumulation in the developing seeds **(Kumawat*et al*., 2003)** by the S application. Such an increase of protein content is in accordance with the findings of **Malik *et al.* 2012; Meena *et al.* 2014.**

Table 4: Influence of different micronutrients on Quality parameters of moong bean

Treatments		Protein content (%)	Protein Yield (kg ha^{-1})
T_1	Control	20.45	143.15
T_2	RDF (20:40:20) kg ha^{-1}	21.60	172.80
T_3	RDF + Zn @ 5 kg ha^{-1}	23.30	221.35
T_4	RDF + B @ 2.5 kg ha^{-1}	23.05	209.76
T_5	RDF+ Mo @ 1 kg ha^{-1}	22.90	199.22
T_6	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}	24.44	246.84
T_7	RDF + Zn @ 5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	24.50	254.80
T_8	RDF + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	24.08	233.58
T_9	RDF + Zn @ 5 kg ha^{-1} + B @ 2.5 kg ha^{-1}+ Mo @ 1 kg ha^{-1}	25.00	325.00
SEm ±		**0.85**	**8.92**
C D (P=0.05)		**2.46**	**25.56**

The increase in protein content with Zn application has also reported by **Patra *et al.* (2009) and Pandey *et al.* (2013).**Higher nitrogen in seed is directly responsible for higher protein because it is a primary component of amino acids which constitute the basis of protein **(Choudhary *et al.* 2013).**Probably higher dose of fertilizers fortified with vermicompost helped in efficient translocation of nitrogen from vegetative parts to the developing seeds as well as synthesis of protein**.**

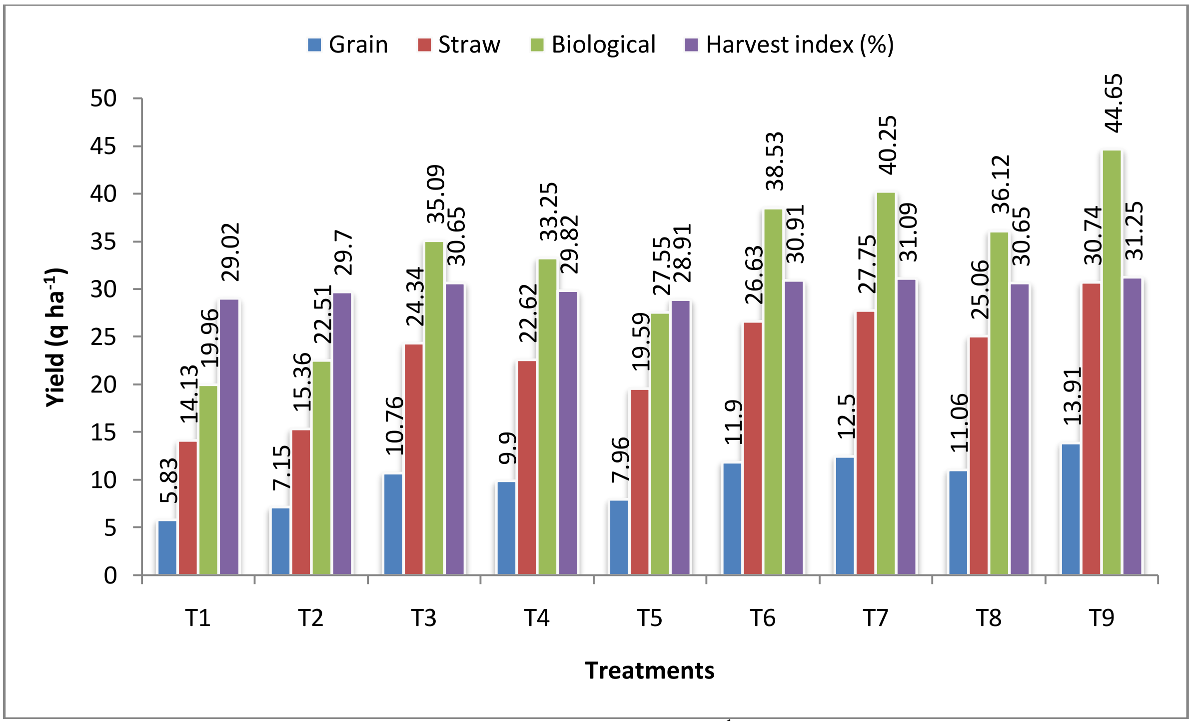

Fig. 1. Effect of micronutrient on yield (kg ha^{-1}) of moong bean crop

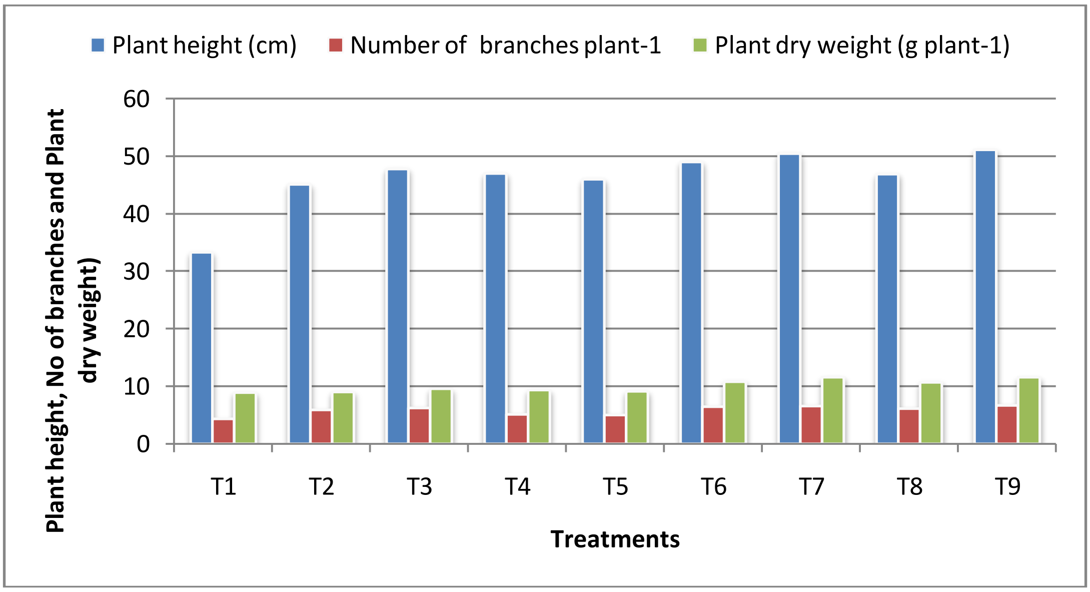

Fig. 2: Influence of different micronutrients on Growth parameters of moong bean at harvest

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