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Short communication

Effect of foliar nutrition on growth and yield of green gram (*Vigna radiata* L.) in red and lateritic soils of West Bengal

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ABSTRACT

The influence of different foliar nutrition (Urea, DAP, NPK-19:19:19, NPK-10:26:26, $ZnSO_4.7H_2O$, Mo and Borax) along with recommended dose of chemical fertilizer (RDF) were evaluated with one control (RDF only) on summer season mungbean cv. Samrat during 2022 at Instructional Farm under Seacom Skills University, Birbhum, West Bengal. The experiment was laid down in randomized complete block design (RCBD) with eight treatment combinations replicated thrice. The results showed that tallest plants (58.5 cm) with more number of leaves (23.9) were observed in RDF + Urea at 2% (sprayed twice at 20 and 40 DAS) treated plots. The same treatment showed the highest number of branches per plant (17.5) with maximum DMA (284.6 g m^{-2}) but in case of underground portion like root length recorded highest in DAP foliar spray plot. Earliest 50% flowering, early pod emergence and early picking was recorded where combined application of RDF + borax at 0.2% (sprayed twice at 20 and 40 DAS). The treatment RDF + DAP at 2% (sprayed twice at 20 and 40 DAS) augmented highest number of pods $plant^{-1}$ (18.8), pod length (6.80 cm), number of seeds pod^{-1} (10.75), seed index (21.2 g), seed yield (845 kg/ha) and stover yield (2020 kg/ha); followed by RDF + NPK (19-19-19) at 1% and RDF + Urea at 2% (sprayed twice at 20 and 40 DAS). Yield increase was to the tune of 3.54% to 10.74%. The gross returns, net returns and benefit: cost ratio were maximum when the crop received RDF + DAP at 2% (sprayed twice at 20 and 40 DAS). Hence, combined use of RDF + DAP at 2% and urea at 2% (sprayed 20 and 40 DAS) is beneficial for green gram production programme during summer season in the Red and Lateritic soils of West Bengal.

***Key words*:** Economics, Foliar nutrition, Green gram, Summer season, Yield

Greengram [*Vigna radiata* (L.) Wilczek] cultivation during the rainfed/summer season can be adversely affected by low soil moisture. Even the timely and appropriate application of fertilizer under rainfed conditions may not be productive due to the limited soil moisture availability. After the rapeseed, mustard, lentil, potato, and other crops have been harvested, summer mungbean is typically sown in the last week of February to the first week of April in West Bengal (Kundu *et al.*, 2021). When moisture availability becomes limited, the application of fertilizers through foliar spray results in efficient absorption. While foliar spray does not replace soil application, it should certainly be regarded as a supplementary approach (Sarkar *et al.*, 2021). Nutrients can be quickly and wastelessly delivered to the site of food synthesis through foliar spraying, reducing the need for fertilizers. In addition, foliar application of nutrients was found to be more advantageous than soil application with the elimination of losses through leaching and fixation. The source-to-sink relationship is broken in legumes when leaf senescence begins earlier than maturity, ultimately reducing yield. Foliar application of micro-nutrient and macro-nutrient is one of the best ways to increase productivity of pulses in summer season. Foliar application of DAP and urea on the foliage of summer greengram crop is a good management practice to obtain a higher crop yield. Numerous research works have established the key determinimg role of Zinc (Zn), Molybdenum (Mo) and Boron (B) in the overall growth and development of pulse crops. Zinc plays a crucial role in plant nitrogen metabolism and is required by a number of enzymatic systems either directly or indirectly (Mondal *et al.*, 2019). Boron (B), an essential component of cell walls, results in improved pollen viability and pollen tube development and also involved in sugar transportation (Jana *et al.*, 2020). Therefore, B deficiency is often understood as an

unsuspected enemy of crop production and also should be mitigated as early as possible. Among those micronutrients, molybdenum (Mo) is of particular concern. NO_3 is converted to NO_2 by the enzyme reductase, which requires molybdenum for the nitrate enzyme to function. Additionally, it is a structural component of the nitrogenase enzyme, which is necessary for the bacteria in legume crop root nodules to fix nitrogen from the air. As a result, protein synthesis and nitrogen metabolism both depend on Mo (Banerjee and Nath, 2021). Mo composition will generally be more articulated under acidic soils where plant accessible types of Mo are immaterial. The time has finally come to look for creative practices, which can ensure better returns with negligible decay of natural resources. Thus, evaluation of promising foliar nutrition practices along with recommended dose of fertilizer of summer greengram is the priority of present-day research in the state. Keeping these in view, a comprehensive study was done on the effect of different macro and micro nutrient foliar spray on growth and yield of summer mungbean in red and lateritic soils of West Bengal.

A field experiment was implemented for greengram crop during pre-*kharif* season (summer) of 2022 on a medium land silt loamy soil at Instructional Farm (23°42′ N latitude, 87°38′ E longitude and at an elevation of 9.75 m above mean sea level) of Seacom Skills University, Kendradangal, Birbhum, West Bengal, India. During cropping period of greengram, average temperature ranged from 20.7°C to 38.6°C and relative humidity varies from 30 to 82.9% in 2022. The rainfall during the experimental period (March to May) was 256.5 mm in summer 2022. The experiment was laid down in randomized block design with 3 replications comprising of 8 different foliar nutrition practices viz. T_1– Recommended dose of fertilizer (RDF) (N, P_2O_5, K_2O - 20, 40, 40 kg/ha), T_2 – RDF + Urea @ 2%, T_3 – RDF + DAP @ 2%, T_4 – RDF + NPK (19-19-19) @ 1%, T_5 – RDF + NPK (10-26-26) @ 1%, T_6 – RDF + Zinc ($ZnSO_4$.7H2O) @ 0.5%, T_7 – RDF + Molybdenum @ 1 ppm and T_8 – RDF + Borax @ 0.2%. Foliar nutrition was applied 20 and 40 days after sowing. The greengram variety 'Samrat' was sown at 30 cm (row to row) × 15 cm (plant to plant) spacing in the plots size of 5m × 4m. Soaked and *Rhizobium* culture treated seeds was sown @ 30 kg ha^{-1} in the field. In order to achieve a more uniform plant stand, only a light pre-sowing irrigation was applied. When the crop required it, necessary field operations like weeding and pest and disease control were carried out. The initial two boundary lines in each side of a plot were left to stay away from border effect. Two pickings followed by whole-plant harvesting were done during second week of May to second week of June. The harvested pods were sun-dried for 2-3 days before being manually threshed by beating the pods with sticks to separate the seeds. After that, the separated seeds were once again sun-dried to reduce the moisture content to 12%. The growth parameters like plant height, number of leaves $plant^{-1}$, branching habit, dry matter (DM) production, root characteristics, nodulation and other phenological characteristics and ultimately seed yield of mungbean were recorded as per standard methods. Recorded data on all measured attributes of greengram was subjected to analysis of variance (ANOVA) according to the techniques define for simple randomized complete block design (RCBD) as described by Gomez and Gomez (1984). Significant difference of sources of variation was tested at the probability level of 0.05. The standard error of the mean (SEm±) and the CD value were indicated in the tables to compare the difference between the mean values.

Growth parameters

Application of foliar nutrition improved growth of summer mungbean resulted in taller plants with highest number of leaves per plant. Tallest plants (58.5 cm) with more number of leaves (23.9) were observed in RDF + Urea at 2% (sprayed twice at 20 and 40 DAS) treated plots (Table 1). Foliar spray of DAP at 2% also produced taller plants (54.6 cm) with more leaves number (23.40), which had significant difference with the plants treated with RDF + Urea at 2%. Lower most value was recorded in control plot where no additional foliar spray was applied. This might be attributed to the fact nitrogen foliar fertilization encouraged and improved plant growth and accelerate cell division which reflected the increase in plant height and more number of leaves (Li *et al.*, 2022). In case of others growth parameters like number of branches per plant and dry matter accumulation gradually increased as the age of the crop progressed towards maturity (Table 1). The highest number of branches per plant (17.5) with maximum DMA (284.6 g m^{-2}) were observed in the plot treated with RDF + Urea at 2% (sprayed twice at 20 and 40 DAS) followed by RDF + DAP at 2% (sprayed twice at 20 and 40 DAS). It was observed that foliar application of water soluble nitrogenous fertilizer increased the growth attributes due to enhanced availability of nutrients through easy penetration of N through

stomata of leaves which affect the availability of nutrients, resulting from the increased effectiveness of plant biology leading to higher branching and dry matter accumulation. Root parameters of mungbean revealed that combined application of RDF + DAP at 2% (sprayed twice at 20 and 40 DAS) recorded longest root length (19.45 cm) followed by RDF + DAP at 2% (sprayed twice at 20 and 40 DAS) (19.21 cm), which had no significant difference between them. Foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation that ultimately improved the below ground plant parts. But, nodule number recorded highest value with the application of RDF + Molybdenum @ 1 ppm (sprayed twice at 20 and 40 DAS) (21.4) with the variation of 19.55%. During symbiotic N fixation, Mo acts as a cofactor for nitrogenase enzymes to catalyze the redox reaction to convert elemental N into ammonium (NH^{4+}) ions, and nitrate reductase enzymes required for the assimilation of soil nitrates may be the reason for increased number of nodules (Banerjee and Nath, 2021).

Phenology

Mungbean had an indetermined type of growth habit in which the vegetative and reproductive stages coexisted for some time. Days taken to 50% flowering in various foliar nutrition managements varied from 41.1 to 44.6 days with the variation of 8.51% (Table 1). Earliest 50% flowering was observed in the plot where combined application of RDF+ borax at 0.2% (sprayed twice at 20 and 40 DAS). Other side, RDF + urea at 2% (sprayed twice at 20 and 40 DAS) plot took the highest days to 50% flowering. Emergence of pod under different foliar nutrition management ranged from 49 to 53.4 days with a variation of 8.97% (Table 1). Where combination of RDF + borax at 0.2% (sprayed twice at 20 and 40 DAS) recorded early pod emergence (49 days) and other side RDF + Urea @ 2% took the more days to emergence of pod. Boron (B) is also an important constituent of cell walls and has a major role in pollen viability and pollen tube development and improve flowering span which ultimately reduce flower drop (Arif *et al*., 2012). However, requirement of days from 1st picking and 2nd picking of pods for various foliar nutrition varied from 70.50 to 76.50 and 73.80 to 79.30 days with a variation of 8.51% and 8.26% with RDF + borax at 0.2% (sprayed twice at 20 and 40 DAS) (Table 1). On the other hands treatment combination of RDF + Urea at 2% recorded more number of days to complete picking of pod.

Yield attributes and yield

Application of different foliar nutrition practices enhanced yield attributes and yield of greengram during summer season, compared to control situation (RDF only) (Table 2). Among different foliar management, combined application RDF + DAP at 2% (sprayed twice at 20 and 40 DAS) augmented highest number of pods $plant^{-1}$ (18.8), pod length (6.80), number of seeds pod^{-1} (10.75) followed by the RDF + urea at 2% (sprayed twice at 20 and 40 DAS) and RDF + NPK (19-19-19) @ 1% (sprayed twice at 20 and 40 DAS) also gave satisfactory results. For 100-seed weight and pod length, there was no significant difference among treatment combinations. The control plot where no extra foliar nutrition was added showed the lowest value in all yield attributes. It is due to

Table 1. Effect of foliar nutrition on growth parameters and phenology of summer mungbean

Treatment	Plant height at harvest (cm)	Number of leaves $plant^{-1}$ at harvest	Number of Branches $plant^{-1}$ at harvest	Dry matter production (g/m^2) at harvest	Root Length (cm)	Number of Nodules $plant^{-1}$ at 60 DAS	Days to 50% flowering	Days to emergence of pod	Days to 1st picking of pods	Days to 2nd picking of pods
RDF	49.6	19.0	13.75	254.7	17.34	17.9	44.0	53.2	75.4	78.6
RDF + Urea 2%	58.5	23.9	17.50	284.6	18.90	19.5	44.6	53.4	76.5	79.3
RDF + DAP 2%	54.6	23.4	17.10	280.7	19.45	20.2	41.7	50.5	72.3	75.5
RDF + NPK (19-19-19) 1%	54.0	23.1	17.00	277.4	19.21	20.0	42.0	50.9	72.8	74.8
RDF + NPK (10-20-26) @1%	53.1	22.9	16.50	265.2	19.00	19.7	42.2	51.7	73.0	74.9
RDF + $ZnSO_4.7H_2O$ @ 0.5%	51.0	20.7	15.50	255.9	18.82	19.6	43.3	52.4	73.5	75.6
RDF + Mo @ 1 ppm	50.7	21.0	15.75	260.1	18.86	21.4	41.5	49.7	71.0	74.2
RDF + Borax @ 0.2	49.8	20.8	15.20	250.8	18.45	19.5	41.1	49.0	70.5	73.8
S.Em $\pm$	0.70	0.28	0.21	3.44	0.24	0.25	0.61	0.66	0.95	1.00
CD (P=0.05)	2.09	0.82	0.63	10.07	0.72	0.75	1.55	1.94	2.77	3.01

Table 2. Effect of foliar nutrition on yield attributes, yield and economics of summer mungbean

Treatment	Number of pod/ plant	Pod length (cm)	Number of seeds/ pod	100 seed weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index	Total cost of cultivation (× 10^3 ₹ ha^{-1})	Gross return (× 10^3 ₹ ha^{-1})	Net return (× 10^3 ₹ ha^{-1})	Benefit-cost (B:C) ratio
RDF	14.5	6.75	9.90	20.8	763	1950	28.12	24.1	59.1	35.0	2.46
RDF + Urea 2%	18.5	6.77	10.45	21.0	822	2006	29.07	25.2	63.7	39.4	2.63
RDF + DAP 2%	18.8	6.80	10.75	21.2	845	2020	29.49	24.7	65.5	40.7	2.65
RDF + NPK (19-19-19) 1%	18.0	6.79	10.40	20.9	830	1995	29.38	25.9	64.3	38.4	2.49
RDF + NPK (10-20-26) @1%	17.8	6.72	10.20	20.7	811	1976	29.10	25.3	62.8	37.5	2.48
RDF + $ZnSO_4.7H_2O$ @ 0.5%	17.2	6.70	10.10	20.6	795	1941	29.06	24.9	61.6	36.7	2.48
RDF + Mo @ 1ppm	17.7	6.74	10.40	20.8	800	1973	28.85	24.6	62.0	37.4	2.52
RDF + Borax @ 0.2	16.9	6.75	10.25	20.7	790	1981	28.51	24.6	61.2	36.6	2.49
S.Em ±	0.22	0.09	0.13	0.27	10.41	24.02	0.35	3.39	8.45	5.05	0.03
CD (P=0.05)	0.65	NS	0.39	NS	30.82	72.12	1.01	9.93	24.72	14.78	0.10

the increased supply of almost all major essential plant nutrients which provides good vegetative growth thus increased the photosynthetic activity and further the translocation and accumulation of photosynthates in the sinks there by allowing the plant to perpetuate with all the yield components. The results were in line with the findings of Kulkarni *et al.* (2016). The land productivity in terms of seed yield of summer greengram was significantly influenced by the foliar nutrition management practices in the Red and Lateritic soil zone of West Bengal. The seed yield of mungbean varied to the range of 763 to 845 kg ha^{-1} and the yield increase was to tune of 3.54% to 10.74% over the control by the foliar application of different macro and micro nutrient in the experiment. In the experiment, the highest seed yield was recorded in the combined application of RDF + DAP at 2% (sprayed twice at 20 and 40 DAS) (845 kg ha^{-1}) followed by the RDF + NPK (19-19-19) at 1% (sprayed twice at 20 and 40 DAS) (830 kg/ha) and the lowest seed yield (763 kg ha^{-1}) was recorded in the control treatment having no foliar spray. The significant improvement in seed yield of greengram mainly attributed to significant improvement in yield parameters like test weight, number of pods per plant and number of seeds per pod as compared to rest of treatments. The increase in yield might be due to supplementation of nutrients at the critical stage without physiological stress. Foliar application of nutrients enhanced the number of floral buds, prevented the floral shedding by maintaining optimum bio-physiological conditions in plants. The size of the yield structure is increased by the availability of assimilates to the sink or yield container, which is facilitated by adequate and consistent nutrient availability through soil and foliar nutrition (Maheswari and Karthik, 2017). In case of stover yield of greengram significantly increased from 1950 to 2020 kg ha^{-1} and the variation was recorded by 3.58%. Among the treatments, the greengram plot fertilized with combined application of RDF + DAP at 2% (sprayed twice at 20 and 40 DAS) recorded the highest stover yield of 2020 kg ha^{-1} followed by the treatment combination of RDF + urea at 2% (sprayed twice at 20 and 40 DAS) (2006 kg ha^{-1}). The causes for the increase in stover yield were the increased dry matter production and efficient assimilate translocation to the developing sink leading to increased biological yield (Chongre *et al.*, 2019). The harvest index of greengram increased from 28.12 to 29.49 and the increment was noted up to 4.87%. Highest value was recorded in the plot fertilized with RDF + DAP at 2% (sprayed twice at 20 and 40 DAS).

Economics

Gross return (₹ 65.3 × 10^3 ha^{-1}), net return (₹ 40.8 × 10^3 ha^{-1}) and benefit: cost (B:C) ratio (2.65) were higher when the crop received foliar spray of DAP at 2% (sprayed twice at 20 and 40 DAS) with recommended dose of fertilizer (Table 2). The next best economic benefit was obtained when application urea at 2% (sprayed twice at 20 and 40 DAS) with recommended dose of fertilizer (Table 2).

Conclusively, foliar application of macro and micro nutrient was found to be superior for enhancing growth and yield of mungbean cv. Samrat (PDM 139) over sole recommended dose of chemical fertilizer (RDF). Among the foliar nutrition management practices, foliar application of DAP at 2%, urea at 2% and NPK (19-19-19) at 1% along with RDF were found more advantageous

in terms of growth and yield as compared to sole RDF. Therefore, these combinations could be more effective in augmenting growth and yield of summer mungbean in the Red and Lateritic soils of West Bengal.

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