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Influence of Foliar Application of 19:19:19 and Mono-Potassium Phosphate on Growth and Yield of Green Gram (*Vigna radiata* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Foliar application or foliar nutrition is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Water soluble fertilizers (19:19:19 and mono potassium phasphate) have been introduced exclusively for foliar feeding and fertilization. There is very little information about the foliar application of water soluble fertilizers. There is need for more research in this field. Therefore, foliar nutrition is being recognized as an important method of fertilization in modern agriculture. The current study aimed to study the effect of foliar application of inorganic sources of

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nutrients for exploiting genetic potential of the crop for supplementing the part of nutrient requirements at critical stages.

Methodology: A field experiment was conducted during late kharif 2019 on sandy loam soils at College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, to study the effect of foliar application of water soluble fertilizers on growth and yield of green gram (*Vigna radiata* L.). The experiment was laid out in a Randomized Complete Block Design comprising of 3 replications and 13 treatment combinations consisting of three water soluble fertilizers along with package of practice (viz., 2 % DAP, 1 % 19:19:19, 2 % 19:19:19, 1 % mono-potassium phosphate, 2 % mono-potassium phosphate, 1 % 19:19:19 + 1 % mono-potassium phosphate). All water soluble fertilizers were given as foliar spray at two crop growth stages (30 and 45 DAS).

Results: Foliar application of monopotassium phosphate and 19:19:19 each @ 1 per cent at 30 and 45 DAS along with package of practice recorded significantly higher plant height (56.04 cm), number of leaves plant^{-1} (8.46), leaf area (5.37 dm^2 plant^{-1}), total dry matter production (22.16 g plant^{-1}), number of pods plant^{-1} (22.10), number of seeds plant^{-1} (12.65), pod length (8.92 cm), seed yield (1038.82 kg ha^{-1}) and haulm yield (1675.28 kg ha^{-1}), thereby achieved yield increment of 25.07 per cent over package of practice and 46.85 per cent over farmers practice as compared to the other treatments.

Conclusion: Foliar application of monopotassium phosphate and 19:19:19 each at 1 per cent at 30 and 45 DAS along with package of practice in late kharif found ideal for achieving higher yield potentiality in green gram.

Keywords: Green gram; foliar application; water soluble fertilizers; mono-potassium phosphate.

1. INTRODUCTION

"The green gram (*Vigna radiata* L.) is one of the thirteen food legume grown in India and third most important pulse crop after chickpea and pigeon pea. In India, it occupies 40.38 lakh hectare areas with the production of 31.50 lakh tones with the productivity of 7.83 q ha^{-1}. It is an excellent source of high quality protein with easy digestibility, consumed as whole grains, dal, sprouted and in variety of ways. Amongst the pulses, green gram ranks second in the nutritive value. It contains about 24 to 25 per cent protein, this being about two third of protein content of soybean, twice that of wheat and thrice that of rice. The protein is comparatively rich in lysine, which is deficient in cereal grains. Hence, a diet combining green gram and cereal grains forms a balanced amino acid diet" [1].

"Green gram, like other pulses are considered as subsidiary crops. It is often grown on marginal lands and is usually intercropped with other pulses or planted on bunds. As a crop of secondary importance in many of these systems, it receives little or no purchased high cost inputs and the crop is mainly grown in rainfed condition with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with the crop. Apart from the genetic makeup, the physiological factor viz., slow rate of dry matter accumulation during pre-flowering phase, low partitioning efficiency of assimilates to grains, poor pod setting due to the flower abscission, onset of leaf senescence during the period of pod development and lack of nutrients during critical stage of crop growth, coupled with a number of disease and pest constitute the major constraints for the poor yield" [2]. "Hence, the productivity of green gram in our country is far below the potential and provides substantial scope for improvement with the adoption of improved agronomic practices. One among them is the foliar application of organic and inorganic sources of nutrients for exploiting genetic potential of the crop is considered to be an efficient and economic method of supplementing the part of nutrient requirements at critical stages" [1].

"During the last few years, there is a steady trend to reduce the use of mineral fertilizers, especially soil applied nitrogen, phosphorus and potassium and supplement the mineral nutrition through non-conventional methods" [3]. "These facts create preconditions to increase the importance of foliar fertilization as an alternative to meet plant nutrient demand during the growing season. The interest on foliar fertilization has risen as a result of many advantages such as

quick and efficient utilization of nutrients, elimination of losses through leaching, fixation and regulating the uptake of nutrients by plant" [4]. "Foliar feeding is often the most effective and economical way to improve plant nutrient deficiency" [5]. "Under rainfed condition when the availability of moisture becomes scarce the application of fertilizers as foliar spray resulted in efficient absorption and usage. Though foliar spray is not a substitute to soil application but it certainly act as a supplement to soil application. In almost all the pulses, the extent of flower drop determine the yield and yield attributing characters. Retention of flowers by the plant gives higher yield more than expected yield. According to several studies conducted in different crops by different scientists over the world revealed that, retention of flowers is possible through foliar application of growth regulators as well as macro nutrients during flower initiation and pod development stages along with soil application of micro nutrients" [6]. From all these literature it is expected that water soluble fertilizer spray will have a significant effect on growth and yield of green gram. Very little information is available regarding the response of green gram to foliar application of water soluble fertilizers along with soil application. Hence, the intent of present investigation was to study the effect of foliar application of water soluble fertilizers on growth and yield of green gram.

2. MATERIALS AND METHODS

A field experiment was conducted during late kharif 2019 at College of Agriculture, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences (KSNUAHS), Shivamogga, Karnataka. The experimental site was situated at 13° 58' to 14° 1' North latitude and 75° 34' to 75° 42' East longitude with an altitude of 650 m above the mean sea level comes under Southern Transition Zone of Karnataka. The experiment was laid out in a Randomized Complete Block Design (RCBD) comprising 3 replication and 13 treatments *viz*., T_1: Farmers practice (50 kg DAP acre^{-1} as basal application), T_2: Package of practice (RDF of 13:25:25 kg N, P_2O_5 and K_2O ha^{-1} + 7.5 t FYM ha^{-1} + 10 kg $ZnSO_4$ ha^{-1}), T_3: T_2 + DAP spray @ 2 % at 30 and 45 DAS, T_4: T_2 + 19:19:19 @ 1 % at 30 DAS, T_5: T_2 + 19:19:19 @ 1 % at 30 and 45 DAS, T_6: T_2 + 19:19:19 @ 2 % at 30 DAS, T_7: T_2 + 19:19:19 @ 2 % at 30 and 45 DAS, T_8: T_2 + mono-potassium phosphate @ 1 % at 30 DAS, T_9: T_2 + mono-potassium phosphate @ 1 % at 30 and 45 DAS, T_{10}: T_2 + mono-potassium phosphate @ 2 % at 30 DAS, T_{11}: T_2 + mono-potassium phosphate @ 2 % at 30 and 45 DAS, T_{12}: T_2 + mono-potassium phosphate and 19:19:19 each @ 1 % at 30 DAS, T_{13}: T_2 + mono-potassium phosphate and 19:19:19 each @ 1 % at 30 and 45 DAS. "Seeds were dibbled at 5 cm depth with a spacing of 30 cm x 10 cm. Irrespective of treatments, recommended dose of fertilizers (RDF) 13:25:25 N: P_2O_5: K_2O kg ha^{-1} in the form of urea, superphosphate and muriate of potash were supplied to all plots. Foliar application of required quantity of NPK (19:19:19), mono-potassium phosphate (MPP) and Di Ammonium Phosphate (DAP) (obtained from farm unit, college of Agriculture, KSNUAHS) were given in two sprays at 30 and 45 DAS. The specification regarding water 19:19:19 and mono-potassium phosphate is given in the Table 1. The data on plant height, number of branches, number of leaves, leaf area and total dry matter (TDM) production were taken at 30 and 60 DAS and at maturity and yield and yield components were recorded at harvest as per standard procedures. The analysis of variance was carried out using the Randomized Complete Block Design" [7].

Table 1. Specification regarding water soluble fertilizers used in the experiment

	Specification	19:19:19 (%)	Mono-potassium phosphate (%)
1	Moisture percent by weight, maximum	1.5	0.5
2	Total nitrogen percent by weight, minimum	19.0	0.0
3	Water soluble phosphate (as P_2O_5) percent by weight, minimum	19.0	52.0
4	Water soluble potassium (as K_2O) percent by weight, minimum	19.0	34.0
5	Sodium as NaCl percent by weight on dry basis, maximum	0.5	0.025
6	Matter insoluble in water percent by weight, maximum	0.5	0.5
7	Recommended dosage for foliar application	1.0-1.5 % solution (10-15 g liter^{-1} of water)	

Table 2. Growth, yield and yield parameters of green gram as influenced by foliar application of water soluble fertilizers at harvest

Treatments	Plant height (cm)	Number of leaves (plant^{-1})	Leaf area (dm^2 plant^{-1})	TDM (g plant^{-1})	No. of pods plant^{-1}	No. of seeds pod^{-1}	Pod length (cm)	Seed yield kg ha^{-1}	Haulm yield
T_1	32.67	3.12	2.51	9.37	12.59	11.84	7.56	707.41	1143.74
T_2	34.60	3.73	2.63	11.29	13.15	12.24	7.74	830.56	1458.95
T_3	37.13	4.35	2.93	12.30	16.52	12.59	7.89	887.23	1488.85
T_4	42.46	4.49	3.16	13.80	18.21	12.61	7.98	899.97	1492.71
T_5	43.64	5.05	3.60	14.80	18.28	12.62	8.19	907.72	1494.61
T_6	44.00	5.74	3.83	16.09	18.54	12.62	8.27	911.56	1502.81
T_7	44.04	5.98	4.02	17.11	19.40	12.63	8.36	919.45	1525.49
T_8	44.66	6.30	4.19	18.62	19.54	12.63	8.41	924.89	1536.04
T_9	46.03	6.57	4.52	19.55	19.55	12.63	8.48	948.27	1551.64
T_{10}	48.95	6.93	4.59	20.64	19.82	12.63	8.53	978.75	1567.15
T_{11}	49.64	7.17	4.77	21.29	20.02	12.64	8.55	983.18	1577.37
T_{12}	54.50	8.28	4.89	21.91	21.64	12.64	8.76	1025.59	1653.93
T_{13}	56.04	8.46	5.37	22.16	22.10	12.65	8.92	1038.82	1675.28
S. Em. ±	2.06	0.40	0.19	0.27	0.68	0.19	0.12	12.39	32.00
CD (*P=.05*)	6.15	1.16	0.56	0.80	2.04	0.58	0.36	37.12	95.41

T_1 : Farmers practice
T_2: Package of practice
T_3: T_2 + DAP spray @ 2 % at 30 and 45 DAS
T_4: T_2 + 19:19:19 @ 1 % at 30 DAS
T_5: T_2 + 19:19:19 @ 1 % at 30 and 45 DAS
T_6: T_2 + 19:19:19 @ 2 % at 30 DAS
T_7: T_2 + 19:19:19 @ 2 % at 30 and 45 DAS
T_8: T_2 + MPP @ 1 % at 30 DAS
T_9: T_2 + MPP @ 1 % at 30 and 45 DAS
T_{10}: T_2 + MPP @ 2 % at 30 DAS
T_{11}: T_2 + MPP @ 2 % at 30 and 45 DAS
T_{12}: T_2 + MPP and 19:19:19 each @ 1% at 30 DAS
T_{13}: T_2 + MPP and 19:19:19 each @ 1% at 30 and 45 DAS

TDM- Total dry matter

3. RESULTS AND DISCUSSION

3.1 Effect of Foliar Application of Water Soluble Fertilizers on Growth Parameters of Green Gram

The foliar application of water soluble fertilizers had recorded significant effect on growth parameters of green gram. The results (Table 2) revealed that significantly higher plant height, number of leaves, leaf area and total dry matter production per plant were recorded under the treatment receiving T_2 + mono-potassium phosphate and 19:19:19 each @ 1 per cent at 30 and 45 DAS (56.04 cm, 8.46, 5.37 dm^2 $plant^{-1}$ and 22.16 g $plant^{-1}$, respectively) it was on par with the treatment T_2 + MPP and 19:19:19 each @ 1 per cent at 30 DAS (54.50 cm, 8.28, 4.89 dm^2 $plant^{-1}$ and 21.91 g $plant^{-1}$, respectively) as compared to package of practice (34.60 cm, 3.73, 2.63 dm^2 $plant^{-1}$ and 11.29 g $plant^{-1}$, respectively) whereas, significantly lower plant height, number of leaves, leaf area and total dry matter production per plant were recorded with the farmers practice (32.67 cm, 3.12, 2.51 dm^2 $plant^{-1}$ and 9.37 g $plant^{-1}$, respectively). This could be due to increase in the activity of meristematic cell, cell division and cell elongation with application of nutrients as they are known to have favorable effects on metabolic process and better vegetative growth. These results are in agreement with the results obtained in soybean [8]. “This may also be attributed to the fact that nitrogen helps in maintaining higher auxin level which might have resulted in better plant height, number of leaves and presumably leaf area of the crop. This resulted into better interception, absorption and utilization of radiant energy, leading to higher photosynthetic rate and finally more accumulation of dry matter by the plants. The significant improvement in dry matter is due to better nutrition and higher availability of NPK which led into better uptake by the crop” [9]. “Faster growth of plants evidenced from increased biomass $plant^{-1}$ at successive stages of crop growth was ascribed to the view that there was better availability of metabolites and nutrients which synchronized to the demand for growth and development of each reproductive structure of the plant” [10].

3.2 Effect of Foliar Application of Water Soluble Fertilizers on Yield and Yield Parameters of Green Gram

The results (Table 2) revealed that significantly higher number of pods $plant^{-1}$, number of seeds pod^{-1} and pod length were recorded with the treatment receiving T_2 + mono-potassium phosphate and 19:19:19 each @ 1 per cent at 30 and 45 DAS (22.10, 12.65 and 8.92 cm, respectively) it was on par with the treatment T_2 + mono-potassium phosphate and 19:19:19 each @ 1 per cent at 30 DAS (21.64, 12.64 and 8.76 cm, respectively) as compared to package of practice (13.15, 12.24 and 7.74 cm, respectively) whereas, significantly lower plant height, number of pods $plant^{-1}$, number of seeds pod^{-1} and pod length were recorded with the farmers practice (12.59, 11.84 and 7.56 cm, respectively). This could be attributed to higher supply of nutrients through mono-potassium phosphate and 19:19:19 at flower initiation and pod development stage which might have caused efficient translocation of photosynthates from source to sink.

“Decreased flower drop due to prolonged assimilatory activity of leaves might be another possible reason for higher yield parameters” [11]. The economic yield is a part of total biological yield of the crop and it is a function of various independent factors. Among several factors responsible for sustained green gram production, adequate supply of essential nutrients in balanced way at critical crop growth stages is one of the key factors for realizing the potential yield. Foliar application of nutrients has become an established procedure in crop production to increase the yield with supplying nutrients throughout the growing period and minimize the nutrient losses due to increased absorption of nutrients.

Seed and haulm yield of green gram differed significantly due to foliar application of water soluble fertilizers. Among the treatments, T_2 + mono-potassium phosphate and 19:19:19 each @ 1 per cent at 30 and 45 DAS increased the seed and haulm yield to the extent of 25.07 per cent and 14.83 per cent, respectively over the package of practice and 46.85 per cent and 46.47 per cent, respectively over the farmers practice (Fig. 1). Among the foliar application of different water soluble fertilizers, irrespective of

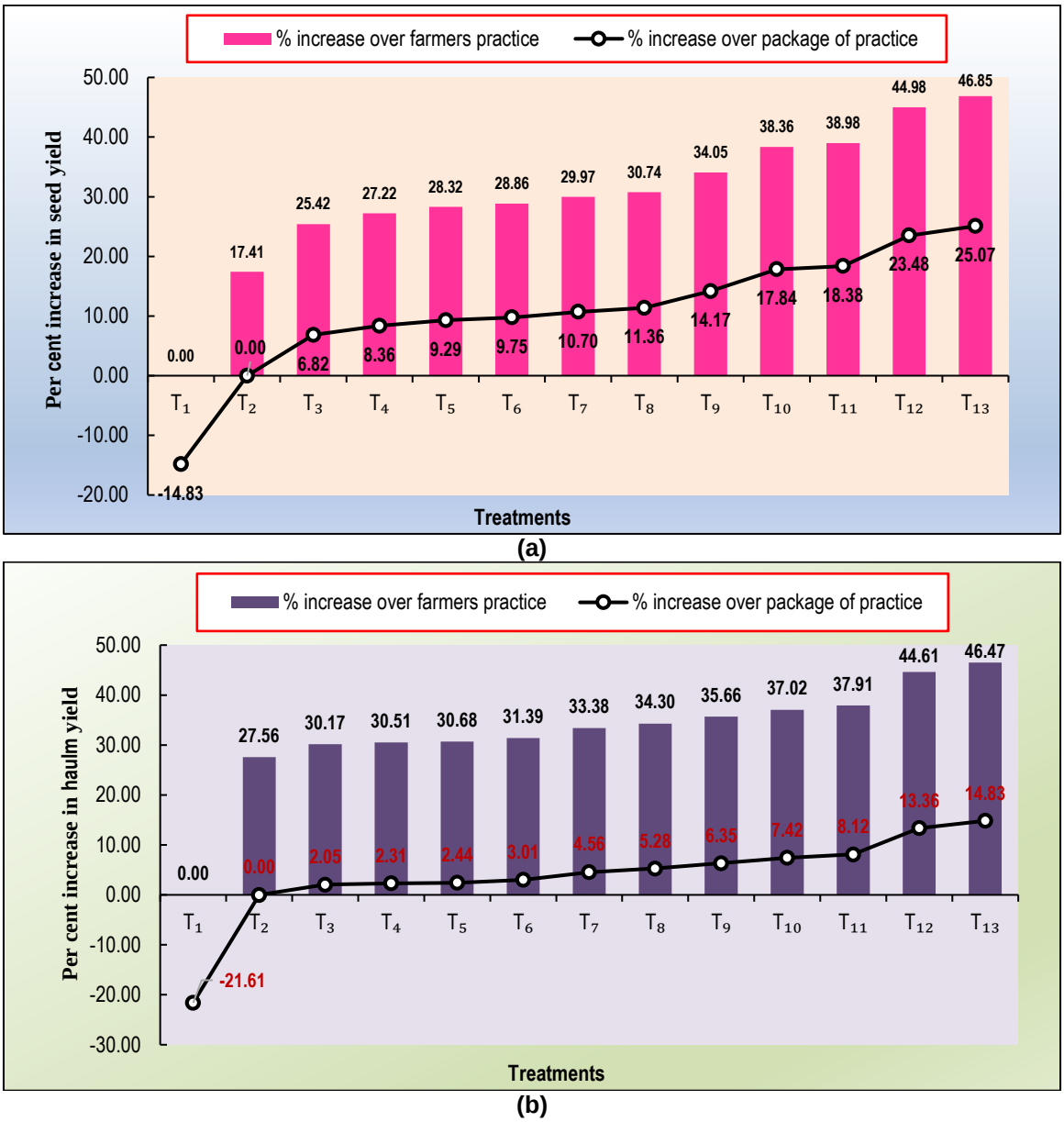

Fig. 1. Influence of foliar application of water soluble fertilizers on per cent increase in (a) seed yield and (b) haulm yield over the farmers practice and package of practice in green gram

T_1 : Farmers practice
T_2: Package of practice
T_3: T_2 + DAP spray @ 2 % at 30 and 45 DAS
T_4: T_2 + 19:19:19 @ 1 % at 30 DAS
T_5: T_2 + 19:19:19 @ 1 % at 30 and 45 DAS
T_6: T_2 + 19:19:19 @ 2 % at 30 DAS
T_7: T_2 + 19:19:19 @ 2 % at 30 and 45 DAS
T_8: T_2 + MPP @ 1 % at 30 DAS
T_9: T_2 + MPP @ 1 % at 30 and 45 DAS
T_{10}: T_2 + MPP @ 2 % at 30 DAS
T_{11}: T_2 + MPP @ 2 % at 30 and 45 DAS
T_{12}: T_2 + MPP and 19:19:19 each @ 1% at 30 DAS
T_{13}: T_2 + MPP and 19:19:19 each @ 1% at 30 and 45 DAS

basal dose of fertilizer application, combined foliar application of mono-potassium phosphate + 19:19:19 each @ 1 per cent at 30 and 45 DAS was significantly superior compared to all other treatments. The significant increase in the seed and haulm yield is due to increased and balanced dose of fertilizer application at critical crop growth stages results in increased nutrient supply and reduced nutrient losses which is reflected through increased growth parameters

like plant height, number of leaves and leaf area which resulted in higher dry matter production and yield parameters like number of pods plant^{-1}, number of seeds pod^{-1} [12]. This might be also due to better translocation of photosynthates from source to sink due to additional supply of nutrients through foliar spray. These results are in close confirmation with the findings in green gram [13] and in black gram [14], who reported that application of 19:19:19 @ 1.0 per cent at vegetative stage, 0:52:34 @ 1.0 per cent at flowering stage and 13:00:45 @ 1.0 per cent at grain filling stage along with RDF recorded highest seed and haulm yield (1469 and 2236 kg ha^{-1}, respectively) over the control (995 and 1695 kg ha^{-1}, respectively). Similarly, these results are close confirmation in green gram [15], chickpea [16], cluster bean [17] and soybean [18, 19, 20 & 21].

4. CONCLUSION

It is clear from the findings that foliar application of mono-potassium phosphate and 19:19:19 each at 1 per cent at 30 and 45 DAS along with package of practice in late kharif found ideal for achieving higher yield potentiality in green gram.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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