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Influence of Foliar Nutrition on Growth and Yield of Pulses Grown under North Eastern Dry Zone of Karnataka: A Review

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ABSTRACT

Maintaining food and nutritional security for the increasing population of the world is a great challenge for us. Pulses, in spite of being major source of protein to this exponentially growing population of the world and it also involved in biological process called "Nitrogen fixation". The productivity of pulses are declining year by year due to many reasons. The major one is as they are grown in rainfed areas with low moisture availability combined with low fertile soils and another important physiological constraint which limit the productivity is flower drop. So, it needs earnest attention in adoption of desirable production technologies to exploit the yield potential of the pulses and it can be possible by foliar application of nutrients at critical stage/s of the crop as there is no regional recommendation of foliar spray during crop growth period and foliar nutrition is recognised as an important method since it facilitates easy and rapid utilization of nutrients.

Key words: *Foliar nutrition, Production, Productivity, Pulses, Rainfed area*

INTRODUCTION

I. Importance of foliar nutrition in pulses

Agriculture still remains the backbone of Indian economy in spite of various technological advancements and industrial development with 70 % of people dependent on agriculture and 25 % of country's Gross Domestic Product coming from agricultural sector. Among the various inputs in agriculture, fertilizer is a vital input since it replenishes the nutrients removed from the soil by crops and also boosts the yield of crops. Method of fertilizer application is a non-monetary input which influences growth and consequently the crop yields.

Pulses play an important role in Indian agriculture. India is a premier pulse growing country. The pulses form an integral part of cropping system of the farmers all over the country because they fit well in crop rotation and crop mixture as well. In India, pulses are being cultivated over an area of 23.6 million hectares with an annual production of 17.2 million tonnes and productivity of 728 kg per hectare[4].

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The per capita availability of pulses in India is 40 gram per person per day as against the minimum requirement of 140 gram per person per day as advocated by Indian Council of Medical Research[3]. The steady increase in Indian population together with stagnant production of pulses over the past four decades compared to cereals has naturally resulted in decreased per cent availability of pulses. Pulses being cultivated under rainfed/summer season leads to low soil moisture, under rainfed condition even application of fertilizer at right time and right quantity may not be efficient due to soil moisture. When availability of moisture becomes scarce, application of fertilizers through foliar spray resulted in efficient absorption. Though foliar spray is not a substitute to soil application but it certainly be considered as a supplement to soil application[45]. Among the methods of fertilizer application, foliar nutrition is recognized as an important method of fertilization, since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients[21].

Pulses are usually grown in higher pH soils, it is well known that micro-nutrients as well as some macro-nutrients may hardly be absorbed by roots due to higher ion concentration, which lowers osmotic potential of soil water and consequently the availability of soil water to the plants became a limiting factor[15] then foliar application is particularly useful[41]. Therefore, foliar feeding of nutrients has become an established procedure in crop production to increase yield and quality of crop products[35] and it also minimizes environmental pollution and improves nutrient utilization through reducing the amounts of fertilizers added to the soil[1].

The nutrients are known to alter the various physiological and biochemical functions which finally influences on the yield of the crop. Sometimes, soil applied nutrients are insufficient for crop to meet out their nutrient requirement and it may be due to non-availability of nutrients due to abrupt soil conditions, exhausted soil condition or nutrient losses through leaching and many more things which can hinder the availability of nutrients to plants and cease the plant growth, which ultimately affect the yield and quality of the crop produce. Furthermore, nutrient status is an important and deciding factor in judging the total dry matter accumulation in plants. In recent years, the use of nutrients as foliar spray is gaining importance in improving the yield potential and also the quality of produce in several crops as to meet out their nutrient requirement inspite of abrupt soil conditions. Foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. During the last decades, foliar feeding of nutrients has become an established procedure in crop production to increase yield and improve the quality of crop products. So, foliar application of nutrients at critical stages of crop growth is most appropriate and accurate method of correcting the nutrient deficiencies and helps to attain maximum potential yield of the crop and ultimately sufficient plant nutrition is absolutely essential for improving their productivity.

In addition, foliar application of nutrients was found to be more advantageous than soil application with the elimination of losses through leaching and fixation. It thus increases photosynthetic rate, better nutrient translocation from the leaves to the developing seeds[24].

Finally, it is most economical way of fertilization to achieve quality production and yield, especially when sink competition for carbohydrates among plant organs take place, while nutrient uptake from the soil is restricted[18] and it is most effective and economical way to improve plant nutrient deficiency[33] and can exploit the potential yield of the crop and constitutes one of the important milestones in the progress of agricultural production. Several scientists have attempted to conduct studies on foliar nutrition and its effect on yield and quality parameters in pulse crops. The present paper is a review of work done on this aspect.

II. Influence on morpho-physiological parameters of various pulses

1. Plant height and number of branches

SI. no	Crop	Chemical dosage and its stage of usage	Findings
1	Mungbean[38]	0.5 per cent zinc sulfate at flowering stage	Higher plant height (28.5 cm) and number of branches (5.5) per plant while in control 27.7 cm, 5.3 and 12.2 per plant, respectively.
2	Cowpea[31]	0.5 per cent $ZnSO_4$ at 25 and 45 days after sowing	Most effective and increased the plant height, number of branches per plant.
3	Pigeonpea[47]	0.5 per cent zinc sulfate at flowering and pod formation stage	Higher plant height (115.5 cm) and number of branches (12.1).
4	Soybean[16]	0.5 per cent zinc sulfate at flowering stage	Higher plant height (34.4 cm)
5	Greengram[10]	2.0 per cent diammonium phosphate + naphthalene acetic acid @ 40 ppm + boron @ 0.2 per cent + molybdenum @ 0.05 per cent at 30 days after sowing	Higher plant height (32.27 cm) at harvest.
6	Greengram[14]	2.0 per cent Diammonium phosphate and urea	Higher plant height (64.5 cm) steadily up to 60 days after sowing than basal application of fertilizers and sprayed with distilled water.
7	Chickpea[5]	1.0 per cent urea during pod filling stage	Higher plant height (129 cm) and more number of branches (5.8).
8	Blackgram[20]	1.0 per cent Urea during flowering and at 15 days after flowering	Taller plants and more number of branches per plant.
9	Chickpea[48]	1.0 per cent urea at flowering and pod development stage	Higher plant height (47.7 cm) and more number of branches (26.6) per plant.
10	Blackgram[39]	2.0 per cent urea at 25 days after sowing and 15 days after first spray	Higher plant height (68 cm).
11	Pigeonpea[11]	2.0 per cent urea at green floral bud stage of inflorescence followed by another spray 2 days after the first spray	Higher plant height (280 cm) and number of branches (36), when compared to control (280 cm and 25).
12	Mungbean[34]	2.0 per cent urea during flowering and pod initiation stages	Higher plant height (21.29 cm) compared to control (16.54 cm).
13	Mungbean[7]	Application of potassium @ 1 kg per hectare as foliar spray during flowering in addition to half dose of basal fertilizer	Higher plant height (28.58 cm).
14	Blackgram[12]	Potassium sulfate @ 20 kg per hectare and foliar spray of potassium sulfate @ 0.5 per cent at 30 and 45 days after sowing	Higher plant height (54.7 cm).
15	Blackgram[2]	0.3 per cent Manganese sulfate at 30 days after sowing	Higher plant height (37.45 cm) and number of branches per plant (6.36).
16	Chickpea[30]	2.0 per cent 19:19:19 (Nitrogen:Phosphorous:Potassium) at the time of flowering as well as pod development stage	Higher plant height (35.55 cm) and number of secondary branches (16.8).
17	Soybean[23]	Nitrogen, phosphorous, potassium and magnesium @ 100 mg per liter of water corresponding to each nutrient at pod formation stage	Higher plant height (44.85 cm) and branches per plant (8.68)

2. Growth parameters and dry matter accumulation of various pulses

SI. No	Crop	Chemical, dosage and its stage of usage	Findings
1	Grrengram[8]	2 per cent Diammonim phosphate along with potassium chloride @ 1 per cent and napthalene acetic acid @ 40 ppm at flowering stage	Increased total dry matter production (24.08 g plant^{-1}) over control (20.24 g plant^{-1}).
2	Chickpea[30]	2.0 per cent 19:19:19 (Nitrogen:Phosphorous:Potassium) at the time of flowering as well as pod development stage	Higher total dry matter accumulation (21.08 g plant^{-1}).
3	Chickpea[5]	1.0 per cent urea at pod filling stage	Higher total dry weight (45.3 g).
4	Greengram[14]	2.0 per cent Diammonium phosphate and urea at flowering stage	Higher leaf area index (5.0) than basal application of fertilizers and sprayed with distilled water.
5	Mungbean[29]	1.5 per cent urea alone or combination of nitrogen and various micro nutrients like boron, molybdenum, zinc, calcium and iron @ 0.1 per cent with four sprays at 4 days interval from flowering to pod development stage	Higher total dry mass per plant (10.2 g).
6	Blackgram[40]	2.0 per cent urea along with 1 ppm brassinollide at 25 days after sowing and 10 days after first spray	Higher leaf area index (0.34, 0.82, 1.89, 1.65) and total dry matter (2.12, 4.84, 10.58, 17.14 g plant^{-1}) at vegetative stage, flowering stage, post flowering stage and harvest stage, respectively.
7	Cowpea[50]	2.0 per cent diammonium phosphate, urea and potassium chloride @ 2.0 per cent each at flowering and branching stage	Higher dry matter accumulation (114.9 g) at harvest.
8	Blackgram[36]	40 ppm naphthalene acetic acid + 0.5 per cent chelated micro nutrient + 2 per cent diammonium phosphate at 30 and 50 days after sowing	Higher leaf area (12.54 dm^2 plant^{-1}), leaf area index (4.18), leaf area duration (60.45 days), crop growth rate (0.19 g m^{-2} day^{-1}) and total higher dry matter production (15.98 g plant^{-1}).
9	Soybean[23]	Nitrogen, phosphorous, potassium and magnesium @ 100 mg per liter of water corresponding to each nutrient at pod formation stage	Higher stem dry weight (14.97 g), leaf dry weight (23.47 g) and total dry weight (38.44 g).
10	Blackgram[2]	Manganese sulfate @ 0.3 per cent at 30 days after sowing	Higher total dry matter (11.85 g), leaf area index (2.47) at 60 days after sowing and leaf area duration between 30-60 days (41.03 days)
11	Blackgram[39]	2.0 per cent urea at 25 days after sowing and 15 days after first spray	Higher leaf area (966.5 cm^2 plant^{-1}), total dry matter production (24.84 g plant^{-1}) at pod filling stage and also observed higher crop growth rate (24.6 g m^{-2} day^{-1}) and leaf area duration between 30-60 days after sowing (48.0 days)
12	Pigeonpea[11]	2.0 per cent urea at green floral bud stage of inflorescence followed by another spray 2 days after the first spray	Higher leaf area (52 dm^2), leaf area Index (2.2) and crop growth rate (9.3 g m^{-2} day^{-1}**)** at flowering and also showed that the growth attributes are positively correlated with seed yield.
13	Blackgram[27]	2.0 per cent urea and 0.1 ppm brassinolide at 25 days after sowing	Higher total dry matter at vegetative stage (2.12 g), flowering stage (4.85 g), pod filling

		and 10 days after the first spray	stage (10.57 g) and harvest stage (17.13 g) per plant, respectively.
14	Blackgram[12]	Potassium sulfate @ 20 kg per hectare and foliar spray of potassium sulfate @ 0.5 per cent at 30 and 45 days after sowing	Higher dry matter production (2832 kg ha^{-1}).
15	Mungbean[34]	2.0 per cent urea at flowering and pod initiation stage	Higher leaf area (520.83 cm^2 $plant^{-1}$)

II. Influence on yield components and yield of various pulses

SI. no	Crop	Chemical dosage and its stage of usage	Findings
1	Soybean[44]	0.5 per cent manganese sulfate + 0.25 per cent zinc sulfate + 0.02 per cent ammonium molybdate + 0.05 per cent borax at 45 days after sowing	Higher grain yield (1832 kg ha^{-1}), stover yield (3734 kg ha^{-1}) and dry matter production at harvest (5208 kg ha^{-1}).
2	Soybean[6]	0.5 per cent zinc sulfate during flowering	Higher number of pods, number of seeds per pod and seed yield over 100 per cent recommended dose of fertilizers.
3	Pigeonpea[13]	Application of zinc sulfate at 25 kg per hectare along with foliar spray of 19:19:19 (N:P:K) @ 0.4 per cent in pigeonpea at flower initiation and pod development	Higher seed yield (1390 kg ha^{-1}).
4	Mungbean[38]	0.1 per cent boron at pre flowering and flowering stage	Higher pod weight (15.7 g), pods per plant (32), seeds per pod (8.5) and seed yield (1293 kg ha^{-1}) compared to pod weight (12.6 g), pods per plant (26.6), seeds per pod (8.1) and seed yield (988 kg ha^{-1}) in control.
5	Soybean[37]	Borax @ 0.5 kg per hectare during flowering stage	Higher seed yield (1973 kg ha^{-1}).
6	Chickpea[26]	0.2 per cent borax at 50 and 60 days after sowing	Higher number of seeds per pod (1.3) and seed yield (17.96 kg ha^{-1}).
7	Blackgram[32]	Boron @ 100 ppm in at 20 and 35 days after sowing	Higher pods per plant (36.7) and seeds per pod (8.00).
8	Mungbean[28]	1.5 per cent urea solution one week before flowering and during the period of pod development	Retarded the loss of chlorophyll and leaf nitrogen in which enhanced total dry matter production, pod production, 100 seed weight and seed yield.
9	Greengram[43]	0.4 per cent urea at flower initiation	Higher seed yield (1229 kg ha^{-1}).
10	Blackgram[39]	2.0 per cent urea at 25 days after sowing and 15 days after first spray	Profound effect in improving number of pods per plant, number of clusters per plant, 100 seed weigh yield, harvest index and also exhibited higher yield (900 kg ha^{-1}) with 20 per cent yield increment over control.
11	Mungbean[34]	2.0 per cent urea during flowering and pod initiation stages	Higher seed yield (792.17 kg ha^{-1}).
12	Blackgram[49]	Urea @ 2.0 % at 40 days after sowing	Observed an increase of 27.4 to 31.0 per cent in grain yield .
13	Mungbean[29]	1.5 per cent urea alone or combination of nitrogen and various micro-nutrients like boron, molybdenum, zinc, calcium and iron @ 0.1 per cent with four sprays at 4 days interval from flowering to pod	Higher pods per plant (15.2), seeds per pod (9.40), 100 seed weight (5.19 g) and harvest index (34.6 %).

		development stage	
14	Chickpea[5]	1.0 per cent urea during pod filling stage	Higher seeds per plant (66), 100 seed weight (36 g) and harvest index (0.45).
15	Greengram[19]	2.0 per cent diammonium phosphate + 100 ppm salicylic acid + 0.05 per cent sodium molybdate to at vegetative and flowering stage	Higher pods per plant (34), grain yield (928 kg ha^{-1}) and haulm yield (1230 kg ha^{-1}) .
16	Chickpea[46]	2.0 per cent urea spray at 75 days after sowing	Higher no. pods per plant (45.3) and seed yield of 2437 kg per hectare.
17	Blackgram[40]	2.0 per cent urea + 1 ppm brassinollide at 25 days after sowing and 10 days after first spray	Higher no. of pods per plant (28.5), seeds per pod (7.20), 100 seed weight (5.1 g) and grain yield (893.3 kg ha^{-1}).
18	Blackgram[25]	Diammonium phosphate @ 2 per cent + TNAU pulse wonder at 5.0 kg per hectare at 45 days after sowing	Higher number of pods per plant (37.15), grain yield (1116 kg ha^{-1}) and haulm yield (3351 kg ha^{-1}).
19	Blackgram[27]	2.0 per cent urea and 0.1 ppm brassinolide at 25 days after sowing and 10 days after the first spray	Higher number of pods per plant (28.4), seeds per pod (7.2) and 100 seed weight (5.1 g).
20	Chickpea[30]	2.0 per cent 19:19:19 (Nitrogen:Phosphorous:Potassium) at the time of flowering as well as pod development stage	Increased yield attributes such as number of pods per plant (35), pod weight per plant (13.20 g) and seed yield (1637 kg ha^{-1}), which was on par with 1.5 per cent at same stage.
21	Greengram[17]	1.0 per cent 19:19:19 (N:P:K) during flower initiation stage	Higher grain yield of 1121 kg per hectare as compared to control (734 kg ha^{-1}).
22	Pigeonpea[22]	1.0 per cent 19:19:19 (N:P:K) at peak flowering stage	Higher number of pods per plant (121.88), pod weight per plant (105.5 g) and grain yield (1661 kg ha^{-1}). The increment of grain yield was to the extent of 17.66 per cent compared to no foliar spray.
23	Blackgram[9]	2.0 per cent urea spray at pre flowering stage	Higher seed yield (1385 kg ha^{-1}), it is on par with 2.0 per cent 19:19:19 (N:P:K). They have also observed with the application of 3.0 per cent 19:19:19 fertilizer spray under no basal dose of fertilizer application recorded higher seed yield (1162 kg ha^{-1}).
24	Soybean[23]	Nitrogen, phosphorous, potassium and magnesium @ 100 mg per liter of water corresponding to each nutrient at pod formation stage	Higher number of pods per plant (92.67), seeds per pod (3.13), 100 seed weight (12.52 g) and grain yield (187.20 g m^{-2}).
25	Blackgram[12]	Potassium sulfate @ 20 kg per hectare and foliar spray of potassium sulfate @ 0.5 per cent at 30 and 45 days after sowing	Higher number of pods per plant (35), number of seeds per pod (7), 100 grain weight (4.81 g), grain yield (1145 kg ha^{-1}) and haulm yield (1645 kg ha^{-1}).
26	Transplanted Pigeonpea[42]	Pulse magic (It contains 10 per cent nitrogen, 40 per cent phosphorous, 3 per cent micronutrient and 20 PPM plant growth regulator) @ 10 g/l to at 50 per cent flowering stage and 15 days after first spray	Higher number of pods per plant (1365), number of seeds per pod (3.5), 100 seed weight (11.34 g), and seed yield (220 g $plant^{-1}$).
27	Blackgram[36]	40 ppm naphthalene acetic acid + 0.5 per cent chelated micro nutrient + 2 per cent diammonium phosphate at 30 and 50 days after sowing	Higher grain yield (1298 kg ha^{-1}), number of pods per plant (38.73), number of seeds per pod (6.47) and test weight (61.90 g) compared to control (749 kg ha^{-1}, 21.80, 4.93 and 45.67 g, respectively).

CONCLUSION

Thus, the reviews indicate that foliar application of nutrients along with recommended dose of fertilizers has increased yield components *viz.*, number of seeds per pod, pod length and number of pods per plant *etc*. Due to this increased yield components there is final increment in yield and this increment in yield is may due to increased plant height, number of branches, leaf area and dry matter production due to foliar spray as it facilitates the higher photosynthates translocation to sink by increasing the photosynthesizing area and its capacity of particular crop. But, still there is controversy is being existed for use of nutrient or combination of nutrient/s, their dose and stage/s of foliar spray among different crops. So, it's a great challenge as well as opportunity for agricultural scientists to work on mineral nutrition and know the nutrient concentration and their appropriate stage of use, as it can help the crop to achieve it's maximum potential yield, hence there will be narrow gap between production and demand of pulses and which further helps to achieve self sufficiency in requirement of pulses.

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