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Influence of Foliar Application of Water Soluble NPK Fertilizer on Yield, Economics Nutrient Uptake and Quality of Lima Bean

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ABSTRACT

A field experiment was conducted at Agronomy Field Unit, Zonal Agricultural Research Station, University of Agricultural Sciences, G.K.V.K., Bengaluru during Kharif, 2012 to study the effect of foliar application of water soluble NPK fertilizer on growth, yield and quality of lima bean (Phaseolus lunatus L.). The experiment was laid out in a Randomized Complete Block Design with eight treatments replicated thrice using a bush type lima bean variety. The results revealed that application of 25:50:25 kg NPK ha^{-1} + foliar application of WSF at branching, 50% flowering and pod development stage (T_8) recorded significantly higher seed yield (1408 kg ha^{-1}) than control (1007 kg ha^{-1}), higher net returns, B: C ratio (Rs.1,14,398 ha^{-1} and 4.8, respectively) when compared to control (Rs.93,419 ha^{-1} and 3.7, respectively). Further, higher NPK uptake (80.38, 19.5 and 98.05 kg ha^{-1}, respectively) was also registered with the same treatment than the control (52.49, 10.77 and 58.15kg ha^{-1} respectively) which reflected on higher protein content of 21.7 per cent where as other quality parameters such as fat and fibre content were not significantly affected by the foliar nutrition of water soluble fertilizers.

Key words: *Lima bean, Water soluble fertilizer (WSF), Foliar application, Nutrient uptake*

INTRODUCTION

India is the largest producer of pulses in the world with a production of 17.3 Mt which contributed towards major share (24%) in the global production[1]. The important pulse crops are chickpea, pigeon pea, mungbean, urdbean, lentil and field pea. The major pulse-producing states are Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka and Andhra Pradesh which together account for about 80% of the total production in India. Though India is a largest producer and consumer of pulses, the per capita availability of pulses has been declining over the years from 60 g/day in 1960's to less than 33 g/day[1], which is far less than the FAO recommendations (80g). To meet the pulses requirement, the production of pulses has to be increased by increasing the productivity, besides enhancing the area under pulses despite the fact there are many constraints for lower productivity of pulses.

Lima bean (*Phaseolus lunatus* L.) is a legume crop belonging to the family Fabaceae, commonly known as the lima bean or butter bean**.** The seeds of lima bean are used as vegetable.

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Lima bean varieties can be grouped into bush type and pole type. The bush type varieties mature earlier than pole types. Like many other legumes, lima bean is also a good source of dietary fibre, virtually fat-free source of high quality protein, rich in minerals like iron, manganese, copper, potassium, phosphorous, magnesium, molybdenum and vitamins like folate and vitamin-B[6]. It contains 23.17 per cent crude protein, 71.14 per cent total carbohydrates and 67.72 per cent starch on fresh weight basis to serve as a potential source of protein and energy[4].

Foliar application of nutrients along with soil application has several advantages in supplementing the nutritional requirements of crops such as rapid and efficient response by the plants, less product needed and independence of soil conditions. Also, foliar nutrition is recognized as an important method of fertilization in modern agriculture which provides efficient nutrition for correcting deficiencies and eliminate the problems like fixation and immobilization of nutrients rapidly especially for short duration crops. Recently, new generation speciality fertilizers have been introduced exclusively for foliar feeding and fertilization which serve better for foliar application and may contain different ratios of N, P and K with or without other nutrients with high solubility and so amenable for foliar nutrition. In this direction, foliar fertilization with major nutrients through water soluble fertilizer on pulse crop like lima bean was studied.

MATERIAL AND METHODS

A field experiment was conducted at Agronomy Field Unit, Zonal Agricultural Research Station, University of Agricultural Sciences, G.K.V.K., Bengaluru during *Kharif, 2012*. The soil of the experimental site was red sandy loamy in texture and pH was normal (6.9). The soil was medium in available nitrogen (332.5 kg ha^{-1}), phosphorus (43.5 kg ha^{-1}) and potassium (183.5 kg ha^{-1}) with low organic carbon status (0.46 %) in the soil. A bush type limabean was sown in the month of August with a spacing of 30 cm between the rows and between the plants. The experiment was laid out in a Randomized Complete Block Design with three replications consisting of eight treatments. *viz.*, **T_1**- NPK at 25: 50: 25 kg ha^{-1} (control), **T_2** - T_1 + water soluble fertilizer (WSF at 0.5 per cent solution) spray at branching, **T_3** - T_1 + WSF spray at 50 % flowering, **T_4** - T_1 + WSF spray at pod development, **T_5** - T_1 + WSF spray at branching and 50 % flowering stage, **T_6** - T_1 + WSF spray at branching and pod development stage, **T_7** - T_1 + WSF spray at 50 % flowering stage and pod development stage and **T_8** - T_1 + WSF spray at branching, 50 % flowering stage and pod development stage.

All the soil applied fertilizers were applied as basal application and water soluble fertilizer 19:19:19 (NPK) at 0.5 per cent solution was given as a foliar spray during branching, 50% flowering and pod development stage as per the treatments.

RESULTS AND DISCUSSION

Effect of foliar application of water soluble NPK fertilizer on yield and economics of lima bean:

The present investigation revealed that, significantly higher pod yield (3250 kg ha^{-1}), seed yield (1408 kg ha^{-1}) and haulm yield (5561 kg ha^{-1}) were recorded with application of 25:50:25 kg NPK ha^{-1} + foliar application of WSF at branching, 50% flowering and pod development stage (T_8) (1408 kg ha^{-1}) than control (2200, 1007and 4406 kg ha^{-1}, respectively).

Noteworthy increase in yield parameters was mainly due to increased nutrient uptake and improved growth parameters. The supply of nutrients through foliar application has made more nutrient availability for uptake. Further better utilization of nutrients by the crop resulted in production of more photosynthates and their partitioning from source to sink. The results might be due to foliar nutrition which preferentially increased the metabolic processes like photosynthesis, enhanced levels of nucleic acids, soluble proteins, carbohydrates which resulted in higher dry matter production and sink size[2,37].

Application of 25:50:25 kg NPK ha^{-1} + foliar application of water soluble fertilizer at branching, 50% flowering and pod development stage (T_8) also resulted in higher net returns (Rs.1,14,398 ha^{-1}) and B: C (4.8) than control (Rs.93,419 ha^{-1} and 3.7, respectively). It was mainly due to higher seed yield and better market price of lima bean with less cost of production.

Effect of foliar application of water soluble NPK fertilizer on nutrient uptake of lima bean

Progressive increase in supply of nutrients through foliar application at different stages significantly increased the seed yield and haulm yield of lima bean than soil application of fertilizers alone (control). Where it has influenced the nutrient uptake of lima bean in which application of 25:50:25 kg NPK ha^{-1} + foliar application of WSF applied at branching, 50% flowering and pod development stage (T_8) recorded significantly higher NPK uptake when compared to control (T_1) (Table 3.). Higher nutrient uptake was mainly due to higher dry matter production and increased sink size as indicated by their correlation (Table 4). Supplying nutrients during crop growth period especially at critical stages by foliar application favored increased availability with readiness for better utilization and nutrient uptake by the crop. Similar results were reported by Kadam *et al*[5]. in soybean and Yadav and Chaudhary[9], in cow pea.

Effect of foliar application of water soluble NPK fertilizer on quality of lima bean

Among different treatments significantly higher protein content was also recorded with T_8 than the T_1 (Table 3.). Since, the higher nitrogen supply through foliar application at different crop growth stages resulted in enhancement of protein content of seeds, suggesting that hydrocarbons synthesized during photosynthetic process are diverted to form more of proteins[2,8,3]. Fibre and fat content of lima bean were not significant among different treatments. All the quality parameters are more of genetic characters and might not be altered by agronomic parameters.

Based on the experimental results it can be concluded that soil application of fertilizers along with foliar application of water soluble fertilizer at 0.5 per cent at different stages of crop could enhance the nutrient uptake by increase availability of nutrients to the crop besides improving protein content of lima bean.

Table 1: Effect of foliar application of water soluble NPK fertilizer (19:19:19 at 0.5 %) on yield of lima bean

Treatments	Pod yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	HI
T_1= NPK at 25: 50: 25 kg ha^{-1} (control)	2200	1007	4406	0.19
T_2= T_1 + WSF spray at branching	2330	1075	4586	0.19
T_3= T_1 + WSF spray at 50 % flowering	2460	1148	4304	0.21
T_4= T_1 + WSF spray at pod development	2650	1213	4534	0.21
T_5= T_1 + WSF spray at branching and 50% flowering stage	2750	1236	3954	0.24
T_6= T_1 + WSF spray at branching and pod development stage	2640	1248	4765	0.21
T_7 =T_1 + WSF spray at 50% flowering stage and pod development stage	2790	1303	5071	0.20
T_8= T_1 + WSF spray at branching, 50% flowering stage and pod development stage	3150	1409	5561	0.20
SE.m ±	**0.15**	62.32	182.2	0.01
CD (p=0.05)	**0.45**	189.04	552.3	NS

NS: Not significant

Table 2: Effect of foliar application of water soluble NPK fertilizer (19:19:19) on economics of lima bean

Treatments	Cost of cultivation (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	B:C
T_1= NPK at 25: 50: 25 kg ha^{-1} (control)	23469	87201	93419	3.7
T_2= T_1 + WSF spray at branching	24031	92893	91487	3.9
T_3= T_1 + WSF spray at 50 % flowering	24031	98338	83487	4.1
T_4= T_1 + WSF spray at pod development	24031	103808	90561	4.3
T_5= T_1 + WSF spray at branching and 50% flowering stage	24593	104775	75584	4.2
T_6= T_1 + WSF spray at branching and pod development stage	24593	106998	92324	4.3
T_7 =T_1 + WSF spray at 50% flowering stage and pod development stage	24593	111873	105176	4.4
T_8= T_1 + WSF spray at branching, 50% flowering stage and pod development stage	25157	121051	114398	4.8

Note: WSF: Water Soluble Fertilizer 19:19:19 (NPK) was used at the rate of 0.5 per cent solution, COC: Cost of cultivation, Cost of lima bean- Rs.80/Kg, Haulm- Rs.150/q, WSF- Rs.150/Kg.

Table 3: Nutrient uptake and Quality parameters of lima bean as influenced by foliar application of water soluble NPK fertilizer (19:19:19 at 0.5 % solution)

Treatments	N	P	K	Protein (%)	Crude fiber (g $100g^{-1}$)	Fat (g $100g^{-1}$)
	(kg ha^{-1})					
T_1= NPK at 25: 50: 25 kg ha^{-1} (control)	52.49	10.77	58.15	20.8	6.75	0.61
T_2= T_1 + WSF spray at branching	52.52	12.61	61.94	20.7	6.24	0.65
T_3= T_1 + WSF spray at 50 % flowering	54.39	11.84	63.69	20.6	7.09	0.66
T_4= T_1 + WSF spray at pod development	53.59	11.31	65.04	21.4	7.49	0.65
T_5= T_1 + WSF spray at branching and 50% flowering stage	55.11	16.33	63.76	21.0	6.77	0.71
T_6= T_1 + WSF spray at branching and pod development stage	68.44	16.04	74.31	21.4	6.64	0.74
T_7 =T_1 + WSF spray at 50% flowering stage and pod development stage	74.71	16.96	80.81	21.5	6.39	0.72
T_8= T_1 + WSF spray at branching, 50% flowering stage and pod development stage	80.38	19.50	98.05	21.7	6.58	0.78
SE.m ±	2.08	0.82	4.26	0.3	0.38	0.04
CD (p=0.05)	6.31	2.48	12.92	0.9	NS	NS

NS: Not significant

Table 4: Correlation coefficients for growth, yield, quality and nutrient uptake of limabean

Sl. No.	Parameters	Correlation coefficients (r)
A	**Growth parameters**	
1	Plant height (cm)	0.870**
2	Number of leaves per plant	0.883**
3	Number of primary branches per plant	0.931**
4	Leaf area (cm^2 $plant^{-1}$)	0.909**
5	Total dry matter production (g $plant^{-1}$)	0.980**
B	**Yield parameters**	
1	Number of pods per plant	0.949**
2	Seed yield $plant^{-1}$ (g)	0.943**
3	100 grain weight (g)	0.949**
C	**Nutrient Uptake**	
1	N uptake (kg ha^{-1})	0.847**
2	P uptake (kg ha^{-1})	0.876**
3	K uptake (kg ha^{-1})	0.889**

**Correlation coefficients (r) are significant at p=0.01

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