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RESEARCH PAPER

Effect of nano urea on total NPK content in leaf and whole plant of French bean (Pole type) under naturally ventilated polyhouse

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Abstract: The present research was conducted during two seasons *i.*e., January-May 2022 and May-September 2022 at Zonal Agricultural and Horticultural Research Station, Shivamogga under naturally ventilated polyhouse. The experiment was laid out in randomized complete block design with eight treatments replicated thrice. The results of pooled data of two seasons revealed that the treatment 75 % RDF (63 N kg ha^{-1}) of N through prilled urea + 0.4 % nano urea foliar spray at 45 and 60 days after sowing (DAS) (T_6) recorded significantly higher total NPK content of leaves after third spray (N- 3.20 %, P- 0.52 %, K- 2.56 %) and total NPK content of whole plant at 60 days after sowing (N- 3.12 %, P-0.47 %, K- 2.52 %) However, it was observed that least values of NPK content in leaves after third spray and 60 DAS in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS (T_2). The treatment 75 % RDF (63 N kg ha^{-1}) of N through prilled urea + 0.4 % nano urea foliar spray at 45 and 60 days after sowing (DAS) (T_6) recorded significantly higher of pod yield (17.16 t ha^{-1}) and least (13.20 t ha^{-1}) was observed in treatment 100 % RDF (63:100:75 NPK kg ha^{-1}) (T_1). From the study, it was concluded that the treatment 75 % RDF of N through prilled urea + nano urea foliar spray 0.4 % at 45 and 60 days after sowing was superior over all other treatments in terms of nutrient and pod yield.

Key words: French bean, Foliar spray, Leaf nutrients, Nano urea

Introduction

French bean (*Phaseolus vulgaris* L.) is diploid (2n=22), annual, herbaceous, self-pollinated vine belongs to the family Fabaceae, native to Central and South America . Pods are the rich source of crude protein (21.25 %), fat (1.7 %), carbohydrates (70 %), iron (0.16 mg), calcium (1.76 mg) and zinc (3.43 mg) per 100 g of edible part (Kaur and Mehta 1994). Besides it has several medicinal properties to manage diabetes, cardiac problems and natural cure for bladder burn. It has both carminative and reparative properties against constipation and diarrhoea , (Duke, 1981). The seeds of French bean are diuretic, hypoglycaemic and hypertensive in nature. The protected structures are the inflamed structures covered with translucent materials and are large enough to grow crops under partial or fully controlled environmental conditions to obtain optimum growth, higher yield, quality and returns and minimizes pest and disease incidence (Neethu *et al.,* 2022).

Foliar nutrition is a technology of feeding plants by spraying water soluble fertilizer directly to the canopy or above ground parts (Rauniyar, 2020). It is a major tool in sustainable and productive nutrient management of crops by increasing the nutrient use efficiency of plants, it reduces the leaching and evaporation losses of nutrients and control soil and ground water pollution. It acts as an efficient method to supply macro and micro-nutrients correct nutrient deficiencies (Oosterhuis, 2009). Application of nano fertilizers are increasing the efficiency of nutrients, yield, quality, environment friendly and reduce nutrient stress that occur to the plant. It also reduces thequantities of fertilizers and input cost. The plants absorb nutrients fastly and it will penetrate into the plant cells through cell wall or stomata, lenticels, hydathodes, nectarthodes (Hayyawi and Estabraq, 2020).

Nano urea (liquid) is an innovative product developed by Indian Farmers Fertiliser Co (IFFCO) and released for commercial use by Government of India during 2020. The IFFCO has recommended to use nano urea at 0.4 per cent as foliar application to field and horticulture crops (Kumar *et al*., 2020). Nitrogen is the major constituent of nano urea which plays the role of essential nutrient required for proper growth and development of plant. The nitrogen is a key constituent of amino acids, enzymes, genetic materials, photosynthetic pigments and energy transfer compounds in plant. It enhances quality, increases the growth of leafy vegetables and protein content of fodder crops. It encourages the uptake and utilization of other nutrients including potassium, phosphorous and controls overall growth of plant (Leghari *et al*., 2016). Foliar application of nano urea (liquid) at critical growth stages of a plant effectively fulfil its nitrogen requirement leads to higher crop productivity and also helps to maintain soil health (Rameshaiah *et al*., 2015).

Material and methods

The investigation was carried out under naturally ventilated polyhouse at Zonal Agricultural and Horticultural Research Station (ZAHRS), Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Navile, Shivamogga, which is situated at 13^0 58 North latitude and 75^0 34 East longitude with an altitude of 650 meters above mean

sea level. It comes under agro-climatic Zone-VII (Southern Transition Zone) of Karnataka, during two periods *i*.e., January-May 2022 and May-September 2022. The experiment was laid out in randomized complete block design (RCBD) with eight treatments and replicated thrice. French bean seeds *cv*., NZ was sown on raised bed in two rows with spacing of 60 cm x 45cm. The initial soil pH was slightly acidic (5.86), lower electrical conductivity (0.22 dS m^{-1}), medium range of organic carbon (0.66 %), lower available nitrogen (219.52 kg ha^{-1}), higher available phosphorous (55.76 kg ha^{-1}) and medium range of available potassium (247.30 kg ha^{-1}) was recorded. The treatments are: T_1 - 100 % RDF (63:100:75 NPK kg ha^{-1}), T_2 - 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS, T_3 - 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30, 45 and 60 DAS, T_4 - 50 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS, T_5 - 50 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30, 45 and 60 DAS, T_6 - 75 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 45 and 60 DAS, T_7 - 75 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 60 DAS, T_8 - T_1 + 0.4 % nano urea foliar spray at 60 DAS. Before sowing, recommended farm yard manure 25 t /ha and the basal dose of NPK fertilizers were applied to all the treatments, where 50 per cent of nitrogen through urea mentioned in the treatment and 100 per cent of P_2O_5 and K_2O supplied common to all the treatments through sources of Urea, SSP and MOP, respectively and remaining 50 per cent of nitrogen given after 30 days after sowing, and nano urea sprayed at 0.4 per cent according to the treatments. The data recorded was subjected to statistical analysis by adopting Fisher's method of analysis of variance (Gomez and Gomez, 1984).

Results and discussion

The data pertaining on NPK content in leaves before and after spray among the treatments was exhibited in Table 1. The results showed non-significant effect on NPK content in leaves before and after first spray. This might be due the minimal absorption of the nutrients by the vine from soil in the initial crop growth stage. These lines are in conformity with the findings of Dubey *et al.* (2018) in barley. Results showed significant variations on NPK content in leaves after second spray. Highest nitrogen content (3.02 %) was recorded in each of 100 % RDF (63:100:75 NPK kg ha^{-1}) (T_1) and T_1 + 0.4 % nano urea foliar spray at 60 DAS (T_8). Whereas, least nitrogen content (2.87 %) was in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS (T_2). Phosphorous was higher (0.40 %) in T_1 + 0.4 % nano urea foliar spray at 60 DAS (T_8) and minimum (0.28 %) in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30, 45 and 60 DAS (T_3). Maximum potassium (2.48 %) was recorded in 100 % RDF (63:100:75 NPK kg ha^{-1}) (T_1). However, least (2.00 %) was recorded in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30, 45 and 60 DAS (T_3). Similarly, among the treatments results showed significant variations on NPK content in leaves after third spray. Highest nitrogen (3.20 %), phosphorous (0.52 %) and potassium (2.56 %) was recorded in 75 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 45 and 60 DAS (T_6) 0.4 % nano urea foliar spray at 45 and 60 DAS (T_6) and minimum nitrogen (3.00 %), phosphorous (0.40 %) and potassium (2.11 %) was found in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS (T_2). These variations in the NPK content in leaves might be due to accumulation and uptake of nutrients by the vine due to foliar application of nano urea on targeted sites and basal application of fertilizers had combined

Table 1. Effect of nano urea on total NPK content in leaf before and after spray on pole type French bean (Pool data)

Treatment No.	Treatment details	Before 1st spray (25th DAS)			After 1st spray (33rd DAS)			After 2nd spray (48th DAS)			After 3rd spray (63rd DAS)		
		N (%)	P (%)	K (%)	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
T_1	100% RDF (63:100:75 NPK kg ha^{-1})	2.81	0.25	2.19	2.85	0.29	2.31	3.02	0.36	2.48	3.13	0.45	2.53
T_2	25% RDF of N through prilled urea + 0.4% nano ureafoliar spray at 30 and 45 DAS.	2.67	0.16	1.74	2.72	0.19	1.84	2.87	0.29	2.02	3.00	0.40	2.11
T_3	25% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30, 45 and 60 DAS	2.68	0.18	1.77	2.73	0.20	1.85	2.90	0.28	2.00	3.09	0.42	2.18
T_4	50% RDF of N through prilled urea + 0.4% nano ureafoliar spray at 30 and 45 DAS	2.70	0.19	1.94	2.75	0.22	2.03	2.92	0.32	2.26	3.06	0.46	2.39
T_5	50% RDF of N through prilled urea + 0.4% nano ureafoliar spray at 30, 45 and 60 DAS	2.73	0.19	1.94	2.78	0.23	2.05	2.92	0.34	2.27	3.15	0.48	2.43
T_6	75% RDF of N through prilled urea + 0.4% nano ureafoliar spray at 45 and 60 DAS	2.76	0.22	2.00	2.81	0.26	2.17	3.00	0.36	2.37	3.20	0.52	2.56
T_7	75% RDF of N through prilled urea + 0.4% nano urea foliar spray at 60 DAS	2.74	0.22	2.02	2.79	0.25	2.16	2.97	0.35	2.30	3.14	0.46	2.47
T_8	T_1 + 0.4% nano urea foliar spray at 60 DAS	2.79	0.25	2.19	2.86	0.28	2.31	3.02	0.40	2.46	3.15	0.43	2.51
	S. Em.±	0.03	0.02	0.10	0.03	0.02	0.11	0.02	0.01	0.05	0.03	0.01	0.04
	C.D. @ 5 %	NS	NS	NS	NS	NS	NS	0.07	0.02	0.14	0.10	0.03	0.12

Note: 100 % of P_2O_5 and K_2O supplied common to all the treatments NS: Non-significant
RDF:- Recommended dose of fertilizer DAS :- Days after sowing.

The uppermost fully developed leaves are selected from the labelled plants from each treatment for estimation of nitrogen, phosphorous and potassium contents at 3 days before and after spray of nano urea at 30, 45, 60 days after sowing.

Table 2. Effect of nano urea on total NPK content of whole plant at 60 days after sowing on pole type French bean (pooled data)

Treatment No.	Treatment details	N(%)	P(%)	K(%)
T_1	100% RDF (63:100:75 NPK kg ha^{-1})	3.07	0.41	2.49
T_2	25% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30 and 45 DAS.	2.95	0.36	2.08
T_3	25% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30, 45 and 60 DAS	3.00	0.37	2.14
T_4	50% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30 and 45 DAS	3.01	0.40	2.37
T_5	50% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30, 45 and 60 DAS	3.08	0.43	2.40
T_6	75% RDF of N through prilled urea + 0.4% nano urea foliar spray at 45 and 60 DAS	3.12	0.47	2.52
T_7	75% RDF of N through prilled urea + 0.4% nano urea foliar spray at 60 DAS	3.07	0.43	2.44
T_8	T_1 + 0.4% nano urea foliar spray at 60 DAS	3.09	0.40	2.48
S. Em.±		0.02	0.01	0.04
C.D. @ 5%		0.07	0.02	0.13
Note	100% of P_2O_5 and K_2O supplied common to all the treatments; RDF: Recommended dose of fertilizer, DAS: Days after sowing			

Table 3. Effect of nano urea on pod yield of pole type French bean (pooled data)

Treatment No.	Treatment details	Pod yield (t/ha)
T_1	100% RDF (63:100:75 NPK kg ha^{-1})	13.20
T_2	25% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30 and 45 DAS.	14.40
T_3	25% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30, 45 and 60 DAS	14.44
T_4	50% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30 and 45 DAS	15.30
T_5	50% RDF of N through prilled urea + 0.4% nano urea foliar spray at 30, 45 and 60 DAS	16.80
T_6	75% RDF of N through prilled urea + 0.4% nano urea foliar spray at 45 and 60 DAS	17.16
T_7	75% RDF of N through prilled urea + 0.4% nano urea foliar spray at 60 DAS	15.85
T_8	T_1 + 0.4% nano urea foliar spray at 60 DAS	13.55
S. Em.±		0.48
C.D. @ 5 %		1.45

Note: 100 % of P_2O_5 and K_2O supplied common to all the treatments;
RDF: Recommended dose of fertilizer, DAS: Days after sowing

effect on the significant increase in NPK content of leaves. The similar results were observed in the findings of Umamaheswarappa *et al.* (2005), Marzouk *et al.*(2019) and El-Ghamry *et al.* (2017). The results pertaining on NPK content in whole plant at 60 DAS was presented in Table 2. The significant variations were observed in nitrogen content in whole plant at 60 days after sowing. Highest nitrogen (3.12 %) was observed in 75 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 45 and 60 DAS (T_6) and it was statistically on par with T_8, T_5, T_7 and T_1 (3.09, 3.08, 3.07 and 3.07 %, respectively) and least (2.95 %) was in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS (T_2). Phosphorous content had showed greater variations. Among the treatments maximum phosphorous content (0.47 %) in whole plant at 60 DAS was recorded in 75 % RDF of N through prilled urea + 0.4% nano urea foliar spray at 45 and 60 DAS (T_6) and it was followed by T_7 and T_5 (0.43 % and 0.43 %, respectively). However, least (0.36 %) was recorded in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS (T_2). During the experimental period, potassium content had showed significant variations. Maximum potassium content (2.52 %) in whole plant at 60 DAS was recorded in 75 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 45 and 60 DAS (T_6) and it was statistically on par with T_1, T_8, T_7 and T_5 (2.49, 2.48, 2.44 and 2.40 % respectively). However, it was observed least (2.08 %) in 25 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30 and 45 DAS (T_2). The significant variations in the NPK content in whole plant might be due to accumulation and uptake of nutrients by combined effect of foliar spray and basal application of fertilizers and also might be due to the effect of root spread inside the soil results in significant increase in NPK content of whole plant. The results were in conformity with Marzouk *et al.* (2019) and El-Ghamry *et al.* (2017). The results pertaining on pod yield was presented in Table 3. Highest pod yield (17.2 t/ha) was recorded in 75 % RDF of N through prilled urea + 0.4% nano urea foliar spray at 45 and 60 days after sowing (T_6) and it was statistically on par 50 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 30, 45 and 60 DAS (T_5) and75 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 60 DAS (T_7) (16.8 t/ha and 15.8 t/ha respectively). However, It was found minimum (13.2 t/ha) 100 % RDF (63:100:75 NPK kg ha^{-1}) (T_1). This significant variations in the yield may be due to foliar application of nano urea at the critical growth stages, which has a small size and large effective area of nano particles helps in easy penetration of nutrients and accumulation of relatively more photosynthates. The present findings were in conformity with the observations of Manjesh *et al.*(2019) in Yardlong bean and Ajirloo *et al*. (2015) in tomato.

Conclusion

From the present investigation, it can be concluded that, 75 % RDF of N through prilled urea + 0.4 % nano urea foliar spray at 45 and 60 days after sowing (T_6) is significantly superior, with respect total NPK content of leaves, whole plant and pod yield as compared to other treatments.

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