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EFFECT OF NANO UREA ON GROWTH, YIELD AND ECONOMICS OF POTATO (*SOLANUM TUBEROSUM* L.)

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ABSTRACT

The present study was conducted during the *rabi* season of 2024-25 at the vegetable unit, Department of Horticulture, University of Agricultural Sciences, Dharwad, to evaluate the effect of nano urea on the growth, yield and economics of potato. The field experiment was laid out in a randomized block design with 11 treatments and three replications. The treatments include different combinations of recommended doses of nitrogen (RDN) through basal urea application and foliar sprays of IFFCO Nano Urea, applied at 30 and 45 days after planting (DAP). The results revealed that, among the treatments, T_7 (125 % RDN - 50 % N through basal + 50 % N through nano urea at 45 DAP) recorded the highest plant height (61.35 cm), leaf area (302.69 cm²), chlorophyll content (49.65 SPAD units), equatorial diameter (5.46 cm), polar diameter (6.58 cm), number of tubers per plant (6.11), total tuber yield (23.72 t ha^{-1}), marketable yield (22.90 t ha^{-1}), economic returns (₹ 2,33,482 ha^{-1}; B:C ratio 2.58) over absolute control for nitrogen (T_1) and RDF (T_2) across all parameters. The study confirms that strategic application of nano urea can significantly improve growth, yield and profitability. Thus, the application of nano urea at 125 % RDN (T_7) with 50 % N through traditional urea and 50 % N through nano urea results in maximizing potato productivity.

Keywords **:** Foliar spray, IFFCO, Nano urea, Potato.

Introduction

Potato (*Solanum tuberosum* L.) is an herbaceous annual crop belonging to family Solanaceae with a chromosome number of 2n = 4x = 48. Originating from the Andean highlands of South America, it is now a principal food and commercial crop worldwide, ranking as the fourth most important staple food after rice, wheat and maize. In India, it holds a premier place among vegetables with a total production of 601.74 lakh tonnes from 23.78 lakh hectares and an average productivity of 25.30 t ha^{-1} (Anon., 2024). Karnataka contributes 2.25 lakh tonnes from 0.23 lakh hectares (Anon., 2023). Despite of its significance, a wide yield gap persists due to improper nutrient management, especially nitrogen a key macro element influencing vegetative growth, chlorophyll synthesis and tuber bulking (Leghari *et al*., 2016). Conventionally, soil-applied neem-coated urea (46 % N) forms the major nitrogen source. Nitrogen losses through volatilization, leaching and denitrification reduce its efficiency and contribute to environmental pollution. To address these, nanotechnology-based inputs emerged as sustainable alternatives. Nano fertilizers, particularly nano urea, enables controlled nutrient release and better absorption, enhancing crop yield and soil health (Rathanayaka *et al*., 2018). Nano urea, developed by IFFCO, contains 4 per cent nitrogen in nano form, with much higher surface area and particle number than conventional urea, improving foliar absorption and reducing losses. In this regard, the foliar application of nano urea at critical growth stages ensures adequate nitrogen supply, promoting vegetative growth, increased tuber formation, productivity and

profitability. Hence, the present investigation was undertaken to study the effect of nano urea on growth, yield and economics of potato.

Material and Methods

The study was conducted at vegetable unit, UAS Dharwad, during *Rabi* season of 2024-25, using variety Kufri Himalini under randomized block design with eleven treatments and three replications. The tubers were planted at 60 × 20 cm spacing. The treatments consists of T_1: Absolute control for nitrogen; T_2: RDF (FYM 25 t + 125:100:125 N:P_2O_5:K_2O kg ha^{-1}; 50 % basal + 50 % top dressing); T_3: 100 % RDN (50 % basal + 50 % nano urea @ 30 DAP); T_4: 100 % RDN (50 % basal + 50 % nano urea @ 45 DAP); T_5: 100 % RDN (50 % basal + 25 % nano urea each @ 30 and 45 DAP); T_6: 125 % RDN (50 % basal + 50 % nano urea @ 30 DAP); T_7: 125 % RDN (50 % basal + 50 % nano urea @ 45 DAP); T_8: 125% RDN (50% basal + 25% nano urea each @ 30 and 45 DAP); T_9: 150 % RDN (50 % basal + 50 % nano urea @ 30 DAP); T_{10}: 150 % RDN (50 % basal + 50 % nano urea @ 45 DAP); T_{11}: 150% RDN (50 % basal + 25 % nano urea each @ 30 and 45 DAP). Five plants were selected randomly from each replication and data were recorded for the characters *viz.,* plant height (cm), leaf area (cm), chlorophyll (SPAD units) content, tuber number, equilateral and polar diameter (cm) of tuber, total yield (t ha^{-1}), marketable yield (t ha^{-1}) and on economic cultivation.

Results and Discussion

The results presented in table 1, table 2 and table 3 revealed significant differences among the treatments with respect to the growth, yield and economic parameters of potato.

At 75 days after planting (DAP), the maximum plant height (61.35 cm) was recorded in T_7 [125% RDN (50% N as basal + 50% N through foliar spray of IFFCO nano urea at 45 DAP)], which was statistically on par with T_{10} (59.78 cm), T_8 (58.36 cm) and T_9 (57.01 cm). The minimum plant height (37.92 cm) was observed in T_1 (absolute control for N). However, at 75 DAP, the treatment T_7 [125 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45 DAP)] registered the maximum leaf area (302.69 cm^2), which is statistically on par with T_{10} (290.04 cm^2) and T_8 (289.31 cm^2). The minimum leaf area (168.29 cm^2) was recorded in T_1 (control). Similarly, highest chlorophyll (49.65 SPAD units) content was noted in T_7, closely followed by T_{10} (49.30 SPAD units) and T_8 (48.29 SPAD units). Whereas, the lowest chlorophyll content (31.33 SPAD units) was recorded in T_1 (Table 1).

The maximum equatorial diameter (5.46 cm) of tubers was observed in T_7, which is statistically on par with T_{10} (5.13 cm) and T_8 (4.97 cm). While, the minimum value (3.86 cm) was recorded in T_1. Similarly, the highest polar diameter (6.58 cm) was found in T_7, which was comparable with T_{10} (6.12 cm), T_8 (5.84 cm) and T_9 (5.75 cm). The control (T_1) recorded the lowest polar diameter (4.32 cm). The maximum number of tubers (6.11 tubers) was recorded in T_7, being on par with T_{10} (6.00) and T_8 (5.76). The minimum number (4.85 tubers) was noted in T_1. The total tuber yield per hectare was significantly affected by the treatments. The highest yield (23.72 t ha^{-1}) was observed in T_7, which was on par with T_{10} (22.50 t ha^{-1}) and T_8 (21.48 t ha^{-1}). The lowest yield (12.35 t ha^{-1}) was obtained in T_1. Similarly, the highest marketable tuber yield (22.90 t ha^{-1}) was recorded in T_7, statistically on par with T_{10} (21.50 t ha^{-1}) and T_8 (20.69 t ha^{-1}), while the lowest yield (11.25 t ha^{-1}) was observed in T_1.

The maximum gross returns (₹ 3,80,800 ha^{-1}) was registered in T_7 [125 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 45 DAP)]. The lowest gross returns (₹ 1,78,850 ha^{-1}) was obtained with T_1 (Absolute control for N). The cost of cultivation was found highest (₹ 1,48,312 ha^{-1}) in T_{11} [150 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)], while the lowest cost of cultivation (₹ 1,44,435 ha^{-1}) was recorded in T_1 (Absolute control for N). Analysis of net returns showed that, the highest net return (₹ 2,33,482 ha^{-1}) was obtained in T_7 [125 % RDN (50 % N through basal + 50 % N through foliar spray of IFFCO nano urea at 45 DAP)]. The next highest (₹ 2,10,038 ha^{-1}) in T_{10} Whereas, lowest net return (₹ 34,415 ha^{-1}) was obtained with T_1 (Absolute control for N). The benefit: cost ratio was highest (2.58) in T_7 [125% RDN (50 % N through basal + 50 % N through foliar spray of IFFCO nano urea at 45 DAP)]. While, lowest benefit: cost ratio (1.24) was recorded in T_1 (Absolute control for N).

The yield of potato varied significantly due to different foliar application of fertilizers. The significantly maximum potato tuber yield (Marketable: 22.90 and total yield 23.72 t ha^{-1}) (Table 2) was documented in treatment T_7 [125 % RDN (50 % N through basal urea + 50 % N through foliar spray of IFFCO nano urea @ 45 DAP)] over RDF (T_2) and absolute control for nitrogen (T_1) (16.82 and 11.25 t ha^{-1}, respectively). Such increased yield in T_7 may be due to slightly higher dose than the recommended as it is evident by Karubakee (2024) in potato and smaller

particle size (10^{-9}/m) with larger surface area of nano urea helped in higher nutrient absorption. Additionally, foliar application of nano urea at 45 DAP coincides with peak tuber growth (Silva *et al*., 2023) which improved translocation of assimilates and increasing total and marketable yields. The 24.57 % increased total tuber yield observed in T_7 over RDF (17.89 t ha^{-1}) (T_2) (Table 2) might be due to enhanced yield components such as higher polar diameter (6.58 cm) and equatorial diameter (5.46 cm) of tuber, number of tubers per plant (6.11). Further, improved yield parameters registered in T_7 are attributed to increased vegetative growth of plant as evidenced by higher plant height (61.35 cm), greater leaf area (302.69 cm²) and higher chlorophyll content (49.65 SPAD units) (Table 1). Such increased yield and growth components by foliar spray of nano urea at 45 DAP may be due to its ultra-fine particles, which rapidly enter plant cells and stimulate biochemical reactions and enzyme activity, resulting in higher nutrient absorption than conventional fertilizers (Benzon *et al*., 2015; Upadhyay *et al*., 2023). Nitrogen is a vital macronutrient required for the synthesis of amino acids, proteins, chlorophyll and cell membranes. Adequate nitrogen availability enhances photosynthetic activity, promotes vigorous vegetative growth and supports overall plant development (Krishnaveni and Ramaswamy, 1985). Similar results on improvement of growth and yield were reported by Chauhan *et al*. (2023), Dutta *et al*. (2023) and Hoque and Khan (2024) in potato and Panda *et al*. (2024) in brinjal. The highest benefit: cost ratio (2.58) (Table 3) was recorded in T_7 [125% RDN (50% N through basal urea + 50% N through foliar spray of IFFCO nano urea @ 45 DAP)], may be due to a greater accumulation of graded marketable tubers which fetched a premium value in the market. Similar improvements in B:C ratio have been reported by Neogi and Das (2022) in potato and Rajesh *et al*. (2021) in sweet corn.

Table 1 : Effect of nano urea on growth parameters of potato at 75 days after planting

Tr. No.	Treatment	Plant height (cm)	Leaf area (cm^2)	Chlorophyll content (SPAD units)
T_1	Absolute control for N	37.92	168.29	31.33
T_2	RDF (FYM : 25 t + 125:100:125 N:P_2O_5:K_2O kg ha^{-1}) (50 % of N as basal soil application + 50 % of N as soil top dressing)	49.45	236.92	39.57
T_3	100 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	50.18	238.11	42.39
T_4	100 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45 DAP)	52.18	274.48	44.62
T_5	100 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	51.47	268.38	43.59
T_6	125 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	55.17	279.62	45.28
T_7	125 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45DAP)	61.35	302.69	49.65
T_8	125 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	58.36	289.31	48.29
T_9	150 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	57.01	282.60	47.18
T_{10}	150 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45 DAP)	59.78	290.04	49.30
T_{11}	150 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	56.44	282.95	47.10
	Mean	53.57	264.85	38.26
	S. Em. ±	2.24	10.93	1.87
	C.D. @ 5%	6.60	32.24	5.52

Note:
RDF- Recommended dose of fertilizer
RDN- Recommended dose of nitrogen
DAP- Days after planting
Entire dose of FYM, P and K was applied as basal dose for all above treatments

Table 2 : Effect of nano urea on yield and yield attributes of potato at harvest

Tr. No.	Treatment	Equatorial diameter of tuber (cm)	Polar diameter of tuber (cm)	No. of tubers per plant	Total tuber yield (t ha^{-1})	Marketable tuber yield (t ha^{-1})
T_1	Absolute control for N	3.86	4.32	4.85	12.35	11.25
T_2	RDF (FYM : 25 t + 125:100:125 N:P_2O_5:K_2O kg ha^{-1}) (50 % of N as basal soil application + 50 % of N as soil top dressing)	4.11	5.24	5.56	17.89	16.82
T_3	100 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	4.33	5.48	5.53	18.14	17.96
T_4	100 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45 DAP)	4.53	5.62	5.56	19.63	18.21
T_5	100 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	4.46	5.51	5.55	18.67	18.01
T_6	125 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	4.66	5.68	5.61	19.88	19.13
T_7	125 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45DAP)	5.46	6.58	6.11	23.72	22.90
T_8	125 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	4.97	5.84	5.76	21.48	20.69
T_9	150 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	4.86	5.75	5.63	20.76	20.21
T_{10}	150 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45 DAP)	5.13	6.12	6.00	22.50	21.50
T_{11}	150 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	4.71	5.71	5.57	20.50	19.33
Mean		44.39	5.62	5.61	19.59	18.73
S. Em. ±		1.98	0.22	0.19	0.82	0.95
C.D. @ 5%		5.84	0.66	0.57	2.41	2.79

Note:
RDF- Recommended dose of fertilizer
RDN- Recommended dose of nitrogen
DAP- Days after planting
Entire dose of FYM, P and K was applied as basal dose for all above treatments

Table 3 : Economics (₹ ha^{-1}) of potato production as influenced by effect of foliar application of nano urea

Tr. No.	Treatment	Grade wise marketable tuber yield (t ha^{-1})			Marketable tuber yield (t ha^{-1})	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
		Grade A (>75g)	Grade B (50-75g)	Grade C (25-50g)					
T_1	Absolute control for N	3.92	5.43	1.90	11.25	1,44,435	1,78,850	34,415	1.24
T_2	RDF (FYM : 25 t + 125:100:125 N:P_2O_5:K_2O kg ha^{-1}) (50 % of N as basal soil application + 50 % of N as soil top dressing)	7.23	7.86	1.73	16.82	1,46,762	2,79,800	1,33,038	1.91
T_3	100 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	7.51	8.65	1.80	17.96	1,46,986	2,97,950	1,50,964	2.03
T_4	100 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45 DAP)	7.61	8.79	1.82	18.21	1,46,986	3,02,250	1,55,264	2.06
T_5	100 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	7.52	8.69	1.80	18.01	1,47,636	2,98,750	1,51,114	2.02
T_6	125 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	8.00	9.22	1.91	19.13	1,47,318	3,17,400	1,70,082	2.15
T_7	125 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea	9.85	10.66	2.39	22.90	1,47,318	3,80,800	2,33,482	2.58

	@ 45DAP)								
T_8	125 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	8.65	9.97	2.07	20.69	1,47,968	3,43,250	1,95,282	2.32
T_9	150 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 30 DAP)	8.45	9.75	2.01	20.21	1,47,662	3,35,350	1,87,688	2.27
T_{10}	150 % RDN (50 % of N through basal + 50 % of N through foliar spray of IFFCO nano urea @ 45 DAP)	9.16	10.22	2.12	21.50	1,47,662	3,57,700	2,10,038	2.42
T_{11}	150 % RDN (50 % of N through basal + 25 % of N through foliar spray of IFFCO nano urea each @ 30 and 45 DAP)	8.08	9.32	1.93	19.33	1,48,312	3,20,700	1,72,388	2.16
	S. Em. ±				0.95	-	-	-	0.08
	C.D. @ 5%				2.79	-	-	-	0.24

Note:
RDF- Recommended dose of fertilizer RDN- Recommended dose of nitrogen
DAP- Days after planting
Entire dose of FYM, P and K was applied as basal dose for all above treatments
Grade A - ₹ 20,000 tonnes^{-1} Grade B - ₹ 15,000 tonnes^{-1} Grade C - ₹ 10,000 tonnes^{-1}

Conclusion

From the study it implies that applying 125 % RDN with 50 % nitrogen through basal urea and 50 % through foliar spray of IFFCO nano urea at 45 DAP (T_7) significantly enhanced potato growth, graded yield and profitability compared to conventional practices. The superior performance of T_7 treatment is attributed to timely nutrient supply, better assimilate partitioning and improved nitrogen use efficiency. Hence, treatment T_7 can be recommended for maximizing the productivity and sustainability of potato cultivation.

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