

Influence of Nano Fertilizers on Growth and Yield Parameters of Potato (*Solanum tuberosum* L.)

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ABSTRACT: A field experiment was conducted at the main experiment station vegetable farm of Achyara Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (Uttar Pradesh) during the Rabi season, 2021-22. The experiment was laid out in randomized block design (RBD) with eleven treatments replicated three times. The treatment comprises T₁ (100% N), T₂ (75% N + 2 Spray of nano N), T₃ (50% N + 2 Spray of nano N), T₄ (0% N + 2 Spray of nano N), T₅ (100% N and Zn (25 kg ZnSO₄/ha)), T₆ (75% N + 2 Spray of nano N + Nano zinc spray), T₇ (50% N + 2 Spray of nano N + Nano zinc spray), T₈ (0% N + 2 Spray of nano N + Nano zinc spray), T₉ (75% N + 2 Spray of Urea (2%)), T₁₀ (75% N + 2 Spray of Urea (2%) + zinc sulphate* (2g/l) spray), T₁₁ (Control). The variety 'Kufri Khyati' was used for the study. The study indicated significant differences among different treatments concerning growth and yield. The Plant emergence was not influenced by various sources of nutrients NPK and nano fertilizers as well as nitrogen and zinc. Among different treatments, a significant effect was observed on plant height at 30 and 60 DAS. Maximum plant height at 30 DAS (21.40 cm) and 60 DAS (61.00 cm) were observed under T₆ treatment, where 75% N + 2 Spray of nano N + Nano zinc spray was applied. Among the different treatments, a significant effect was also observed on tuber yield ha⁻¹ as compared to the control plot. Maximum tuber yield (322.27 q ha⁻¹) was observed in T₆ treatment (where 75% N + 2 Spray of nano N + Nano zinc spray) while minimum tuber yield was recorded with T₄ treatment 0% N + 2 Spray of nano N was applied. Along with the different treatments was also observed significant effect on haulm yield ha⁻¹ was as compared to control plots. Maximum haulm yield (177.25 q ha⁻¹) was observed in T₆ treatment (where 75% N + 2 Spray of nano N + Nano zinc spray) while minimum haulm yield was recorded in T₄ treatment where 0% N + 2 Spray of nano N was applied.

Keywords: Nano fertilizers, potato, growth, and yield.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important food crops all over the world and is an important food crop grown in more than 150 countries in the world. Potato is the third most consumed crop, just after rice and wheat, in the world (Champouret 2010; Verzaux 2010; Visser *et al.*, 2009). It is an excellent source of carbohydrates with low-fat contents which makes it a balanced food globally potato is sharing about 19.34 million ha in the world, with a total production of 376 million tones fao stat 2018 (Altaf and Inam ul Haq 2020). India now ranks third in average 2.07 million ha and second in production at 45.95 million tonnes with productivity of 22.21 t/ha. The

contribution of Uttar Pradesh alone in the area, production, and productivity is 0.65 m ha, 15.58 mt, and 22.7 t/ha respectively (Anonymous, 2020). Nanotechnology, which utilizes Nanomaterials of less than 100 nm size, has emerged as an innovative science to develop concentrated sources of plant nutrients having higher absorption rates, utilization efficacy, and minimum losses. Chemical fertilizer contributes to over 40% of our agriculture's food grain production. Due to ultra-small particle size, such nutrients can rapidly be uptake by the plants so minimizing nutrient losses. Inside the plant cell, these nutrients slowly release the active nutrient component which involves in the plant's cellular metabolism for their growth and development.

Therefore, it is critical to develop nanotechnology-based Nano fertilizers that are available for ready uptake by plants (Kumar *et al.*, 2021). The nutritional quality of field crops production and availability, their sufficiently effective legislation, and associated risk management is the prime limiting factors in their general adoption as plant nutrient sources. IFFCO has successfully innovated and achieved the goal of the development and manufacturing of Nano Urea (Kumar *et al.*, 2021). Foliar application of Nano fertilizers increases nutrient use efficiency nutritional quality of crops and soil health through bio-fortification. The growth and yield of potatoes strongly depend on the availability of nutrients, especially nitrogen (N). Urea is widely used as an N source because it can trigger biomass and total N accumulation in potatoes. Potato requires high doses of N fertilizers to achieve maximum yield. However, N recovery in potatoes is often low because of the plant's poorly developed root system. Therefore, the input of N fertilizers has been increased over the years to maximize tuber yields; however, excessive application of N fertilizers may reduce tuber yields (Kondal *et al.*, 2021).

MATERIALS AND METHODS

An investigation on the topic "Influence of nano fertilizers on growth and yield parameters of Potato (*Solanum tuberosum* L.)" had planned during *Rabi* season 2021-22. The experiment was conducted at the main experiment station vegetable farm of Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (Uttar Pradesh). The Vegetable Farm lies on Ayodhya-Raibareli road, about 35 km from Ayodhya at 26047' N

latitude, 82012' E longitude, and an altitude of 113 m above the mean sea level. Geographically, this region falls under a sub-tropical climate and it is situated at 26047' N latitude, 82012' E longitude, and at an Indo-Gangetic alluvial of eastern Uttar Pradesh in India. The experiment was conducted in a randomized block design (RBD) with three replication to examine. The eleven (11) treatments Like T₁ (100% N), T₂ (75% N + 2 Spray of nano N), T₃ (50% N + 2 Spray of nano N), T₄ (0% N + 2 Spray of nano N), T₅ (100% N and Zn (25 kg ZnSO₄/ha)), T₆ (75% N + 2 Spray of nano N + Nano zinc spray), T₇ (50% N + 2 Spray of nano N + Nano zinc spray), T₈ (0% N + 2 Spray of nano N + Nano zinc spray), T₉ (75% N + 2 Spray of Urea (2%)), T₁₀ (75% N + 2 Spray of Urea (2%) + zinc sulphate* (2g/l) spray), T₁₁ (Control). The variety Kufri Khyati' was used for the study. The experiment consisted of Nano fertilizers *viz.* Nano Urea (liquid), Nano Zinc alone, and a combination of NPK were applied to potatoes as per the treatments. Data recorded on various parameters of growth and yield attributes were subjected to statistical analysis by following fisher's method of analysis of variance (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

Plant emergence. Tuber emergence of potato at 30 DAS presented in Table 1 revealed that different treatments did not show any significant effect on emergence. Maximum emergence (97.40%) in T₈ treatment (where 0% N + 2 Spray of nano N + Nano zinc spray was applied) was recorded. However, the minimum was recorded (93.23 %) in T₃ treatment.

Table 1: Effect of different treatments on tuber emergence (%) at 30 DAS.

Treatments	Emergence
T ₁	93.75
T ₂	96.35
T ₃	93.23
T ₄	96.35
T ₅	94.27
T ₆	94.27
T ₇	94.27
T ₈	97.40
T ₉	95.83
T ₁₀	94.79
T ₁₁	95.17
SEm±	0.92
C.D. at 5%	NS

*N: Nitrogen, DAS: Days after sowing

Plant height. The data on the plant height of potatoes recorded at 30 and 60 DAS of crop growth stage have been presented in table 2 revealing that the plant height increased with the advancement in age of the plant. Different treatments increased the plant height significantly over control at 30 and 60 DAS. The tallest

plant was recorded under T₆ treatment at 30 DAS (21.40 cm) and at 60 DAS (61.00 cm), which was significantly superior to T₃, T₂, T₁, T₇, T₈, T₉, T₁₀, and T₁₁. However minimum plant height at 30 and 60 DAS was recorded (19.29 and 45.00 cm) in T₄ treatment.

Table 2: Effect of different treatments on plant height (cm) at 30 and 60 DAS.

Treatments		Plant height	
		30 DAS	60 DAS
T ₁	100% N	20.80	57.60
T ₂	75% N + 2 Spray of nano N	21.20	59.70
T ₃	50% N + 2 Spray of nano N	19.40	47.70
T ₄	0% N + 2 Spray of nano N	19.29	45.00
T ₅	100% N and Zn (25 kg ZnSO ₄ /ha)	21.00	58.20
T ₆	75% N + 2 Spray of nano N + Nano zinc spray	21.40	61.00
T ₇	50% N + 2 Spray of nano N + Nano zinc spray	20.50	53.70
T ₈	0% N + 2 Spray of nano N + Nano zinc spray	19.80	46.00
T ₉	75% N + 2 Spray of Urea (2%)	19.40	45.90
T ₁₀	75% N + 2 Spray of Urea (2%) + zinc sulphate* (2g/l) spray	20.90	57.90
T ₁₁	Control	20.30	52.35
SEm±		0.76	1.83
C.D. at 5%		NS	5.41

*N: Nitrogen, Zn: Zinc, DAS: Days after sowing

Tuber yield (q ha⁻¹). A perusal of the data is presented in table 3. Indicate that all the treatments resulted in a significant increase in the potato tuber yield as compared to the control. The maximum tuber yield (322.27 q ha⁻¹) was recorded under T₆ treatment where nano nitrogen & nano Zn management was applied (75% N + 2 Spray of nano N + Nano zinc spray) which

was significantly superior over the rest of the treatments. However minimum tuber yield (215.06 q ha⁻¹) was recorded in T₄ treatment. The total yield was recorded as highest (499.52 q ha⁻¹) under T₆ treatments when applied (75% N + 2 Spray of nano N + Nano zinc spray) and however minimum yield (333.26 q ha ha⁻¹) was recorded under T₄ treatments.

Table 3: Effect of different treatments on tuber yield (q ha ha⁻¹).

Treatments		Tuber yield (q ha ⁻¹)	Haulm yield (q ha ⁻¹)	Total yield (q ha ⁻¹)
T ₁	100% N	292.32	160.70	453.02
T ₂	75% N + 2 Spray of nano N	301.43	165.80	467.23
T ₃	50% N + 2 Spray of N	246.96	135.80	382.767
T ₄	0% N + 2 Spray of nano N	215.06	118.20	333.26
T ₅	100% N Zn (25 kg ZnSO ₄)	309.90	170.45	480.35
T ₆	75% N + 2 Spray of nano N + Nano zinc spray	322.27	177.25	499.52
T ₇	50% N + 2 Spray of nano N + Nano zinc spray	266.71	146.45	413.16
T ₈	0% N + 2 Spray of nano N + Nano zinc spray	220.05	110.00	330.05
T ₉	75% N + 2 Spray of Urea (2%)	285.81	157.20	443.01
T ₁₀	75% N + 2 Spray of Urea (2%) + zinc sulphate* (2g/l) spray	304.90	167.60	472.5
T ₁₁	Control	267.74	146.20	413.94
SEm±		8.56	5.89	
C.D. at 5%		25.26	17.38	

*N: Nitrogen, Zn: Zinc, DAS: Days after sowing, q ha⁻¹: Quintal per hectare

Tuber yield (q ha⁻¹) grade wise. The data about tuber yield grade-wise (0-25, 25-50, 50-75, and >75) have been presented in Table 4. The critical examination of data revealed that T₇, T₅, T₃, T₂, T₁, T₇, T₈, T₉, T₁₀ and T₁₁ treatments resulted in a significant increase in tuber yield in each graded size (25 to >75g size) over control. T₆ Treatment recorded maximum tuber yield in

each grade *i.e.* 0-25g (21.05 q ha ha⁻¹), 25-50g (69.01 q ha ha⁻¹), 50-75g (103.52 q ha ha⁻¹) and >75g (128.69 q ha ha⁻¹) respectively, where nano fertilizers applied (75% N + 2 Spray of nano N + Nano zinc spray). While minimum tuber yields in each graded size were found under T₄ treatment.

Table 4: Effect of different treatments on tuber yield grade-wise (q ha ha⁻¹).

Treatments		Tuber yield grade wise			
		0-25 g	25-50 g	50-75 g	>75 g
T ₁	100% N	17.58	63.19	94.57	116.97
T ₂	75% N + 2 Spray of nano N	19.53	64.67	96.79	120.44
T ₃	50% N + 2 Spray of N	17.36	58.59	77.26	93.75
T ₄	0% N + 2 Spray of nano N	16.28	51.65	78.13	69.01
T ₅	100% N Zn (25 kg ZnSO ₄)	18.66	66.84	100.26	124.13
T ₆	75% N + 2 Spray of nano N + Nano zinc spray	21.05	69.01	103.52	128.69
T ₇	50% N + 2 Spray of nano N + Nano zinc spray	18.66	60.33	90.71	97.01
T ₈	0% N + 2 Spray of nano N + Nano zinc spray	16.49	53.17	79.86	70.53
T ₉	75% N + 2 Spray of Urea (2%)	18.45	61.41	91.80	114.15
T ₁₀	75% N + 2 Spray of Urea (2%) + zinc sulphate* (2g/l) spray	19.75	65.32	98.09	121.74
T ₁₁	Control	18.07	59.94	88.99	100.73
SEm±		0.57	2.17	3.47	3.60
C.D. at 5%		1.68	6.40	10.23	10.62

*N: Nitrogen, Zn: Zinc, DAS: Days after sowing, q ha⁻¹: Quintal per hectare, g: Gram

CONCLUSION

This study's conclusion was the integration of 75% nitrogen through inorganic urea, and 2 % nano urea was found superior in the growth and yield of potatoes. A combination of inorganic and nano nitrogen in the proportion of 75% through urea + 2% nano urea, nano zinc, and NPK uptake by potato tuber and haulm was a better response of nutrients. Based on the result, it may be concluded that the influence of nano fertilizers and management (75% N through urea, 2 Sprays of nano N, and Nano zinc spray) was found to better treatment on growth and yield.

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Conflicts of Interest. None.

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