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Effect of foliar application of nano urea on yield and production economics of wheat crop under normal and saline-sodic soils

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Abstract
A field experiment was conducted to evaluate the effect of foliar application of nano urea applied in different concentrations and at different growth stages on nutrient uptake, yield and production economics of wheat (*Triticum aestivum* L) cv. "Phule samadhan" under normal field (EC < 2 dSm^{-1}) and saline-sodic field ((EC >4 dSm^{-1}) over two seasons *viz*., *Rabi*, 2021 and *Rabi*, 2022 at Post Graduate Institute Research Farm Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in randomized block design with eight treatments and three replications for wheat crop. The results revealed that among the different treatments, application of 75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea first 40 % at 30 DAS (tillering) and second 60% at 60 DAS (flowering) was found beneficial to increase grain yield and highest B:C ratio (2.07 and 1.77) in the year 2021-22 and 2022-23 respectively however; the treatment of GRDF 100% N through urea (Soil application) + 2 water sprays were found at par.

Keywords: Nano urea, yield, economics, normal soil, saline-sodic soil

Introduction
The role of macro and micro nutrients is crucial in crop nutrition for achieving higher yields (Raun & Johnson, 1999) [14]. The soils of India are deficient in nitrogen and are supplemented with chemical fertilizer for enhancing the crop productivity. Nitrogenous fertilizers play a vital role in modern farm technology, however only 20- 50% of the soil applied nitrogen is recovered by the annual crops (Bajwa, 1992) [4]. The left-over nitrogen is lost from the soil system through denitrification, volatilization and leaching. The partial and in-efficient use of nitrogen results in lower crop harvests. Moreover, fertilizers are energy intensive to produce and are very expensive. The present price hike of fertilizers is one of the main constraints to increase the economic yield of crops. Thus, efforts are needed to minimize its losses and to enhance its economic use. Foliar fertilization, that is nutrient supplementation through leaves, is an efficient technique of fertilization which enhances the availability of nutrients. It has been observed that utilization of fertilizers especially urea applied through soil is not as effective as when it is supplied to the plant through foliage along with soil application (Mosluh *et al*., 1978) [11]. It also ensures the ample availability of nutrients to crops for obtaining higher yield (Arif *et al*., 2006) [3]. Several researchers justified the idea that nutrients (like N) may be taken up through roots and leaves and may spread within the plant (Ahmed & Ahmed, 2005; Hassanein, 2001) [1, 5]. The efficiency of N assimilation through foliage, however, depends upon several factors including varieties or genotypes. The study under report was initiated to investigate the efficiency of foliar application of nano urea for yield and yield components of wheat when applied at different growth stages.

Materials and Methods
A field study was conducted over two seasons *viz*., *Rabi*, 2021 and *Rabi*, 2022 at Post Graduate Institute Research Farm Department of Soil Science and Agricultural Chemistry, Mahatma Phule Krishi Vidyapeeth, Rahuri. to evaluate the effect of foliar application of nano urea on yield and yield components of wheat genotype "Phule Samadhan". The topography of experimental field was uniformly levelled. The soils of the experimental site were grouped under Inceptisol order belongs to member of fine montmorillonite hyperthermic family of *Vertic Haplustepts*. The details of the experiments are given below:

1.	Location	:	PG Research Farm, Dept. of Soil Sci. and Agril. Chem. MPKV, Rahuri
2.	Year of start	:	2021
3.	Crop	:	Wheat
4.	Variety	:	*Phule Samadhan*
5.	Spacing	:	20 cm
6.	Seasons	:	*Rabi*-2021 and *Rabi*-2022
7.	Soil types	:	Normal and Saline sodic soils (2 soil types)
8.	Plot size	:	Gross: 3.60 m × 4.20 m, Net: 3.20 m × 3.80 m
9.	Nano Urea	:	Total nitrogen 4%
10	Design	:	Randomized Block Design (RBD)
11	Treatments	:	8
12	Replications	:	3

1. Treatment details
The particulars of treatments along with their respective symbols are given below:

T1	:	Absolute control
T2	:	GRDF 100% N through urea (Soil application) + 2 water sprays
T3	:	75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea
T4	:	50% N through urea (Soil application) + 50% N through two foliar sprays of nano urea
T5	:	50% N through urea (Soil application) + 25% N through two foliar sprays of nano urea
T6	:	25% N through urea (Soil application) + 75% N through two foliar sprays of nano urea
T7	:	100% N through four foliar sprays of nano urea
T8	:	50% N through urea (Soil application) + 50% N through four foliar sprays of urea

Note:
1. Recommended dose of fertilizer 120:60:40 Kg ha^{-1}
2. Vermicompost @ 5 t ha^{-1} and P_2O_5 @ 60 kg ha^{-1}, K_2O @ 40 kg ha^{-1} were common to treatments T_2 to T_8
3. Two foliar sprays at 30 DAS (tillering) @ 40 % and at 60 DAS (flowering) @ 60%.
4. Four foliar sprays of nano urea in splits at 30, 45, 60 and 75 DAS @ 10%, 30%,30% and 30% respectively

2. Application of nano urea

Nano urea was applied in each plot as per the treatments during the crop growth with the help of sprayer. As one bottle of nano urea (500 ml) is equal to one bag of urea, a total of 2898 ml nano urea is required per hectare for wheat crops. Two foliar sprays of nano urea first - 40 % at 30 DAS (tillering), second - 60% at 60 DAS (flowering) and four foliar sprays of nano urea in splits at 30, 45, 60 and 75 DAS @ 10%, 30%,30% and 30%, respectively were applied as per treatments. We know 500 lit of water is required for spraying one ha of crop, therefore, 0.756 lit of water was used for each plot according to treatments with nano urea.

3. Grain yield (q/ha)

From the individual plot, crop from net plot area was harvested, sun dried for 3-4 days and was subsequently threshed (through manually by beating the bundles on stone tiles) and cleaned. The grain thus obtained, were weighed and expressed in quintals per hectare (q/ha).

4. Straw yield (q/ha)

The total biological yield (grain + straw) from the net plot was recorded and straw yield was worked out by subtracting the grain yield from the biological yield and expressed in quintals per hectare (q/ha).

5. Studies on economics

1. Cost of cultivation

The cost of cultivation includes all the costs that are incurred during for raising of the crop from field preparation till harvesting and threshing. The cost of different operations prevailing in the local area and the cost of inputs prevailing in the local market was used for calculating the cost of cultivation. On the basis of benefit cost ratio (gross return/cost of cultivation), the most beneficial treatment for the crop was identified

2. Gross returns

Gross return was calculated by using the minimum support price for grain yield and local running price for straw yield.

3. Net returns

The net return was calculated by deducting the cost of cultivation from the gross returns and expressed as Rs ha^{-1}.

4. Benefit cost ratio

By dividing the net returns with cost of cultivation of different treatments that were studied the B:C ratio of different treatments was obtained.'

The data was carried out by the 'Analysis of variance' method by Panse and Sukhatme (1985) [13]. The appropriate standard error (S.E+) for each factor was worked out and whenever the treatments were significant critical differences (C.D.) at 5 per cent probability level was calculated and indicated.

Results and Discussion

1. Yield of wheat crop

The data presented in table no. 2.1 revealed that the highest grain yield was achieved in the treatment T3 (39.33 and 36.68 q ha^{-1}, respectively) under normal and saline-sodic plot. In general, treatment T3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea at tillering and flowering stage was found to best treatment for achieving higher grain yield under both the types of soil this might be due to that nanoparticle induced enhancement in photosynthesis and nutrient use efficiency leading to more production of grain yield and also this can be attributed to the stimulating effect of urea through improving the physiological performance of plants and multiple advantage of foliar application method such rapid and efficient response to plant needs, less product needed and independence of soil conditions (Yildirim *et al*.,2007).

In case of straw yield was found significantly maximum in the treatment T2 (47.66 q ha^{-1}) under normal soil while, in case of saline- sodic soil, it was found highest in the treatment T3 (44.43 q ha^{-1}). Increase in straw yield might be due to foliar spray of Nano-Urea owing to quick absorption of Nano-Urea by the plant and easiness of translocation which aided in better photosynthesis and more dry matter production in normal soil. Similar results were also recorded by Sahu *et al*. (2022) [15]. The reasons responsible for the decrease in straw yield in saline-sodic soil may be due to osmotic inhibition of the ions, toxic effects of the ions and nutritional imbalance caused by salinity (Levitt, 1972) [9].

These findings were quite similar to that of the findings of Sahu *et al*. (2022) who reported that two spray of nano urea at 75 % recommended dose of nitrogen + two foliar sprays of nano urea resulted in enhanced straw yield. Nearly similar findings were also reported by Khalil *et al*. (2019) [6], Astaneh *et al*., (2018) [2] and Meena *et al*., (2021) [10].

Table 1: Effect of foliar application of nano urea on yield of wheat crop under normal and saline-sodic soil

Sr. No	Treatments	Grain yield (q ha-1)		Straw yield (q ha-1)	
		Normal soil	Saline- sodic soil	Normal soil	Saline- sodic soil
T1	Absolute control	10.43	9.86	13.25	12.22
T2	GRDF 100% N through urea (Soil application) + 2 water sprays	37.70	36.32	47.66	44.30
T3	75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea	39.33	36.68	46.58	44.43
T4	50% N through urea (Soil application) + 50% N through two foliar sprays of nano urea	34.19	31.14	45.28	40.13
T5	50% N through urea (Soil application) + 25% N through two foliar sprays of nano urea	33.03	28.51	42.09	39.26

T6	25% N through urea (Soil application) + 75% N through two foliar sprays of nano urea	17.72	21.40	26.93	33.40
T7	100% N through four foliar sprays of nano urea	15.51	19.06	25.67	32.37
T8	50% N through urea (Soil application) + 50% N through four foliar sprays of nano urea	33.10	29.13	41.27	38.70
	SE m±	**0.81**	**0.21**	**0.69**	**0.70**
	CD at 5%	**2.39**	**0.63**	**2.04**	**2.06**

2. Effect of Foliar Application of Nano Urea on Production Economics of Wheat Crop

The treatment wise economics of cultivation was worked out with the help of operating cost of individual treatment and the cost of production. Data pertaining to cost of cultivation, gross returns, net returns and B:C ratio of wheat under different treatments have been presented in tables 2.2 and 2.3 for the years 2021-22 and 2022-23, respectively.

2.1. Cost of Cultivation (₹ ha^{-1})

The highest cost of cultivation (57429 and 60955 ₹ ha^{-1}) was recorded in the treatment T_8-50% N through urea (Soil application) + 50% N through four foliar sprays of nano urea during the years 2021-22 and 2022-23, respectively followed by the treatment T_7- 100% N through four foliar sprays of nano urea (57357 and 60871 ₹ ha^{-1}) during the years 2021-22 and 2022-23 respectively. The lowest cost of cultivation (22521 and 24838 ₹ ha^{-1}) was recorded with the absolute control treatment during the years 2021-22 and 2022-23 respectively under normal and saline-sodic soil. The cost remains same for both the type of soils in first year crop season while in next year it increased around by 3000 ₹ ha^{-1} due to increase in cost of inputs.

2.2. Gross Return (₹ ha^{-1})

Normal soil

In the year 2021-22, the maximum gross return (115600 ₹ ha^{-1}) was recorded in the treatment T_3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea while, in the year 2022-23, it was recorded maximum in the treatment T_2- GRDF 100% N through urea (Soil application) + 2 water sprays (100684 ₹ ha^{-1}).

Saline-sodic soil

The maximum gross return (99002 and 103435 ₹ ha^{-1}) was recorded in the treatment T_3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea during the years 2021-22 and 2022-23, respectively.

2.3. Net Return (₹ ha^{-1})

Normal soil

In the year 2021-22, the highest net return was found in the treatment T_3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea (59735 ₹ ha^{-1}) while, in the year 2022-23, the highest net return was recorded with the treatment T_2- GRDF 100% N through urea (Soil application) + 2 water sprays (41644 ₹ ha^{-1}).

Saline-sodic soil

The highest net return (43136 and 44437 ₹ ha^{-1}) was recorded in the treatment T_3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea during the years 2021-22 and 2022-23, respectively.

Higher net returns under treatment might be attributed to higher gross returns in comparison to the cost increase in these treatments. The highest returns obtained in the above treatments is mainly due to higher economic yield. The results corroborate the findings of Sudhakar *et al*. (2001) [17] and Saleem *et al* (2013) [16].

2.4. Benefit-Cost Ratio

Normal soil

It was reflected from tables 2.3 and 2.4 that in the year 2021-22, the highest B:C ratio (2.07) was recorded in the treatment T_3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea while, in the year 2022-23, it was recorded highest (1.71) in the treatment T_2-GRDF 100% N through urea (Soil application) + 2 water sprays followed by the treatment T_3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea and (1.70).

Saline-sodic soil

The highest B:C ratio (1.77 and 1.75) was recorded in the treatment T_3-75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea during the years 2021-22 and 2022-23, respectively. This was followed by treatment T_2- GRDF 100% N through urea (Soil application) + 2 water sprays (1.75 and 1.74) during the years 2021-22 and 2022-23, respectively.

The higher B: C was attributed to higher gross and net returns with almost similar cost of cultivation in comparison with remaining treatments. It was noted that the commercial formulation of nano urea was not much costlier; that's why there was not a big variation in cost of cultivation among different treatments imposed under same level of recommended N. As the cost involved towards nano urea commercial formulation was not much higher and was comparable with urea soil application, these two treatments resulted in higher returns. In the year 2021-22, the absolute control plot gave minimum B:C ratio to the tune of 1.35 and 1.24, respectively in normal and saline-sodic soil however; in the year 2022-23, it was 1.09 and 1.06, respectively in normal and saline-sodic soil which might be due to variation in cost of cultivation and net returns. Similar findings were also observed by Kumar *et al*., (2015) [7].

It was clear from the production economics that 25% N through two foliar sprays of nano urea at tillering and flowering stage resulted in the same value as achieved under GRDF 100% N through urea (Soil application) + 2 water sprays. Our present findings are also supported by the findings of Kumar *et al*. (2020) [8] and Panda *et al*. (2020) [12] who also reported that use of nano-fertilizers in combination with conventional fertilizers enhances the grain yield and straw yield, thus maximize the gross and net return.

In general, it was depicted from the data that among the different treatments, application of 75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea first 40 % at 30 DAS (tillering) and second 60% at 60 DAS (flowering) was found beneficial for increase in yield contributing characteristics, physiological parameters, grain yield, nutrient use efficiency and monetary returns of

rabi wheat grown under normal and saline-sodic soil, however; the treatment of GRDF 100% N through urea (Soil application) + 2 water sprays was found at par.

As far as saving of urea is concerned, there was saving of 25 % of N through urea as soil application which was compensated from 25 % N through two foliar sprays of nano urea first 40 % at 30 DAS (tillering) and second 60% at 60 DAS (flowering).

Table 2: Effect of foliar application of nano urea on economics of wheat crop under normal and saline-sodic soil in year 2021-22

Sr.No	Treatments	Normal soil				Saline-sodic soil			
		Groos income (₹ ha^{-1}) A	Total cost of cultivation (₹ ha^{-1}) B	Net income (₹ ha^{-1}) A-B	B: C ratio	Groos income (₹ ha^{-1}) A	Total cost of cultivation (₹ ha^{-1}) B	Net income (₹ ha^{-1}) A-B	B: C ratio
T_1	Absolute control	30374.96	22521	7853.96	1.35	28020.48	22521	5499.48	1.24
T_2	GRDF 100% N through urea (Soil application) + 2 water sprays	107157.55	55901.6	51255.95	1.92	97800.19	55901.6	41898.59	1.75
T_3	75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea	115600.71	55865.45	59735.26	2.07	99002.26	55865.45	43136.81	1.77
T_4	50% N through urea (Soil application) + 50% N through two foliar sprays of nano urea	99906.20	55829.3	44076.90	1.79	83700.62	55829.3	27871.32	1.50
T_5	50% N through urea (Soil application) + 25% N through two foliar sprays of nano urea	96007.95	55481.3	40526.65	1.73	76822.55	55481.3	21341.25	1.38
T_6	25% N through urea (Soil application) + 75% N through two foliar sprays of nano urea	49642.87	55792.15	-6149.28	0.89	59581.20	55792.15	3789.05	1.07
T_7	100% N through four foliar sprays of nano urea	42924.37	57357	-14432.6	0.75	54376.51	57357	-2980.49	0.95
T_8	50% N through urea (Soil application) + 50% N through four foliar sprays of nano urea	92624.59	57429.3	35195.29	1.61	77950.43	57429.3	20521.13	1.36

Note: Price of produce (Grain 2600 ₹ q^{-1} and Straw 50 ₹ q^{-1}), Nano urea- 240 ₹ 500 ml^{-1}, Spraying charges- 40 Rs/15 L pumps, Vermicompost- 5.0 ₹ kg^{-1}

Table 3: Effect of foliar application of nano urea on economics of wheat crop under normal and saline-sodic soil in year 2022-23

Sr. No.	Treatments	Normal soil				Saline-sodic soil			
		Groos income (₹ ha^{-1}) A	Total cost of cultivation (₹ ha^{-1}) B	Net income (₹ ha^{-1}) A-B	B: C ratio	Groos income (₹ ha^{-1}) A	Total cost of cultivation (₹ ha^{-1}) B	Net income (₹ ha^{-1}) A-B	B: C ratio
T_1	Absolute control	27061.04	24838.5	2222.54	1.09	26321.98	24838.5	1483.48	1.06
T_2	GRDF 100% N through urea (Soil application) + 2 water sprays	100684.57	59039.94	41644.63	1.71	102687.12	59039.94	43647.18	1.74
T_3	75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea	100586.79	58997.94	41588.85	1.70	103435.83	58997.94	44437.89	1.75
T_4	50% N through urea (Soil application) + 50% N through two foliar sprays of nano urea	88580.35	58955.94	29624.41	1.50	88432.12	58955.94	29476.18	1.50
T_5	50% N through urea (Soil application) + 25% N through two foliar sprays of nano urea	85947.90	58607.94	27339.96	1.47	80997.07	58607.94	22389.13	1.38
T_6	25% N through urea (Soil application) + 75% N through two foliar sprays of nano urea	48552.85	58912.94	-10360	0.82	59126.92	58912.94	213.98	1.00
T_7	100% N through four foliar sprays of nano urea	43275.58	60871.94	-17596.3	0.71	51555.35	60871.94	-9316.59	0.85
T_8	50% N through urea (Soil application) + 50% N through four foliar sprays of nano urea	89880.29	60955.94	28924.35	1.47	83190.81	60955.94	22234.87	1.36

Note: Price of produce (Grain 2800 ₹ q^{-1} and Straw 50 ₹ q^{-1}), Nano urea- 240 ₹ 500 ml^{-1}, Spraying charges- 50 Rs/15 L pumps, Vermicompost- 5.0 ₹ kg^{-1}

Conclusion

On the basis of two-years experimentation results during *rabi*-2021 and *rabi*-2022, it is concluded that among the different treatments, application of 75% N through urea (Soil application) + 25% N through two foliar sprays of nano urea first 40 % at 30 DAS (tillering) and second 60% at 60 DAS (flowering) was found beneficial to increase grain yield and highest B:C ratio (2.07 and 1.77) in the year 2021-22 and 2022-23 respectively however; the treatment of GRDF 100% N through urea (Soil application) + 2 water sprays were found at par.

References

1. Ahmed MA, MKA Ahmed. Growth and productivity of wheat plants as affected by complete foliar fertilizer compound under water stress conditions in newly cultivated sandy land. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo,2005:13:269- 284.
2. Astaneh N, Bazrafshan F, Zare M, Amiri B, Bahrini A. Effect of nano chelated nitrogen and urea fertilizers on wheat plant under drought stress condition. Nativa Sinop,2018:6(6):587-593
3. Arif M, MA Chohan, S Ali, R Gul, S Khan. Response of wheat to foliar application of nutrients. J. Agric. and Bio. Sci.,2006:1(4):30-34
4. Bajwa MI. Soil fertility management for sustainable agriculture. Proc. 3rd National Congress of Soil Science, held at Lahore from 20th to 22nd March 1990, 1992, 7-25.
5. Hassanein MS. Effect of variety and nitrogen levels on growth, yield and yield components of wheat (*Triticum aestivum* L.) in newly cultivated land. Egypt. J. Agron.,2001:23:111-131.
6. Khalil MH, Abou-Hadid AF, Abdrabou RT, Al-halim A, AbdEl-Maaboud MS. Response of two maize cultivars (*Zea mays* L.) to organic manur and mineral nano nitrogen fertilizer under Siwa Oasis conditions. Arab Universities Journal of Agricultural Sciences,2019:27(1):299-312.
7. Kumar R, Bohra JS, Kumawat N, Singh AK. Fodder yield, nutrient uptake and quality of baby corn (*Zea mays* L.) as influenced by NPKS and Zn fertilization1. Research on Crops,2015:16(2):243-249.
8. Kumar Y, Tiwari KN, Nayak RK, Rai A, Singh SP, Singh AN, *et al*. Nanofertilizers for increasing nutrient use efficiency, yield and economic returns in important winter season crops of Uttar Pradesh. Indian Journal of Fertilisers,2020:16:772-786.
9. Levitt J. High temperature heat stress, In: Response of plant to environment stress. Acad. Press, New York, 1972, 229-269.
10. Meena RH, Jat G, Jain D. Impact of foliar application of different nano fertilizers on soil microbial properties and yield of wheat. Journal of Environmental Biology,2021:42:302-308.
11. Mosluh KI, J Seth, AKK Rashid. Efficacy of urea spray for wheat crop under irrigated conditions on Iraq. Plant and Soil,1978:49:175-178.
12. Panda P, Maitra S, Panda SK, Shankar T, Adhikary R, Saira M, Gaikwad DJ. Influence of nutrient levels on productivity and nutrient uptake by finger millet (*Eleusine coracana* L.) varieties. Crop Research,2020:56:128-34.
13. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. Publication and information division, Indian Council of Agricultural Research, New Delhi, 1985, 347.
14. Raun WR, Johnson GV. Improving nitrogen use efficiency for cereal production. Agronomy Journal,1999:91:357–363.
15. Sahu TK, Kumar M, Kumar N, Chandrakar T, Singh DP. Effect of nano urea application on growth and productivity of rice (*Oryza sativa* L.) under midland situation of Bastar region. Pharma Innovation,2022:11(6): 185-187
16. Saleem I, Javid S, Sial RA, Ehsan S, Ahmad ZA. Substitution of soil application of urea with foliar application to minimize the wheat yield losses. Soil & Environment, 2013, 32(2).
17. Sudhakar G, Solamalai A, Rasisankar N. Yield and economic of semidry rice as influenced by cultivars and levels of nitrogen. *Indian Journal of Dryland Agricultural Research and Development*,2001:16(1):42-44.
18. Yildrim EI, Guvenc M Turan, Karatas A. Effect of foliar urea application on quality, growth, mineral uptake and yield of broccoli (*Brassica oleracea* L., var. Italica) plant. Sci. Environ,2007:53(3):120–128.