Original Research Article

Nitrogen management through nano urea and conventional urea and its effect on wheat (*Triticum aestivum* L.) growth and yield

Abstract

The field experiment was carried out at Agronomy Research Farm of Acharya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during Rabi Season 2021-22 to study the "Study on performance of nitrogen management through nano urea and conventional urea in wheat (*Triticum aestivum* L.)" The experiment was laid out in Randomized Block Design with four replications and six treatments i.e. T_1: Control, T_2 : 100% RDN through conventional Urea (40% at Basal+ 30% at 30DAS+30% at 50DAS), T_3 : 75% RDN through conventional Urea as Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), T_4 : 50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), T_5 : 25% RDN through conventional Urea as Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), T_6 : 100% RDN through Nano Urea as Topdressing (50% at 30DAS+50% at 50DAS). The observation on different growth and yield parameters were recorded and analyzed statistically. The experimental results revealed that among the treatments, treatment T_4 recorded highest plant height, number of tillers m-2 , leaf area index, dry matter accumulation, number of spikes m-2 , length of spike, grains spike-1 , yield and nutrient uptake. The highest net returns (₹ 51286 ha-1) and B:C ratio (1.42) were noticed by the application of T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS). From this study, it can be concluded that T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) found most economical over other treatments, it gave more net returns.

Key word- Top dressing, Nano urea, Basal dose and wheat.

Introduction-

Wheat (Triticum aestivum L.) is one of the most widely grown cereals in the world, and important staple foods for over 2.5 billion people. The usage of synthetic N fertilizers since the industrial revolution has resulted in an increase in atmospheric NO, one of the most major anthropogenic greenhouse gases causing global warming (AtaUl-Karim et al., 2016). Despite earlier efforts, the Nitrogen Use Efficiency (NUE) in agricultural systems has remained low, implying that more than half of the N applied to agricultural soils is potentially lost to the environment on a worldwide scale (AtaUl-Karim et al., 2016). Among mineral nutrients, nitrogen is the first and foremost nutrient required for crop plants as it is a vital structural constituent of many proteins and enzymes chlorophyll, Rubisco, nucleic acids, some hormones and thus N fertilization is an essential agronomic management practice to enhance the crop productivity and plays a significant role during the vegetative growth of crops (AtaUl-Karim et al., 2016); but unfortunately, nitrogen is lost through the processes of nitrate leaching, de-nitrification and ammonia volatilization and runoff to surface and ground water and so induces economic losses and environmental pollution. Nano fertilizers in boosting nutrients uptake and nutrients use efficiency, reducing losses through leaching and gaseous emissions along with reducing the risk of nutrient toxicity for ensuring food security achieved through higher productivity and economic turnouts by practicing the sustainable farming practices (Tarafdar, 2013). Suryaprabha. (2012) reported that nitrogen nutrition improves the potential of wheat to alleviate the effects of drought stress during vegetative growth periods. The leaves are a sink for N during the vegetative stage and, afterwards, this N is remobilized for use in the developing seeds. Much of this remobilization occurs during senescence where N is transported mainly via amino acids. Up to 80% of grain N contents are derived from leaves in wheat (Kumar et al., 2014).

Methods and material

The field experiment was carried out at Agronomy Research Farm of Acharya Narendra Dev University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during Rabi Season 2021-22 to study the “Study on performance of nitrogen management through nano urea and conventional urea in wheat (Triticum aestivum L.)” The experiment was laid out in Randomized Block Design with four replications and six treatments i.e. T1: Control, T2 : 100% RDN through conventional Urea (40% at Basal+ 30% at 30DAS+30% at 50DAS), T3 : 75% RDN through conventional Urea as Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), T4 : 50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), T5 : 25% RDN through conventional Urea as Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), T6 : 100% RDN through Nano Urea as Topdressing (50% at 30DAS+50% at 50DAS). To evaluate the treatment effect, the various morphological observations, growth analysis and yields were recorded in the experiment at 30, 60, 90 days after sowing and at harvest stage. The recommended dose of fertilizers for wheat are 120:60:40 kg of N, P2O5, K2O ha-1 respectively. Full dose of P2O5, K2O and 50% of

Nitrogen were applied at the time of sowing. Growth parameters were recorded before harvesting of crop. Harvesting was done when the spikelet matured and plant was dried up. The threshing of the crop was done by manually by plot wise and grain and straw where collected separately.

Result and Discussion –

Initial plant population

The observed data presented in Table.1 reveals that their was no significant difference between the plant population (m^{-2}) among different treatments due to conventional urea and nano urea. Thus, the plant population was almost unvaried in all the plots.

Plant height

The plant height at 30 DAS was found maximum under T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) which was found to be par with the T_3 (75% RDN through conventional Urea as Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) and found significant over other treatments. The maximum plant height (99.79cm) recorded in T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) which was found to be significant over other treatments. However, lowest plant height recorded in control..

No. of Tillers

The maximum number of tillers (m^{-2}) at 30 DAS was recorded in T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) which was found at par with T5 (25% RDN through conventional Urea as Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), T3 (75% RDN through conventional Urea as Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) and T2 (100% RDN through conventional Urea (40% at Basal+ 30% at 30DAS+30% at 50DAS) and significant over other treatments. The number of tillers (m-2) at 60 DAS, 90 DAS and at harvest found maximum in T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) which was found at par with T_5 (25% RDN through conventional Urea as Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS), and significant over other treatments. The lowest number of tillers (m^{-2}) was recorded with control. Application of traditional fertilizer, alone or in combination with Nanofertilizer, had a substantial impact on the quantity of reproductive tillers (Benzon et al. 2015).

Leaf Area Index

The leaf area index at 30 DAS was found maximum under T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) and significant over other treatments. The leaf area index at 60 DAS and 90 DAS was found maximum under T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) which was found at par with T_5 25% RDN through conventional Urea as Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) and superiorly significant over other treatments. The lowest leaf area index was recorded in control.

Dry matter Accumulation

The dry matter accumulation (g m^{-2}) at 30, 60 and 90 DAS was recorded maximum at T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) which was found to be par with T3 (75% RDN through conventional Urea as Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) and significant over other treatments. The lowest dry matter accumulation (g m^{-2}) was recorded in control. Foliar application of nano fertilizers significantly improved dry matter accumulation; this could be due to the fact that nano fertilizers have higher surface area, which improves reactivity and thus improves nutrient uptake in plants, resulting in a cumulative increase in plant height, leaf area, and number of tillers m-2 . Enhanced leaf area assists in greater solar radiation consumption and accessible nutrients, both of which are critical for higher photosynthetic surface area, resulting in more accumulation and transfer of photosynthates, which ultimately increased biomass output. These findings were in accordance with those of Dhoke et al. (2013), , Armin et al. (2014), Benzon et al. (2015), and Hafeez et al. (2015).

Yield attributes

The significant highest number of effective tillers was recorded in T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) while the lowest number of effective tillers recorded in control. The majority of the time, rising tiller numbers are attributed to higher nitrogen rates. A similar study found that increasing the nitrogen rate increases the number of tillers. The number of reproductive tillers was considerably reduced when conventional fertilizer was used alone or in combined with Nano-fertilizer (Benzon et al. 2015).

The highest spike length (11.69cm) was observed in T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) which was found to be at par with T2 (100% RDN through conventional Urea (40% at Basal+ 30% at 30DAS+30% at 50DAS) and T5 (25% RDN through conventional Urea as Basal + 75% RDN through Nano Urea as Topdressing at 30 and 50 DAS) and significantly higher over other treatments while the lowest spike length (9.50cm) was recorded in control. The highest No. of grains spike^{-1} (45.30) was recorded in T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) which was significantly higher over other treatments. The lowest No. of grains spike^{-1} (36.40) observed in T1 (control). Test weight was not significantly influenced by various treatments. Although test weight is a genetic trait, the foliar application of nano fertilizers had no effect on it.

Yield

The data presented in Table 2 revealed that highest grain yield (36.35 q ha-1) and straw yield (51.06 q ha-1) was observed in treatment T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) which was found to be at par with T_5 (25% RDN through conventional Urea as Basal + 75% RDN through Nano Urea at Topdressing (at 30 and 50 DAS) and significant over other treatments while the lowest grain yield (25.25 q ha-1) and straw yield (38.39 q ha-1) recorded in T1 control The results on harvest index Table2 indicated that harvest index was non-significant in relation to the application of conventional urea and nano urea. The highest harvest index (42.35%) recorded in treatment T4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing at 30 and 50 DAS) and the lowest harvest index (37.74%) observed in T1 control.

Economics

Maximum cost of cultivation (36278₹ ha-1) recorded in T_2 (100% RDN through conventional Urea (40% at Basal+ 30% at 30DAS+30% at 50DAS) due to high cost involved in conventional urea than the nano urea. While the Maximum gross returns (87302₹ ha-1) and Net returns (51286 ₹ ha-1) recorded in T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) and minimum gross returns (55120₹ ha-1) and and minimum net gross returns (20016 ₹ ha-1) was observed in control. Among the various treatments T_4 (50% RDN through conventional Urea as Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS) recorded highest benefit cost ratio (1.42), whereas T1 (Control) recorded lowest benefit cost ratio (0.54).

References

Al-Juthery, H.W., Habeeb, K.H., Altaee, F.J.K., AL-Taey, D.K. and Al-Tawaha, A.R.M., 2018. Effect of foliar application of different sources of nano-fertilizers on growth and yield of wheat. Bioscience research, 25(4): 3976-3985

Armin, M., Akbari, S. and Mashhadi, S. 2014. Effect of time and concentration of nano- Fe foliar application on yield and yield components of wheat. International Journal of Biosciences, 4(9): 69-75.

Benzon, H., Rubenecia, M., Ultra, V. and Lee, S. 2015. Nano-fertilizer affects the growth, development, and chemical properties of rice. International Journal of Agronomy and Agricultural Research (IJAAR), 7(1): 105-117

Dhoke, S. K., Mahajan, P., Kamble, R. and Khanna, A. 2013. Effect of nano-particle suspensions on the growth of mung (Vigna radiata) seedlings by foliar spray method. Nano-technology Development, 3(1): 1-5

Hafeez, A., Razzaq, A., Mahmood, T. and Jhanzab, H. M. 2015. Potential of copper nanoparticles to increase growth and yield of wheat. Journal of Nano science with Advanced Technology, 1(1): 6-11

Kumar, R., Pandey, D. S., Singh, V. P. and Singh, I. P. 2014. Nano-technology for better fertilizer use (Research Experiences at Pantnagar). Research Bulletin no. 201.

Suriyaprabha, R., Karunakaran, G., Yuvakkumar, R., Prabu, P., Rajendran, V. and Kannan, N. 2012. Growth and physiological responses of maize (Zea mays L.) to porous silica nano-particles in soil. Journal of Nano-particle Research, 14(12): 1- 14.

Tarafdar, J. C., Sharma, S. and Raliya, R. 2013. Nano-technology: Interdisciplinary science of applications. African Journal of Biotechnology, 12(3): 219- 226.

Treatments	Plant population	Plant height (m)				Number of tillers (m^{-2})			
	15 DAS	30DAS	60DAS	90DAS	At harvest	30DAS	60DAS	90DAS	At harvest
T1. Control	175.75	20.45	61.50	87.36	89.25	194.60	243.50	250.80	250.60
T2.100% RDN through conventional Urea (40% at Basal+ 30% at 30DAS+30% at 50DAS)	177.25	23.25	64.85	94.66	96.27	197.20	284.40	297.00	299.50
T3.75% RDN through conventional Ureaas Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	178.0	24.67	65.25	95.20	96.60	200.50	287.60	298.50	303.40
T4.50% RDN through conventional Ureaas Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	179.25	25.78	67.03	99.28	99.79	201.20	301.40	311.40	311.00
T5.25% RDN through conventional Ureaas Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	176.75	22.88	65.85	95.75	97.28	198.20	291.50	303.75	307.20
T6.100% RDN through Nano Urea as Topdressing (50% at 30DAS+50% at 50DAS)	175.50	19.66	64.37	95.15	96.25	195.50	256.00	275.50	285.50
SEm ±	1.74	0.48	0.71	0.66	0.62	1.82	3.91	3.01	2.45
CD at 5%	NS	1.45	2.19	2.01	1.9	5.46	11.85	9.23	6.87

Table 1 Growth characters as affected by nitrogen management through nano urea and conventional urea.

Table 2 **Growth characters as affected by nitrogen management through nano urea and conventional urea.**

Treatments	Leaf Area Index			Dry matter Accumulation				Effective tillers (m^{-2})	Spike length(cm)	No. of grains spike^{-1}	Test weight (g)
	30DAS	60DAS	90DAS	30DAS	60DAS	90DAS	At harvest				
T1. Control	1.35	2.60	2.83	52.49	379.69	583.95	622.85	237.20	9.50	36.40	32.94
T2.100% RDN through conventional Urea(40% at Basal+ 30% at 30DAS+30% at50DAS)	1.44	3.87	4.12	63.12	451.28	777.31	923.26	296.63	11.25	44.20	38.20
T3.75% RDN through conventional Ureaas Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	1.43	3.82	4.08	64.70	441.82	767.82	911.45	282.30	10.80	42.70	37.95
T4.50% RDN through conventional Ureaas Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	1.46	4.25	4.42	66.40	454.20	791.56	928.59	305.20	11.69	45.30	38.85
T5.25% RDN through conventional Ureaas Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	1.42	4.14	4.39	61.25	435.28	762.23	898.26	286.30	11.05	41.36	36.36
T6.100% RDN through Nano Urea as Topdressing (50% at 30DAS+50% at 50DAS)	1.39	3.80	4.03	54.25	427.48	723.60	880.54	292.50	10.90	40.20	35.95
SEm ±	0.03	0.07	0.05	0.67	1.08	6.95	2.36	0.82	0.23	0.37	2.21
CD at 5%	0.08	0.23	0.16	2.21	3.29	21.16	4.73	2.52	0.71	0.82	NS

Table 3 **Yield and economics of wheat as affected by nitrogen management through nano urea and conventional urea.**

Treatments	**Grain yield ($q\ ha^{-1}$)**	**Straw yield ($q\ ha^{-1}$)**	**Biological yield ($q\ ha^{-1}$)**	**Harvest index (%)**	**Cost of cultivation (₹ ha^{-1})**	**Gross return (₹ ha^{-1})**	**Net return (₹ ha^{-1})**	**Benefit cost ratio**
T1. Control	25.25	38.39	63.64	37.74	34378	54394	20016	0.54
T2.100% RDN through conventional Urea(40% at Basal+ 30% at 30DAS+30% at50DAS)	34.50	47.31	81.81	41.97	36278	83204	46926	1.29
T3.75% RDN through conventional Ureaas Basal + 25% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	33.51	46.52	80.03	41.25	36124	82128	46004	1.27
T4.50% RDN through conventional Ureaas Basal + 50% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	36.35	51.06	87.41	42.35	36016	87302	51286	1.42
T5.25% RDN through conventional Ureaas Basal + 75% RDN through Nano Urea as Topdressing (at 30 and 50 DAS)	35.35	49.22	84.57	41.24	35802	81205	45503	1.28
T6.100% RDN through Nano Urea as Topdressing (50% at 30DAS+50% at50DAS)	33.83	47.55	80.35	40.10	35604	80125	44521	1.25
SEm ±	0.45	0.35	0.66	0.87	-	-	-	-
CD at 5%	1.37	0.96	1.91	NS	-	-	-	-