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Effect of source of nitrogen on yield and nutrient uptake in wheat

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Abstract
A field experiment was conducted during the rabi season of 2020-21 at the Research Farm, BSP FC, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, to evaluate the effect of different nitrogen sources on growth, yield, nutrient uptake and economics of wheat (*Triticum aestivum* L.). The experiment was laid out in a randomized block design comprising 11 nitrogen management treatments with three replications. Treatments included recommended fertilizer dose (120:60:40 kg NPK ha^{-1}) alone and in combination with different concentrations of Nutriventia liquid urea and nano urea. Application of nitrogen sources significantly influenced dry matter accumulation, yield attributes, grain yield, biomass production and nutrient uptake. The highest dry matter accumulation, grain yield (61.29 q ha^{-1}), biomass yield (95.53 q ha^{-1}), nutrient uptake and economic returns were recorded with recommended NPK combined with nano urea at 10 ml ha^{-1}. This treatment also recorded the highest net monetary return (₹111,509 ha^{-1}) and benefit-cost ratio (3.33). Thus, nano urea integrated with recommended NPK improved wheat productivity, nutrient utilization and profitability.

Keywords: Nitrogen management, wheat, *Triticum aestivum* L., nano urea, liquid urea, nutrient uptake, grain yield, biomass yield, nutrient use efficiency, economics

Introduction
Wheat (*Triticum aestivum* L.) is the second most significant cereal in India following rice, contributing substantially to the national food security by providing more than 50% of the calories to the people who mainly depend on it. For the last several years, India is the 2nd largest producer of wheat in the world next to China. According to USDA, wheat production of India was estimated 80.71million tones. Crop responses to N fertility are well documented and, for crops such as wheat where high protein is desirable, it is important to use adequate fertilizer rates or grain quality can decline. Unfortunately, one of the challenges with higher N rates is that the potential for lodging also increases, and, when lodging occurs, yield benefits are often reduced or yields can even decline. Wheat is the principal food grain produced in the United States. Nitrogen (N) is the nutrient that most commonly limits wheat yield and quality. Nitrogen use efficiency is currently only about 40 percent. A considerable increase from the previously estimated 33 percent NUE in the late 1990s is primarily due to advance in nutrient management strategies and cutting edge technologies. Development of efficient N management and improving N recommendations are fundamental issues that must be addressed to maintain or increase the sustainability of wheat production in the future.

While spring wheat's primary value is its quality, represented by high grain protein content, N is vital to both yield and protein production. When evaluating NUE in spring wheat, combining yield and protein into protein yield parameter (calculated as a product of grain yield and percent grain protein) makes sense Kumbhare *et al* 2023a[1, 2] and Sharma *et al* 2025[3]. Protein yield enables us to calculate the efficacy of a particular treatment (such as fertilizer product or application method) [1, 3] from the perspective of producing a better return on the investment via optimizing grain yield and quality simultaneously. Foliar application of fluid fertilizer to wheat is not a new concept. *The* renewed interest of wheat producers in foliar fertilization is partially due to active promotion of fluid products as more efficient when compared to the more traditionally dry granular fertilizers.

Methodology
An field experiment was conducted at Research Farm, BSP FC, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during rabi 2020-21. *The* experiment was laid in randomized block design consisting of 11 different treatments of nitrogen management having three replications.

The treatment T_1- control, T_2 - RDF, T_3 - RDF + Nutriventia Liquid Urea ml, TRDF + Nutriventia Liquid Urea 4 ml, T_4- RDF + Nutriventia Liquid Urea 6 ml, T_5- RDF + Nutriventia Liquid Urea 8 ml/ha, T_6- RDF + Nutriventia Liquid Urea 10 ml/ha T_7- RDF + Nano urea 2 ml, T_8 RDF + Nano urea ml, T_9- RDF + Nano urea 6 ml, T_{10}- RDF + Nano urea 8 ml/ha, T_{11}- RDF + Nano urea 10 ml/ha. Recommended dose of fertilizer *i.e.*, 120:60:40kg NPK ha^{-1} was applied as per treatment. Half dose of nitrogen was supplied through Di-ammonium phosphate (DAP) and urea with full dose of phosphorus (P2O5) as DAP and potash (K2O) as murate of potash were applied before sowing of seeds as basal application. *The* remaining half dose of nitrogen was applied in two equal splits as top-dressing during CRI (crown root initiation) and jointing stage as per treatment. Spray of growth regulators was done as per the treatments. Commercially liquid urea were used at the desired concentrations. In control treatment where no growth regulators were to be applied only water was sprayed @ 400 l/ha. Two sprays of each liquid urea treatments were done at first node stage and at flag leaf stage.

Total uptake

Total uptake of N, P and K was calculated for each treatment separately by using the following formula.

Total nitrogen uptake ($kgha^{-1}$)=N uptake by grain + N uptake by straw Uptake of N, P and K by wheat plants was expressed in kg ha^{-1}

Dry matter accumulation

The dry matter accumulation by wheat was significantly influenced by different fertilizer levels and growth regulators at 60, 90 and at harvest. All the treatments varied significantly from one another on their effect on dry matter accumulation with higher values recorded with the application of recommended doses of NPK with nano urea followed by while significantly lower values were recorded in control plot Tripathi *et al* 2025 [4].

The dry matter accumulation by wheat crop was not influenced by liquid and nano urea during the initial one recording dates of 30 DAS while the effects were significant at later stages of 60,90 and at harvest. This was because of the fact that the first spray of growth regulators was done only at about 45 DAS and the effect of growth regulators applied at that time was not visible at 30 DAS and hence no treatment differences were visible. However, the effect of their applications done at about 60,90 DAS and all the later stages of crop growth same.

Table 1: Effect of various ntirogent fertilizer on dry matter accumulation

Treatments	Dry Matter Accumulation (g/m-2)			
	30 DAS	60 DAS	90 DAS	Harvest
T_1	55.55	523.51	995.43	1137.3
T_2	56.56	531.55	1004.64	1180.6
T_3	57.82	688.74	1115.87	1293.8
T_4	57.38	561.99	1090.26	1194.3
T_5	58.07	606.3	1120.72	1255.5
T_6	59.01	731.36	1212.14	1357.2
T_7	59.25	734.6	1212.45	1378.8
T_8	59.62	751.72	1224.99	1418.3
T_9	60.55	895.81	1233.65	1518.5
T_{10}	61.55	896.81	1235.41	1526.5
T_{11}	62.34	897.85	1237.24	1529.5
C.D at 5%	0.85	2.52	1.22	1.24

Table 2: Efficacy of Nitrotecnia-400 gg and nano urea nitrogen based fertilizer on growth, yield and quality of Wheat

Treatments	Plant Height c.m.	Yield attributes			Yields	
		Earhead /sq.m.	Grains/ Earhead	1000 Grains Weight, g	Yield, q/ha	Biomass, q/ha
T_1	90.05	382.17	40.03	32.28	40.88	69.85
T_2	88.73	352.26	38.68	34.05	42.27	74.57
T_3	93.78	389.95	42.09	36.91	49.47	81.49
T_4	99.94	406.78	43.61	41.78	53.21	87.38
T_5	101.93	421.17	45.26	43.06	56.67	90.91
T_6	89.15	381.27	39.13	31.38	47.98	88.95
T_7	87.83	351.36	37.78	33.15	48.37	83.67
T_8	92.88	389.05	41.19	36.01	48.57	80.59
T_9	99.04	405.88	42.71	40.88	52.31	86.48
T_{10}	100.03	420.27	44.36	42.16	55.77	90.01
T_{11}	106.55	425.79	49.88	47.68	61.29	95.53
S.E.m+	0.44	1.18	0.12	0.02	1.12	1.16
C.D at 5%	1.12	3.89	0.38	0.06	3.36	3.48

Grain yield

The perusal of data revealed that grain yield significantly influenced due to the application of different fertilizers levels and plant growth regulators Under the nutrient management and growth regulators practices, application of recommended doses of NPK with RDF + liquid produced maximum grain yield which was significantly higher grain yield than the absolute control and RDF (120:60:40) and it was at par with the application of Trecommended doses of NPK with RDF + liquid urea produced significantly higher grain yield than all rest of the treatments. However, minimum grain yield was recorded in absolute control. A close perusal of data revealed that the different fertilizer doses and growth regulators had a significant influence on the straw yield of wheat. With the application of

recommended doses of RDF + liquid urea and nano urea producing significantly highest yield. This was due to the significantly highest number of tillers/m2 recorded in this treatment (Nirala *et al* 2022, Tomar et 2023b, Tiwari *et al* 2011) [5, 8, 7, 6].

This treatment was followed by application of Tand 100% recommended doses of NPK with liquid urea 10ml in that order, each treatment differing significantly from one another. *The* lowest straw yield recorded in the control was due to the inability of the soil to provide adequate amount of nutrients to the plants in absence of applied fertilizers (Singh *et al* 2013a, Singh *et al* 2013b, Nirala *et al* 2022, Tomar et 2023b, Tiwari *et al* 2011) [9, 10, 5, 8, 7, 6].

Biomass yield

A close perusal of data revealed that the different fertilizer doses and growth regulators had a significant influence on the straw yield of wheat. With the application of RDF + with

Nano urea 10 ml /ha producing significantly highest yield (95.53q /ha). This was due to the significantly highest number of tillers / m² recorded in this treatment. This treatment was followed by application of TRDF + Nutriventia Liquid Urea 10 ml/ha and RDF + with Nano urea 8 ml /ha in that order, each treatment differing significantly from one another. *The* lowest straw yield recorded in the control was due to the inability of the soil to provide adequate amount of nutrients to the plants in absence of applied fertilizers Jha *et al* 2024[11], Tripathi *et al* 2025[4] and Sharma *et al* 2025) [3, 4, 11].

Nutrient uptake

Nitrogen, phosphorus and potassium content in grain and straw increased with increasing nutrient levels fig 1. Maximum N, P, K content in grain and straw were observed in with RDF + nano urea 10 ml /ha fertilizer recommended doses of NPK with growth RDF + liquid urea 10 ml /ha and minimum in control Patel *et al* 2023[12], Sahu *et al* 2023[13] Raghuwanshi *et al* 2023[14, 15], Shri *et al* 2015, Shrivastava,*et al* 2014, Verma *et al* 2016a[16, 17]. This may be due to adequate nutrients availability to the plants which increased the nitrogen content and also have positive effect on growth, similarly, on the phosphorus and potassium content in grain and straw. Different sprays did not have any significant effect on nitrogen, phosphorus and potassium content in grain and straw. These results are in contradiction to those of Singh *et al.* (2008) [12, 13, 14, 18, 16]. Grain and straw analysis show that uptake of NPK increased with different nutrient levels (fig1). Singh *et al.* (2008)[19] reported that the increment in N uptake was probably due to improvement in soil conditions, which promoted the proliferation of roots and plant demand, which in turn drew more nutrients from larger area and greater depth Tiwari *et al* 2013[20],Singh *et al* 2013 [10, 9], Bhalse *et al* 2023, Bhayal *et al* 2022[57, 21] Jha *et al* 2022[23], Jha *et al* 2020[24],Tiwari *et al* 2011b) [7, 20, 21, 23, 24]. Under various spray treatments, maximum NPK uptake was recorded in recommended doses of NPK with RDF + liquid. Effect of liquid urea on growth, biochemical, yield and yield components of wheat crop recorded higher root growth due to maximum nutrient uptake, and protein content compared to control(Jha *et al* 2016, Jha *et al* 2007, Malviya *et al* 2012, Kumhar *et al* 2022,Tiwari *et al* 2011b,Tomar *et al* 2023b) [25, 8, 26, 27, 28, 6].

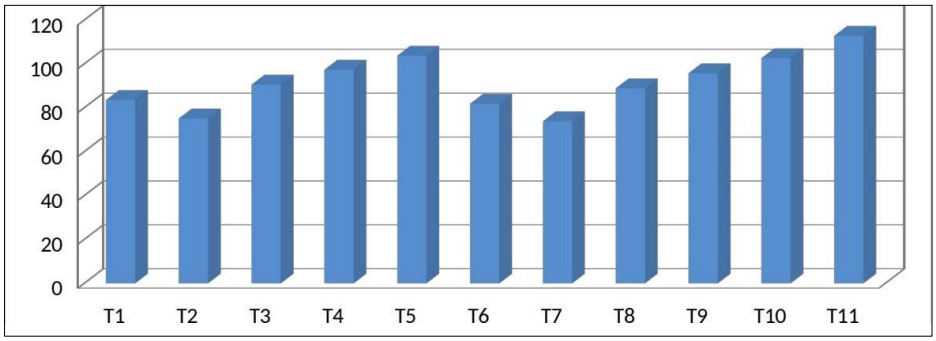

Fig 1: Nutrient uptake influenced by different treatments

Economics

The higher gross return under recommended doses of NPK with RDF with nano urea 10 ml fallowed by RDF + Nutriventia Liquid Urea 10 ml fallowed by recommended doses of RDF with nano urea 8 ml was due to higher grain and straw yields obtained with higher nutrient levels. These results are in conformity with those of MGFEY Tiwari *et al* 2013[20], Tomar *et al* 2023a[6, 8], Bhalse *et al* 2024 [58], Chauhan *et al* 2017 [29], Dubey *et al* 2022 [30] a Kumhar *et al* 2025.. Whereas maximum net return was obtained in recommended doses of NPK with Nano urea 10 ml and lowest was found in control treatment (59436 rs /ha) [20, 6]. whereas lowest B:C 2.27) was obtained in control due to lower yields. *The* higher B:C (3.33) in recommended doses of NPK with nano urea 10 ml /had was due to higher grain and straw yield (Chand *et al* 2025, Bhalse *et al* 2024, Gajbhiye *et al* 2024, Dwivedi *et al* 2012,Gangwar *et al* 2011, Jha *et al* 2014, Jha at al 2016) [31, 25, 33, 34, 32, 35].

Table 3: Effect of various treatment on economics

Treatments	Cost of cultivation (Rs/ha)	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	B:C Ratio
T_1	46852	106288	59436	2.27
T_2	47458	109902	62444	2.32
T_3	47589	128622	81033	2.70
T_4	47698	138346	90648	2.90
T_5	47888	147342	99454	3.08
T_6	47985	124748	76763	2.60
T_7	47456	125762	78306	2.65
T_8	47562	126282	78720	2.66
T_9	47666	136006	88340	2.85
T_{10}	47789	145002	97213	3.03
T_{11}	47845	159354	111509	3.33

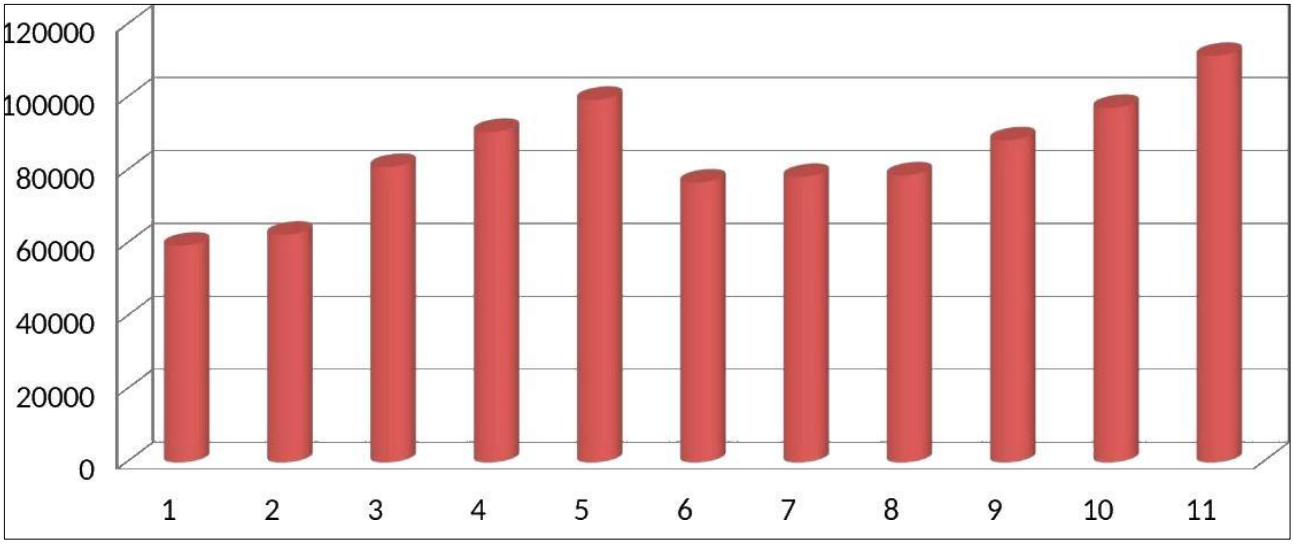

Fig 2: Net monetary returns Rs /ha as influenced by various treatments

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