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Effect of nano urea on productivity of wheat (*Triticum aestivum* L.) under irrigated condition

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Abstract
The present experiment was conducted at Indira Gandhi Krishi Vishwavidyalaya, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, (C.G.) during *rabi* season 2021-22 with a view to study the "Effect of nano urea on productivity of wheat (*Triticum aestivum* L.) under irrigated condition". The experiment was conducted in randomized block design and the treatments were consisted of thirteen levels of nutrient combination. Results revealed that treatment T_4 (100% N + 2 spray of urea (5%) at tillering and jointing stages) recorded the highest plant height, number of total tillers, dry matter accumulation (g plant^{-1}), ear length (10.59 m^{-2}), number of grains ear head^{-1} (28.10), test weight (43.65 g), grain yield (42.76 q ha^{-1}) and straw yield (40.32 q ha^{-1}) which was significantly superior over other treatments but was at par with T_3 (100% N + 2 spray of nano urea at tillering and jointing stages).

Keywords: Nano urea, wheat, yield, yield attributes

Introduction
Wheat (*Triticum aestivum* L.) is an important cereal crop belongs to family "Poaceae" and genus "Triticum". It is the world's most important cereal crop, accounting for 30% of all cereal food produced globally and is a staple food for nearly 10 billion people in 43 nations. It has been under cultivation in the Indian subcontinent from pre-historic times and is an integral part of country's economy and food security. Wheat accounts for almost 55% of all carbohydrates and 20% of all dietary calories consumed globally (Graur and Breiman, 1995) [4]. Wheat is grown in India on 31.61 m ha and produces of 109.52 m t with national average productivity of 3.46 t ha^{-1} during 2020-21 (Anonymous, 2021a) [1].

Chhattisgarh State is divided into 3 Agro-Climatic Zones with immense potential for Agricultural development. In Chhattisgarh, wheat is a major cereal crop of *rabi* season in rice based cropping system under irrigated condition and maximum farmers grow wheat crop after harvesting of rice in midland to low land condition. Wheat is one important crop of Chhattisgarh and the cropping system of the state is mainly rain dependent. In Chhattisgarh, wheat occupies an area 227 (000 ha) and average productivity of 1.6 t ha^{-1} (Anonymous, 2021b) [2].

Nitrogen is essential nutrient for plant growth and involved in important synthesis and formation of many important substances and compounds in plant such as amino acids, enzymes, DNA, RNA and chlorophyll. It is responsible for greenness, vigorous growth and overall crop development, therefore it must be available for plants in adequate amounts. Nano fertilizers have emerged as a promising alternative for ensuring high crop yield while remaining environmentally friendly. Liquid nano fertilizer which is currently the best alternative to common urea fertilizer. One nano urea liquid particle is 30 nano meters in diameter, with 10,000 time's higher surface area to volume size than normal granular urea. Foliar application of nano urea liquid at critical crop growth stages of a plant effectively fulfils its nitrogen requirement and leads to higher crop productivity and quality in comparison to conventional urea.

Materials and Methods
A field experiment was carried out during *rabi* season of 2021-22 at Indira Gandhi Krishi Vishwavidyalaya, Barrister Thakur Chhedilal College of Agriculture and Research Station, Bilaspur, (C.G). The test variety was HI 1544 which was sown in second week of November

(17th Nov) and harvest in first week of April (5th April). The soil of the experimental field was neutral in reaction (6.2 pH) and clay loam in texture. The experiment was laid out in randomized block design with thirteen treatments and three replications. The treatment comprised of T_1: 100% RDN + plain water spray at tillering and jointing stages, T_2: 100% RDN + one spray of nano urea at tillering stage, T_3: 100% RDN + two spray of nano urea at tillering and jointing stages, T_4: 100% RDN + two spray of urea (5%) at tillering and jointing stages, T_5: 75% RDN + plain water spray at tillering and jointing stages, T_6: 75% RDN + one spray of nano urea at tillering stage, T_7: 75% RDN + two spray of nano urea at tillering and jointing stages, T_8: 75% RDN + two spray of urea (5%) at tillering and jointing stages, T_9: 50% RDN + plain water spray at tillering and jointing stages, T_{10}: 50% RDN + one spray of nano urea at tillering stage, T_{11}: 50% RDN + two spray of nano urea at tillering and jointing stages, T_{12}: 50% RDN + two spray of urea (5%) tillering and jointing stages and T_{13}: control.

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, P_2O_5, K_2O ha^{-1} respectively. Full dose of P_2O_5, K_2O 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.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Plant height

Among the applied treatments, T_4 {100% N + two spray of urea (5%)} recorded significantly higher plant height at 30 (37.63 cm), 60 (75.92 cm) and 90 days after sowing (93.89 cm) as well as at harvest (92.98 cm) as compare to other treatments (Table 1). However, it was at par with treatment T_3 (100% N + 2 spray of nano urea). The significantly lowest plant height (68.12 cm) was observed in treatment T_{13} (control).

Number of total tillers (m^{-2})

The number of total tillers (m^{-2}) recorded at 30 (217.89), 60 (327.00) and 90 days after sowing (398.37) as well as at harvest (366.67) were significantly higher in treatment T_4 as compare to other treatments (Table 2). However, it was at par with treatment T_3 (100% N + 2 spray of nano urea).The significantly lowest number of tillers (294.79) was observed in treatment T_{13} (control).

Dry matter accumulation (g $plant^{-1}$)

Dry matter accumulation did not reach the level of significance at 30 DAS (Table 3). However, significant data were found in 60, 90 DAS and at harvest. The highest dry matter was accumulated (*viz*., 0.66, 8.78, 18.59, 24.71) in treatment T_4 receiving 100% RDN with two spray of urea (5%), being significantly superior over other treatments which was at par with treatment T_3 and T_8. The minimum dry matter was accumulated by plants in control plot (T_{13}). Effect of increasing nitrogen level with foliar application of urea on total dry matter production revealed significant difference. It might be due to increased photosynthetic rate and higher leaf area that increased total dry matter production. The finding of Rahman *et al.* (2014) [7] is in similar pattern of the present study.

Table 1: Effect of nano urea on plant height (cm) at different growth stages of wheat

Treatments		Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Recommended N dose (1/3rd basal, 1/3rd CRI and 1/3rd at tillering stage) + Plain water spray at tillering (40-45 DAS) and jointing (60-65 DAS) stages	33.26	68.97	87.51	85.08
T_2	Recommended N + one spray of nano urea at tillering stage	34.24	70.11	90.06	88.14
T_3	Recommended N + two spray of nano urea at tillering and jointing stages	36.18	73.80	92.54	91.00
T_4	Recommended N + two spray of urea (5%) at tillering and jointing stages	37.63	75.92	93.89	92.98
T_5	75% N + Plain water spray at tillering and jointing stages	31.66	65.74	83.78	82.18
T_6	75% N + one spray of nano urea at tillering stage	32.97	67.92	85.99	84.02
T_7	75% N + two spray of nano urea at tillering and jointing stages	33.37	69.08	89.67	87.26
T_8	75% N + two spray of urea (5%) at tillering and jointing stages	35.36	71.99	90.88	89.22
T_9	50% N + Plain water spray at tillering and jointing stages	27.77	61.89	77.08	74.49
T_{10}	50% N + one spray of nano urea at tillering stage	29.48	63.02	81.33	79.11
T_{11}	50% N + two spray of nano urea at tillering and jointing stages	31.09	64.97	84.50	81.97
T_{12}	50% N + two spray of urea (5%) at tillering and jointing stages	32.89	67.10	85.62	83.13
T_{13}	Control (without N only)	24.12	48.71	69.34	68.12
S.Em ±		0.91	1.61	1.67	1.46
CD (P=0.05)		2.67	4.72	4.72	4.26

Table 2: Effect of nano urea on number of plant tillers (m^{-2}) at different growth stages of wheat

Treatments		No. of total tillers (m^{-2})			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Recommended N dose (1/3rd basal, 1/3rd CRI and 1/3rd at tillering stage) + Plain water spray at tillering (40-45 DAS) and jointing (60-65 DAS) stages	198.27	301.00	373.49	343.07
T_2	Recommended N + one spray of nano urea at tillering stage	204.98	309.56	379.81	350.10
T_3	Recommended N + two spray of nano urea at tillering and jointing stages	210.65	320.51	390.35	357.46
T_4	Recommended N + two spray of urea (5%) at tillering and jointing stages	217.89	327.00	398.37	366.67
T_5	75% N + Plain water spray at tillering and jointing stages	189.33	288.67	360.43	333.06
T_6	75% N + one spray of nano urea at tillering stage	196.04	297.00	367.03	339.70
T_7	75% N + two spray of nano urea at tillering and jointing stages	201.31	307.23	378.33	347.91
T_8	75% N + two spray of urea (5%) at tillering and jointing stages	208.43	314.60	386.67	356.73
T_9	50% N + Plain water spray at tillering and jointing stages	175.52	268.67	340.68	316.40
T_{10}	50% N + one spray of nano urea at tillering stage	181.54	276.50	347.05	323.11
T_{11}	50% N + two spray of nano urea at tillering and jointing stages	187.90	287.00	358.37	329.67
T_{12}	50% N + two spray of urea (5%) at tillering and jointing stages	194.22	294.00	365.67	338.04
T_{13}	Control (without N only)	137.56	202.00	255.21	294.79
S.Em ±		4.26	4.61	4.63	4.55
CD (P=0.05)		12.43	13.02	13.51	13.28

Table 3: Effect of nano urea on dry matter accumulation at different growth interval of wheat

Treatments		Dry matter accumulation (g $plant^{-1}$)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Recommended N dose (1/3rd basal, 1/3rd CRI and 1/3rd at tillering stage) + Plain water spray at tillering (40-45 DAS) and jointing (60-65 DAS) stages	0.62	7.76	16.08	21.11
T_2	Recommended N + one spray of nano urea at tillering stage	0.64	8.09	17.13	22.34
T_3	Recommended N + two spray of nano urea at tillering and jointing stages	0.65	8.52	18.06	23.93
T_4	Recommended N + two spray of urea (5%) at tillering and jointing stages	0.66	8.78	18.59	24.71
T_5	75% N + Plain water spray at tillering and jointing stages	0.60	7.03	14.74	19.08
T_6	75% N + one spray of nano urea at tillering stage	0.61	7.34	15.47	20.27
T_7	75% N + two spray of nano urea at tillering and jointing stages	0.63	7.92	16.60	22.16
T_8	75% N + two spray of urea (5%) at tillering and jointing stages	0.64	8.38	17.64	23.65
T_9	50% N + Plain water spray at tillering and jointing stages	0.52	5.99	13.05	16.94
T_{10}	50% N + one spray of nano urea at tillering stage	0.54	6.53	13.99	18.69
T_{11}	50% N + two spray of nano urea at tillering and jointing stages	0.57	6.89	14.52	19.12
T_{12}	50% N + two spray of urea (5%) at tillering and jointing stages	0.59	7.23	15.12	19.85
T_{13}	Control (without N only)	0.51	4.84	11.30	12.57
S.Em ±		0.02	0.14	0.38	0.44
CD (P=0.05)		NS	0.42	1.13	1.30

Ear length

At harvest, application of 100% RDN with two spray of urea (5%) i.e., T_4 had maximum spike length (10.59 cm) which was at par with T_3 (10.18 cm) and T_8 (9.96 cm) and lowest spike length (7.63 cm) was recorded under control T_{13} (Table 4). Due to the increasing nitrogen dose, the plant received more nutrition for development and growth, resulting in healthier spike length growth.

Number of grains ear head^{-1}

At harvest, among the application of 100% RDN with two spray of urea (5%) i.e., T_4 had maximum number of grains earhead^{-1} (28.10) which was at par with 100% RDN with two spray of nano urea T_3 (27.33), 75% RDN with two spray of urea (5%) i.e., T_8 (26.68) and significantly superior over the other treatments and the lowest number of grains was recorded under the treatment control T_{13} (19.39).

Test weight (g)

At harvest, the treatment 100% RDN with two spray of urea (5%) i.e., T_4 had the higher test weight (43.65 g) which was at par with the treatment T_3 and T_8. The lowest test weight (38.55 g) was recorded under control treatment T_{13}. The results are in line with Rahman *et al.* (2014) [7] who reported significant increase in thousand-grain weight with application of nitrogen.

Grain yield (q ha^{-1})

Application of 100% RDN with two spray of urea (5%) *viz.*, T_4 produced significantly highest grain yield (42.76 q ha^{-1}) but was at par with 100% RDN with two spray of nano urea T_3 (39.61 q ha^{-1}) and 75% RDN with two spray of urea (5%) T_8 (39.27 q ha^{-1}) further the lowest grain yield was recorded (21.58 q ha^{-1}) under control T_{13}. This may be due to the provision of N through urea spray at later growth stages which might have enhanced accumulation of assimilates in the grains and thus resulting in heavier grains of wheat. Such type of result were also found by Khaled *et al.* (2021) [6] and Baloch *et al.* (2019) [3].

Straw yield (q ha^{-1})

Treatment T_4 {100% RDN with two spray of urea (5%)} had the higher straw yield (40.32 q ha^{-1}) which was significantly superior over the other treatments and the lower straw yield was recorded under control T_{13}.

Table 4: Effect of nano urea on yield attributing characters and yield of wheat

Treatments		Ear length (cm)	Number of grains ear head^{-1}	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})
T_1	Recommended N dose (1/3rd basal, 1/3rd CRI and 1/3rd at tillering stage) + Plain water spray at tillering (40-45 DAS) and jointing (60-65 DAS) stages	9.26	25.58	40.96	36.05	37.45	73.50
T_2	Recommended N + one spray of nano urea at tillering stage	9.41	25.87	41.52	38.45	38.63	77.08
T_3	Recommended N + two spray of nano urea at tillering and jointing stages	10.18	27.33	43.01	39.61	39.63	79.24
T_4	Recommended N + two spray of urea (5%) at tillering and jointing stages	10.59	28.10	43.65	42.76	40.32	83.08
T_5	75% N + Plain water spray at tillering and jointing stages	9.06	23.34	39.84	32.18	34.79	66.97
T_6	75% N + one spray of nano urea at tillering stage	9.21	23.92	40.61	35.24	36.92	72.16
T_7	75% N + two spray of nano urea at tillering and jointing stages	9.35	25.83	41.54	37.56	37.29	74.85
T_8	75% N + two spray of urea (5%) at tillering and jointing stages	9.96	26.68	42.63	39.27	39.22	78.49
T_9	50% N + Plain water spray at tillering and jointing stages	8.37	23.11	38.91	28.62	31.88	60.50
T_{10}	50% N + one spray of nano urea at tillering stage	8.83	24.03	39.25	30.25	35.37	65.62
T_{11}	50% N + two spray of nano urea at tillering and jointing stages	8.92	23.41	39.77	31.84	34.91	66.75
T_{12}	50% N + two spray of urea (5%) at tillering and jointing stages	9.10	23.81	40.38	33.47	37.36	70.83
T_{13}	Control (without N only)	7.63	19.39	38.55	21.58	29.4	50.98
S.Em ±		0.38	0.74	0.72	1.46	1.67	2.51
CD (P=0.05)		1.11	2.18	2.10	4.26	4.85	7.35

Conclusion

Application of 100% RDN + two spray of urea (5%) T_4 illustrated significantly higher grain (42.76 q ha^{-1}) and straw (40.32 q ha^{-1}) yield of wheat.

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