

Impact of foliar supplementation of nitrogenous fertilizer on yield attributes and yield of wheat (*Triticum aestivum* L.)

Abstract

Foliar supplementation of nitrogenous fertilizers has emerged as one of the catalysts in improving nitrogen use efficiency, enhancing crop yield and yield attributes while reducing cultivation costs. Liquid fertilizers play a key role in precise nutrient management, providing required quantity of nutrients throughout the crop growth period and improving yield attributes and yield of the crop. A field experiment was conducted during *Rabi* season of 2022-23 & 2023-24 to study the effect of soil and foliar supplementation of nitrogenous fertilizer on the performance of wheat. The experiment laid out adopting Split Plot Design with 3 main plots and 5 sub plots treatment combinations replicating thrice of wheat (DBW187) viz, M₁-100% recommended dose of nitrogen (RDN), M₂- 75% recommended dose of nitrogen (RDN), M₃- 50% recommended dose of nitrogen (RDN), and five different sub plots viz. S₁-One spray of nano urea at tillering stage, S₂- Two spray of nano urea at tillering and jointing stage, S₃- Two spray of urea (5%) at tillering and jointing stage, S₄- One spray of NPK 19:19:19 (1%) at tillering stage and S₅-No Spraying (Control). The results showed that the recommended dose of nitrogen significantly improved wheat yield and related attributes. The full (100%) recommended dose of nitrogen increased grain yield (4309 kg/ha), straw yield (6307 kg/ha), biological yield (10616 kg/ha), harvest index (40.58), number of ear heads per square meter (324.39), ear head length (10.11 cm), number of grains per ear head (47.93), and 1000-grain weight (42.49 g) over the treatment of 75% and 50% RDN. Additionally, foliar nitrogen supplementation positively affected grain and straw yields. The highest values for ear head number (320.69), ear head length (9.89 cm), grains per ear head (47.44), 1000-grain weight (42.03 g), grain yield (4229 kg/ha), straw yield (6301 kg/ha), biological yield (10530 kg/ha) and harvest index (40.69) were achieved with two sprays of urea (5%) at tillering and jointing stages over one spray of nano urea or NPK 19:19:19 at the tillering stage, however, the effect of two sprays of urea (5%) was statistically at par with two sprays of nano urea.

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Key words:Foliar Supplementation, Nano urea, Recommended Dose of Nutrient, Wheat, Yield

Introduction

The state Bihar is one of the promising states in Wheat (*Triticum aestivum* L.) production during *rabi* season. Among different foliar supplementation of nitrogenous fertilizer, urea solution at various concentration, water soluble mixed fertilizer of NPK etc. Among them, nano-scale urea particles are gaining popularity now -a days. India has become the first country globally to start commercial production of Nano Urea and is the second largest consumer of Nano urea in the world. Nano Urea is the only nano fertilizer approved by the Government of India and included in the Fertilizer Control Order (FCO). Nano Urea contains 4% total nitrogen (w/v) evenly dispersed in water. In Nano Urea, nitrogen particle size varies from 20-50 nm. The particle size of Nano Urea is small, that is why plants absorb nitrogen easily and efficiently. Nano Urea, being an eco-friendly product, will protect the health of the soil. Apart from direct savings, the transportation cost of the Nano Urea is also very small and the storage is also quite easy for the farmers. In general, Nano Urea is sprayed on leaves and it easily enters into the plant through stomata and other openings and is assimilated by the plant cells. It is easily distributed through the phloem from the source to sink inside the plant as per its needs. Unutilized nitrogen is stored in the plant vacuole and is slowly released for proper growth and development of the plant. It effectively fulfills crop nitrogen requirements and increases leaf photosynthesis, root biomass, effective tillers and branches and ultimately the yield and nutrient-use efficiency of the crop (Kiran and Samal, 2021; Kumar *et al.*, 2021; Qureshi *et al.*, 2018). In other hand, N:P:K 19:19:19 is a complete water-soluble, called as perfect fertilizer which provides all major macro-nutrients N-P-K in a balanced ratio to the plants through foliar spray at the time of maximum requirement with the lowest losses. N:P:K :: 19:19:19 can fulfill any deficiency of one or all three major plant nutrients and minimizes the cost of basal fertilizers. N:P:K :: 19:19:19 increases growth, lowers the cost of production per unit crop yield, minimizes the chemical load on the environment and enables the country to strengthen the fertilizer supplies in the event of their shortages or price escalation thereby ensuring a wiser and long-lasting use. Foliar application of N:P:K :: 19:19:19 significantly increased yield of the crop by providing ideal quantity of all three major nutrients N, P and K

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(Tarafdar *et al.*, 2012). Furthermore, urea 5 % as foliar spray is widely used in agricultural as well as in horticultural crops to provide additional nitrogen supply over recommended doses. Basically, foliar application delivers nitrogen directly to the plant, ensuring quick absorption of nutrients specially at critical growth stages of the plant, showing immediate impact on growth parameters like plant height, canopy spread, and canopy volume. Additional urea supplementation enhances yield components, such as grains per spike, productive tillers, and 1000-grain weight. Moreover, urea foliar spray can also improve quality attributes, such as nitrogen contents in grains of the plant (Ramadas *et al.*, 2019). Hence, application effectiveness can be decreased by runoff from leaf surfaces, rain and overhead irrigation, and rapid drying of spray solutions on leaves and enhance growth, number of productive tillers per unit area, biological yield, grain yield and harvest index (Ramadas *et al.*, 2019).

Keeping this advantage of foliar supplementation in mind, the experiment was conducted to study the effect of soil and foliar supplementation of nitrogenous fertilizer on yield attributes and yield of wheat.

Materials and Methods

The experiment was carried during two consecutive *rabi* seasons of 2022-23 and 2023-24, to investigate the effect of soil and foliar supplementation of nitrogenous fertilizer on yield attributes and yield of wheat (DBW-187) at the Bihar Agricultural University, Sabour. The University is situated over the Middle Gangetic plains of Agro-climatic Zone III A of Bihar. It is located between 25°50' N latitude and 87°19' E longitude, at an elevation of 37.19 meters above mean sea level. The soil of the experimental site was sandy loam with 0.43% oxidizable organic carbon, available N (180.38 kg/ha), available P (19.61 kg/ha) and available K (181.11 kg/ha). The climatic condition of this place is tropical to subtropical and somewhat semi-arid in nature and is characterized by very dry summer, moderate rainfall and very cold winter. The experiment laid out adopting a Split Plot Design with three (03) main plots treatments viz, M₁-100% recommended dose of nitrogen (RDN), M₂- 75% recommended dose of nitrogen (RDN), M₃- 50% recommended dose of nitrogen (RDN), and five (05) sub plots treatments viz. S₁- One spray of nano urea at tillering stage, S₂- Two spray of nano urea at tillering and jointing stage, S₃- Two spray of urea (5%) at tillering and jointing stage, S₄- One spray of NPK 19:19:19 (1%) at tillering—and S₅-No Spraying stage

(Control) replicating thrice with wheat (DBW187) crop. The recommended dose of fertilizer (RDF) was (150: 60: 40 N: P₂O₅: K₂O kg ha⁻¹), where 50% dose of N-fertilizer recommendation was applied as basal and rest 50% was applied in two (02) splits, one at [Crown root initiation \(CRI\)](#) stage (21DAS) and second one at panicle initiation (55 DAS) in case of M₁. Same trend was followed in M₂ and M₃ with the respective dose of 75% RDN and 50% RDN. Full dose of phosphorus and potassium were applied as basal irrespective of all treatments. The seed rate of 100 kg ha⁻¹ was sown in line at 20cm spacing with 4-5 cm depth. Irrigation was given as per the schedule i.e at CRI stage (21DAS), Flowering stage (75 DAS) and Milking stage (95 DAS) of wheat.

Measurement of Yields and Yield attributes:

Yield attributing characters like effective tillers/m², spike length (cm), spikelets/spike, grains/spike and 1,000-grain weight (g) were calculated by random sampling at four (04) locations of five (05) tagged plants of experimental plots. The panicles/ ear heads at maturity from the 1.0 m² demarcated area of each plot was counted. Five (05) panicles/ear head from each tagged plant were selected and threshed separately. The number of grains per panicle was counted and mean value was determined. The threshed grains of each plot were cleaned and thoroughly dried. From each plot a composite sample of grains was collected and 1000-grains were counted, weighed on the electronic balance and expressed in g.

Grain yield was determined from 4.0 m² selected area in each plot. The grains obtained from the harvested bundle of the selected area was weighed (kg m⁻²) after threshing, winnowing and drying (10% moisture for wheat) and then expressed in terms of kg ha⁻¹. After separating the grains from the harvested bundle the straw yield was recorded in kg m⁻² for each plot and then expressed in terms of kg ha⁻¹.

Harvest index was calculated by dividing economic (grain) yield by the total biological (grain + straw) yield and expressed as percentage:

$$H.I. = \frac{\text{Economic yield (grain yield) kg ha}^{-1}}{\text{Biological yield (grain + straw yield) kg ha}^{-1}} \times 100$$

Result and Discussion

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After two years of experimentation, it was observed that 100% Recommended Dose of Nitrogen (RDN) (M₁) had the highest number of effective tillers/m² (324.39), the longest ear heads (10.11 cm), the highest number of grains per ear heads (47.93) and the highest 1000 grain weight (42.49 g). 100% RDN was significantly higher than the other soil supplementations i.e. 75% RDN (M₂) and 50% RDN (M₃) (Table 1). This may be due to the fact that, sufficient amount of nitrogen at the critical stages which would have maintained a continuous supply of nitrogen, leading to the meristematic activity and stimulation of cell elongation in plants which resulted in higher effective tillers/m², grains per ear heads, spike length (cm) and 1000 grain weight. These result findings were in close agreement with the findings of Jassim *et al.* (2019). Among the foliar supplementation, significantly higher yield attributes, viz. effective tillers/m², spike length (cm), spikelets/spike, grains/spike and 1,000-grain weight (g) was obtained under two spray of urea (5%) at tillering and jointing stage (S₃) comprising the maximum value of effective tillers/m² (320.69 cm), ear heads (9.89 cm), number of grains per ear heads (47.44 cm) and 1000 grain weight (42.03 g) as compare to the other nutrient spraying i.e. one time nano urea at tillering stage, NPK 19:19:19 (1%) at tillering stage even though from no spraying (control). However, the treatment of two spray of urea (5%) was statistically at par with two time spraying of nano urea at tillering and jointing stage of wheat. The fact may be due to formation of more photosynthate assimilation and translocation of photosynthates from the source to the sink in addition to timely supply of nitrogen stimulates the initiation of grain formation which helps to increase the yield contributing characters like effective tillers/m², grains per ear heads, spike length (cm) and 1000 grain weight (AL-gym AJK and AJK, Al-Asady MHS, 2020).

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Table 1: Effect of soil and foliar supplementation of nitrogenous fertilizer on yield attributes of wheat

Treatments (Main Plots)	Yield attributing characters			
	Effective tillers/m ²	Number of grains per ear heads	Spike length (cm)	1000 grain weight (g)

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M1- 100% RDN	324.39	47.93	10.11	42.49
M2- 75% RDN	303.62	44.34	9.55	41.71
M3- 50% RDN	292.49	40.60	8.98	40.80
SEm±	6.02	1.03	0.10	0.89
CD (P=0.05)	19.62	3.25	0.40	NS
Treatments (Sub Plots)				
S1- One spray of nano urea at tillering stage	309.11	43.11	9.49	40.28
S2-Two spray of nano urea at tillering and jointing	317.83	46.56	9.67	41.55
S3-Two spray of urea (5%) at tillering and jointing	320.69	47.44	9.89	42.03
S4-One spray of NPK 19:19:19 (1%) at tillering	310.58	43.89	9.50	41.19
S5-No Spraying (Control)	298.63	40.33	9.11	40.69
SEm±	3.16	0.87	0.13	0.69
CD (P=0.05)	9.22	2.53	0.37	NS

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Further, significantly highest grain yield (4309.23 kg/ha), straw yield (6307.7 kg/ha), biological yield (10616.93 kg/ha) and harvest index (40.58) was recorded under application of 100% RDN, which was statistically superior over the value obtained under 75% RDN and 50% RDN. Basically, the yields of crop is determined by the prevailing agronomic management techniques besides its genotypical potential and environmental condition in which it is exposed during its life cycle (Kumar *et al.*, 2020; Khalil *et al.*, 2019). 100% recommended dose of fertilizer provides the nutrients as per the region-specific recommendation of the crop leads to optimum yield level.

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Among the foliar nitrogenous fertilizer application, the maximum grain yield (4229.6 kg/ha), straw yield (6301.8 kg/ha), biological yield (10530.6 kg/ha) and harvest index (40.69) was recorded in two spray of urea (5%) at tillering and jointing stage and it was statistically superior over the value obtained under one spray of nano urea at tillering stage, one spray of NPK 19:19:19 (1%) at tillering stage and over No Spraying (Control), hence, the results was statistically at par with two spray of nano urea at tillering and jointing stage (Table 2). The reason behind the fact that nitrogenous fertilizer conjugation with traditional nitrogen fertilizers improve nutrient absorption efficiency, enhance photosynthesis, increase nutrient translocation, and ultimately increase the yield level. These results are close with

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results of Kumar *et al.*, 2020; Khalil *et al.*, 2019; Ma *et al.*, 2010 and Liu and Liao, 2008.

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Table 2: Effect of soil and foliar supplementation of nitrogenous fertilizer on yield performance of wheat

Treatments (Main Plots)	Yield			
	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)	Biological yield (kg ha ⁻¹)	Harvest Index (%)
M1- 100% RDN	4309.23	6307.7	10616.93	40.58
M2- 75% RDN	4071.65	5967.2	10038.85	40.45
M3- 50% RDN	3765.29	5617.3	9382.59	40.03
SEm±	55.10	82.02	136.99	0.23
CD (p=0.05)	192.33	287.98	537.80	NS
Treatments (Sub Plots)				
S1- One spray of nano urea at tillering stage	4075.7	6075.2	10150.9	40.15
S2- Two spray of nano urea at tillering and jointing	4197.8	6157.8	10355.6	40.54
S3- Two spray of urea (5%) at tillering and jointing	4229.6	6301.8	10530.6	40.69
S4- One spray of NPK 19:19:19 (1%) at tillering	4104.6	6113.4	10218	40.35
S5-No Spraying (Control)	3843.9	5751.6	9595.5	40.06
SEm±	35.51	51.61	87.10	0.29
CD (p=0.05)	103.65	150.66	254.24	NS

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Conclusions:

The significantly higher yield attributes and yield was obtained with 100% recommended dose of fertilizer (150: 60: 40 N: P₂O₅: K₂O kg ha⁻¹). Location specific fertilizer recommendation provides right amount of fertilizer at the right time can help to achieve optimal yields. While, two spray of urea (5%) at tillering (45DAS) and jointing (65 DAS) stage of wheat, increased the yield. Foliar fertilization can be an efficient way to supplement nutrients during the middle and late stages of wheat growth. Additional supplementation through foliar spraying of nitrogenous fertilization offers added advantage to boost the physiological processes of the plants at critical stages of their development. Further, the study revealed that nano urea did not outperform over other foliar sprays, but no yield reduction due to spraying of nano urea was found.

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