Original Research Article

Effect of nano urea and foliar spray of urea on growth and yield of wheat (*Triticum aestivum* L.)

ABSTRACT

In pursuit of high yield today's agriculture cultivars put the environment at greater risk by the inputs of chemical fertilizers. Using Nano urea we can minimize the inputs damage upto a certain extent. With this objective, field experiment was carried out during *Rabi* seasons of 2022-2023 at Crop Research Farm, Department Of Agronomy, SHUATS, Prayagraj, Uttar Pradesh on topic "Effect of nano urea and foliar spray of urea on growth and yield of wheat". The treatment include two factors, Factor- 1 Nitrogen (50 %, 75%, 100%) and Factor- 2 Foliar Spray (2ml/L nano urea, 4 ml/L nano urea, 2% urea) and one control was laid out in Randomized Block Design (RBD) with 10 treatments and three replications. Result revealed that 100% nitrogen along with foliar spray of 4ml/L nano urea recorded significant effect on Growth, yield and yield parameters. Treatment 6 recorded maximum plant height (101.62 cm), dry weight (21.95 g) number of tillers/running row (85.02), number of effective tillers/m^2 (340.08), number of grains/spike (54.16), test weight (48.52 g), grain yield (6.30 t/ha) and straw yield (7.98 t/ha)

Keywords: Wheat, Nano Urea, foliar spray, growth, yield and yield parameters.

1. Introduction

"Wheat (*Triticum aestivum* L.) belongs to family Poaceae and is very important crop as it contributes major portion of staple food for the world's population and provides more calories and protein in the world's diet than any other cereal" (CIMMYT, 2002) [1]. "Due to its abundance in many nutritional and health benefits such as dietary fibre, magnesium, and protein, farmers can expect a high harvest from this crop. Albumins and globulins of wheat endosperm represent 20% to 25% of total grain proteins" (Belderok et al. 2000) [2].

"Due to its wide adaptability it can be grown not only in the tropical and sub-tropical zones, but also in the temperate zone. As the crop have such importance and wide adaptability scientists are always focusing to produce higher yields to feed the nation. In 2019, the daily total protein intake per person in is 64.9 grams, in which the contribution of wheat was 15.1 grams (23.2%)" (FAOSTAT, 2022) [3]. "The world population is expected to reach from 8.9 to 10.6 billion by 2050, compared with 7.75 billion in 2020" (World Bank, 2022) [4]. "The nutri-rich cereal is grown in diversified environments; globally wheat occupies around 217 million hectares holding the position of highest acreage among all crops with an annual production having around 731 million tonnes" (USDA, 2019) [5]. In India wheat is grown on 33.61 million hectare and produces of 106.21 million tonnes with national average yield of 3160 kg/ha during 2019-20 (Anonymous, 2020) [6]. However there is an increase in wheat production in India by 5.97 million tonnes; from 106.21 million tonnes in 2020 (Anonymous, 2020) [6] to 112.18 million tonnes in 2022(Ministry of agriculture) [7], which is higher by 5.97 million tonnes. The area under wheat cultivation is significantly increased from 29.8 million hectare to 33.61 million hectare. This is due to sharp rise in minimum support price of this nutri- cereal crop (Sendhil et al. 2012) [8].

"In India Uttar Pradesh has largest share in area with 9.75 million hectare (32%), followed by Madhya Pradesh (18.75%), Punjab (11.48%), Rajasthan (9.74%), Haryana (8.36%) and Bihar (6.82%). However, a major expansion in wheat area was observed in the states such as Jharkhand (51%), Madhya Pradesh (27%) and Rajasthan (13%)" (Sendhil et al. 2012) [8]. "Uttar Pradesh

still holds the position of largest producer in the country accounting for about 33.95 million tonnes which is roughly 31.77 % of the total production to all India". (Directorate of economics, 2022) [9]. Out of 112.18 million tonnes 71.22 million tonnes; i.e. 79.89 % wheat is produced by only three states Uttar Pradesh (33.95 million tonnes) Madhya Pradesh (22.42 million tonnes) and Punjab (14.82 million tonnes). This rise in productivity is due to adoption of high-yielding varieties coupled with other inputs like nano urea.

"Globally wheat is cultivated in an area about 217 million hectares with a record production of 731 million tonnes. Maximum area under wheat is in India (14%), followed by Russia (12.43%), China (11.14%) and the USA (6.90%) which altogether accounts for about 45% of global area. However, China is the major producer of wheat with a record production of 136 million tonnes, followed by India (98.51mt), Russia (85mt) and the USA (47.35mt). Around 449 million tonnes (58%) of wheat has been produced from traditional wheat-growing countries like China, India, Russia, the USA, Canada, Ukraine and Pakistan". (USDA, 2019) [5]. Wheat has numerous advantage so it is important to double the yield of crop in significant manner globally by 2050 (Hunter et al. 2017). [10]. In India with a limited scope for increasing the crop acreage besides the production threats and challenges at the forefront (Sharma and Chatrath et al. 2012)and (Sharma and Sendhil et al. 2013) [11] [12.] "The production target has been fixed at 140 million tonnes by 2050" (ICAR- IIWBR, 2012) [13].

"Nano urea has claimed to meet such objectives by being economically and fiscally sound. Due to various factors such as growing population, soil nutrient depletion, limited land resource, and climate change, there is a need of input having greater efficiency and environment friendly. Additionally the use efficiency of nutrients for traditional fertilizers is abysmally low. It has been reported that around 40–70 % of nitrogen, content of applied fertilizers are lost in the environment and could not reach the plant which causes significant economic losses" (Trenkel et al. 2010 ,Solanki et al. 2015) [14], [15]. To combat this, we have to utilize new inputs in our agriculture which have more output and minimal damage. One such inputs which can be used is Nano-fertilizers

Nano-fertilizers are modified form of traditional fertilizers, which are based on nano technology. These nano fertilizers can be used to fill this void in the market for conventional and innovative fertilizer market. When nitrogen is applied to soil 40–70 % of nitrogen is (Trenkel et al. 2010, Solanki et al. 2015) [14], [15]. Nitrogen is lost through the processes of nitrate leaching, de-nitrification and ammonia volatilization which is growing concerns for economic losses and environmental pollution. Moreover, nitrogen volatilization results in the release of nitrous oxides and thus being the greenhouse gases, contribute to the global warming. It is also pertinent to mention that ammonium ions react with alkaline rain water which leads to the formation of ammonia gas that escapes into the atmosphere and thus becoming a source of environmental pollution. To combat this above problems only one input is needed in our farming i.e. nano urea.

Nano urea provides greater nutrient use efficiency to plants with less input and minimal environment pollution. Due to their nano size (Kumar et al. 2021) [16] they have higher nutrient use efficiency and enhanced profitability, which facilitates better uptake from leaves and have high availability and absorption which fulfil the 4R principles resulting in production of more photosynthesis and biomass for crops. "Nano-urea have numerous advantage in terms of application (less input), slow release mechanism, reduction in transportation and application cost, and cause comparatively low salt accumulation in soil as compare to conventional fertilizers. These effectively meet crop nutrient requirement with increased bioavailability of nutrients. Nano urea increase nitrogen use efficiency and nutritional quality of crops through biofortification". (Kumar et al. 2021) [16].

"Nano urea regulates the release of nutrients and delivers the correct quantity of nutrients required by the crops in suitable proportion and promotes productivity while ensuring environmental safety. It has reported that nanofertilizer increased the NUE up to 45 %" (Rahale and C.S. 2010) [17]. In a study, the nutrient release pattern of nanofertilizer formulations including nitrogen fertiliser is analysed.The study have shown the nanoclay-based fertilizer formulations (zeolite and montmorillonite with a dimension of 30–40 nm) are capable of

releasing the nutrients for a longer period of time (>1000 h) than conventional fertilizers (Subramanian and Rahale (2009) [18] same finding were also done by (Saurabh et al. 2019) [19].

Nano urea helps to attain higher crop yield due to small size and more surface area. It has been reported that with application of nano urea there is increase 8% in yield as per 11,000 field trials conducted across India (kumar et al.2021) [16]. Additionally, by increasing agricultural yield and improving crop quality, it increases farmers' revenue. Nano urea crops have better nutritional quality and protein content as compare conventional urea. Moreover adopting this method reduces the need for chemical use because the requirement for nitrogen is met by two sprays of nano urea during important growth stages. As Nano urea is liquid based foliar application to plant; these liquid based bottles are easy to transport and store which economically sound in logistics and warehousing cost. Carrying bottle over urea sacks is convenient to farmers.

2. MATERIALS AND METHODS

The experiment was laid out during the *Rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 250 39" 42" N latitude, 810 67" 56" E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in Randomized Block Design (RBD) consisting of ten treatments.
T1 50% nitrogen + foliar spray of 2ml/ L nano urea, T2 75% nitrogen + foliar spray of 2ml/ L nano urea T3 100% nitrogen + foliar spray of 2ml/ L nano urea, T4 50% nitrogen + foliar spray of 4ml/ L nano urea, T5 75% nitrogen + foliar spray of 4ml/ L nano urea, T6 100% nitrogen + foliar spray of 4ml/ L nano urea, T7 50% nitrogen + foliar spray of 2% urea, T8 75% nitrogen + foliar spray of 2% urea, T9 100% nitrogen + foliar spray of 2% urea, T10 Control RDF 120:60:40 NPK kg/ha. All the treatment was replicated thrice. The recommended dose of phosphorus (60kg/ha), potassium (40 kg/ha) were applied at the time of sowing as a basal dose The sources of phosphorus and potassium were SSP and MOP. Nitrogen was applied through urea as per treatments in split does during the crop period. Additionally nitrogen sources i.e. Nano urea and foliar spray of urea was applied by foliar mean at 20 and 50 days after sowing. Sowing of healthy seed was done with spacing of 22.5cm x 10cm. All cultural operations were performed as per recommendations. Observations were recorded from five random plants of each treatment on different aspects of crop, viz., growth, yield and yield parameters.

2.1 Chart 1: Details for Treatment Combinations

Sr. No	Treatment Combinations
1	50% nitrogen + foliar spray of 2ml/ L nano urea
2	75% nitrogen + foliar spray of 2ml/ L nano urea
3	100% nitrogen + foliar spray of 2ml/ L nano urea
4	50% nitrogen + foliar spray of 4ml/ L nano urea
5	75% nitrogen + foliar spray of 4ml/ L nano urea
6	100% nitrogen + foliar spray of 4ml/ L nano urea
7	50% nitrogen + foliar spray of 2% urea
8	75% nitrogen + foliar spray of 2% urea
9	100% nitrogen + foliar spray of 2% urea
10	Control (RDF) 120-60-40 NPK kg/ha.

3. RESULT AND DISCUSSION:

3.1 Effect on Growth parameters

3.1.1 Plant height (cm)

There is a significant increase in plant height as the growth progressed, as shown in (table 1). Maximum plant height (101.62) observed in treatment 6 (100% nitrogen + foliar spray of 4ml/L nano urea). However, treatment 9 (100% nitrogen + foliar spray of 2% urea) was found to be statically at par with treatment 6.

The higher plant height was observed with application of 100% nitrogen. Nitrogen is an essential nutrient and it is effective for increasing crop yield. As large number of previous studies have demonstrated that application of nitrogen can increase the height of the crop, (Guo et al. 2019) and (Zhang et. al 2018). [20], [21]. Similar findings haven been reported by (Rawat et al. 2000) and (Iqtidar et al. 2006).[22], [23] The levels of nitrogen influenced plant height significantly. Further increase in plant height was due to foliar

spray of nano urea because nano urea applicaton increased the NUE up to 45 % (Rahale and C.S. 2010) [17] which directly promoted plant height. Application of nano urea avoid the loss of nitrogen through the processes of nitrate leaching, de-nitrification and ammonia volatilization and get directly available to plants without any losses.

3.1.2 Plant dry weight (g/plant)

With crop growth, the weight of plant dry matter also rose (table 1). Significant and maximum dry weight (21.95 g) was observed in treatment 6 (100% nitrogen + foliar spray of 4ml/ L nano urea). However treatment 9 (100% nitrogen + foliar spray of 2% urea), treatment 3 (100% nitrogen + foliar spray of 2ml/L nano urea) and treatment 5 (75% nitrogen + foliar spray of 4ml/ L nano urea) was found to be statically at par with treatment 6.

Effect of increasing nitrogen level upto 100% have significant on plant dry weight. Nitrogen increased photosynthetic rate and higher leaf area that increased total dry matter accumulation.Similar finding has been reported by (Rahman et al. 2014) [24]. Nitrogen is a crucial element driving plant growth that directly affects leaf area, leaf emergence rate, photosynthetic capacity, and radiation interception(Tafteh et al. 2012) [25] .Further increase in plant dry weight is due to application of nano urea. Nano urea has higher surface area to volume size ratio, they have high availability and absorption which facilitates better uptake from leaves, resulting in production of more phosynthesis and biomass required for healthy crops. Our results are also in conformity with (Kumar et al. 2021) [16].

3.1.3 Number of tillers/running row

Maximum number of tillers/running row (85.02) were found in treatment 6 (100% nitrogen + foliar spray of 4ml/ L nano urea), However treatment 9 (100% nitrogen + foliar spray of 2% urea), treatment 3 (100% nitrogen + foliar spray of 2ml/L nano urea) was found to be statically at par with treatment 6. Tillers positively correlated with leaf nitrogen accumulation (Ding et al. 2023) [26] and nano urea have higher-absorption rate, utilization efficacy which further enchanced tillers growth.

3.2 Yield and yield attributes

3.2.1 Number of effective tillers/m^2

Significant and maximum (340.08) tillers/m^2 was observed (table 2) in treatment 6 (100% nitrogen + foliar spray of 4ml/ L nano urea), However treatment 9 (100% nitrogen + foliar spray of 2% urea), treatment 3 (100% nitrogen + foliar spray of 2ml/L nano urea) was found to be statically at par with treatment 6.

3.2.2 Number of grains/ spike

Significant and higher (54.16) grains/spike was observed in treatment 6 (100% nitrogen + foliar spray of 4ml/ L nano urea), However treatment 9 (100% nitrogen + foliar spray of 2% urea) was found to be statically at par with treatment 6. Wheat grain was found to have a positive quadratic relationship with the nitrogen application rate (Hawkesford et. al 2014) [27]. Our result also in conformity with (Hawkesford et. al 2014). [27].

3.2.3 Test weight

The data showed that highest test weight (48.52) was recorded in treatment 6 (100% nitrogen + foliar spray of 4ml/ L nano urea. However treatment 9 (100% nitrogen + foliar spray of 2% urea) was found to be statically at par with treatment 6.

3.2.4 Grain yield (t/ha)

Significant and higher (6.30 t/ha) grain yield s was observed in treatment 6 (100% nitrogen + foliar spray of 4ml/ L nano urea) However treatment 9 (100% nitrogen + foliar spray of 2% urea) was found to be statically at par with treatment 6. The nitrogen has significant effect on the grain yield. It is reported that "synergistic effect of the nano-fertilizers on the efficacy of conventional fertilizer for better nutrient absorption by plant cells resulting to optimal growth plant parts and metabolic process such as photosynthesis leads to higher photosynthesis accumulation and translocation to the economic parts of the plant, thus resulting in high yield which may be attributed to increased source (leaves) and sink (economic part) strength" (Taiz and et al. 2006) [28] Foliar application of Nano-fertilizers significantly increase the crop yield (Tarafdar et al. 2012).[29] As mentioned earlier, nanofertilizers may have affected these processes through its nutrient transportation capability in terms of penetration and movement of a wide range of nutrients, from roots uptake to foliage penetration and movements within the plant.

3.2.5 Straw yield (t/ha)

The data revealed that higher (7.98 t/ha) straw yield was observed in treatment 6 (100% nitrogen + foliar spray of 4ml/ L nano urea). Lowest straw yield was found in treatment 1 (50 % nitrogen + foliar spray of 2ml/ L nano urea)

Table 1. Effect of nano urea and foliar spray of urea on growth parameters of wheat

S. No.	Treatment combinations	Plant height (cm)	Plant dry weight (g)	Number of tillers/ running row meter
1	50% nitrogen + foliar spray of 2ml/ L nano urea	97.26	19.15	82.05
2	75% nitrogen + foliar spray of 2ml/ L nano urea	99.10	20.41	83.42
3	100% nitrogen + foliar spray of 2ml/ L nano urea	100.03	21.63	84.77
4	50% nitrogen + foliar spray of 4ml/ L nano urea	98.22	20.17	83.02
5	75% nitrogen + foliar spray of 4ml/ L nano urea	99.43	21.14	83.62
6	100% nitrogen + foliar spray of 4ml/ L nano urea	101.62	21.95	85.02
7	50% nitrogen + foliar spray of 2% urea	97.47	19.36	82.51
8	75% nitrogen + foliar spray of 2% urea	99.12	20.87	83.58
9	100% nitrogen + foliar spray of 2% urea	100.81	21.83	84.94
10	Control RDF (120:60:40 NPK kg/ha.)	97.33	19.30	82.27
	F test	S	S	S
	SEm(+)	0.28	0.32	0.20
	CD (p= 0.05)	0.83	0.96	0.61

Table 2 Effect of nano urea and foliar spray of urea on yield attributes of wheat

S. No.	Treatment combinations	Number of effective tillers/m^2	Number of grains/ spike	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
1	50% nitrogen + foliar spray of 2ml/ L nano urea	315.91	49.33	45.81	4.51	5.17
2	75% nitrogen + foliar spray of 2ml/ L nano urea	333.68	51.50	46.48	5.09	6.21
3	100% nitrogen + foliar spray of 2ml/ L nano urea	339.08	53.17	47.93	5.73	7.33
4	50% nitrogen + foliar spray of 4ml/ L nano urea	332.10	50.98	46.30	4.99	6.04
5	75% nitrogen + foliar spray of 4ml/ L nano urea	334.49	52.00	47.21	5.65	7.06
6	100% nitrogen + foliar spray of 4ml/ L nano urea	340.08	54.16	48.52	6.30	7.98
7	50% nitrogen + foliar spray of 2% urea	330.04	50.70	46.18	4.72	5.71
8	75% nitrogen + foliar spray of 2% urea	334.32	51.66	47.16	5.17	6.41
9	100% nitrogen + foliar spray of 2% urea	339.76	53.86	48.02	5.89	7.54
10	Control RDF (120:60:40 NPK kg/ha.)	320.03	50.41	46.00	4.61	5.46
	F test	S	S	S	S	S
	SEm(+)	0.81	0.30	0.33	0.16	0.20
	CD (p= 0.05)	2.42	0.90	0.99	0.47	0.58

4. CONCLUSION

Based on the above findings it is concluded that treatment 6 with the application of 100% Nitrogen along with spray of 4ml/L nano urea at 20 and 50 days after sowing performs positively and improves the growth parameters yield and yield attributes of Wheat. Since the results are based on a single season, further trails could be needed for additional confirmation.

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