Efficacy of nano fertilizers on Yield, Attributes and economics of wheat

Abstract

Aim: The present investigation was carried out to study the effect of foliar application of nano-fertilizers N and P on yield, and the economics of wheat in Semi-arid and sub-tropical region of Central Plain Zone of Uttar Pradesh.The experiment was laid out in triplicate following a randomized block design with twelve treatments comprising foliar application Semi-different doses of Nano N and P.Foliar application of 1st spray of Nano N and P at 30 days after sowing (DAS) + 2nd spray of Nano N and Zn at 45 DAS along with 75% recommended dose of fertilizers (RDF) significantly (P=0.05) increased yield and have better economics.Foliar application of nano-fertilizers leads to significant improvement of crop productivity of wheat in Semi- arid and sub-tropical region of Uttar Pradesh. Moreover, the foliar application of nano-fertilizers, *i.e.,* Nano N has direct role in increasing yield as nutrient get easily available to plant in case of foliar spray.

Key words: Foliar application, Nano-fertilizers, Wheat productivity, Wheat economics

Introduction

Wheat (*Triticum aestivum* L.) is the staple food of 40 % human population across the globe and second most important cereal after rice. This covers world 222.27 million ha, produces 779.3 million metric tonnes, and yields 3.51 tonnes per hectare (USDA report, 2021-22). In India, wheat plays a vital role in food and nutritional security with an area of 31.31 million ha and an output of 109.6 million metric tonnes with average productivity of 3.52 Metric tonnes per hectare (USDA report, 2019). The world's 7.7 billion people will grow to 9.7 billion by 2050. India is the second-most populated country (1.3 billion) after China (1.41 billion) and is anticipated to surpass China in seven years, reaching 1.7 billion by 2050. (The UN World Population Prospects: The 2019 Revision). Wheat will likely remain crucial to global food security.

Low nutrient use efficiency is an issue when building and evaluating agricultural production systems. It can be considerably affected by fertilizer, soil, and water management to maximize crop output and minimize nutrient loss from the field (Fixen*et al*., 2015). The indiscriminate use of inorganic fertilizers for the past 50 years has reduced the quality and quantity of agricultural

produce. Due to the global energy crisis and the rising cost of chemical fertilizer, nano-fertilizer is gaining popularity as a plant nutrient. A correct blend of nano and inorganic fertilizer is needed to increase yield and maintain soil health. Wheat needs nitrogen and phosphorus for growth and yield. Nano-fertilizer reduces soil contamination and boosts fertility. Nanomaterials alone or with inorganic fertilizers can improve soil nutrition and fertility.

Nano-scale matter has novel, distinct properties than macroscopic matter. Reduced molecular size and changing molecular interactions change characteristics. High reactivity, increased bioavailability and bioactivity, adhesion effects, and surface effects of nanoparticles are important in agricultural revolution (Gutierrez *et al*., 2011). Custom-made things are formed from atoms; their qualities depend on their arrangement. Nano fertilizers increase growth metrics (plant height, leaf area, number of leaves per plant), dry matter production, chlorophyll production, and photosynthesis rate, resulting in higher photosynthetic production and translocation than standard fertilizers (Ali and Al- Juthery, 2017 ; Singh *et al*., 2017).

Foliar applications nourish plants by spraying liquid fertilizers or other chemical or natural products directly on the leaves of macro and micronutrients for optimal production and reduced losses (Rahman *et al*., 2014). Optimal N management for wheat maximizes productivity, water use, and environmental contamination (Corbeels*et al*., 1999; Al-Taey, *et al*, 2018).

To improve seed maturation and development, phosphorus is necessary (Ziadi*et al*., 2008). (Liakas*et al*., 2001) P treatment encourages tillering of wheat and decreases lodging in wheat, as well as improving photosynthetic activity and transfer to the maturing grains (Hadis *et al*.,2018). This makes the grains heavier (Crista *et al*., 2012; Rietra*et al*., 2017). Wheat grain production can increase by 20% with proper phosphorus application (Abdel-Aziz *et al*., 2016). P applications could rise, enhancing N and P absorption (Abdel-Aziz *et al*., 2018). Various researches suggested various P application rates.

As a result, we wanted to find out how foliar feeding of Nano-fertilizers of N and P compared to the control and traditional fertilizer affected several yield-related parameters.

Material and Method

Study Area: The experiment was conducted during rabi 221-2022 atthe Student's Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The region falls under central plain zone of Uttar Pradesh. The climate of the study area is Semi- arid and sub-tropical with an average minimum and maximum temperature (January- April) ranging between 4.3°C to 36.9 °Cduring winter season.

Experimental design and treatments: The experiment was laid out in a randomized block design and replicated thrice in the plot size of 3.20 m x 2.20 m (7.04 m^2). The experiment consisted of 12 treatments *viz.*,T1: Control; T2: 100 % NPK (150:60:40 kg ha^{-1}); T3: 75 % NPK (112.5: 45: 30 kg ha^{-1}); T4: 75 % NPK + Nano N spray at 30 DAS; T5: 75 % NPK + Nano N spray at 45 DAS; T6: 75 % NPK + Nano N spray at 30 and 45DAS; T7: 75 % NPK + Nano P spray at 30 DAS; T8: 75 % NPK + Nano P spray at 45 DAS; T9: 75 % NPK + Nano P spray at 30 and 45DAS; T10: 75 % NPK + Nano N and Nano P spray at30 DAS; T11: 75 % NPK + Nano N and Nano P spray at45 DAS; T12: 75 % NPK + Nano N and Nano P spray at30 and 45 DAS were applied to wheat variety Karan Vandana (DBW 187) in rabi season of 2021-22. The recommended dose of fertilizer were 150 kg N, 60 kg P_2O_5, 40 kg K_2O ha^{-1} and also other agronomic practices recommended for central plain Zone were followed as per package and practices, Government of Uttar Pradesh. The grains obtained from the produce of individual plot were recorded as grain yield kg per plot and later it was converted into kg ha^{-1}.

Application protocol of foliar spray: Foliar sprays were given as 1^{st} application at 30 days after sowing and 2^{nd} application at 45 days after sowing in selected treatments with the help of knapsack sprayer fitted with flat fan nozzle. Nano N @ 4 ml l^{-1} water and Nano DAP @ 250 ml $acre^{-1}$ with @ 500 l water ha^{-1}as per scheduled treatments.

Estimation of yield: Yield character was recorded as per standard methods (Singh *et al.*, 2018). The grain and straw yield was recorded from the net plot area of each treatment.

Economic Analysis: Economic analysis *i.e.* (Cost of Cultivation, Gross Returns, Net Returns, B:C ratio) as per standard methods (Barker, 2011). Minimum support price for grain and local prices for straw were used to calculate monetary return of crop.

Statistical analysis: SPSS Version 10.0, SPSS, Chicago, IL, was used for statistical analysis. SPSS was used to determine the statistical significance of treatment effect at 5% probability level. Further, F- test and significance of difference between treatments was investigated using critical difference (CD) as stated by Gomez and Gomez (1984).

Result and Discussion

The application of foliar sprays of nano-fertilizer improved the grain, straw and biological yields of wheat were significantly influenced (Table 1).Application of T12 (75 % NPK coupled with spray of Nano N and Nano P spray at 30 and 45 DAS) obtained highest grain yield (61.48 q ha^{-1}), straw yield 94.39(q ha^{-1}) with increased grain yield by 7.25 q ha^{-1} (11.8 %) and 25.27 q ha^{-1} (41.10 %) over 100% NPK and control. Followed by T10 (75 % NPK + Nano N and Nano P spray at 30 DAS), T6 (75 % NPK + Nano N spray at 30 and 45 DAS), T11 (75 % NPK + Nano N and Nano P spray at45 DAS) as compared to control. Wheat yield characteristics improves with foliar treatment of N and P nano-fertilizers in combination with conventional fertilizers (Abdel-Aziz *et al*., 2016).

Although fertilizers are crucial for the growth and development of plants, the majority of applied fertilizers remain inaccessible to plants due to a variety of processes, including leaching, photolysis, hydrolysis, and decomposition. The function of these nutrients in promoting plant growth is responsible for the improvement in yield attribute and yield at foliar feeding of nano N and P fertilizer with commercial fertilizers. These components are necessary for the plant to flourish at its best and finish its life cycle (Ali, 2012; Al-Taey*et al*., 2017). In order to increase the quality and production of wheat, the nutrients nitrogen, phosphorus, and potassium are among the most important macronutrients (Rahman *et al*., 2014). These processes include the production of chloroplasts and thylakoids as well as the synthesis of chlorophyll (Masoud *et al*., 2012). It also participates in the transfer of energy inside the plant, several enzymatic processes, photosynthesis, respiration, and the synthesis of proteins, and as a result, it is essential for plant growth (Ali, 2012). Wheat was more productive because Nano fertilizer was easily absorbed by the epidermis of leaves and moved to stems, facilitating the uptake of active chemicals (Abdel-Aziz *et al*., 2018). Nano fertilizers contain large surface areas and particles that are smaller than the pore size of plant leaves, which can boost penetration into plant tissues from the applied surface and improve nutrient uptake and usage efficiency (Qureshi *et al*., 2018 and Dimkpa*et al*., 2015). It is generally known that applying foliar nitrogen and phosphorus improves photosynthetic capability, maintains healthy leaf nutrition, and maintains carbon balance (Gosavi*et al*., 2017).

The application of Nano mediated fertilizes significantly influenced the economics of wheat. Economics of any crop directly influences the crop growing by the farmer. It can be directly determined by the B: C ratio of crop. Crop grown with 75 % NPK + Nano N and Nano P spray at 30 and 45 DAS got highest B: C ratio (2.36) with cost of cultivation of 72548 **(**₹ ha^{-1}**)** and net return of 98529.2 (₹ ha^{-1})followed T10 (75 % NPK + Nano N and Nano P spray at 30 DAS), T6 (75 % NPK + Nano N spray at 30 and 45DAS), T11 (75 % NPK + Nano N and Nano P spray at45 DAS and lowest in the crop grown with Control.The higher economics of the wheat is due to the realization of maximum grain yield achieved by the adoption of comprehensive and integrated nitrogen management practices involving optimum level of basal RDF application and foliar nutrition of nano N and P at 30 and 45 DAS stage of the crop (Ajith *et al*., 2021) and (Kumar *et al*., 2021).

Table 1. Effect of foliar application of nano-fertilizers on yield of wheat

Symbol	Treatments	Yield (q ha^{-1})			
		Grain	Straw	Biological	Harvest index
T_1	Control	36.21	50.79	89.21	40.59
T_2	100 % NPK (150:60:40 kg ha^{-1})	54.23	81.78	136.01	39.87
T_3	75 % NPK (112.5: 45: 30 kg ha^{-1})	46.2	66.30	112.5	41.07
T_4	75 % NPK + Nano N spray at 30 DAS	54.32	83.53	137.85	39.41
T_5	75 % NPK + Nano N spray at 45 DAS	53.75	78.54	132.29	40.63
T_6	75 % NPK + Nano N spray at 30 and 45 DAS	56.55	85.45	142	39.82
T_7	75 % NPK + Nano P spray at 30 DAS	53.00	76.41	129.41	40.96
T_8	75 % NPK + Nano P spray at 45 DAS	52.2	73.68	125.88	41.47
T_9	75 % NPK + Nano P spray at 30 and 45 DAS	55.12	79.99	135.11	40.80
T_{10}	75 % NPK + Nano N and Nano P spray at 30 DAS	59.60	87.20	146.8	40.60
T_{11}	75 % NPK + Nano N and Nano P spray at 45 DAS	56.20	82.38	138.58	40.55
T_{12}	75 % NPK + Nano N and Nano P spray at 30 and 45 DAS	61.48	94.39	155.87	39.44

	SEm±	**2.0**	**2.87**	**4.83**	**0.01**
	CD (P = 0.05)	**5.60**	**8.24**	**13.9**	**NS**

Table 2 Effect of foliar application of nano-fertilizers on economics of wheat

Symbol	Treatments	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C Ratio
T_1	Control	62304	98358.15	36054.2	1.58
T_2	100 % NPK (150:60:40 kg ha^{-1})	68294.6	150163.45	81868.9	2.20
T_3	75 % NPK (112.5: 45: 30 kg ha^{-1})	66796	126243	59447.0	1.89
T_4	75 % NPK + Nano N spray at 30 DAS	68164	151219.8	83055.8	2.22
T_5	75 % NPK + Nano N spray at 45 DAS	68164	147576.25	79412.3	2.17
T_6	75 % NPK + Nano N spray at 30 and 45DAS	69532	156673.25	87141.3	2.25
T_7	75 % NPK + Nano P spray at 30 DAS	68304	145000	76696.0	2.12
T_8	75 % NPK + Nano P spray at 45 DAS	68304	142023	73719.0	2.08
T_9	75 % NPK + Nano P spray at 30 and 45DAS	69812	151061.8	81249.8	2.16
T_{10}	75 % NPK + Nano N and Nano P spray at30 DAS	69672	163694	94022.0	2.35
T_{11}	75 % NPK + Nano N and Nano P spray at45 DAS	69672	154433	84761.0	2.22
T_{12}	75 % NPK + Nano N and Nano P spray at30 and 45 DAS	72548	171077.2	98529.2	2.36

Conclusion

Based on the above results, it can be concluded that foliar application of nano-fertilizers not only improves the yield but also have a better economics of crop. Nano-fertilizers can serve as an efficient nutrient delivery system thereby reducing the quantity of nutrients required.

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