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Effect of nano fertilisers on nutrient availability, growth and yield of wheat

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Abstract
The field experiment was carried on the topic Effect of nano fertilizers on nutrient availability, growth and yield of wheat. The experiment was conducted on wheat variety Karan Vandana with six treatments *viz*., T_1 (RDF (120:60:40 kgha^{-1} N: P_2O_5:K_2O), T_2 [Recommended dose of P_2O_5& K_2O+ (50% RDN in one spray +2 spray of Nano Urea)], T_3 [100% N through FYM], T_4 [100%N through Vermicompost], T_5 [50% RDF+25% Vermicompost] and T_6 [75% RDF+ 25% Vermicompost] in RBD replicated three times. The treatment combination consists of FYM, doses of fertilizers and Vermicompost. The study it is concluded that among the different treatments T_2 [Recommended dose of P_2O_5+50% RDN +Nano Urea (2 spray) was found to be the significant treatment in increasing the crop growth, straw yield, plant height, no. of branches per plant, straw yield, grain yield as well as highest benefit: cost ratio of wheat.

Keywords: Nanotechnology, vermicompost, nutrient

Introduction
Nanotechnology is one of the cornerstone technologies in the 21st century. In traditional fertilizers, there is a huge loss of fertilizers by various manners like drift, leaching, runoff, microbial degradation, hydrolysis and photolysis. Bioaccessibility of nutrients to plant is much lower relative to the rate of conventional fertilizers applied. It also gives rise to air and water adulteration. Nutrient use efficiency for standard fertilizers rarely surpasses 30-40% i.e., NUE of conventional nitrogen (30-35%), phosphorus (18-20%), and potassium (35-40%) (Shang *et al*. 2019) [11]. Nano fertilizer nutrient use efficiency (NUE) is high as it is delivered to the site according to the crop demand. Nano fertilizer nutrient release character is according to the crop absorption rate, unlike conventional fertilizer in which nutrient release rate is substantial than crop absorption rate, causing low fertilizer use efficiency and environmental jeopardy (Shang *et al*. 2019) [11]. The engineered nano fertilizers improve crop nutrition more healthily through their unique nutrient releasing property. Concomitantly this can vanquish disease by upgrading plant's safeguarding ability (Adisa *et al*. 2019) [17]. The slow and balanced nutrient discharging style of nano fertilizers contributes to the availability of nutrients to crops for more than 35 days (Thirunavukkarasu *et al*. 2015) [7].
Nano fertilizers facilitate slow and continues release of nutrients and thus reduce the loss of nutrients and enha Nano fertilizers improve crop growth, yield and quality which also increase nutrient use efficiency, reduce wastage of fertilizers and cost of cultivation. These are very effective for nutrient management in precision agriculture and may provide nutrient throughout the crop growth period. (Meena Dharam Singh *et al*., 2017) [4].
The use of nano-fertilizers causes an increase in nutrients use efficiency, reduces soil toxicity, minimizes the negative effects associated with over dosage and reduces the frequency of the application. Thus, nanotechnology has a high potential for achieving sustainable agriculture, (A. Qureshi *et al*., 2018) [3].
In India, Indian Farmers Fertilizer Cooperative Limited (IFFCO), 1st time launched foliar Nano fertilizers developed at IFFCO Nano Biotechnology Research Centre (NBRC), Kalol, Gujarat.

The core of nanotechnology is nanomaterial with up to 100-nanometer particle size and high absorption due to its unique property i.e., high surface area to volume ratio. Nano fertilizer has lower runoff of fertilizers (80%) and surface area 10000 times more than traditional fertilizer (Anonymous 2019a) [53]. Nano fertilizers can potentially reduce volatilization and leaching losses, so the negative impact of fertilizers on the environment can be decreased to a large extent (Zulfiqar *et al*. 2019) [9]. The nutrients makeup in nano fertilizers is in one of three-techniques either the nutrients stay within the nanomaterials like nanotubes, nanoporous substance or enveloped with a fine shielding polymer film or furnished as particle or emulsion of the nanoscale attribute (Derosa *et al*. 2010) [10]. Nutrient liberation from nano fertilizers aligns with the plant's demand, inhibiting the untimely transformation of nutrients to their chemical or gaseous form. In this context, nano fertilizers have a colossal role in bringing down the losses of nutrients from fertilizers.

Crops utilize lower than 50% of the total applied conventional N, P and K fertilizer result in loss by 40-70, 80-90, and 50-90%, respectively (Zulfiqar *et al*. 2019) [9]. These losses have a more significant impact on soil micro biodiversity and soil fertility. Nano fertilizers are now termed smart fertilizers‟ because of their potential to reduce conventional fertilizer dose and diminish environmental menace due to the intelligent nutrient delivery mechanism. Because of its slow releasing property, it can release and make nutrients‟ bioavailability to plant for an extended period, unlike conventional fertilizer, which releases nutrient rapidly and thus finishes it in a short duration.

The use of nano-fertilizers cause an increase in nutrients use efficiency, reduces soil toxicity, minimizes the negative effects associated with over dosage and reduces the frequency of the application. Thus, nano technology has a high potential for achieving sustainable agriculture, (A. Qureshi *et al.*, 2018) [3].

Experimental findings

Results of the present investigation entitled "Effect of nano fertilizers on Nutrients availability, growth and yield of wheat (*Triticum aestivum*)*''*conduct on several quantitative and qualitative aspect are covered during *rabi* season of 2023-2024 has been described in this chapter through, appropriate data tables, bardiagrams and graphical representations and discussed through scientific explanations. The laboratory's research was conducted at the Faculty of Agricultura Sciences and Allied Industries of the Rama University in Kanpur. The results of the study have been presented and discussed under the following headings:

Plant Height (cm)

Plant height of wheat was remarkably influenced at all four growth stages recorded at (30, 60, 90, 120 DAS and at harvest stage) by doses of nano fertilizers during the experiment. The data pertaining to plant height (cm) is presented in Table 4.1and in Fig. 4.1. Plant height of wheat increased progressively with growth of crop. Data showed that plant height increased with the advancement in crop age up to 120 DAS and this increase was rapid during early crop growth period.

A significant effect of use of nano fertilizers was observed on the plant height of wheat at 60, 90, and 120 DAS while at 30DAS it was non-significant. Maximum plant height (73.75, 83.35 and 94.51) were recorded in T_5 at 60, 90, 120 DAS respectively, which was significantly superior over T_1 and T_2. The increase in plant height might be due to better nourishment by nano fertilizers. Plant height is the resultant vegetative and reproductive development of plants. Similar results were also reported by Ghosh and Malic

Dry Matter Accumulation (g/m^2)

Data of dry matter accumulation of wheat was remarkably influenced at all four stages (30, 60, 90, and 120 DAS and harvest stage) by doses of nano fertilizers during the experiment have been given in Table 4.2 and Fig. 4.2. Dry matter accumulation of wheat plant increased remarkably with growth of crop.

At early stage of 30 DAS of growth showed non-significant difference in doses of nano fertilizers. However, in advanced growth stage, dry matter accumulation were significantly affected by dose of nano fertilizers at 60 DAS, 90 DAS and harvest stage. Maximum Dry matter accumulation (385.20, 705.80, and 929.00) were recorded in T_5 [Recommended PK +50% N+2 spray of Nano N +Nano Zn (1 spray) +NanoCu (1spray)] at 60, 90, 120 DAS, respectively which was significantly superior over T_1 and T_2 treatments. The increase in Dry matter accumulation might be due to better nutrition and availability of nutrients by nano fertilizers. The increase in dry matter accumulation might be due to cumulative vigorous growth which in turn put forth more photosynthetic surface, chlorophyll formation, biomass and more nutrient uptake. Increased crop growth rate is attributed to higher drymatter accumulation at periodic intervals.

Similar findings were reported by Mosanna and Berherozyar (2015) [2], Hafeez *et al*. (2015) [26] and Benzon *et al*. (2015) [24].

Leaf Area Index

The data of leaf area index of wheat was remarkably influenced at three stages (30, 60, 90 DAS) have been presented in Table4.4 and depicted in fig 4.4. Leaf area index of wheat plant increased remarkably with growth of crop. The leaf area index increased with the advancement of the crop age upto 90 DAS and thereafter, it decreased. At 30DAS, the effect of treatments on leaf area index was non-significant. Maximum leaf area index 4.75, 4.50 and 3.20 was recorded at 60, 90 and120 DAS, respectively under T_5 treatment which were significantly superior over $T_1$and T_2. The increase in leaf area index might be due to better nourishment by nano fertilizers (Dhoke *et al*., 2013) [57] also reported similar findings.

Number of Tillers meter-2

The data on number of tillers has been presented in Table4.5 and depicted in Fig. 4.5. The number of tillers/meter^{-2} increased with the advancement of crop up to 90 DAS and the maximum increase was observed between 30 and 60 DAS. The maximum number of tillers/m^{-2} were (409.0, 414.60 and 406.20 with T_5 at 60, 90 and 120 DAS respectively, which was significantly superior over rest of the treatments there was no. At 30DAS

Significant difference among the treatments. The increase in number of tillers might be due to better utilization of nutrients by nano fertilizers application that increased with the advancement in crop age and this increase was rapid during early crop growth period. Nano-fertilizers induced increased activity of chloroplast that provide possible underlying mechanism for enhanced growth and increase in number of tillers (Hong *et al*., 2005) [58].

Leaf Area Index

The data of leaf area index of wheat was remarkably influenced at three stages (30, 60, 90 DAS) have been presented. Leaf area index of wheat plant increased remarkably with growth of crop.

The leaf area index increased with the advancement of the crop age up to 90DAS and thereafter, it decreased. At 30 DAS, the effect of treatments on leaf area index was non-significant. Maximum leaf area index 4.75, 4.50 and 3.20 was recorded at 60,90and120 DAS, respectively under T_5 treatment which were significantly superior over $T_1$and T_2. The increase in leaf area index might be due to better nourishment by nano-fertilizers (Dhoke *et al*., 2013) [57] also reported similar findings.

Results and Discussion

Number of effective tillers/meter2giveninTable4.6and illustrated in Fig. 4.6 revealed that effective tillers/meter2 increased significantly with the application of different treatments. Maximum effective tiller/meter2 was 13.22 under T_2 treatment which was significantly superior over rest of the treatments. This might be due to better utilization of nano fertilizers. Further, nano-fertilizers are considered the biological pump for the plants to absorb nutrients and water (Ma *et al*., 2009) [59].

Economics

The treatment wise economic returns were worked out with the help of operating Cost of individual treatments and the cost of production. The data obtained have been presented in the Table 4.14. Variation on gross returns and net returns has been founded by application of treatments. The common cost of cultivation Rs. 29372/-was added for the all treatments for calculation of cost of cultivation. All the treatments gain higher gross return, net return and benefit cost ratio over T_5treatment. The maximum gross return of Rs.104020/ha was obtained with T_5 treatment and lowest gross income Rs. 85450/ha with T_1. Highest net return Rs.73368/- was followed by T_3 (Rs. 65784/ha). However, lowest net return of (Rs. 56078/ha) was found with T_1. Highest benefit cost ration (2.39) was recorded with T_5 followed T_3 (2.14) and T_4 (2.01) treatments, respectively. Whereas minimum B-Cratio was recorded (1.90) with T_1 treatment. Similar findings were also observed by Kumar *et al*. (2014) [37].

Summary

An experiment entitled, "Effect of Nano Fertilizer on Nutrient Availability Growth and Yield of Wheat (*Triticum aestivum* L.)" was conducted during the *rabi* season of 2023-24. The experiment was laid out in randomized block design with 6 treatments *viz*.T_1:RDF (120: 60: 40) kgha-1 N: P_2O_5: K_2O T_2: Recommended dose of P_2O_5 & K_2O +50% RDN in one spray through Nano Urea respectively (2 spray) +2 spray of nano N. T_3 100% N through FYM T_4: 100% N through Vermicompost T_5 50 RDF + 25%Vermicompost + 25% FYM T_6 75% RDF +25% Vermicompost The soil of the experimental field was silt loam in texture, low in organic carbon, available nitrogen, potassium, phosphorous, zinc and copper. The wheat variety Karan Vandana was sown in the experiment.

Full dose of PandK along with half of N were applied as basal dose at the time of sowing through inorganic source of nutrients *viz*. Urea, DAP and MOP, respectively and remaining two half was applied later on. Foliar forms of Nano-N, Cu and Zn were applied as per treatments. Irrigation was applied at regular intervals in wheat as per need. All recommended package and practices visa vis plant protection were uniformly followed in all the treatments. The salient findings of the present investigation have been summarized in this chapter.

1. Application of nano fertilizers had a well pronounced effect on plant height, leaf area index, number of tillers meter-2, dry matter accumulation, leaf area, of wheat crop at almost all growth stages. All these parameters recorded significantly higher in treatment T_2 over T_1 and T_2. However, T_2 was almost at par with rest of the treatments.
2. The nano fertilizer treatments applied in wheat showed effects on yield attributes. The significantly higher number of effective tillers per meter-2 were noted in T_5 while length of spike, number of grains per spike and test weight were non-significant. Grain, straw and biological yield were significantly superior in T_5 over rest of the treatments. Lowest yield was recorded in treatment T_1 (RDF (120:60: 40 kg ha^{-1} N: P_2O_5: K_2O).
3. Among the various nano fertilizer treatments, the maximum available nitrogen,
4. Phosphorus and potassium were recorded in treatment T_1 (RDF (120:60:40kgha-1 P_2O_5:K_2O) which was significantly superior over rest of the treatments. Maximum available Zn and Cu were found under T_5 treatment. However, as regards the available micronutrients, different treatments could not affect significantly. As regard the bulk density, pH, EC and OC different treatments could not affect significantly.
5. Higher gross returns, net return and benefit cost ratio were recorded in treatment T_5 (T_2+ NanoZn (1 spray) +NanoCu (1 spray) whereas, the lowest gross return, net return and benefit cost ratio were recorded in treatment T_1 (RDF (120:60: 40 kgha^{-1} N: P_2O_5: K_2O).

Conclusion

On the basis of one year study, it is concluded that among the different nano fertilizers, treatment T_5 (Recommended PK+50% N+ Nano N (2 spray)+NanoZn (1 spray) +NanoCu (1 spray)was found to be the best treatment in increasing the crop growth, yield as well as h Morales, D.A.B., Ortega, O.A.; Maldonado, Pliego, C.G.M. and Mendoza, A.B. (2017). Application of nano-elemnts in plant nutrition and its impact in ecosystem. Adv. Nat. Sci. Nanosci. Nano technol. 8: 013001.

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