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Effect of Various Nano PGR on Growth and Productivity of wheat (*Triticum aestivum* Var. Shriram Super 252)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Nano PGR is a multifaceted field and has vast application in all spheres of life. But in agriculture the application and utility islimited. Use of nano PGR can assist to tackle these issues to some extent. by bieng more efficient and have longer lasting nutrient release and a higher water holding capacity reducing soil erosion, It also release multiple types of nutrient simultaneously. These nano particles are having high reactivity, better catalytic surface, rapid chemical reaction, rapidly

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dispersible and adsorb abundant water. The present study was conducted in the agricultural experimental farm of Calcutta University, Baruipur, 24 Parganas (south), West Bengal during winter season of 2016 and 2017 to study the "effect of various nano PGR on growth and productivity of wheat (Shriram super 252)" being conducted under slightly acidic lower gangetic alluvial region of West Bengal. The experiment was laid out in a Randomized Complete Block Design with three replications. The treatments of the experiment was T_1 was control ; T_2 = NPK @ 100:50:50 and foliar spray of green Nano PGR @ 0.5ml L^{-1}; T_3 = NPK @ 75:30:30 and foliar spray of Yellow Nano PGR @ 0.5ml L^{-1}; T_4 = NPK @ 75:30:30 and foliar spray of Red Nano PGR @0.5ml L^{-1}; T_5 = NPK @ 75:30:30 and foliar spray of Green Nano PGR @ 1ml L^{-1}; T_6 = NPK @ 75:30:30 foliar spray of Yellow Nano PGR @ 1ml L^{-1}; T_7 = NPK @ 75:30:30 and foliar spray of red Nano PGR @ 1ml L^{-1}; T_8 = NPK @ 75:30:30 and foliar spray of Green Nano PGR @ 1.5ml L^{-1}; T_9 = NPK @ 75:30:30 and foliar spray of Yellow Nano PGR @ 1.5ml L^{-1} ; T_{10} = NPK @ 75:30:30 and foliar spray of Red Nano PGR @ 1.5ml L^{-1} .The recommended dose of inorganic fertilizer was 100:50:50 and 75:30:30 of N, P_2O_5 and K_2O kg ha^{-1}respectively.All the yield attributing characters showed that the usage of different doses of green nano PGR through foliar application has positive effects compared to yellow and red nano PGR and the lowest was from control.

Keywords: Nano PGR; foliar; Gangetic; treatments; micronutrients.

1. INTRODUCTION

The wheat (*Triticum aestivum)* is the major source of plant based human nutrition and a part of daily dietary need in one form or the other. Wheat grains contain 14.7% protein, 2.1% fat, 78.1% starch and 2.1% mineral matter [1]. Soil fertility is an important factor, which determines the growth of plants. Soil fertility is determined by the presence or absence of macro and micronutrients, which are required in minute quantities for plant growth. Micronutrients also enhance plant productivity; leaf area and grain yield as well as enhance the enzymatic system of plants. Micronutrients are elements with specific and essential physiological functions in plant metabolism [2]. Elements B, Cu, Fe, Cl, Mn, Mo and Zn are called "trace elements" [3]. Management practices of Zn leads to improvement of soil Zn status [4]. These are regarded as catalytic agents required for growth in lower amount and serve mainly as constituents of prosthetic groups in metallo-proteins and also as activators of enzymatic reactions. Zinc has been found useful in improving yield and yield components of wheat Cakmak *et al.,*[5]it helps improves early season performance, more tillers and lesser interveinal chlorosis. Zn deficiency is found on many millions of hectares of cereal-growing areas, resulting in significant reductions in yield and quality of food crops [6]. Sensitivity to B deficiency of reproductive development in wheat and other Triticeae cereals, may also be related to B supply to these organs during critical time [7,8]. It is necessary to apply balanced fertilizer in required dose, at proper time and with the proper method this can be done by foliar fertilization i.e. nutrient supplementation through leaves. Foliar application overcomes soil fertilization limitations like leaching, insoluble fertilizers precipitation, antagonism between certain nutrients, heterogenic soils unsuitable for low dosages and fixation/absorption reactions like in the case of phosphorus and potassium Foliar fertilization (or foliar feeding) is a moderately new and contentious technique of feeding plants by applying liquid fertilizer directly to their leaves [9]. Foliar spray of Zn shows better yield in Wheat [10,11]. Nanotechnology has been described as the next great frontier of agricultural science and occupies a prominent position in transforming agriculture and food production through efficient management of soil nutrients. Nano particles as fertilizers can easily be absorbed by plants and they may exhibit prolonged effective duration of nutrient supply in soil or on plant [12]. This research is to evaluate the effect of application of different nano PGR on growth parameters of wheat and assess the effect of different doses of nano PGR on productivity of wheat and also to compare the efficiency of different nano PGR formulations on growth and productivity of wheat.

2. MATERIALS AND METHODS

The experiments was conducted under lower gangetic alluvial region of West Bengal during the rabi season of 2016-17 (December to April) at the agricultural experimental station of Calcutta University, Baruipur, 24 Parganas (south), West Bengal. The field experiment was laid out in Randomized Complete Block Design with 3 replications following micro plot technique.

The individual plot size is 10sq.mt (size of the unit plot 2mx4.5m). The distance between two adjacent replications (block) was 1m. There are 10 treatments(T) where T_1 is control and only N,P,K is added and T_2 to T_{10} are given different doses of nano PGR as given below in Table 1.

Urea, Single Super Phosphate and Muriate of Potash were the sources of N, P_2O_5 and K_2O kg ha^{-1} respectively as mineral fertilizers A fertilizer doses of 100kg N, 50kg P_2O_5 and 50 kg K_2O/ha in the form of urea, single super phosphate and muriate of potash respectively. Dilute solutions of various doses of nano plant growth regulator (PGR) was applied at the rate of 0.5ml $plot^{-1}$(10sq/m), 1.0ml $plot^{-1}$(10sqm) and 1.5ml$plot^{-1}$(10sqm) as foliar spray 52 days after sowing(DAS). Foliar application was done twice during the flowering stage and grain filling stage. The test weight, grain yield tone per hectare (t ha^{-1})no. of spikelet, no. of effective tillers, no. of tillers were recorded after harvesting. Periodic data on the plant height, spike length, were recorded at 30, 60, 90 DAS and after harvesting to find the effect of different treatment's on wheat (Shriram super 252) growth parameters and yield attributes. Grain yield and Biological yield were calculated in kg ha^{-1} and converted to t ha^{-1} and Harvest Index is also obtained according to the following formula:

1.grain yield(kg/ha) = ((grain yield (kg)sub/plot)/ (area sub/plot)) ×1000

2.Biological yield(kg/ha) = ((biological yield (kg)sub/plot)/(area sub/plot))×1000

3.Harvest index (H.I) = ((grain yield)/(biological yield))×100

The results of the experiment obtained from the wheat crop characters, yields and other analysis is taken with statistical analysis and interpretation.

3. RESULTS AND DISCUSSION

Application of different doses of various nano plant growth regulators (PGR) as a foliar spray to the wheat crop showed significant difference on test weight (Table 2). The highest test weight (4.79g) was observed in T_8 with green nano PGR @1.5ml L^{-1} treatment whereas the lowest (3.42g) was with control treatment T_1. Application of various nano plant growth regulators played a significant role on the yield and yield components of wheat (Table 2). The highest grain yield (10.2t ha^{-1}) was achieved from green nano PGR @ 1.5ml L^{-1} treatment T_8, followed by T_2 and T_5 with a grain yield of 9.66 and 9.63t ha^{-1} respectively. Here, it can be stated that application of green nano PGR was more effective than other PGR. The lowest grain yield (4.5 t ha^{-1}) was obtained from the control plot T_1 with no treatment which was significantly different from all other treatments (Table 2). The number of grains per spike was significantly influenced by the application of foliar spray of green nano PGR at different doses. It was found that the maximum number of grains per spike or spikelet 48.33 was achieved from the treatment green nano PGR @ 1.5ml L^{-1} T_8 which was almost statistically similar with T_2 green nano PGR @ 0.5ml L^{-1}. Again, the minimum number of grains per spike (40.33) was obtained from the treatment T_1 (control) plot which was significantly different from all other treatments (Table 2). All the foliar nutrient treatments recorded significantly higher number of grains/spike over the control treatments. The effective number of tillers of wheat were significantly affected by the different doses of nano PGR, having the maximum number of effective tillers under T_8 treatment with foliar spray of green nano PGR @ 1.5ml L^{-1} (13.33) and lowest under T_1 treatment with no foliar spray applied(Table 2). For the variation in the number of tillers, it was found that the number of tillers in wheat crop was significantly affected by the different doses of nano plant growth regulator with the highest number of tiller under T_8,T_2 and T_5 treatment having 12 tillers and lowest in control plot T_1 (4.66) with no treatments(Table 2).

The plant height of the wheat (Shriram super 252) at 30 DAS did not show much difference by the application of 100:50:50 and 75:30:30 of recommended dose of N, P, K fertilizers as per treatment during land preparation and at this stage the nano fertilizer spray was not yet applied(Table 3). Although it was observed that there was a slight difference between the control plot and the treated plots the treated plot had a contribution for slightly higher plant height then the controlled plot. Significant variation in plant height at 60 DAS. The tallest plant height (88.33cm) was observed in the crop field which was treated with T_8 treatment followed with T_2, T_5 (87.66 & 87cm) respectively which was found to be slightly statistically identical. The shortest plant height was observed in T_1 (77.33 cm) which was under a control plot were no treatment was given. Data on final plant height of wheat growth was presented in Table 3. Different treatments with nano plant growth regulator and recommended dose of fertilizer greatly influenced the plant height at 30, 60 and 90 DAS and CD

was found at 5% level of significance. Maximum plant height was observed under T_8 (89.66cm) treated with foliar spray of green nano PGR @ 1.5ml and NPK 75:30:30, followed by T_2 and T_5 with 89.33cm and 88cm respectively, with the shortest plant height under controlled plot with height of 79.66cm. The data on plant height showed that application of green nano PGR had significantly positively affected the plant height of the wheat crop. However, plant height under controlled plot without foliar application of nano PGR, were the shortest among all the treatments. Results revealed that the longest spike length (13.33cm) was achieved from green nano PGR and the shortest spike length (8cm) was obtained from control treatment which was significantly shorter from all other treatments. The results showed that green nano PGR had positive effects to spike length (Table2). There was a significant effect of different levels of nano PGR on spike length of wheat as shown in Table 3. The treatment T_8 (green nano PGR @ 1.5ml L^{-1}) produced the longest spike length (13.66cm). The shortest spike length (8.16cm) was observed in control T_1 treatment. From the above findings, it is conclude that the spike length was enhanced by Green Nano PGR. Nanotechnology-based fertilizers are reported to be more soluble or more reactive than their bulk counterparts [12].

Table 1. Detail of the treatments involved in the experiment during rabi season. The table below shows the details

Treatment combinations	Notation used
T_1 CONTROL	T_1
T_2 NPK @ 100:50:50 and foliar spray of green Nano PGR @ 0.5ml L^{-1}	T_2
T_3 NPK @ 75:30:30 and foliar spray of Yellow Nano PGR @ 0.5ml L^{-1}	T_3
T_4 NPK @ 75:30:30 and foliar spray of Red Nano PGR @0.5ml L^{-1}	T_4
T_5 NPK @ 75:30:30 and foliar spray of Green Nano PGR @ 1ml L^{-1}	T_5
T_6 NPK @ 75:30:30 Foliar spray of Yellow Nano PGR @ 1ml L^{-1}	T_6
T_7 NPK @ 75:30:30 and Foliar spray of red Nano PGR @ 1ml L^{-1}	T_7
T_8 NPK @ 75:30:30 and Foliar spray of Green Nano PGR @ 1.5ml L^{-1}	T_8
T_9NPK @ 75:30:30 and Foliar spray of Yellow Nano PGR @ 1.5ml L^{-1}	T_9
T_{10} NPK @ 75:30:30 and Foliar spray of Red Nano PGR @ 1.5ml L^{-1}	T_{10}

Table 2. Effect of different doses of various nano plant growth regulators as a foliar spray of wheat in Test weight, Grain yield, No. of spikelet, No. of effective tillers and no. of tillers

Sl. No	Treatment combinations.	Test weight (g)	Grain yield (t ha^{-1})	No. of grains/ spikelet.	No of effective tillers.	No of tillers.
1.	T_1 CONTROL	3.42	4.50	40.34	4.34	4.67
2.	T_2 NPK @ 100:50:50 and foliar spray of green Nano PGR @ 0.5ml L^{-1}	4.57	9.67	48.01	12.67	12
3.	T_3 NPK @ 75:30:30 and foliar spray of Yellow Nano PGR @ 0.5ml L^{-1}	4.28	8.13	45.34	7	11.34
4.	T_4 NPK @ 75:30:30 and foliar spray of Red Nano PGR @0.5ml L^{-1}	4.11	6.43	45.67	11.33	10.34
5.	T_5 NPK @ 75:30:30 and foliar spray of Green Nano PGR @ 1ml L^{-1}	4.44	9.63	47.34	12.34	12.00
6.	T_6 NPK @ 75:30:30 Foliar spray of Yellow Nano PGR @ 1ml L^{-1}	3.99	8.01	44.34	10.34	10.67
7.	T_7 NPK @ 75:30:30 and Foliar spray of red Nano PGR @ 1ml L^{-1}	4.02	8.01	45.34	11.34	7.67
8.	T_8 NPK @ 75:30:30 and Foliar spray of Green Nano PGR @ 1.5ml L^{-1}	4.79	10.02	48.34	13.34	12.00
9.	T_9NPK @ 75:30:30 and Foliar spray of Yellow Nano PGR @ 1.5ml L^{-1}	4.34	8.23	46.00	10.00	11.67
10.	T_{10} NPK @ 75:30:30 and Foliar spray of Red Nano PGR @ 1.5ml L^{-1}	3.93	6.97	44.00	7.00	6.34
	SE(d)	0.38	1.68	2.32	2.93	2.67
	CD 5%	0.48	2.80	2.01	1.48	1.63

Table 3. Periodic record of plant height and spikelet height in wheat

Sl. No	Treatment combinations.	30 DAS	60 DAS		90 DAS	
		Plant height	Plant height	Spikelet height	Plant height	Spikelet height
1.	T_1 CONTROL	24.84	77.33	8.00	79.67	8.17
2.	T_2 NPK @ 100:50:50 and foliar spray of green Nano PGR @ 0.5ml L^{-1}	31.34	87.67	13.00	89.34	13.33
3.	T_3 NPK @ 75:30:30 and foliar spray of Yellow Nano PGR @ 0.5ml L^{-1}	28.84	81.67	12.00	86.67	12.33
4.	T_4 NPK @ 75:30:30 and foliar spray of RedNano PGR @0.5ml L^{-1}	25.00	84.67	11.33	86.34	12.00
5.	T_5 NPK @ 75:30:30 and foliar spray of Green Nano PGR @ 1ml L^{-1}	30.34	87.00	12.67	88.00	13.00
6.	T_6 NPK @ 75:30:30 Foliar spray of Yellow Nano PGR @ 1ml L^{-1}	28.34	82.00	12.00	85.34	12.34
7.	T_7 NPK @ 75:30:30 and Foliar spray of red Nano PGR @ 1ml L^{-1}	24.67	84.33	11.33	85.67	11.67
8.	T_8 NPK @ 75:30:30 and Foliar spray of Green Nano PGR @ 1.5ml L^{-1}	31.67	88.33	13.33	89.67	13.67
9.	T_9NPK @ 75:30:30 and Foliar spray of Yellow Nano PGR @ 1.5ml L^{-1}	29.34	85.66	12.33	87.00	12.67
10.	T_{10} NPK @ 75:30:30 and Foliar spray of Red Nano PGR @ 1.5ml L^{-1}	27.00	81.00	11.00	83.00	12.00
	SE(d)	2.66	3.46	1.50	2.98	1.52
	CD 5%	1.89	2.28	1.73	2.98	1.19

Table 4. Grain yield(t ha-1), biological yield(t ha-1) and harvest index(%) of wheat

Treatment	Grain Yield (t/ha)	Straw Yield (t/ha)	Biological Yield	Harvest Index (%)
T_1	4.5	5.9	10.4	43.26
T_2	9.6	10.9	20.5	46.82
T_3	8.1	9.3	17.4	46.45
T_4	6.4	7.9	14.3	44.75
T_5	9.6	11.0	20.6	46.60
T_6	8.1	9.5	17.6	46.02
T_7	9.3	11.1	20.4	45.58
T_8	10.2	11.5	21.7	47.00
T_9	8.2	9.4	17.6	46.59
T_{10}	6.9	8.1	15.0	46,00
SE(d)	1.75	1.77	3.52	1.14
CD 5%				1.99

Harvest index of wheat increased significantly with foliar application of green, yellow and red nano PGR + NPK over control. Maximum harvest index was recorded at 47% in the treatmentT_8receiving nutrient as foliar application of green nano PGR 1.5ml L^{-1} with 47% followed by T_2 (48.82%) and T_5 (46.60%) receiving nutrient as foliar application of green nano PGR 0.5ml $L^{-1}$and 1ml L^{-1} respectively, over that of control to which were not given any

treatments(Table 4). Therefore it was recorded that T_1 (43.26%) had significantly lower harvest index than any other treatments. Similar findings were reported in yield and productivity of wheat plant on addition of micronutrients by Ramatullah et al., [13] but with nano PGRs, it is more environmental friendly as it is required in lesser quantity reducing agricultural waste, therefore it is more beneficial than conventional fertilizers.

4. CONCLUSION

Harvest Index was reported to be increased in all the given treatment. Different doses of the nano PGRs shows positive results with variations from each treatments. The highest test weight , highest grain yield, longest spike length and the maximum harvest index was also recorded in the treatment T_8 receiving nutrient as foliar application of green nano PGR 1.5ml L^{-1} was observed whereas T_1 showed the lowest test weight, the lowest grain yield and shortest spike length .Here, it can be stated that application of green nano PGR was more effective than other PGR. Therefore with the help of nano PGRs, it reported that it maximizes crop yield, reduce crop failure, decreases agricultural waste, and improves environmental stress responses. It will also help farmers in using PGRs in precision agriculture making farming more sustainable and mitigate the effect of climate change on crops.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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