Environment and Ecology 41 (4B) : 2675—2678, October—December 2023
Article DOI: https://doi.org/10.60151/envec/BHSR1892
ISSN 0970-0420

Effect of Plant Growth Regulators and Nano Zinc on Growth and Yield of Wheat (*Triticum aestivum* L.)

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Received 15 January 2023, Accepted 5 May 2023, Published on 29 November 2023

ABSTRACT

The field experiment was conducted during *rabi* 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (UP). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.8), low in the organic carbon (0.49 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments including control each replicated thrice on the basis of one year experimentation. The treatments consist of T_1: Nano zinc 40 ppm + Chloromequat chloride 0.25 mg/l, T_2: Nano zinc 40 ppm + Salicylic acid 400 mg/l, T_3: Nano zinc 40 ppm + Benzyl amino purine 200 mg/l, T_4: Nano zinc 80 ppm + Chloromequat chloride 0.25 mg/l, T_5: Nano zinc 80 ppm + Salicylic acid 400 mg/l, T_6: Nano zinc 80 ppm + Benzyl amino purine 200 mg/l, T_7: Nano zinc 120 ppm + Chloromequat chloride 0.25 mg/l, T_8: Nano zinc 12 ppm + Salicylic acid 400 mg/l, T_9: Nano zinc 120 ppm + Benzyl amino purine 200 mg/l and T_{10}: Control are used. The results obtained that growth parameters viz., plant height (83.50 cm), Number of tillers per plant (12.67) and dry weight (35.12 g/plant) were recorded higher with the application of Nano zinc 120 ppm + Salicylic acid 400 mg/l. Significantly maximum yield parameters viz., number of grains per spike (28.00), number of effective tillers/hill (9.47), and test weight (42.39 g) were recorded superior with the application of Nano zinc 120 ppm + Salicylic acid 400 mg/l.

Keywords FYM, Nano zinc, Salicylic acid, Growth, Yield.

INTRODUCTION

Cereals grains such as wheat (*Triticum aestivum* L.) contain only small concentrations of Zn. Wheat is the second most important crop in India after rice and contributes nearly 35% to the national food basket. India will require 109 million tons of wheat to feed the population of 1.25 Billion by 2020 AD which can be achieved by growth rate of 2.2% but the current

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growth rate is only 1.0%.

According to official sources, the country's wheat production is expected to reach a new record of over 112 million tonnes in the 2022/23 financial year (July-June). Wheat production fell to 106.84 million tonnes in the 2021/22 crop year due to heatwaves in major producing countries, according to Ministry of Agriculture data. In 2020/21, the country achieved a record wheat production of 109.59 million tons. According to the latest data, as of January 6th of the current *rabi* season of the 2022-2023 cropping year (July-June), the area sown by farmers with wheat was 3.3216 million hectares, compared with the same as last year 3,298,800 ha Rajasthan (252,000 ha), Uttar Pradesh (169,000 ha), Maharashtra (120,000 ha), Gujarat (070,000 ha), Chhattisgarh (630,000 ha), Bihar State (0.44 million ha), West Bengal got higher coverage. According to data, Jammu and Kashmir (0.1 million hectares), Assam (0.03 million hectares).

Salicylic acid (SA) induced drought tolerance can be a key trait for increasing and stabilizing wheat production. These SA-induced traits were studied in two *Triticum aestivum* L. Variety; drought-tolerant, kundan and drought-sensitive, Lok1 rehydrates under two different water deficit regimes during vegetative and flowering stages. SA alleviated the adverse effects of water stress on photosynthesis in Kundan. SA provokes a protective response against drought by increasing antioxidant enzymes and osmo regulators (proline and total soluble sugars). Differential proteomics has revealed a key role for carbon metabolism and signaling in enhancing drought tolerance in Kundan, and shifted to defense, energy production and protection in Lok1. Thioredoxin played a key role between SA and redox signaling in activating defense responses. Drought is an important limiting factor for wheat production in most agricultural areas of the world. Water deficit stress significantly decreased yield and total biomass, while cytokinin-treated wheat plants retained higher biomass and yield.

Wheat is an extensively used crop globally. About 50% of the world's population takes wheat as a staple diet. Because wheat contains protein and diet fibers which are compulsory for human nutrition. Wheat is normally grown in rain-fed conditions, but as the drought stress increases yield loss may occur worldwide (Rana *et al.* 2013). Hussain *et al.* (2018) stated that exposing leaves to ZnO NPs enhanced wheat growth and physiology under his Cd stress at normal soil moisture. This mode of exposure of ZnO NPs enhanced antioxidant enzyme activity in Cd-loaded maize plants while also minimizing electrolyte leakage (EL), malondialdehyde (MDA) and hydrogen peroxide (H_2O_2) concentrations (Rizwan *et al.* 2019). Overall, soil application of His ZnO NPs at normal soil moisture (Khan *et al.* 2019) or foliar application alone or in combination with various other supplements mitigated His Cd toxicity in wheat. was previously reported (Ali *et al.* 2019). However, there is little or no information about the foliar effect of ZnO NPs on his Cd uptake by wheat under limited soil-water conditions.

Zinc oxide nanoparticles are nanoparticles of zinc oxide (ZnO) that have diameters less than 100 nanometers. They have a large surface area relative to their size and high catalytic activity. Presently, many kinds of metal oxide NP shave have been applied in agriculture, specifically in fertilization and plant protection in abiotic and biotic stress conditions. Zinc oxide nanoparticles solubility decreases if the soil pH increases and that is the main reason ZnONPs are less available to plants. Transport of these NPs into different plant parts may be limited, due to the presence of different kinds of barrier roots present.

MATERIALS AND METHODS

Field experiments were conducted at the SHUATS Agriculture Department Crop Research Farm in Playa Graj (United States) during *rabi* 2022. The experiment was set up with a Randomized Block Design with nine treatments along with control each replicated thrice based on one season of experimentation. The treatments consists of T_1: Nano zinc 40ppm + Chloromequat chloride 0.25 mg/l, T_2: Nano zinc 40 ppm + Salicylic acid 400 mg/l, T_3: Nano zinc 40 ppm + Benzyl amino purine 200 mg/l, T_4: Nano zinc 80 ppm + Chloromequat chloride 0.25 mg/l, T_5: Nano zinc 80 ppm + Salicylic acid 400 mg/l, T_6: Nano zinc 80 ppm + Benzyl amino purine 200 mg/l, T_7: Nano zinc 120 ppm + Chloromequat chloride 0.25 mg/l, T_8: Nano zinc 120 ppm + Salicylic acid 400 mg/l,

Table 1. Effect of plant growth regulators and nano zinc on growth and post harvest observations on wheat.

Treatments	Plant height (cm)	Number of tillers/ hill	Dry weight (g/plant)
T_1	107.50	7.92	42.13
T_2	110.70	8.14	42.50
T_3	106.00	7.71	41.77
T_4	111.40	8.81	43.39
T_5	112.30	9.71	43.58
T_6	111.30	8.71	42.82
T_7	114.80	9.81	44.41
T_8	115.30	10.48	45.08
T_9	112.40	9.81	43.66
T_{10}	103.40	7.48	40.58
F – test	S	S	S
SEm (±)	1.44	0.11	0.82
CD (p=0.05)	4.29	0.33	2.43

T_9: Nano zinc 120 ppm + Benzyl amino purine 200 mg/l, T_{10}: Control are used.

RESULT

Growth parameters

The perusal of data indicates (Table 1) that plant height measured at (i.e., At harvest), At harvest, higher plant height (115.30 cm) has been recorded with the application of Nano zinc 120 ppm + Salicylic acid 400 mg/l, minimum plant height was recorded in Control (150:60:40) (NPK) kg/ha (103.40 cm) and Nano zinc 120 ppm + Chlormequat chloride 0.25 mg/l (114.80 cm) and Nano zinc 120 ppm + Benzyl amino purine 200 mg/l (112.40 cm) was statistically at par to Nano zinc 120 ppm + Salicylic acid 400 mg/l. highest tillers/hill (10.48) has been recorded with the application of Nano zinc 120 ppm + Salicylic acid 400 mg/l and minimum plant height was recorded in Control (150:60:40) (NPK) kg/ha (7.48), Nano zinc 120 ppm + Chloromequat chloride 0.25 mg/l (9.81) which was statistically at par with Nano zinc 120 ppm + Salicylic acid 400 mg/l. At harvest, the highest plant dry weight (45.08 g) has been recorded with the application of Nano zinc 120 ppm + Salicylic acid 400 mg/l and minimum dry weight was recorded in Nano zinc 40 ppm + Chloromequat chloride 0.25 mg/l (40.58 g), and Nano zinc 120 ppm + Chloromequat chloride 0.25 mg/l (44.41 g), Nano zinc 120 ppm + Benzyl amino purine 200 mg/l (43.66 g) which were statistically at par with Nano zinc 120 ppm + Salicylic acid 400 mg/l.

Yield and yield attribuits

A significantly higher number of tillers/hill (28.00) were recorded with the application of Nano zinc 120 ppm + Salicylic acid 400 mg/l, the minimum was recorded in Control (150:60:40) (NPK) kg/ha (21.20) whereas with the application of Nano zinc 120 ppm + Chloromequat chloride 0.25 mg/l (27.00) were found to be statistically at par with the highest. A significantly higher number of effective tillers per hill (9.47) were recorded with the application

Table 2. Effect of Plant growth regulators and Nano zinc on yield attributes of wheat..

Sl. No.	Treatments	Number of grains/spike	Number of effective tillers/hill	Test weight	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
1	Nano zinc 40 ppm + Chloromequat chloride 0.25 mg/l	23.00	6.91	34.13	5.59	7.49	42.73
2	Nano zinc 40 ppm + Salicylic acid 400 mg/l	24.29	7.13	34.64	5.72	7.54	43.14
3	Nano zinc 40 ppm + Benzyl amino purine 200 mg/l	22.60	6.70	33.20	5.54	7.59	42.20
4	Nano zinc 80 ppm + Chloromequat chloride 0.25 mg/l	25.47	7.80	35.27	5.75	7.46	43.51
5	Nano zinc 80 ppm + Salicylic acid 400 mg/l	26.28	8.70	34.75	5.76	7.50	43.41
6	Nano zinc 80 ppm + Benzyl amino purine 200 mg/l	25.36	7.70	34.16	5.74	7.59	43.03
7	Nano zinc 120 ppm + Chloromequat chloride 0.25 mg/l	27.00	8.80	36.13	5.82	7.63	43.25
8	Nano zinc 120 ppm + Salicylic acid 400 mg/l	28.00	9.47	36.80	5.94	7.65	43.72
9	Nano zinc 120 ppm + Benzyl amino purine 200 mg/l	26.67	8.80	35.47	5.76	7.69	42.81
10	Control (150:60:40) (NPK) kg/ha	21.20	6.47	32.61	5.48	7.41	42.49
	F – Test	S	S	NS	S	S	NS
	Em (±)	0.32	0.14	1.01	0.08	0.05	0.37
	CD (p=0.05)	0.97	0.42	-	0.24	0.16	-

of Nano zinc 120 ppm + Salicylic acid 400 mg/l, the minimum was recorded in Control (150:60:40) (NPK) kg/ha (6.47) whereas with the application of Nano zinc 120 ppm + Chloromequat chloride 0.25 mg/l (8.80) were found to be statistically at par with the highest. Significantly highest test weight (36.80 g) was recorded with the application of Nano zinc 120 ppm + Salicylic acid 400 mg/l, the minimum was recorded in Control (150:60:40) (NPK) kg/ha (32.61 g) and there was no significant difference in between the treatments (Table 2).

DISCUSSION

This increase in height was due to extended intermodal length. Such an increase could be ascribed to higher precursor activity of ZnO NPs in auxin production. Adhikari *et al*. (2015) also reported that the application of ZnO nanoparticles on maize plants enhances plant growth as compared to conventional zinc fertilizer ZnSO.

Nanoparticles with a tiny size and a big effective surface area can easily penetrate the plant, resulting in increased zinc uptake. Zinc acts as an enzyme activator in plants and is directly engaged in the manufacture of auxin, which results in the production of additional cells and dry matter, which is then stored as a sink in seeds. These results were by Parmar Snehalbhai (2016). Application of nano fertilizers to wheat plants activates enzymes by fusing with the formation of chlorophyll in most plants, promoting the formation of growth hormones such as tryptophan. This increase in production is the main place to store carbohydrates in plants, which eventually led to an increased number of seeds per plant as a source and storage of carbohydrates, and increased yield (Afshar *et al.* 2014). This result suggests that Potarzycki and Grzebisz (2009) found that maize grain production was significantly improved by supplying plants with sufficient exogenous nitrogen and zinc, and that increased grain yield was associated with maize yield components such as z consistent with our conclusion that it was due to an increase. Piston length and multiple rows per piston. The number of grains per cob and thousand-grain weight are increased, making the plant more efficient at using nitrogen.

CONCLUSION

It was concluded that, application of Nano zinc 120 ppm with the combination of Salicylic acid 400 mg/l had performed better in growth and yield of wheat.

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