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EFFECT OF ZnO NPs ON GROWTH AND PRODUCTIVITY IN ONION

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ABSTRACT:

Nanotechnology has the potential to refashion agriculture and food industry due to development of new tools for the treatment of diseases and rapid disease detection as well as mechanism to absorb nutrients by plants hence the present study was planned to study the effect of ZnO Np on onion growth and productivity. Sowing was done in second week of June. Thirty days old onion seedlings were transplanted in pots. In each pot, 4 same size seedlings were planted at equal distance and depth. Plants were sprayed with graded concentrations (00, 10, 20, 30, and 40 μg ml^{-1}) of ZnO NPs along with sticker. Plants were treated after every 20 days. Growth parameters like plant height, No. of leaves, Leaf area, etc., were determined after 3 month. Yield parameters like Fresh weight of bulbs and bulb diameter were determined at the time of harvest. The results of present investigation clearly indicate that ZnO NPs applied at 10-20 μg ml^{-1} doses significantly increased plant height, number of leaves per plants and bulb weight.

Key Words: ZnO Nanoparticles, Yield, Growth parameter.

INTRODUCTION:

Agricultural scientists are facing challenges like stagnation in crop yields, low nutrient use efficiency, declining soil organic matter, multi-nutrient deficiencies, weather change, shrinking arable land and water accessibility as well as shortage of labor. In spite of immense constraints, India need to attain a sustainable growth in agriculture at the rate of 4% to meet the food security challenges. To address these problems, there is a need to explore nanotechnology tools to deliver the accurate quantity of nutrients and pesticides that promote productivity while ensuring environmental safety. The nanotechnology can be exploited in the value chain of entire agriculture production system (Subramanian and Tarafdar, 2011).

Various researchers have studied effects of NPs on seed germination and plant growth with the goal to promote their use for agricultural applications (Khot *et al.*, 2012, Raskar and Laware, 2013, Raskar and Laware, 2014). The positive morphological effects of NPs include enhanced percent germination, length of root and shoot and their ratio and vegetative biomass of seedlings in many crop plants like corn, wheat, ryegrass, alfalfa, soybean, rapeseed, tomato, radish, lettuce, spinach, onion, pumpkin and cucumber. Enhancement of many physiological parameters related to plant growth and development were also reported due to NPS in soybean (Lu *et al.,* 2002; Sheykhbaglou, *et al.,* 2010), spinach (Hong, et *al.,* 2005; Zheng *et al.,* 2005; Gao *et al.,* 2006; Yang *et al.,* 2007; Linglan *et al.,* 2008), tomato (Khodakovskaya,*et al.,* 2009) and peanut (Liu,*et al.,* 2010). Hence the present study was planned to study the effect of ZnO Np on onion growth and productivity.

MATERIALS AND METHODS :

Sowing was done in second week of June. Thirty days old onion seedlings were transplanted in pots. In each pot, 4 same size seedlings were planted at equal distance and depth. Plants were sprayed with graded concentrations (00, 10, 20, 30, and 40 μg ml^{-1}) of NPs along with sticker. Plants were treated after every 20 days. Growth parameters like plant height, No. of leaves, Leaf area, etc., were determined after 3 month. Yield parameters like Fresh weight of bulbs and bulb diameter were determined at the time of harvest. Experiments were carried out in triplicate. Data were subjected to statistical analysis: ANOVA (Analysis of variance)

RESULT & DISCUSSION :

1. Growth Parameters:-

1. Plant height:

In case of ZnO NPs treatment, plant height increased up to 20 μg ml^{-1} concentrations (36.00 cm) and it decreased in 40 μg ml^{-1} (28.83 cm) as compared to control plants. In 20 μg ml^{-1} concentration plant height was increased by 16.19% and in 40 μg ml^{-1} concentrations it was decreased by 4.65 %. In control plant height was

30.17 cm while in 10 µg ml^{-1} and 30 µg ml^{-1} concentrations it was 33.01 and 32.35 cm respectively. (Table- 1.1).

2. Number of leaves per plant:

The number of leaves per plant was 7.3 in 20 µg ml^{-1} concentration, which were more than control (6.3); the leaf number was increased by 15.87% over control. Leaf number was decreased to 5.6 in 40 µg ml^{-1} and the decrease was 11.11% over control. Number of leaves per plant was 6.8 and 6.6 in 10 µg ml^{-1} and 30 µg ml^{-1} concentrations of ZnO NPs respectively (Table - 1.1).

3. Leaf area:

Result indicate that the leaf area in ZnO NPs treated plant gradually and significantly increased from 380 to 508 cm^2 with increasing concentration up to 20 µg ml^{-1} concentration of ZnO NPs, it was increased by 33.68% over control and then decreased up to 346 cm^2 in 40 µg ml concentration of ZnO NPs. it was decreased by 8.94% over control (Table - 1.1).

2. Yield parameters

1. Bulb Diameter:

Results on average bulb diameter in both treatments are given Table -1.2 Result suggests that bulb diameter in ZnO NPs treated plants increased (3.09 cm-3.53 cm) from control to 20 µg ml^{-1} concentration of ZnO NPs and then it decreased up to 2.76 cm in 40 µg ml^{-1} concentration of ZnO NPs. Bulb diameter increased by 14.24% in 20 µg ml^{-1} concentration and decreased by 10.68 % 40 µg ml^{-1} concentration of ZnO NPs over control.

2. Weight of Bulb:

Data on weight of bulb in ZnO Np treatments are given in Table-1.2. Results indicate that the weight of 10 bulbs increased from 256.23 gm to 333.36 gm in control to 20 µg ml^{-1} concentration of ZnO NPs and it was decreased up to 198.4 gm in 40 µg ml^{-1} concentration of ZnO NPs over control. Results indicate that lower concentrations enhance productivity and higher concentrations affect the productivity in onion by NPs.

Results depicted in Table-1.1 and Table-1.3 clearly indicates that ZnO NPs at 10 to 30 µg ml^{-1} significantly increased vegetative growth, bulb yield in treated onion plants. The increase in plant height and number of leaves per plant in onion might be due to fundamental role of Zn in protecting and maintaining structural stability of cell membranes (Welch *et al.*, 1982) and use in protein synthesis, membrane function, cell elongation as well as tolerance to environmental stresses (Cakmak, 2000). Tisdale, *et al.* (1985) reported that zinc is involved in auxin metabolism and other enzymatic reactions, which might have increased leaf length.

Deore *et al* (2010) studied the effect of liquid organic fertilizer supplemented with chelated micronutrients (containing Zn) on red pepper and observed increased growth and yield. Similarly Datir *et al.* (2010) studied the effect of organically chelated micronutrients (containing Zn) on growth and productivity in okra and reported increased growth and yield due to chelated micronutrient fertilizer. Datir *et al.* (2012) also reported application of amino acid chelated micronutrients (containing Zn) for enhancing growth and productivity in chili (*Capsicum annum* L.) Prasad *et al.* (2012) suggested that ZnO NPs are absorbed by plants to a larger extent as compared to $ZnSO_4$ bulk. They observed beneficial effects of NPs in enhancing plant growth, development and yield in peanut at lower doses, but at higher concentrations ZnO NPs were detrimental just as the bulk nutrients. Similar results were noted by Racuciu and Creanga (2007) on plant growth in *Zea mays* at early ontogenetic stages due to treatment of magnetic NPs coated with tetramethyl ammonium hydroxide.

CONCLUSIONS:

The results of present investigation clearly indicate that ZnO NPs applied at 10-20 µg ml^{-1} doses significantly increased plant height, number of leaves per plants and bulb weight. Data respect These findings clearly reveal that ZnO NPs played major role in enhancing plant height leaf number and leaf area for light interception and photosynthesis. Results indicate that the lower concentrations of ZnO NPs are not harmful for growth of onion plants. Vegetative growth, leaf area and bulb yield increased in lower concentrations of NPs, however these parameters showed decreased values in treatments with higher concentrations of NPs. The increase in yield in ZnO NP treated plants might be due to more leaf area and by overall increased plant growth.

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Table- 1.1: Effect of ZnO NPs on growth in onion

ZnO NPs (µg ml^{-1})	Height of plant(cm)	PI/PD	Leaves/ plant	PI/PD	Leaf area/ plant (cm^2)	PI/PD
Control	30.17	0.00	6.30	0.00	380.00	0.00
10 µg ml^{-1}	33.01	8.60	6.80	7.93	452.28	19.02
20 µg ml^{-1}	36.00	16.19	7.30	15.87	508.16	33.73
30 µg ml^{-1}	32.35	6.74	6.60	4.76	438.38	15.36
40 µg ml^{-1}	28.83	-4.65	5.60	-11.11	346.82	-8.73
CD 5%	2.83		0.91		29.54	

CD 5%: Critical difference at 5% probability; PI/PD: percent increase/decrease over control

Table -1.2: Effect of ZnO NPs on productivity in onion

ZnO NPs (µg ml^{-1})	Bulb Diameter (cm)	PI/PD	Single bulb Weight (g)	PI/PD	10 bulbs Weight (g)	PI/PD
Control	3.09	0.00	25.67	0.00	256.23	0.00
10 µg ml^{-1}	3.28	6.15	31.24	21.69	320.00	24.88
20 µg ml^{-1}	3.53	14.24	33.33	29.84	333.36	30.10
30 µg ml^{-1}	3.20	3.60	27.53	7.25	278.93	8.85
40 µg ml^{-1}	2.76	-10.68	21.23	-17.29	198.34	-22.59
CD 5%	0.27		2.46		35.19	

CD 5%: Critical difference at 5% probability; PI/PD: percent increase/decrease over control