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Effect of graphene and titanium dioxide NPs on growth and yield characteristics of okra (*Abelmoschus esculentus*)

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Abstract
Influence of different concentration of graphene nanoparticles (NPs) and Titanium dioxide (TiO_2)NPs on growth characteristics like germination percentage, plant height, no of leaves and yield of okra crop of two varieties (NAYAN-11 and STAR-77), was evaluated in pot experiment. The seeds of okra varieties were soaked in different concentrations of graphene NPs (500 ppm and1000 ppm) and TiO_2 NPs (25ppm, 50 ppm and 100 ppm) along with tap water as control. Results showed that graphene NPs at 1000 ppm and TiO_2 NPs at 100 ppm exhibited significant effects on growth and yield characteristics of okra crop.

Keywords: graphene, titanium dioxide, NPs, growth characteristics, okra

Introduction
Okra *Abelmoschus esculentus* (L), a malvaceous vegetable, is cultivated throughout the tropical and warm temperate regions of the world. India is a major vegetable producing and consuming country. Among the cultivated fruit vegetables grown in the country, okra *Abelmoschus esculentus* (L). Moench is one of the important commercially cultivated vegetable crops, popularly called as Bhindi or Lady's finger. It is used in various culinary preparations like sabji, curry and also eaten raw as a salads.

Predicated on their properties like phase, size, distribution and structure of NPs they are considered as unique which have less than 100 nm size. The NPs have more consequentiality in the fields like consumer products, energy and agriculture. NPs designates a particle which have minuscule atomic size is varying in between 1 to 100 nm (Ball, 2002; Roco, 2003) [8], due to their minute size they have different physical and chemical properties compare to other bulk materials (Nel *et al.*, 2006) [6].

Graphene NPs can facilely perforate in to seed and facilitate the more uptake of water which results the expeditious germination. At seedling magnification it is able to perforate root tip cells. The graphene treated plants have lower biomass than the control which shows graphene NPs had different characteristics as compare to other NPs and have different effects on seedling magnification (Zheng *et al.*, 2005) [11]. Low dose of graphene can promote the seed germination (Yijia *et al.*, 2018) [10]. Titanium dioxide is infrequently found ninth element and second transition metal found in earth crust. The consequential effect of titanium compound on the plants is to augment the yield upto 10 to 20 % through improving biochemical characteristics. Lower concentration of TiO_2 can increment the seed germination and magnification of seedling in comparison to high concentration of TiO_2 (Feizi *et al.*, 2013) [2]. TiO_2 NPs are efficient nutrient source for plants to promote biomass due to increment in metabolic activities, and utilization of nutrients by incrementing microbial activities (Raliya *et al.*, 2015).

In view the facts described above, an experiment was conducted to study the effect of graphene and titanium dioxide NPs on growth and development of okra plants.

Materials and Methods
The experiment was carried out during *zaid* season Department of Biological Sciences, SHUATS, Allahabad (U.P.) which is located at 25º 24' 42" N latitude, 81º 50' 56" E longitude and 98 m altitude above the mean sea level. The climate of Allahabad city is subtropical. The winter season is very cold (temperature reaching as low as 2.5ºC and in summer season temperature reaching up to 48ºC. The experiment was laid out in CRD design with six treatments and four replication. Seeds of okra varieties (NAYAN-11&STAR-77) were used for the experimental purpose.

Seeds of both the okra varieties were soaked with different concentrations of graphene NPs (500 ppm and 1000 ppm) and TiO_2 NPs (25 ppm, 50 ppm and 100 ppm) along with tap water as control.

Growth parameters

The various growth characteristics like germination percentage, plant height, no. of leaves are discussed below.

1. Germination (%)

The seeds were drawn randomly from each treatment and the germination test was conducted by adapting the between paper method at $25+10^{C}$ and 98+1% relative humidity in the seed germinator in four replications of 100 seeds each. On seventh day of germination test, the number of normal seedlings germinated were counted and expressed as germination percentage.

Germination (%) = seed sprouted / total seeds sprouted) X 100.

2. Plant height (cm)

The plant height was measured from base of the plant to the tip of the main shoot for three randomly tagged plants with the help of scale at 20 and 40 DAS. The average of three plants was computed and expressed as the plant height in centimeters.

3. Number of leaves per plant

The numbers of green trifoliate leaves present on each plant were counted manually from the three tagged plants at 30 and 60 DAS. The mean number of leaves per plant was calculated and expressed in number of leaves per plant.

4. Yield per plant

The total number of fruits from plants was counted manually from each treatment. Average was worked out and recorded as number of fruits per plant.

Results and discussion

1. Growth parameters

The various growth characteristics like germination percentage, plant height, no. of leaves are discussed below.

1. **Germination percentage (%)** The maximum germination percentage was observed (1000ppm graphene) (97%) and minimum germination percentage was observed in (100ppm TiO_2) (60%).
2. **Plant height (cm) –** The maximum plant height was observed in control (9.6cm) at 20 and control (21.5cm) at 40 DAS and minimum plant height was observed in treatment 1000ppm gaphene (6.7 cm).at 20 and 100ppm TiO_2(16.2 cm).at 40 DAS.
3. **Number of leaves per plant –** The maximum number of leaves per plant was observed in 500ppm graphene, 25ppm TiO_2, 50ppm TiO_2 (4.0) at 20 DAS and (100ppm TiO_2) (7.0) (V1T5) at 40 DAS and minimum number of leaves per plant was observed in treatment control (3.2).at 20 DAS and (1000ppm graphene) (6.0) (V1T2) at 40 DAS.

Table 1: Effect of graphene and titanium dioxide NPs on germination percentage (%) in okra varieties (NAYAN-11 and STAR-77)

Germination percentage (%)		
Treatments	**Nayan-11**	**STAR-77**
T0(control)	80	80
T1(500 ppm graphene)	93	85
T2(1000 ppm graphene)	97	90
T3(25 ppm TiO_2)	78	80
T4(50 ppm TiO_2)	76	70
T5(100 ppm TiO_2)	75	60

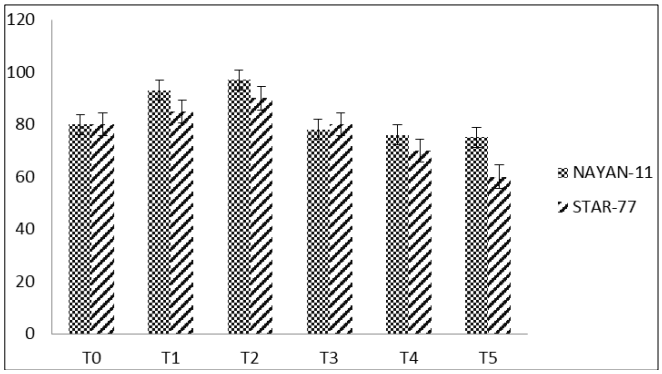

Fig 1: Effect of graphene and titanium dioxide NPs on germination percentage in okra varieties (NAYAN-11 and STAR-77)

Table 2: Effect of graphene and titanium dioxide NPs on plant height (cm), no. of leaves at 20 and 40 DAS in okra varieties (NAYAN-11 and STAR-77)

	Plant height (cm) at 20 and 40 DAS				**Number of leaves at 20 and 40 DAS**			
	20 DAS		**40 DAS**		**20 DAS**		**40 DAS**	
Treatments	**Nayan-11**	**Star-77**	**Nayan-11**	**Star-77**	**Nayan-11**	**Star-77**	**Nayan-11**	**Star-77**
T0(control)	9.60	7.70	21.56	18.95	3.50	3.25	6.75	7.00
T1(500 ppm graphene)	9.50	8.19	19.89	19.78	4.00	3.75	6.50	7.75
T2(1000 ppm graphene)	8.70	6.78	21.29	17.14	3.75	3.75	6.00	7.00
T3(25 ppm TiO_2)	8.86	7.15	20.58	17.09	4.00	4.00	6.25	6.75
T4(50 ppm TiO_2)	8.90	6.95	20.85	19.05	4.00	3.75	6.75	7.25
T5(100 ppm TiO_2)	7.31	7.60	16.24	19.28	3.75	4.00	7.00	7.00
Mean	8.81	7.39	20.07	18.55	3.83	3.75	6.54	7.13
C.V.	10.10	18.17	17.05	14.03	19.92	22.66	14.97	11.58
S.E	0.45	0.67	1.71	1.30	0.38	0.43	0.49	0.41
C.D.5%	1.32	1.99	5.08	3.87	1.14	1.26	1.45	1.23

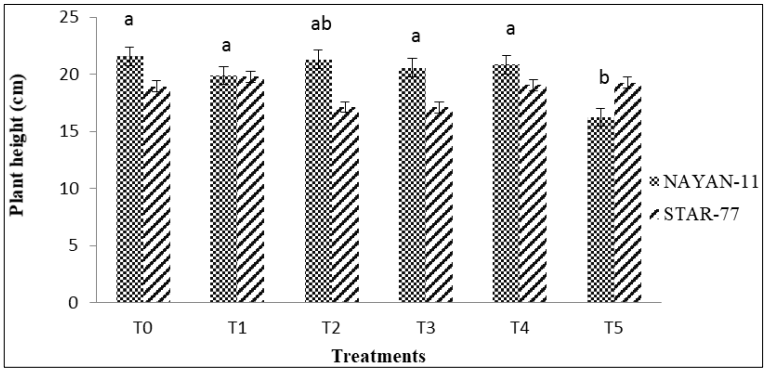

Fig 2.1: Effect of different concentration of graphene and titanium dioxide NPs on plant height (cm) at 20 DAS in okra varieties (NAYAN-11 and STAR-77)

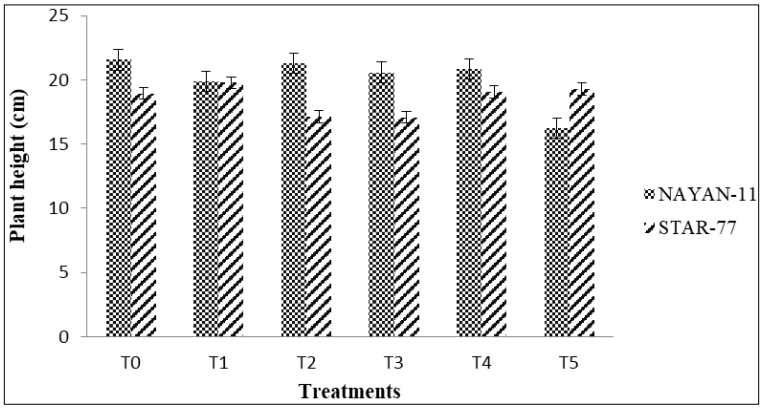

Fig 2.2: Effect of different concentration of graphene and titanium dioxide NPs on plant height (cm) at 40 DAS in okra varieties (NAYAN-11 and STAR-77)

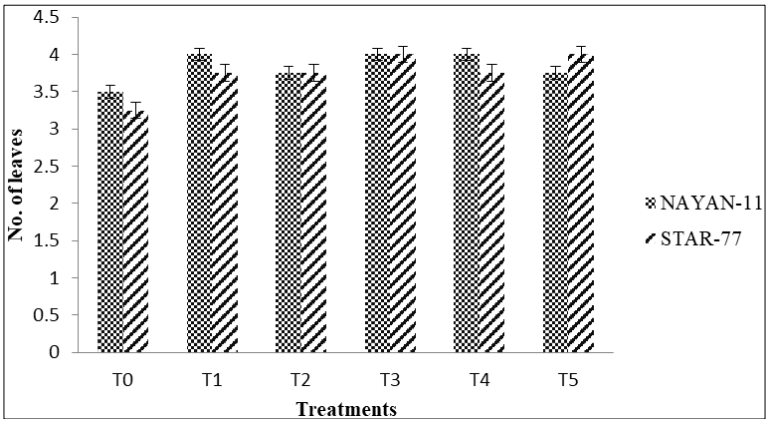

Fig 3.1: Effect of different concentration of graphene and titanium dioxide NPs on number of leaves at 20 DAS in okra varieties (NAYAN-11 and STAR-77)

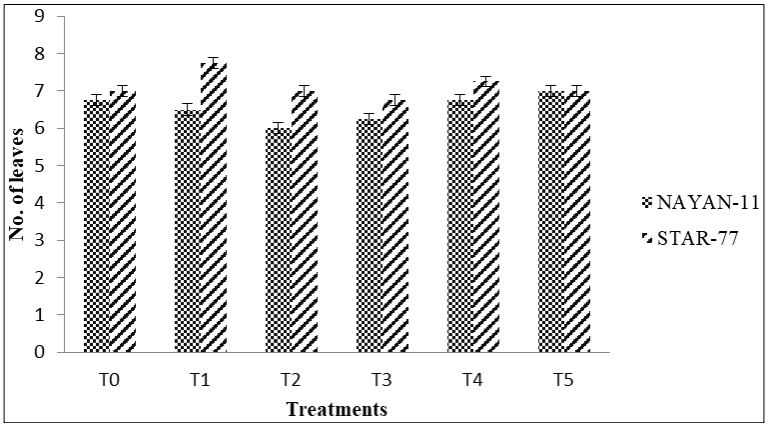

Fig 3.2: Effect of different concentration of graphene and titanium dioxide of graphene and titanium dioxide NPs on number of leaves at 40 DAS in okra varieties (NAYAN-11 and STAR-77)

Discussion

Different concentrations of graphene NPs are used among those, 1000 ppm graphene promote seed germination by penetrating the seed coat same results found in wheat crop (Zheng *et al.*, 2005) [11]. Different concentrations of graphene NPs are used among those rapid germination of seed and higher percentage of germination rates graphene showed to unfavourably affect seedling biomass accumulation graphene penetration of vacuole and its deposition in root tips were two causing factors for biomass production reduced. Different concentrations of TiO_2 NPs are used among those, nano sized 25 ppm TiO_2 in an appropriate concentration could increase the germination of seed and growth of seedling in comparison to bulk TiO_2, similar results are reported in wheat (Feizi *et al.*, 2013) [2]. Different concentrations of TiO_2 NPs are used among those, nano sized 25 ppm TiO_2increase plant growth when seeds were soaked in NPs or sprayed with NPs, similar results are reported in (Zheng *et al.*, 2005) [11].

Conclusion

Among the treatments 1000 ppm graphene NPs, 100 ppm TiO_2 NPs was found to be most favouring to morphological parameters in both the varieties. 100 ppm TiO_2 NPs was favours the yield of okra crop. Between both the varieties, NAYAN-11 showed better performance than STAR-77 in growth and yield parameters in okra crop.

References

1. Corredor E, Risueno MC, Testillano PS. Carbon-iron magnetic NPs for Agronomic use in Plants. Plants Signalling and Behavior. 2010; 5(10):1295-1297.
2. Feizi H, Kamali M, Jafari L, Rezvani, Moghaddam P. Phytotoxicity and stimulatory impacts of nano sized and bulk titanium dioxide on fennel (*Foeniculum vulgare* Mill). Chemosphere. 2013; 91(4):506-511.
3. Hong F, Yang F, Liu C, Gao Q, Wan Z, Gu F *et al*. Influence of nano-TiO2 on the chloroplast aging of Spinach under light. Biological Trace Element Research. 2005a; 104:249-260.
4. Lei Z, Mingyu S, Chao L, Liang C, Hao H, Xiao W *et al*. Effects of nano anatase TiO2 on photosynthesis of spinach chloroplasts under different light illumination. Biol Trace Elem Res. 2007; 119:68-76.
5. Mishra V, Mishra RK, Dikshit A, Pandey AC. Interactions of NPs with plants: an emerging prospective in the agriculture industry. In: Ahmad P, Rasool S (eds) Emerging technologies and management of crop stress tolerance: biological techniques. 2014; 1:159-180.
6. Nel A, Xia T, Madler L, Li N. Toxic potential of materials at the nano level. Science. 2006; 311:622-627.
7. Raliya R, Tarafdar JC. Zn ONPs biosynthesis and its effect on phosphorous-mobilizing enzyme secretion and gum contents in cluster bean (*Cyamopsis tetragonoloba* L.), 2013.
8. Roco MC. Broader societal issue on nanotechnology. Journal of NPs Research. 2003; 5:181-189.
9. Yang F, Hong F, You W, Liu C, Gao F, Wu C *et al*. Influence of nano-anatase TiO2 on the nitrogen metabolism of growing spinach. Biol Trace Elem Res. 2006; 110(2):179-190.
10. Yijia He, Ruirui Hu, Yujia Zhong, Xuanliang Zhao, Qiao Chen Hongwei Zhu. Graphene oxide as a water transporter promoting germination of plants in soil. Nano research. 2018; 11(4):1928-1937.
11. Zheng L, Hong F, Lu S, Liu C. Effect of nano-TiO2 on strength of naturally aged seeds and growth of spinach. Biol Trace Elem Res. 2005; 105:83-91.