The Pharma Innovation Journal 2022; 11(2): 1259-1263

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(2): 1259-1263

www.thepharmajournal.com
Received: 12-11-2021
Accepted: 22-01-2022

U Jayvanth Kumar
Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Mahendra Bairwa
Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Khushbu
Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Manisha Rolaniya
Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
U Jayvanth Kumar
Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of different concentrations of iron oxide and zinc oxide nano-particles on quality of strawberry (*Fragaria x ananassa* Dutch) cv. chandler

U Jayvanth Kumar, Mahendra Bairwa, Khushbu and Manisha Rolaniya

Abstract
The field experiment was carried out at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, India during Rabi season (Nov-April) 2016-17. The experiment was laid out in 4×4 factorial randomized block design with 16 treatments in three replications. It is concluded that the treatments T_{15} (Z_3F_3: ZnO NPs@150ppm + FeO NPs @150ppm), were found best in terms of quality parameters namely TSS (16.97 ^{0}B), acidity (0.51), pH(3.36), ascorbic acid (57.43) chlorophyll 'a'(2.70) chlorophyll 'b'(3.87) and total chlorophyll content (4.77) was obtained in T_{15} (Z_3F_3: ZnONPs@150ppm + FeO NPs@150ppm).

Keywords: Strawberry, Zinc oxide, iron oxide nano-particles, quality

Introduction
The modern cultivated strawberry *(Fragaria x ananassa* Dutch.) is a hybrid of two largely dioeciousoctoploid species, *Fragaria chelonesis* Dutch *and Fragaria varginiana* Dutch. Fragaria species belongs to family Rosaceae with a basic chromosome number of X=7, the cultivated strawberry *Fragaria X ananassa* Dutch. Has chromosome number (2n) of 56. Basically, it is herbaceous perennial and short day plant grows predominantly in the temperate climate. Among all the different types of berries, strawberry gives the quickest return in a shortest possible period. (Boriss *et al.,* 2006) [2]. The area under fruit production in India is 6405 thousand hectares with a production of 91443.41 thousand metric tons (2015-16). Area under Strawberry production is one thousand hectares with production 5 thousand metric tons in (2015-16). Leading states in area and production of strawberry are Meghalaya, Himachal Pradesh and Jammu & Kashmir. (Area and Production of Horticulture Crops–Govt. of India). Over the last few years, strawberries have experience one of the highest rate of consumption growth, where it is the highest consumed fresh fruits, rich in proteins, minerals Ca, P and K, fair source of Vit. A, B1, B2, niacin and Vit. C and it is regarded as one of the best natural sources of antioxidant. Besides, strawberry can be processed for making wine, jam, jelly, ice cream and soft drinks etc. In India, strawberry is confined only to the Hilly Tracts of Himachal Pradesh, Uttaranchal, parts of Uttar Pradesh and Kashmir valley. However, its cultivation has spread to tropical and subtropical zones, where other states like Meghalaya, Sikkim and Mizoram have taken up the cultivation of this viable fruit. So far, Maharashtra is the leading state in the production of strawberry. (Lyngdoh, 2014) [11].
Nanotechnology research is one of the major emerging areas of research with its application in science and technology for the purpose of manufacturing new materials at the nanoscale level (Albrecht *et al.*, 2006.) [1]. The use of nanoparticles on growth of plants and for the control of plant diseases is a rather recent practice (Zheng *et al.*, 2005: Shah & Belozerova 2009). However, interests in reasearchs have been increasing on the biological effects of nanopaticles on higher plants. The prefix nano is derived from the greek word nanos meaning "dwarf" that refers to things of one billionth (10 -9 m) in size. The term nanotechnology was coined by Professor Norio Taniguchi of Tokyo Science University in 1974 to describe the precision of the industrialized biomaterials at the nanometer level (Taniguchi, 1974) [21], (Raliya and Tarafdar 2013) [14] reported that ZnONPs induced a significant improvement in Cyamopsis tetragonoloba plant biomass, shoot and root growth, root area, chlorophyll and protein synthesis, rhizospheric microbial population, acid phosphatase, alkaline phosphatase and phytase activity in cluster bean rhizosphere. It is evident from the correlative light and scanning microscope, and inductive coupled plasma/atomic emission spectroscopy that

seedling roots of *Vignaradiata* and *Cicer arietinum*a bsorbed ZnONPs and promoted the root and shoot length, and root and shoot biomass (Mahajan *et al.,* 2011) [12]. Nano ZnO supplemented with MS media promoted somatic embryogenesis, shooting, regeneration of plantlets, and also induced proline synthesis, activity of superoxide dismutase, catalase, and peroxidase thereby improving tolerance to biotic stress (Helaly *et al.,* 2014) [8]. Nano iron oxide at the concentration of 0.75g/L increased leaf +pod dry weight and pod dry weight. The highest grain yield was observed by using 0.5g/L nano iron oxide that showed 48% increase in grain yield in comparison with control. Other measured traits were not affected by the iron nanoparticles. Treatments were five levels of nano-iron oxide (0,0.25, 0.75 & 1 g/L) (Sheykhbaglou *et al.,* 2010) [18].

Keeping in view the role of NPs, the present investigation has taken up to find out the most suitable dose of ZnO NPs and FeO NPson on quality of Strawberry.

Materials and methods

The experiment was conducted during *rabi* season 2016-17 on crop research farm of Department of Horticulture, Naini Agricultural Institute, Prayagraj. The area is situated on the south of Prayagraj on the right side of the river Yamuna on the South of Rewa road at a distance of about 6 km from prayagraj city. It is situated at 25024'23" N latitude, 81050'38" E longitude and at the altitude of 98 meter above the sea level (MSL).

The treatment consisted of different levels of zinc oxide and Iron oxide,T_o (Control), T_1 Z_1 (50ppm ZnO NPs), T_2 Z_2 (100 ppm ZnO NPs), T_3 Z_3(150 ppm ZnO NPs),T_4 F_1(50 ppm FeO NPs), T_5F_2(100 ppm FeO NPs), T_6 F_3 (150 ppm FeO NPs), T_7 Z_1 F_1 (50ppm ZnO NPs + 50ppm FeO NPs), T_8 Z_2 F_1(100ppm ZnO NPs + 50ppm FeO NPs), T_9 Z_3 F_1 (150ppm ZnO NPs+ 50ppm FeO NPs), T_{10} Z_1F_2 (50ppm ZnO NPs + 100ppm FeO NPs), T_{11} Z_2 F_2 (100ppm ZnO NPs+ 100ppm FeO NPs), T_{12} Z_3 F_2 (150ppm ZnO NPs + 100ppm FeO NPs), T_{13} Z_1F_3 (50ppm ZnO NPs + 150ppm FeO NPs), T_{14} Z_2F_3 (100ppm ZnO NPs + 150ppm FeO NPs), T_{15} Z_3F_3 (150ppm ZnO NPs + 150ppm FeO NPs). The trial was laid out in a factorial randomized block design with three replication (*Fragaria x ananassa* Dutch) cv. Chandler were applied uniformly in all the plots using recommended dose of nitrogen, phosphorus and potassium respectively. Basal dose of fertilizer was applied as Farm Yard Manure in the plots. All the agronomic practices were carried out uniformly to raise the crop.

Results and discussions

The data presented in Table and Fig. clearly shows that the maximum total soluble solids (16.53^0brix) was recorded in fruit receiving T_3Zinc Oxide (150ppm). Minimum total soluble solids (8.56^0brix) was recorded in fruit with T_0(control).It also found that foliar spray of Iron Oxide increases total soluble solids and maximum total soluble solids (14.14^0brix)were recorded with T_6(150ppm). A minimum total soluble solids (12.22^0brix) were noticed with T_0(control). The interaction between Zinc Oxide and Iron Oxide was found significant. Maximum TSS was recorded with treatment T_{15} ($16.97\ ^0$ B) followed by treatment T_7 (12.30^0 B) whereas; treatment T_0 shows minimum TSS ($6.70\ ^0$ B). These results are closely confined with (Davarpanah *et al.,* 2013 and Dhoke *et al.,* 2013) [4, 6].

The data presented in Table and Fig. clearly shows that the maximum acidity (0.80) was recorded T_0 (control), minimum (0.59) was recorded in fruit with receiving Zinc Oxide (150ppm). It also found that foliar spray of Iron Oxide and maximum acidity (0.73) was recorded with T_0 (control). A minimum (0.67) were noticed with T_6Iron Oxide (150ppm). The interaction between Zinc Oxide and Iron Oxide was found significant. Maximum acidity was recorded with treatment T_{15} (0.51) followed by treatment T_7 (0.76) whereas; treatment T_0 shows minimum acidity (0.82).

The data presented in Table and Fig. clearly shows that the maximum pH of fruit (5.40) was recorded T_0 (control), minimum (3.72) was recorded in fruit with receiving Zinc Oxide (150ppm). It also found that foliar spray of Iron Oxide and maximum pH (4.78) was recorded with T0 (control)). A minimum (4.19) were noticed with T_6Iron Oxide (150ppm).The interaction between Zinc Oxide and Iron Oxide was found non-significant. By the mean it was seen that the interaction between Zinc Oxide and Iron Oxide minimum (3.37) was recorded in T_{15} Z_3F_3(150ppm ZnO NPs and 150ppm FeO NPs), which was higher than other treatment. The maximum (5.90) was recorded in T_0 (control).

Data pertaining to the effect of foliar application of Zinc Oxide and Iron Oxideon ascorbic acid content is given in table and graphically reflected by fig. Maximum ascorbic acid (54.25mg/100g) was recorded with ZnO NPs T_3 (ZnO NPs150ppm), minimum ascorbic acid was (41.44mg/100g) with T_0 (control) which was significant. It also found that foliar spray of Iron Oxide and maximum ascorbic acid (49.32 mg/100g) was recorded with T_6Iron Oxide (150ppm). A minimum (45.66 mg/100g) were noticed with T_0(control).The interaction between Zinc Oxide and Iron Oxide on ascorbic acid was non-significant. By the mean it was seen that the interaction between Zinc Oxide and Iron Oxide maximum (57.43mg/100g) ascorbic acid was recorded in T_{15} Z_3F_3(150ppmZnO NPs and 150ppm FeO NPs), which was higher than other treatment. The minimum ascorbic acid was (40.13mg/100g) was recorded in T_0(control).

Data pertaining to the effect of foliar application of Zinc Oxide and Iron Oxide Chlorophyll 'a' content is given in table and graphically reflected by fig. Maximum Chlorophyll 'a' content (2.46) was recorded with ZnO NPs T_3 (ZnO NPs 150ppm), minimum Chlorophyll 'a' content was (1.33) with T_0 (control) which was significant. It also found that foliar spray of Iron Oxide and maximum Chlorophyll 'a' content (2.03) was recorded with T_6Iron Oxide (150ppm). A minimum (1.73) were noticed with T_0 (control)) which was significant. The interaction between Zinc Oxide and Iron Oxide on chlorophyll' a' content was non-significant. By the mean it was seen that the interaction between Zinc Oxide and Iron Oxidemaximum (2.7) chlorophyll 'a' content was recorded in T_{15} Z_3F_3(150ppmZnO NPs and 150ppm FeO NPs), which was higher than other treatment. The minimum chlorophyll 'a' content was (1.2) was recorded in T_0 (control). These results are closely confined with (Javadimoghadam *et al.,* 2015 and Ganesan *et al.,* 2016) [9, 7].

Data pertaining to the effect of foliar application of Zinc Oxide and Iron Oxide Chlorophyll 'b' content is given in table and graphically reflected by fig. Maximum was Chlorophyll 'b' content (3.69) recorded with ZnO NPs,T_3 (ZnO NPs 150ppm), minimum Chlorophyll 'b' content was (2.31) with T_0 (control) which was significant. It also found that foliar spray of Iron Oxide and maximum chlorophyll 'b' content (3.15) was recorded with T_6Iron Oxide (150 ppm). A minimum (2.81) were noticed with T_0 (control)) which was significant. The interaction between Zinc Oxide and Iron Oxide on Chlorophyll 'b' content was non-significant. By the mean it was seen that the interaction between Zinc Oxide and Iron Oxidemaximum (3.87) chlorophyll 'b' content was recorded in T_{15} Z3F3(150ppmZnO NPs and 150ppm FeO NPs), which was higher than other treatment. The minimum chlorophyll 'b' content was (2.17) was recorded in T_0-(control).

Data pertaining to the effect of foliar application of Zinc Oxide and Iron Oxide total chlorophyll content is given in table and graphically reflected by fig. Maximum was total chlorophyll content (4.65) recorded with ZnO NPs T_3 (ZnO NPs 150ppm), minimum total chlorophyll content was (3.30) with T_0 (control) which was significant. It also found that foliar spray of Iron Oxide and maximum total chlorophyll content (4.11) was recorded withT_6Iron Oxide (150ppm). A minimum (3.81) were noticed with T_0 (control) which was significant. The interaction between Zinc Oxide and Iron Oxide on total chlorophyll content was non-significant. By the mean it was seen that the interaction between Zinc Oxide and Iron Oxide maximum (4.77) total chlorophyll content was recorded in T_{15} Z3F3(150ppmZnO NPs and 150ppm FeO NPs, which was higher than other treatment. The minimum total chlorophyll content was (3.20) was recorded in T_0(control). These results are closely confined with (Khalid *et al.*, 2013, Javadimoghadam *et al.*, 2015 and Ganesan *et al.*, 2016) [10, 9, 7].

Table 1: Influence of various treatments on Quality of Strawberry.

Treatment	TSS(^{0}brix)	Acidity (%)	pH	Ascorbic acid
T_0	6.70	0.82	5.90	40.13
T_1	12.83	0.77	4.86	43.93
T_2	13.20	0.71	4.43	46.46
T_3	16.13	0.64	3.93	52.13
T_4	7.40	0.81	5.66	40.53
T_5	9.17	0.80	5.10	41.76
T_6	10.97	0.78	4.96	43.33
T_7	12.30	0.76	4.63	44.50
T_8	12.37	0.76	4.63	45.03
T_9	13.10	0.74	4.50	46.30
T_{10}	13.87	0.71	4.00	47.60
T_{11}	14.73	0.68	3.96	49.80
T_{12}	15.53	0.66	3.93	50.23
T_{13}	16.50	0.61	3.86	53.20
T_{14}	16.50	0.59	3.73	54.23
T_{15}	16.97	0.51	3.36	57.43
F-test	S	S	S	S
S.Ed. (±)	0.34	0.01	0.26	1.03
C.D. (at 5%)	1.00	0.02	0.74	3.02

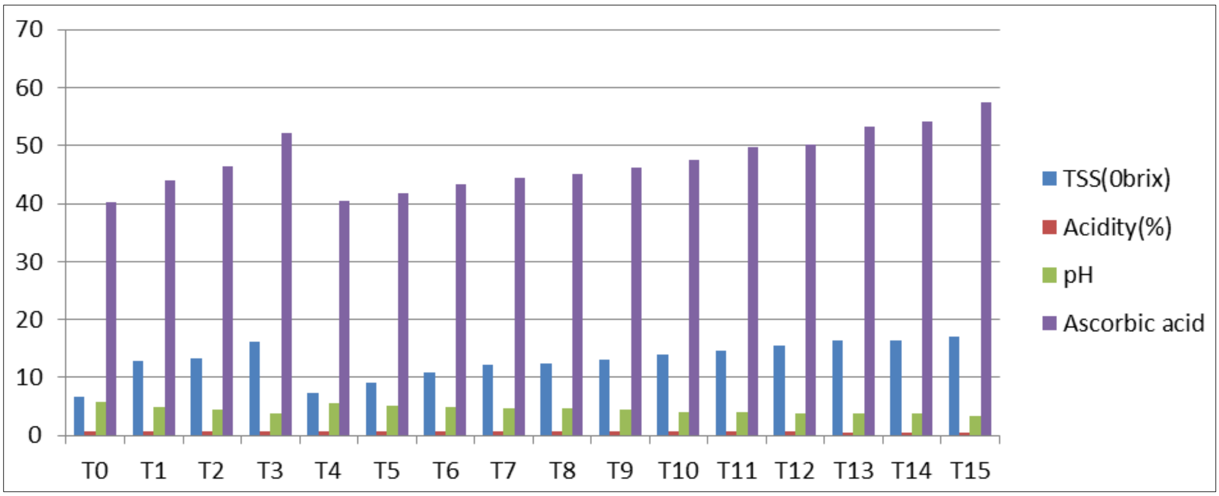
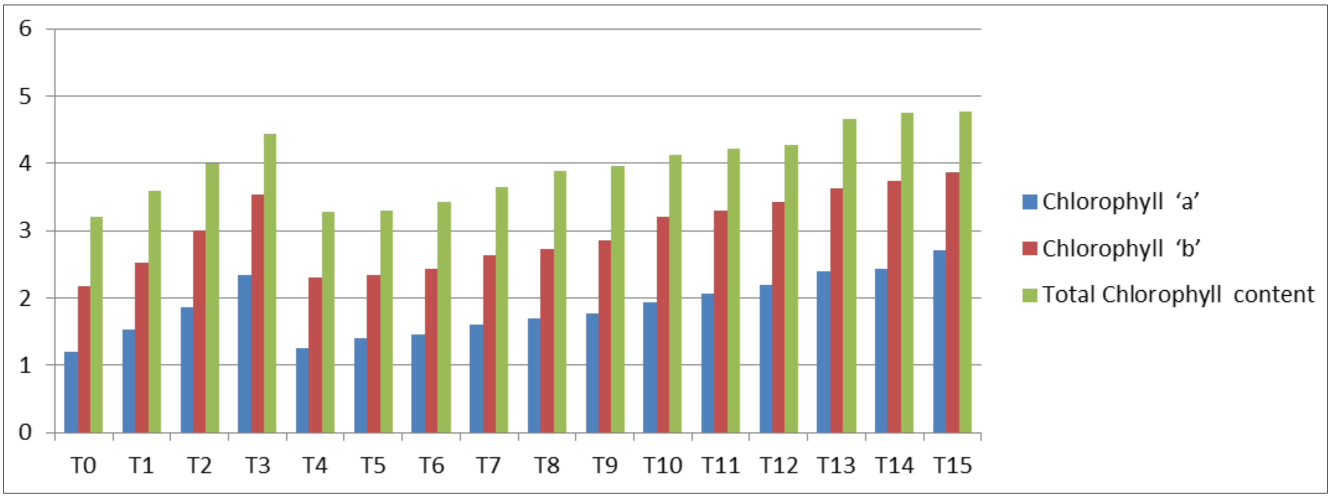


Table 2.

Treatment	Chlorophyll 'a'	Chlorophyll 'b'	Total Chlorophyll content
T_0	1.20	2.17	3.20
T_1	1.53	2.53	3.59
T_2	1.86	3.00	4.00
T_3	2.33	3.53	4.44
T_4	1.26	2.30	3.28
T_5	1.40	2.33	3.29
T_6	1.46	2.43	3.43
T_7	1.60	2.63	3.65

T_8	1.70	2.73	3.89
T_9	1.76	2.86	3.96
T_{10}	1.93	3.20	4.12
T_{11}	2.06	3.30	4.21
T_{12}	2.20	3.43	4.28
T_{13}	2.40	3.63	4.65
T_{14}	2.43	3.73	4.75
T_{15}	2.70	3.87	4.77
F-test	S	S	S
S.Ed. (±)	0.07	0.06	0.11
C.D. (at 5%)	0.20	0.18	0.33



Conclusion

On the basis of present investigation in both successive year 2016-17, it is concluded that the treatment $T_{15}Z_3F_3$ (150ppm ZnO NPs + 150ppm FeO NPs) was found best in terms of quality characters of strawberry. So application of this Zinc oxide and Iron oxide nanoparticles@150ppm combination can be recommended to growers after few more conjunctive trials.

Acknowledgements

Authors are sincerely thankful to SHUATS for taking their keep interest and encouragement to carry out the research work at Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, U.P.

References

1. Albrecht Evans MA, Rasto CL. Green chemistry and the health implications of nanoparticles. *Green Chem.* 2006;8(4):17-32.
2. Boriss H, Brunke H, Kreith M. Commodity Profile, Strawberries. Agricultural marketing resource center. *Agricultural Issues Center University of California*. 2006;2(3):22-27.
3. Chowdappa P, Gowda SV. Nanotechnology in crop protection. Status and Scope. *Pest Management in Horticultural Ecosystems.* 2013;19(2):131-151.
4. Davarpanah S, Mohammad A, Mohammad AA, Babalar M, Mohammad EM. Effect of iron foliar application (Fe-Eddha) on quantitative and qualitative characteristics of pomegranate CV. Malas–e-Saveh. *World of Sciences Journal.* 2013;2(4):179-184.
5. De la Rosa G, Lopez-Moreno ML, De Haro D, Botez CE, Peralta Videa JE, Gardea Torresdey JL. Effects of ZnO NPs nanoparticles in alfalfa, tomato, and cucumber at the germination stage. Root development and X-ray absorption spectroscopy studies. *Pure Appl*. Chem. 2013;85(12):2161-2174.
6. Dhoke KS, Mahajan P, Kamble Rajashri, Khanna A. Effect of nanoparticles suspension on the growth of mung (*Vignaradiata)* seedlings by foliar spray method Nanotechnology Development. *Journal of Nanotechnology*. 2013;3(8):1-5.
7. Ganesan VS, Lazer FJB. Iron Oxide Nanoparticles Promotes Agronomic Traits of Ginger (*Zingiber officinale* Rosc.). *Int. J. Adv. Res. Biol. Sci.* 2016;3(3):230-237.
8. Helaly MN, El-Metwally MA, El-Hoseiny H, Omar SA, El-Sheery NI. Effect of nano-particles on biological contamination of *in vitro* cultures and organogenic regeneration of banana. *Aust. J. Crop. Sci.* 2014;8(3):612-624.
9. Javadimoghadam A, Moghadam AL, Danaee E. Response of Growth and Yield of Cucumber Plants (*Cucumis sativus* L.) to Different Foliar Applications of Nano- Iron and Zinc. *Intl. Res. J. Appl. Basic. Sci.* 2015;9(9):1477-1478.
10. Khalid S, Khalid MQ, Ishfaq AH, Khalid SK, Qureshi US. Effect of organic amendments on vegetative growth fruit and yield quality of strawberry. *J. Agric. Res.* 2013;26(2):69-74.
11. Lyngdoh S. Strawberry cultivation, Horticultural Revolution in Meghalaya with reference to Sohliya and Mawpran Villages. *Journal of Economics and Finance*. 2014;4(5):21-26.
12. Mahajan P, Dhoke SK, Khanna AS. Effect of nano-ZnO particle suspension on growth of mung (*Vignaradiata*) and gram (*Cicer arietinum*) seedlings using plant agar method. *J Nanotechnol*. 2011;2(3):1-7.
13. Nair VR, Nair SH, Maekawa NG, Yoshida T, Kumar Y. Nano-particulate material delivery to plants. *Plant Sci.* 2010;3(5):154-163.

14. Raliya, Tarafdar. Zinc oxide NPs, Biosynthesis and its effect on phosphorus mobilizing enzyme secretion and gum contents in cluster bean (*Cyamopsis tetragonoloba* L.) *J.C. Agric Res.* 2013;2(1):48-57.
15. Panwar J, Jain N, Bhargaya A, Mohammad SA, Yeoung-Songyun. Positive effect of zinc oxide nano-particles on tomato plants. A step towards developing nano-fertilizers. *International Conference on Environment Research and technology*. 2012;2(5):349-352.
16. Prasad TNVKV, Sudhakar P, Sreenivasulu P, Latha P, Munaswamy V, Reddy KR, *et al*. Effect of nanoscale Zinc Oxide Nanoparticles on the germination, growth and yield of peanut. *J. Plant. Nutr*. 2012;35(6):905-927.
17. Ramesh M, Palanisamy K, Babu K, Sharma NK. ().Effects of bulk &nano-titanium dioxide and zinc oxide on physio-morphological changes in (*Triticumaestivum* Linn*).J. Glob Biosci*. 2014;3(6):415-422.
18. Sheykhbaglou R, Sedghi M, Tajbakash Shishevan M, SeyedSharifi R. Effect of nano iron oxide particles on agronomic tratits of soyabean.*Not Sci. Bio.* 2010;2(2):112-113.
19. Shailynti Lyngdoh. Strawberry cultivation, Horticultural Revolution in Meghalaya with reference to Sohliya and Mawpran Villages. *Journal of Economics and Finance*. 2014;4(5):21-26.
20. Siddiqui HM, Mohamed AWH, Mohammad F, Mutahhar Y, Khaishany AI. Role of Nanoparticles in Plants. *Springer International Publishing Switzerland.* 2015;3(5):05-0-9.
21. Taniguchi N. On the basis concept of nanotechnology. Proceedings of the International Conference on production Engineering. Part II. *Japan Society of Precision Engineering.* 1974;3:18-23.
22. Zahang D, Wei S, Su X, Wu J, Kaila, Karki AB, *et al.* Carbon stabilized iron nanoparticles for environmental remediation. *The Royal Society of Chemistry.* 2010;1:5-8.