www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(2): 1720-1722

www.thepharmajournal.com
Received: 08-12-2022
Accepted: 22-01-2023

Perminder Singh Brar
Department of Soil Science and Water Management, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Rajesh Kaushal
Department of Soil Science and Water Management, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Corresponding Author:
Perminder Singh Brar
Department of Soil Science and Water Management, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

Effects of various nutrient sources and nanoparticles (TiO_2) on cabbage and capsicum quality indicators

Perminder Singh Brar and Rajesh Kaushal

Abstract
The most significant crops in hilly areas are cabbage and capsicum, which can also help the mountainous region's economy and provide good returns for small and marginal farmers. The current research entitled, Influence of different nutrient sources and nanoparticles (TiO_2) on quality parameters of cabbage and capsicum was conducted between 2021–2022 on the research farm of the Department of Soil Science and Water Management in Nauni, Solan. There were thirteen different treatments combinations included in the study comprising T_1 as control i.e., 100% RDN through chemical fertilizers, from T_2 to T_{13} contains 100% RDN through chemical fertilizers and also in combination of 50-50% RDN through chemical fertilizers and vermicompost on nitrogen equivalence basis along with TiO_2 application as seed treatment and foliar spray with concentration of 50, 100 and 150 ppm in capsicum and 500, 1000 and 1500 ppm in cabbage, that were replicated three times in Randomized Block Design. The results demonstrated that the polar diameter, equatorial diameter, fruit shape index and pericarp thickness of cabbage and capsicum fruits were non-significantly affected by different nutrient sources (chemical fertilizers and vermicompost) when combined with TiO_2 nanoparticles applied as seed treatment or foliar spray.

Keywords: cabbage, capsicum, titanium dioxide, seed treatment, foliar spray

Introduction
Cropping sequences is a rotation system approach in crop production that enabling the available natural resources to be preserved and more efficiently utilized. It is the growing of the succession of crops on one field in particular time [1]. Cabbage (*Brassica oleracea* L.) is a member of the Cole crops, and it's important as fresh and processing vegetable crop in most of the countries, and of various types including red, savoy and mini cabbage etc. Cole crops are biennials, but are generally grown as annuals especially in Rabi season, belong to family Brassicaceae. Bell pepper or Shimla Mirch (*Capsicum annuum* L.) a member of family Solanaceae, is also a high value crop and its fruit are non-pungent, color may be green, yellow or red. Fruits are being used in immature or green stage for various purposes. The crop can be raised both under polyhouse conditions and in open field conditions. Nanotechnology is progressively moving away from the experimental into the practical areas Nanotechnology has provided the feasibility of exploiting nanoscale or nanostructured materials as fertilizer carriers or controlled-release vectors for building of so-called *"smart fertilizer"* as new facilities to enhance nutrient use efficiency and reduce costs of environmental protection [2]. Nanofertilizers deal with active nutritional ingredients at nanoscale (1–100 nm) dimensions. These engineered nanoparticles (ENPs) are able to enter into plants cells and leaves, and can also transport DNA and chemicals into plant cells [3]. The benefits of nano material-based formulations are the improvement of efficacy due to higher surface area to the volume ratio, which provides a better opportunity for interaction [4], higher solubility, induction of systemic activity due to smaller particle size and higher mobility and lower toxicity due to elimination of organic solvents in comparison to conventionally used pesticides and their formulations [5]. Nanotechnology provides novel materials which offer the unique and important solutions to the limitations of other conventional materials with numerous potentials and also it is estimated to become a driving economic force with a high potential for achieving sustainable agriculture, especially in developing countries in the near future. In the field of agriculture, the use of nanomaterial is comparatively new and needs further exploration. Moreover, the emphasis is given to the recent developments in plant science that focuses on agricultural practices, plant growth and yield.
TiO_2 NPs were chosen because they are among the most commonly mentioned type in the literature that aim at using NPs for agricultural purposes [6].

The significant interest of using nanotechnology in agriculture includes specific applications like nano fertilizers and nano pesticides to track products and nutrients levels to increase the productivity without decontamination of soils and waters and protection against pest and diseases [7]. Titanium dioxide (TiO_2) is considered as a beneficial element for plant growth and development and also one of the most widely used in the agriculture and energy sectors [8]. Some research work that mainly focuses on the agriculturally positive side of nano-particles [9]. The most important effects of titanium on plants are enhancement of the yield, an improvement of some essential element contents in plant tissues, and an enhancement of the chlorophyll content in paprika (*Capsicum annuum* L.) [10]. Application of nano TiO_2 enhanced germination, improved growth and nitrate reductase activity in soybean [11]. Also, it has been found that TiO_2nanoparticles encourage spinach (*Spinacia oleracea)* seed germination and plant growth of spinach [12]. Use of nanoparticles as fertilizer has a great potential to enhance crop growth and minimize environmental hazards [13]. Engineered nanoparticles could sequester nutrients on their surfaces, and thus, serve as a nutrient stock to the organisms [14]. Even, when applied as foliar spray also enhanced crop growth of Cluster bean (*Cyamopsis tetragonoloba* L.) [15]. Nano formulated fertilizers can be easily absorbed by plants and they may exhibit prolonged effective duration of nutrient supply in soil or on plant [16].

Materials and Methods

The research farm of the Department of Soil Science and Water Management at Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, is where the experimental site is located (HP). It symbolizes the mid-hills sub-humid (Agro-climate zone-II) of Himachal Pradesh and is located in 30o 52′ North latitude and 77o 11′ East longitude at an elevation of 1260 m above mean sea level with an average slope of 7-8%. The research region is located in Himachal Pradesh's sub-humid mid-hills (Agro-climatic zone-II). Around 1115 mm of rain falls on average in the area each year, with the monsoon season accounting for around 75% of total annual precipitation (mid-June to mid-September). Winter rains are scarce and mostly fall in January and February. The average lowest and maximum temperatures are between 4 and 36 degrees Celsius. The hottest months are May and June, and the coldest are December and January. According to the USDA's Soil Taxonomy, the research area's soils are classified as being in the order Inceptisol and subgroup Eutrochrept (1975). Ferromagnesian shales and dolomitic limestone are responsible for the formation of these soils. Chemical fertilisers (Urea, Single Super Phosphate, and Muriate of Potash) and bulky manures are some of the several nutrient sources used in study (Farm Yard Manure and Vermicompost). Additionally, different amounts of titanium dioxide (TiO2) were given as a foliar spray and a seed treatment (50, 100, 150 ppm for Capsicum and 500, 1000, 1500 ppm for Cabbage). After transplanting, 15 days later, foliar spray was administered. There were three replications and 13 treatment combinations, with treatment T_1 serving as the control. Treatments T_2-T_{13} comprised of 100% RDN (chemical fertilizers) and 50–50% RDN (chemical fertilizers and vermicompost), respectively, along with seed treatment and foliar spray of 50, 100 and 150 ppm TiO_2 nanoparticles for capsicum and 500, 1000 and 1500 ppm TiO_2 nanoparticles for cabbage.

Results and Discussion

The polar diameter of head at marketable maturity was determined after splitting the head of cabbage into two equal halves, and the vertical length of the head is measured in cm to estimate the polar diameter. The horizontal length of the head, after it had been divided into two equal halves, was measured in centimeters in order to determine the equatorial diameter of the head at marketable maturity. After cutting the fruits from stem end to blossom end, the polar and equatorial diameter of fruit was measured with a digital vernier calliper for capsicum fruit shape index. For pericarp thickness of capsicum fruits, fruits were cut transversely and then measured in millimeters using a digital vernier calliper. The results in the Table show that the application of nanoparticles (TiO2) with different combinations of dietary sources had no discernible impact on the polar diameter and equatorial diameter. In cabbage, the equatorial diameter ranged from 11.86 to 15.49 cm, and the polar diameter ranged from 10.81 to 11.70 cm. Additionally, the application of nanoparticles (Ti) in combination with the variable source of nutrients, such as chemical fertilizers (Urea, Single Super Phosphate, Muriate of Potash) and bulky manures, caused the fruit quality parameters of capsicum, such as fruit shape index and pericarp thickness, to vary non-significantly (Farm Yard Manure and Vermicompost). The range of pericarp thickness varies from 3.75 to 4.27 mm, while the range of fruit shape index ranges from 1.02 to 1.26.

Table 1: Influence of different nutrient sources and nanoparticles (TiO_2) on quality parameters of cabbage and capsicum.

	Cabbage (2021-22)		Capsicum (2021-22)	
	Polar diameter (cm)	**Equatorial diameter (cm)**	**Fruit shape index**	**Pericarp thickness (mm)**
T_1	11.04	11.86	1.02	3.75
T_2	10.81	12.55	1.23	4.20
T_3	11.35	13.45	1.17	4.27
T_4	11.37	13.13	1.17	4.03
T_5	11.50	14.54	1.17	4.07
T_6	11.12	14.11	1.16	4.04
T_7	10.96	14.41	1.14	4.00
T_8	11.18	14.84	1.26	3.97
T_9	10.98	15.49	1.10	3.97
T_{10}	11.70	15.41	1.13	3.87
T_{11}	11.03	15.40	1.21	3.85
T_{12}	11.48	13.74	1.17	3.88
T_{13}	10.94	14.49	1.15	3.98
Mean	11.19	14.11	1.16	3.99
CD $_{(0.05)}$	NS	NS	NS	NS

Acknowledgement

For providing the essential research facilities, the authors are grateful to the Department of Soil Science and Water Management at the Dr. YS Parmar University of Horticulture and Forestry in Nauni, Solan (Himachal Pradesh).

References

1. Matthews KB, Buchan K, Sibbald AR, Craw S. Combining deliberative and computer-based methods for multi-objective land use planning. Journal of Agricultural Systems. 2006;87:18-37.

2. Chinnamuthu CR, Boopathi PM. Nanotechnology and Agroecosystem. Madras Agricultural Journal; c2009;96:17-31.
3. Galbraith DW. Nano biotechnology: silica breaks through in plants. Nature Nanotechnology. 2007;2(5):272-273.
4. Naderi MR, Danesh-Shahraki A. Nanofertilizers and their roles in sustainable agriculture. International Journal of Agricultural and Crop Sciences. 2013;5(19):2229-2235.
5. De Rosa MC, Monreal C, Schnitzer M, Walsh R, Sultan Y. Nanotechnology in fertilizers. Nature Nanotechnology. 2010;5(2):91.
6. Gogos A, Knauer K, Bucheli TD. Nanomaterials in plant protection and fertilization: Current state, foreseen applications, and research priorities. Journal of Agricultural and Food Chemistry. 2012;60(39):9781-9792.
7. Anupam M, Sinha I, Das R. Application of Nanotechnology in Agriculture: Future Prospect, paper presented in conference at Mumbai; c2015.
8. Chaudhary I, Singh V. Titanium Dioxide Nanoparticles and its Impact on Growth, Biomass and Yield of Agricultural Crops under Environmental Stress: A Review. Research Journal of Nanoscience and Nanotechnology. 2020;10:1-8.
9. Fraceto LF, Grillo R, De Medeiros GA, Scognamiglio V, Rea G, Bartolucci C. Nanotechnology in agriculture: Which innovation potential does it have? Frontiers in Environmental Science. 2016;4:20.
10. Hruby M, Cigler P, Kuzel S. Titanium in plant nutrition: The contribution to understanding the mechanism of titanium action in plants. Journal of Plant Nutrition. 2002;25:577-598.
11. Lu CM, Zhang CY, Wen JQ, Wu GR, Tao MX. Research of the effect of nanometer materials on germination and growth enhancement of Glycine max and its mechanism. Soybean Science. 2002;21:168-172.
12. Zheng L, Hong F, Lu S, Liu C. Effect of nano-TiO2 on strength of naturally aged seeds and growth of spinach. Biological Trace Element Research. 2005;105:83-91.
13. Vakhrouchev AV, Golubchikov VB. Numerical investigation of the dynamics of nanoparticle systems in biological processes of plant nutrition. Journal of Physics: Conference Series. 2007;61(1):31-35.
14. Navarro E, Baun A, Behra R, Hartmann NB, Filser J, Miao A, *et al*. Environmental behavior and ecotoxicity of engineered nanoparticles to algae, plants, and fungi. Ecotoxicology. 2008;17:372-386.
15. Raliya R, Tarafdar JC. ZnO Nanoparticle Biosynthesis and Its Effect on Phosphorous-Mobilizing Enzyme Secretion and Gum Contents in Clusterbean (*Cyamopsis tetragonoloba* L.). Agricultural Research. 2013;2:48-57.
16. Rameshaiah GN, Jpallavi S. Nano fertilizers and nano sensors–an attempt for developing smart agriculture. International Journal of Engineering Research and General Science. 2015;3(1):314-320.