www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(2): 1717-1719

www.thepharmajournal.com
Received: 01-11-2022
Accepted: 07-01-2023

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

Interaction of TiO_2-nanoparticles with conventional and organic nutrient sources on cabbage and capsicum quality parameters

Perminder Singh Brar and Rajesh Kaushal

Abstract
The two most prominent vegetable crops grown in the Western Himalayas are cabbage and capsicum, both of which have the potential to boost the economies of mountainous regions and offer substantial returns, particularly for small and marginal farmers. The current research entitled, Effect of Ti-nanoparticles with conventional and organic nutrient sources on cabbage and capsicum quality parameters was conducted between 2020–2021 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 Ti-nanoparticles 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 findings show that different nutrient sources (chemical fertilizers and vermicompost) in combination with nanoparticles (TiO_2) applied as seed treatments or foliar sprays did not influence the fruit quality parameters (Polar diameter, equatorial diameter, fruit shape index and pericarp thickness) of cabbage and capsicum.

Keywords: nanoparticles, cabbage, capsicum, fruit quality parameters, organic, fertilizers

Introduction

Significant technical advancements and innovations have been made in recent years in agriculture to meet the growing challenges of sustainable agricultural production and food security [1, 2]. The world needs to generate 50% more food by 2050 to meet the needs of 9 billion people. This goal can only be accomplished by technical interventions to increase productivity, as land and water resources are constrained. Arable land shortage, irrigation, and reliance on conventional crops are the key concerns that have drawn the researchers' attention to using various methods. It is not surprising that attempts have been made to improve the agricultural sector using nanotechnology and nanomaterial because of nanomaterials' obvious special and incredible properties [3-5]. Nanotechnology, a new emerging and fascinating field of science, permits advanced research in many areas, and nanotechnological discoveries could open up novel applications in the field of biotechnology and agriculture. In the field of electronics, energy, medicine, and life sciences, nanotechnology offers expanding research, such as reproductive science and technology, conversion of agricultural and food wastes to energy and other useful byproducts through enzymatic nano bioprocessing, chemical sensors, cleaning of water, disease prevention, and treatment in plants using various nanocides [6]. Although fertilizers are very important for plant growth and development, most of the applied fertilizers are rendered unavailable to plants due to many factors, such as leaching, degradation by photolysis, hydrolysis, and decomposition. Hence, it is necessary to minimize nutrient losses in fertilization, and to increase the crop yield through the exploitation of new applications with the help of nanotechnology and nanomaterials.

Nano fertilizers or nano-encapsulated nutrients might have properties that are effective to crops, released the nutrients on-demand, controlled release of chemicals fertilizers that regulate plant growth and enhanced target activity [7]. Higher plants, as sessile organisms, have a remarkable ability to develop mechanism to perform better under suitable and unsuitable conditions. Nowadays scientists/ researchers want to develop new techniques that could be suitable for plants to boost their native functions. Nanoparticles have unique physicochemical properties and the potential to boost the plant metabolism [8].

The engineered nanoparticles are able to inter into plants cells and leaves, and also can transport DNA and chemicals into plant cells [9]. This area of research offers new possibilities in plant biotechnology to target specific genes manipulation and expression in the specific cells of the plants. The researchers have augmented plants' ability to harvest more light energy by delivering carbon nanotubes into chloroplast, and also carbon nanotubes could serve as artificial antennae that allow chloroplast to capture wavelengths of light which is not in their normal range, such as ultraviolet, green, and near-infrared [10]. The engineered carbon nanotubes also boost seed germination, growth, and development of plants [11]. However, the majority of studies on NPs to date concern toxicity. Comparatively few studies have been conducted on NPs are beneficiary to plants. Research in the field of nanotechnology is required to discover the novel applications to target specific delivery of chemicals, proteins, nucleotides for genetic transformation of crops [12]. Nanotechnology has large potential to provide an opportunity for the researchers of plant science and other fields, to develop new tools for incorporation of nanoparticles into plants that could augment existing functions and add new ones.

TiO_2 NPs have been applied to protect seeds, enhance plant growth and germination, control crop diseases [13], degrade pesticides and detect their residues [14]. In addition, these NPs have been reported to increase root and shoot growth, seed or produce yield, and improve plant health. An increase in chlorophyll production, soluble leaf protein [15], and carotenoids content [16], and increase in uptake of several essential elements [17] was also reported. Environmental stresses, such as drought in wheat [18] and high Cd levels in maize [19], were also alleviated significantly with the use of TiO_2 NPs.

Materials and Methods

The experimental site was situated at the research farm of the Department of Soil Science and Water Management, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP). It is situated at 30º 52′ North latitude and 77º 11′ East longitude at an elevation of 1260 m above mean sea level having average slope of 7-8% and represents the mid-hills sub-humid (Agro-climate zone-II) of Himachal Pradesh. study area falls in sub-humid mid-hills (Agro-climatic zone-II) of Himachal Pradesh. The average annual rainfall of the area is about 1115 mm and about 75 per cent of it is received during the monsoon period (mid-June to mid-September). Winter rains are meagre and received during the months of January and February. The average minimum and maximum temperature ranges from 4 °C to 36 °C. May-June is the hottest and December-January is the coldest months. The soils of study area belong to order Inceptisol and sub group Eutrochrept according to Soil Taxonomy of USDA (1975) [6]. These soils owe their origin to ferromagnesian shales and dolomitic limestone. The various nutrient sources that are used during research are**:** Chemical fertilizers (Urea, Single Super Phosphate, Muriate of Potash) and Bulky Manures (Farm Yard Manure and Vermicompost). Along with this, Titanium dioxide (TiO_2) applied as seed treatment and foliar spray at different concentrations (50, 100, 150 ppm for Capsicum and 500, 1000, 1500 ppm for Cabbage). Foliar spray was given at 15 days after transplanting. There were three replications and 13 treatment combinations i.e., T_1-control and treatments T_2 to T_{13} consist of 100% RDN (through chemical fertilizers) and 50-50% RDN (through chemical fertilizers and vermicompost) along with seed treatment and foliar spray of 50, 100 and 150 ppm TiO_2 nanoparticles in capsicum and 500, 1000, 1500 ppm TiO_2 nanoparticles in cabbage.

Results and Discussion

The polar diameter of the head of cabbage at marketable maturity is estimated by measuring vertical length of head in centimeters after cutting it into two equal halves. Similarly, the equatorial diameter of the head at marketable maturity was measured by taking horizontal length of head in centimeters after cutting it into two equal halves. For fruit shape index of capsicum, the polar and equatorial diameter of fruit was measured with digital vernier calliper after cutting the fruit from stem end to blossom end. Ratio of polar diameter to equatorial diameter was worked out to calculate fruit shape index. The pericarp thickness of capsicum fruit was worked out after cutting the fruits transversely and measurement was taken with digital vernier caliper in millimeters. According to the results in the Table 1, the application of nanoparticles (Ti) with various nutritional source combinations resulted in non-significant effect on polar diameter and equatorial diameter. The range of polar diameter varies from 10.55 to 11.66 cm and the range of equatorial diameter varied from 11.44 to 14.94cm in cabbage. Also, the fruit quality parameters of capsicum i.e., fruit shape index and pericarp thickness varied non-significantly by the application of nanoparticles (Titanium dioxide) in combination with the variable source of nutrients i.e., Chemical fertilizers (Urea, Single Super Phosphate, Muriate of Potash) and Bulky Manures (Farm Yard Manure and Vermicompost). The range of fruit shape index varied from 1.01 to 1.23 and the range of pericarp thickness varies from 3.57 to 4.19 mm.

Table 1: Effect of Ti-nanoparticles with conventional and organic nutrient sources on cabbage and capsicum quality parameters.

	Cabbage (2020-21)		Capsicum (2020-21)	
	Polar diameter (cm)	**Equatorial diameter (cm)**	**Fruit shape index**	**Pericarp thickness (mm)**
T_1	10.55	11.44	1.01	3.57
T_2	10.69	12.10	1.23	4.11
T_3	11.23	12.97	1.15	4.19
T_4	11.25	12.66	1.16	3.95
T_5	11.38	14.02	1.19	3.98
T_6	11.00	13.62	1.16	3.96
T_7	10.84	13.90	1.05	3.92
T_8	10.99	14.32	1.12	3.89
T_9	10.79	14.94	1.06	3.87
T_{10}	11.51	14.85	1.08	4.06
T_{11}	11.11	14.84	1.06	4.03
T_{12}	11.29	13.24	1.08	3.63
T_{13}	11.66	13.97	1.07	3.89
Mean	11.10	13.61	1.11	3.93
CD $_{(0.05)}$	*NS*	*NS*	*NS*	*NS*

Acknowledgement

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

References

1. Dwivedi S, Saquib Q, Al-Khedhairy AA, Musarrat J. Understanding the role of nanomaterials in agriculture In: Microbial Inoculants in Sustainable Agricultural Productivity, Singh DP, Singh HB, and Prabha R, Eds., Springer, New Delhi, India, 2016, pp. 271-288.
2. Kou TJ, Yu WW, Lam SK, Chen DL, Hou YP, Li ZY. Differential root responses in two cultivars of winter wheat (*Triticum aestivum* L.) to elevated ozone concentration under fully open-air field conditions. Journal of Agronomy and Crop Science. 2018;204:325-332.
3. Grillo R, Rosa AH, Fraceto LF. Engineered nanoparticles and organic matter: a review of the state-of-the-art. Chemosphere, 2015, 608-619.
4. Handford CE, Dean M, Henchion M, Spence M, Elliott CT, Campbell K. Implications of nanotechnology for the agri-food industry: opportunities, benefits and risks. Trends in Food Science & Technology. 2014;40:226-241.
5. Husen A, Siddiqi KS. Phytosynthesis of nanoparticles: concept, controversy and application. Nanoscale Research Letters. 2014;9:1.
6. Nair R, Varghese SH, Nair BG, Maekawa T, Yoshida Y, Kumar DS. Nanoparticulate material delivery to plants. Plant Science 2010;179:154-163.
7. DeRosa MC, Monreal C, Schnitzer M, Walsh R, Sultan Y. Nanotechnology in fertilizers. Nature Nanotechnology. 2010;5:91. doi:10.1038/nnano.2010.2.
8. Giraldo JP, Landry MP, Faltermeier SM, McNicholas TP, Iverson NM, Boghossian AA, *et al*. Plant nanobionics approach to augment photosynthesis and biochemical sensing. Natural Materials, 2014, doi:10.1038/nmat3890.
9. Torney F, Trewyn BG, Lin VS-Y, Wang K. Mesoporous silica nanoparticles deliver DNA and chemicals into plants. Nature Nanotechnology. 2007;2:295-300.
10. Cossins D. Next generation: nanoparticles augment plant functions. The incorporation of synthetic nanoparticles into plants can enhance photosynthesis and transform leaves into biochemical sensors. The scientist, news & opinion, March 16. http://www.the-scientist.com/?articles.view/articleNo/39440/title/Next-Generation–Nanoparticles-Augment Plant-Functions/.
11. Lahiani MH, Dervishi E, Chen J, Nima Z, Gaume A, Biris AS, *et al*. Impact of carbon nanotube exposure to seeds of valuable crops. ACS Appl Mater Interfaces. 2013;5:7965-7973.
12. Scrinis G, Lyons K. The emerging nano-corporate paradigm: nanotechnology and the transformation of nature, food and agri-food systems. International Journal of Food Science and Agriculture. 2007;15:22-44.
13. Servin A, Elmer W, Mukherjee A, De la Torre-Roche R, Hamdi H, White JC, *et al*. A review of the use of engineered nanomaterials to suppress plant disease and enhance crop yield. Journal of Nanoparticle Research. 2015;17:92.
14. Aragay G, Pino F, Merkoçi A. Nanomaterials for Sensing and Destroying Pesticides. Chemical Reviews. 2012;112:5317-5338.
15. Raliya R, Biswas P, Tarafdar JC. TiO_2 nanoparticle biosynthesis and its physiological effect on mung bean (*Vigna radiata* L.). Biotechnology Reports. 2015;5:22-26.
16. Raliya R, Nair R, Chavalmane S, Wang WN, Biswas P. Mechanistic evaluation of translocation and physiological impact of titanium dioxide and zinc oxide nanoparticles on the tomato (*Solanum lycopersicum* L.) plant. Metallomics. 2015;7:1584-1594.
17. Tan W, Du W, Barrios AC, Armendariz R, Zuverza-Mena N, Ji Z, *et al*. Surface coating changes the physiological and biochemical impacts of nano-TiO2 in basil (Ocimum basilicum) plants. Environmental Pollution. 2017;222:64-72.
18. Mustafa H, Ilyas N, Akhtar N, Raja NI, Zainab T, Shah T, *et al*. Biosynthesis and characterization of titanium dioxide nanoparticles and its effects along with calcium phosphate on physicochemical attributes of wheat under drought stress. Ecotoxicology and Environment Safety. 2021;223:112519.
19. Lian J, Zhao L, Wu J, Xiong H, Bao Y, Zeb A, *et al*. Foliar spray of TiO_2 nanoparticles prevails over root application in reducing Cd accumulation and mitigating Cd-induced phytotoxicity in maize (*Zea mays* L.). Chemosphere, 2020, 239.