Egyptian J. Desert Res., **69**, No. 1, 101-121 (2019)

IMPACT OF BIO-FERTILIZER AND TIO_2 NANOPARTICLES SPRAY ON GROWTH, PRODUCTIVITY AND PICKLE QUALITY OF TURNIP CROP (*BRASSICA RAPA*)

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The field work was carried out at the Experimental Farm of Desert Research Center at Siwa Oasis, Marsa Matrouh Governorate. During the two consecutive seasons of 2015/2016 and 2016/2017, the experiments were conducted to study the effect of bio-fertilizers namely Nitroben at the rate of 1.5 kg/fed, Phosphorin at the rate of 1.5 kg/fed and a mixture of them and nano-titanium dioxide (TiO_2) as foliar application at the rate of 0, 1 and 2 mg/L on growth, yield, chemical composition and pickle quality of turnip plant, purple top white glop cv. grown in sandy soil conditions. Results revealed that the highest values of growth, yield parameters and chemical contents were clear with bio-fertilizer application compared to control treatment (without application). No significant differences were found between bio-fertilizer treatments on most parameters. The highest values of growth, yield parameters and chemical contents were obtained with TiO_2 application at the rate 2 mg/L, followed by rate of 1 mg/L as compared to control treatment (without application). No significant differences were found among TiO_2 nanoparticle treatments on most parameters. Regarding to the effect of the bio-fertilizers and TiO_2 treatments on turnip pickle quality, it was found that, Nitroben and Phosphorin bio-fertilizers and TiO_2 spray had the more acceptable sensory scores and excellent texture characteristics. Also, investment ratio had been calculated.

Keywords: Trunip, biofertilizer, TiO_2 nanoparticles, growth, yield, chemical composition, pickling, sensory properties

Siwa Oasis is located in the northern part of the Western Desert of Egypt. The total cultivated area is (20940 fed). It is characterized by hot and dry climate conditions. The Oasis displays numerous landforms: salt marshes, salt lakes and cultivated lands. The main activity in Siwa Oasis is agriculture which is depending on palm date and olive trees and its industries such as Packaging of palm dates, extract olive oil and pickling olives.

Turnip (*Brassica rapa*) is a member of the cruciferous family, turnip is a plant widely cultivated for its enlarged roots and for the foliage. Both its enlarged roots and foliage are very rich in minerals, vitamin A and C. They also contain about 92.3% water, 0.8% protein, 0.2% fats, 6% carbohydrates and 0.7% ash (Thompson and Kelly, 1957). Turnip used as salad, cooked and pickled. Also, it had an oilseed for medical Industries (Khashayar, 2007). Turnip is a short duration rapid season and as a fodder, it is palatable, also it is rich in available carbohydrate. As will as it is also succulent and more digestible

Bio-fertilizers, help in augmenting the crop productivity through effective mobilization of major plant nutrients like N, P and K and other minor nutrients needed by the crop. These beneficial microorganisms are also known to secrete plant growth promoting substances like IAA, GA, cytokinins, vitamins for the improvement of crop growth, yield and for quality produce (Natarajan, 2007; Sreenivasa et al., 2010; Kumar et al., 2013 and Mehdizadeh et al., 2013).

Application of nitrogen along with the bio-fertilizer significantly increased morphological, yield and quality characters as compared to application of nitrogen without bio-fertilizer (Bashyal, 2011). Also, bio-fertilizer showed higher vegetative growth parameters (plant height; leaves and branches number; as well as fresh and dry weight of leaves and stems); yield and its components; physical heads quality (weight, diameter and height); vitamin C; N; P and K in tissues of broccoli leaves and heads than the untreated plants (Zaki et al., 2012). Moreover, the development and use of bio-fertilizers is considered as an important alternative for the partial or total substitution of synthetic fertilizers (Aghili et al., 2014).

As for, bio-fertilizer is low cost input, compatible with chemical fertilizers and pesticides, safe to crop and users both, eco-friendly and pose no danger to the environment; also minimizes the pollution by excessive uses of chemical fertilizer (Abul Hossain, 2012).

Fawzy et al. (2012) studied pepper plants and found that, using bio-fertilizers Microbin and Biogen significantly increased the vegetative growth characters, increased chlorophyll content of leaves, total amount of N, P and K content of leaves, also increased chemical properties (T.S.S, Acidity, Ascorbic acid and Carotenoids) of fruits. Molla et al. (2012) on tomatoes found that, vegetative growth, such as plant height, number of leaves and branches per plant was significantly influenced by the application of bio-fertilizers alone or in combination with NPK.

Nanotechnology permits broad advances in agricultural research, such as production science and technology, conversion of agricultural wastes to energy through enzymatic nanobioprocessing, disease prevention and treatment in plants using various nanocides (Carmen et al., 2003)

Nanoparticles are new material, which are stimulates crop growth, improves soil environment and promotes crop growth metabolism (Lu et al. 2002). Nanoparticles (nano-scale particles = NSPs) are atomic or molecular aggregates with at least one dimension between 1 and 100 nm (Roco, 2003), that can drastically modify their physical–chemical properties when compared to the bulk material (Nel et al., 2006). Nanoparticles have a large specific surface area that can provides for a good level of reactivity and this character facilitates effective absorption of fertilizers and pesticides at nanoscale (Sheykhbaglou et al., 2010).

Titanium dioxide (TiO_2) is a non-toxic, white pigment, it is use in manufacture of paints, plastics, paper, ink, rubber, textile, cosmetics, leather, and ceramics (Moore, 1997). Also, Barley (2003) reported that TiO_2 is considered to be non-toxic and harmless, that is approved for the use in food up to 1% of product final weight. Studies reported that nano-TiO_2 can promote plant photosynthesis and nitrogen metabolism and then greatly improve growth at a suitable concentration (Hong et al., 2005; Zheng et al., 2005 and Yang et al., 2007). Moreover, Gao et al., (2008) revealed that treated plant by nano-anatase TiO_2, Rubisco carboxylase activity was 2.67 times that of control.

They also reported that the application of TiO_2 significantly reduced incidence of rice blast and tomato mould with a correspondent 20% increase in grain weight due to the growth promoting effect of TiO_2 nano-particles (NPL 2002). TiO_2 nanoparticles increasing of light energy absorption by photosystem I and transfer of it into the photosystem II, transfer of electrons and also by development of photolysis of water and releasing of oxygen, caused an increasing in the yield of plant (Mingyu et al., 2007).

Food and Agriculture Organization (FAO) and World Health Organization (WHO) recommended a daily intake dose of vegetable and fruits to prevent diseases, therefore, continued attention to increasing vegetables consumption is an important way to improve nutrition and reduce disease risk (Ann et al., 2000). Fruits and vegetables are easily perishable due to their high moisture content, so, processing techniques considered to be the optimum solution to extend their shelf life, moreover, provide human with their nutritional needs.

Pickling is one of the most important food preservation techniques that reducing food spoilage, increasing availability beyond the season and produce products with an excellent sensory property (Das et al., 2016). Market demand for pickled vegetables has increased due to their rich nutritional properties, better organoleptic characteristics, therefore, the pickled vegetables become the ideal candidates for the commercial scale by the local food movement participants (Vatansever et al., 2017). So, the aim of this study is evaluated the impact of bio-fertilizer and TiO_2 nanoparticles spray on growth and productivity of turnip cultivar, as well as, the quality of processed pickled turnip.

MATERIALS AND METHODS

The field work was carried out at Siwa Research Station of the Desert Research Center, Marsa Matrouh Governorate, during the two consecutive winter seasons of 2015/2016 and 2016/2017. The experiments were conducted to study the effect of bio-fertilizers which were purchased from the General Authority of Agricultural Funds and Equalization, namely Nitroben (non symbiotic nitrogen fixing bacteria), Phosphorin (phosphate solubilizing bacteria) and Nano titanium dioxide as foliar application on growth, yield and chemical composition of turnip plants, Purple top white glop cv. grown in sandy soil conditions.

Twelve treatments were used which were the combination of four bio-fertilizers *i.e.,* Nitroben at the rate 1.5 kg/fed; Phosphorin at the rate 1.5 kg/fed; Mixing (Nitroben + phosphorin at the rate 1.5 kg/fed, for each one) were added during land preparation and control treatment (without application) and three levels of nano titanium dioxide foliar application *i.e.,* (1; 2 mg/L and control spray by tap water). The physical and chemical soil characteristics of the studied site were determined according to Page et al., (1982) and Klute (1986) respectively, as recorded in table (1). The chemical analysis of irrigation water was carried out using the standard method of Page et al. (1982) and presented in table (2)

Table (1). Some physical and chemical properties of the experimental soil site.

Soil depth (cm)	Texture class	Soluble anions (me/L)			pH soil paste	E.C. (dSm^{-1})	Soluble cations (me/L)			
		HCO_3^-	$SO_4^=$	Cl^-			Ca^{++}	Mg^{++}	Na^+	K^+
0 – 25	Sandy loam	0.75	0.85	4.25	6.7	0.58	1.15	0.45	3.92	0.33

pH: Acidity, E.C.: Electrical conductivity, me/L: milli equivalent per liter

Table (2). Chemical analysis of the irrigation water.

Samples	pH	E.C. (dSm^{-1})	Soluble cations (me/L)				Soluble anions (me/L)		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	$SO_4^{=}$	Cl^{-}
1st. season	7.1	5.54	10.1	13.32	39.4	1.17	9.35	15.1	39.5

pH: Acidity, E.C.: Electrical conductivity, dSm^{-1}: decimeter per meter

Organic manure was added at the rate of 20 m^3/fed, and calcium super-phosphate (15.5% P_2O_5) at the rate of 350 kg/fed, were added during land preparation. Nitrogen fertilizer as ammonium sulphate (20.5% N) and potassium sulphate (48% K_2O) at the rate of 250 and 150 kg/fed, respectively. Nitrogen and potassium quantities were divided and applied with irrigation every week during growing season started after 15 days from planting. Turnip seeds were planted in first week of November through the two growing seasons respectively. Turnips are precision seeded in multiple rows on raised beds that range from (70-75 cm) wide and 25 m long, with 4 rows to 10-15 cm apart and plants in rows spaced (7.5-10 cm) apart. Planting density is important because the root quality suffers when turnips are crowded and irrigated with drip irrigation system. All agricultural practices were as Egyptian ministry of agriculture recommendation.

1. Preparation of TiO_2 Nanoparticles

Titanium nanoparticles (TiO_2) were prepared by laser ablation of a Titanium plate (99.9% in purity) in 10 ml deionized water. Q-switched Nd:YAG (Quantel) pulse laser generating 8 ns pulses at the wavelength of 1064 nm with the repetition rate of 10 Hz and the energy density was 400 J/ cm2, was focused using a 100 mm focal length lens on the metal plate immersed in water according to Siuzdak et al. (2014). The required quantities were prepared at the Laser Institute of Cairo University.

2. Vegetative Growth Parameters

Vegetative growth samples were taken after 60 days from planting, four plants were selected randomly from each plot and the following characteristics were recorded i.e., plant fresh weight (g), plant height (cm), leaves number per plant, dry matter percent, leaf area was measured using an automatic leaf area meter AREAMETR (cl-202), total chlorophyll in plant leaves were measured using Minolta chlorophyll meter (model SPAD 502). Chlorophyll measurements were made using the recently fully expanded leaf and 5 readings were averaged per experimental unit according to A.O.A.C. (1990).

3. Root and Yield Parameters

At harvest time stage (90 days from planting date), a sample of 20 plant were randomly taken from each experimental plot for characteristics, *i.e.,* plant weight, average root fresh weight and dry matter percentage, root diameter and length were recorded. In addition to root yield for m^2 and total yield (ton/fed).

4. Chemical Constituents

Three samples of root from each experimental unit were taken and oven dried at 70ºC until stable weight then grinded to fine particles and used to determine chemical contents N, P and K. Phosphorus was determined using the colorimetric method for phosphorus content using spectrophotometer according to Cottenie et al. (1982), Total nitrogen was determined using the modified Micro Kjeldahl method. Potassium percentage was measured using Flame photometer by method as described by Brown and Lilliland (1964). Total carbohydrates were determined according to A.O.A.C. (1990).

5. Processing of Turnip Pickle

Turnips of the best treatments were processed as a pickle according to (Yamani et al., 1999), where turnip of each treatment was hand-washed, cut into pieces and put into glass jars. A brine containing 6% (w/v) sodium chloride was then added to the jars, the final pack-out ratio was about 55 :45 (w/w). A thin semi-rigid plastic sheets were pressed over them in order to prevent the turnip pieces from rising. The jars were then closed and left at room temperature (25±2°C) for three weeks.

6. Texture Analysis

The Hardness (N) of the turnip pickles treatments were estimated using Instron Universal Testing Machine (Model 2519-105, USA) at Research Park (CURP), Faculty of Agriculture, Cairo University. Six test from each sample were taken. The machine test speed was 200 mm/min and hardness (N) was recorded electronically.

7. Sensory Evaluation

Sensory evaluation of the turnip pickles treatments were carried out by ten panelists at Agricultural Industrialization Unit, Desert Research Center, Cairo, Egypt. The panelists were asked to evaluate appearance, color, taste, texture and overall acceptability using 10-point scale for grading the quality of samples as described by A.A.C.C. (2000). The panelists were asked to note any differences between the pickled turnips treatments, without knowing the identity of the treatments. All analyses were performed in triplicate and data were subjected to analysis of variance (ANOVA) ($P<0.05$).

8. Investment Ratio

Investment Ratio (IR) = (total revenue, LE / total cost, LE) for fresh yield and pickle production following Rana et al. (1996).

9. Experimental Design and Statistical Analysis

The experimental treatments were arranged in split plot design with three replicates, the main plots were assigned for bio-fertilizer amendments, whereas, foliar spray rates were randomly arranged in the sub plots. Statistical analyses of obtained data were done according to Thomas and Hills (1975).

RESULTS AND DISCUSSION

1. Vegetative Growth

Growth parameters *i.e.,* chlorophyll content, leaf area, plant height and weight, no. of leaves/plant and shoot dry matter percent and were presented in tables (3 and 4). Obtained results indicated that there are significant positive effects for both bio-fertilizer and foliar spray application on all investigated growth parameters. Presented data in the tables (3 and 4) show the following:

1. The highest values of leaf area, plant height and weight, no. of leaves/plant were clear with bio-fertilizer mixture (nitroben + phosphorin) treatment, but the highest values of shoot dry matter percent were clear with the bio-fertilizer phosphorin treatment. Also, no significant differences among all treatments for total chlorophyll parameter in both growing seasons. These results are in the same line with those reported by Fawzy et al. (2012) and Molla et al. (2012), who indicated that bio-fertilizers significantly increased the vegetative growth characters (plant length, number of leaves and stems per plant) of pepper and tomato plants.
2. The highest values of plant height and weight, no. of leaves/plant; shoot dry matter percent; chlorophyll content and leaf area were recorded with TiO_2 nanoparticles spray at the rate of 2 mg/L, followed by the rate of 1 mg/L. However, no significant differences appeared among all TiO_2 nanoparticles spray treatments in both growing seasons. The positive effect of TiO_2 nanoparticles application may be due to that it increases

the photosynthetic activities in plants. The results recorded in tables (3 and 4) are in the same line with those obtained by Zheng et al. (2005), Hong et al. (2005) and Yang et al. (2007), who reported that nano-TiO_2 can promote plant photosynthesis and nitrogen metabolism and then greatly improve growth characters.

3. The interaction between the two studied factors showed that the high values of leaves weight / plant were recorded with bio-fertilizer phosphorin with TiO_2 nanoparticles spray at the rate of 2 mg/L in the first season only and with bio-fertilizer nitroben + phosphorin with TiO_2 nanoparticles spray treatment at the rate of 2 mg/L in the second season only.

Table (3). Effect of bio-fertilizer and TiO_2 nanoparticles spray on total chlorophyll and leaf area (cm^2) of turnip plants during 2015/2016 and 2016/2017 growing seasons.

Seasons				**1st season**				
Characters	**Total chlorophyll**				**Leaf area (cm^2)**			
Treatments / Bio-fertilizer	**Cont.**	**TiO_2 1 mg**	**TiO_2 2 mg**	**$\bar{X}$**	**Cont.**	**TiO_2 1 mg**	**TiO_2 2 mg**	**$\bar{X}$**
Control	45.3	50.8	52.3	49.5	72.3	75.0	75.3	74.2
Nitroben	46.3	51.7	53.7	50.6	78.3	84.0	86.7	83.0
Phosphorin	46.3	54.3	55.7	52.1	79.7	91.0	93.0	87.9
Nitro. + Phos.	48.3	51.0	52.0	50.4	89.3	92.0	100.3	93.9
$\bar{X}$	46.6	52.0	53.4		79.9	85.5	88.8	
				2nd season				
Control	45.7	48.0	49.0	47.6	81.7	84.0	85.3	83.7
Nitroben	47.3	53.0	54.7	51.7	93.7	100.7	103.7	99.3
Phosphorin	47.0	52.7	53.0	50.9	92.0	104.7	103.3	100.0
Nitro. + Phos.	46.3	52.0	54.7	51.0	99.0	109.7	114.7	107.8
$\bar{X}$	46.6	51.4	52.8		91.6	99.8	101.8	
L.S.D. (0.05) for:			**Sea. 1**	**Sea. 2**			**Sea. 1**	**Sea. 2**
Bio-fertilizer			NS	NS			3.25	5.87
TiO_2			2.581	1.202			4.32	3.11
Bio X TiO_2			NS	NS			NS	NS

Table (4). Effect of bio-fertilizer and TiO_2 nanoparticles spray on turnip plant height, leaves weight, number of leaves/plant and shoot dry matter percentage during 2015/2016 and 2016/2017growing seasons.

Seasons	1st season															
Characters	Plant height (cm)				Number of leaves/plant				Leaves weight (g)				Shoot dry matter (%)			
Treatments / Bio fertilizer	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$
Control	37.7	43.5	44.7	42	6.67	7.33	7.33	7.11	86.5	91.5	94.0	90.7	11.8	11.5	11.9	11.75
Nitroben	44.5	48.2	52.6	48.4	7.33	8.67	9.33	8.44	103.2	116.9	123.8	114.7	12.7	13.6	13.6	13.33
Phosphorin	44.7	51.8	49.4	48.7	8.33	10.00	9.33	9.22	93.7	116	128	112.5	12.9	14.5	14.1	13.8
Nitro. + Phos.	47.0	56.3	54.6	52.6	9.00	9.67	10.33	9.67	102.6	121.6	123.6	115.9	12.2	14	14.0	13.4
$\bar{X}$	43.5	49.98	50.38		7.83	8.92	9.08		96.5	111.5	117.3		12.4	13.4	13.4	
	2nd season															
Control	43.3	44.1	47.0	44.8	7.0	8.0	8.7	7.9	86.5	94.5	96.7	92.6	11.1	11.7	11.9	11.6
Nitroben	43.5	50.6	51.4	48.5	9.3	10.0	10.3	9.9	108.2	116.6	126.5	117.1	11.7	12.8	13.7	12.7
Phosphorin	43.1	49.6	49.8	47.5	9.7	9.3	11.0	10.0	101.6	123.5	124.6	116.6	13.1	13.7	13.9	13.57
Nitro. + Phos.	44.7	50.4	52.8	49.3	9.0	11.0	11.3	10.4	104	127.0	131.5	120.8	12.6	13.8	13.8	13.44
$\bar{X}$	43.6	48.7	50.2		8.8	9.6	10.3		100	115.4	119.8		12.1	13.0	13.3	
L.S.D. (0.05)			**Sea. 1**	**Sea. 2**			**Sea. 1**	**Sea. 2**			**Sea. 1**	**Sea. 2**			**Sea. 1**	**Sea. 2**
Bio fertilizer			3.95	2.32			0.852	1.04			5.39	6.43			0.65	0.44
TiO_2			4.16	3.14			0.918	1.19			4.46	2.34			0.63	0.45
Bio X TiO_2			NS	NS			NS	NS			8.93	4.68			NS	NS

2. Root and Yield Parameters

Root and yield parameters; i.e., root length, diameters, dry matter percent yield of meter square and total yield/fed, were presented in tables (5 and 6). The obtained results indicated that there were significant positive effects for both bio-fertilizer amendments and spray application treatments on all investigated yield parameters. From the data, the following could be remarked:

1. Bio-fertilizer phosphorin treatment recorded the highest values of root length and yield of m^2 in the first season only and the highest values of root diameter in both seasons. Moreover, mixing nitroben + phosphorin treatment recorded the highest values of root length, weight and yield of (m^2) in the second season only and highest values of root dry matter and total yield in both seasons. In general, no significant differences were recorded between all bio-fertilizer treatments for all parameters as compared with the control (without addition) in both growing seasons. The positive effect of bio-fertilizer application may be due to that it improves effective mobilization of major plant nutrients like N, P and K and other minor nutrients needed by the plant. Also, these beneficial microorganisms are also known to secrete plant growth promoting substances like IAA, GA, cytokinins and vitamins for the improvement of crop growth, yield and quality (Natarajan, 2007; Sreenivasa et al., 2010; Kumar et al, 2013 and Mehdizadeh et al, 2013). These results are in same line with those reported by Bashyal (2011), who found that the application of nitrogen along with the bio-fertilizer significantly increased morphological, yield and quality characters as compared to the application of nitrogen without bio-fertilizers.
2. The highest values of root length, diameters, dry matter percent yield of meter square and total yield/fed, were recorded with TiO_2 nanoparticles spray at the rate of 2 mg/L, followed by the rate 1 mg/L. Significant positive differences were found between all TiO_2 nanoparticles spray treatments compared with the control treatment (spray by tap water) in both growing seasons. The positive effect of TiO_2 nanoparticles application may be due to that it increases the photosynthetic activities in plants and promotes crop growth metabolism. The results are in the same line with studies reported that nano-TiO_2 can promote plant photosynthesis and nitrogen metabolism and then greatly improve growth and yield (Hong et al., 2005; Zheng et al, 2005 and Yang et al., 2007).

Table (5). Effect of bio-fertilizer and TiO_2 nanoparticles spray on turnip plant root length, diameter, weight and dry matter percentage during 2015/2016 and 2016/2017growing seasons.

Seasons	1st season															
Characters	Root Length				Root diameter				Root weight				Root dry matter (%)			
Treatments / Bio fertilizer	Cont.	TiO_2 1 mg	TiO_2 2 mg	X‾	Cont.	TiO_2 1 mg	TiO_2 2 mg	X‾	Cont.	TiO_2 1 mg	TiO_2 2 mg	X‾	Cont.	TiO_2 1 mg	TiO_2 2 mg	X‾
Control	8.3	9.3	10.2	9.3	5.6	7.3	8.3	7.1	168.3	186.6	193.5	182.8	14.0	14.1	14.8	14.3
Nitroben	12.4	14.1	13.8	13.4	9.1	11.2	14.9	11.7	227.5	293.1	314.8	278.5	14.8	15.8	16.1	15.5
Phosphorin	13.5	14.9	15.2	14.5	11.8	13.4	13.6	13.0	273.8	275.9	279.0	276.3	14.7	16.2	16.5	15.8
Nitro. + phos.	13.0	14.3	15.3	14.2	11.9	13.4	13.4	12.9	249.0	260.3	316.7	275.3	15.3	16.1	17.5	16.3
X‾	11.8	13.1	13.6		9.6	11.3	12.6		229.7	254.0	276.0		14.7	15.5	16.3	
	2nd season															
Control	8.7	11.3	11.5	10.5	7.0	8.5	8.9	8.1	178.0	180.2	197.8	185.3	14.4	14.9	15.1	14.8
Nitroben	11.4	13.0	14.5	12.9	10.4	12.8	13.2	12.1	210.2	237.9	281.1	243.0	16.1	16.7	16.6	16.5
Phosphorin	12.8	14.5	14.2	13.8	11.4	13.5	13.5	12.8	259.3	269.9	243.6	257.6	14.9	16.4	16.6	15.9
Nitro. + phos.	12.7	13.4	15.2	13.8	12.5	12.5	13.3	12.7	278.6	310.2	305.2	298.0	16.1	17.2	16.4	16.5
X‾	11.4	13.0	13.9		10.3	11.8	12.3		231.5	249.5	256.9		15.4	16.3	16.2	
L.S.D. (0.05)			Sea. 1	Sea. 2			Sea. 1	Sea. 2			Sea. 1	Sea. 2			Sea. 1	Sea. 2
Bio fertilizer			1.25	0.80			1.46	0.895			33.25	34.64			0.98	0.873
TiO_2			1.05	0.77			1.00	0.946			20.32	18.19			0.77	0.600
Bio. X TiO_2			NS	NS			NS	NS			NS	NS			NS	NS

Table (6). Effect of bio-fertilizer and TiO_2 nanoparticles spray on total chlorophyll and leaf area (cm^2) of turnip plants during 2015/2016 and 2016/2017 growing seasons.

Seasons	1st season							
Characters	Root yield (m^2)				Total root yield/fed			
Treatments / Bio-fertilizer	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$
Control	2.30	2.80	2.70	2.60	9.20	11.2	10.8	10.4
Nitroben	2.27	3.10	3.51	2.96	9.07	12.4	14.0	11.8
Phosphorin	3.24	3.56	3.69	3.50	12.9	14.2	14.7	13.9
Nitro. + Phos.	3.04	3.69	3.69	3.47	12.1	14.7	14.7	13.9
$\bar{X}$	2.71	3.29	3.40		10.8	13.1	13.5	
	2nd season							
Control	2.20	2.57	2.66	2.47	8.80	10.3	10.6	9.90
Nitroben	2.50	2.90	3.19	2.86	10.0	11.5	12.7	11.4
Phosphorin	3.01	3.45	3.37	3.28	12.0	13.8	13.4	13.1
Nitro. + Phos.	2.97	3.56	3.47	3.33	11.8	14.2	13.8	13.3
$\bar{X}$	2.67	3.12	3.17		10.6	12.4	12.6	
L.S.D. (0.05)			Sea. 1	Sea. 2			Sea. 1	Sea. 2
Bio-fertilizer			0.37	0.34			1.47	1.35
TiO_2			0.22	0.18			0.8	0.73
Bio X TiO_2			NS	NS			NS	NS

3. Chemical Constituents

Chemical constituent parameters i.e., N (%), P (%), K (%) and total carbohydrates (%) are presented in table (7). Obtained results indicated that there are significant positive effects for both bio-fertilizer amendments and spray application on some investigated chemical constituent parameters. From the data, the following could be remarked:

1. Statistical analysis of data in table (7) shows that the highest values of N (%), K (%) and total carbohydrates were recoded with bio-fertilizer mixture (nitroben + phosphorin) treatment in both growing seasons. The results are in the same trend with those reported by Zaki et al. (2012), who found increasing in vitamin C, N, P and K in tissues of broccoli leaves and heads in treated plants by bio-fertilizer compared to the untreated plants.
2. The highest values of N (%) content were recorded with TiO_2 nanoparticles spray at the rate of 2 mg/L in both seasons, but the same rate of TiO_2 treatment recorded the highest values of P (%) and total carbohydrates in

Table (7). Effect of bio fertilizer and TiO_2 nanoparticles spray on turnip plant N (%), P (%), K (%) and total carbohydrate during 2015/2016 and 2016/2017 growing seasons.

Seasons	1st season															
Characters	N (%)				P (%)				K (%)				total carbohydrate			
Treatments Bio fertilizer	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$	Con t.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$	Cont.	TiO_2 1 mg	TiO_2 2 mg	$\bar{X}$
Control	1.1	1.15	1.41	1.22	0.092	0.104	0.103	0.100	2.70	2.54	2.73	2.65	15.2	15.8	15.4	15.5
Nitroben	1.52	1.73	1.77	1.67	0.105	0.117	0.114	0.112	2.93	3.35	3.18	3.15	15.6	18.0	18.7	17.4
Phosphorin	1.72	1.84	1.72	1.76	0.102	0.109	0.119	0.110	3.24	3.24	3.43	3.30	16.4	18.4	18.5	17.8
Nitro. + phos.	1.56	1.92	1.87	1.78	0.093	0.105	0.124	0.107	3.18	3.44	3.29	3.30	16.4	19.8	19.8	18.6
$\bar{X}$	1.47	1.66	1.69		0.098	0.109	0.115		3.01	3.14	3.16		15.9	18.0	18.1	
	2nd season															
Control	1.35	1.44	1.57	1.45	0.095	0.103	0.106	0.102	2.72	2.64	2.70	2.68	15.8	16.8	17.5	16.7
Nitroben	1.70	1.97	2.06	1.91	0.105	0.125	0.107	0.112	2.90	3.31	3.22	3.14	16.7	19.6	19.8	18.7
Phosphorin	1.74	2.14	2.18	2.02	0.097	0.110	0.112	0.106	3.05	3.39	3.16	3.20	18.1	19.1	19.3	18.8
Nitro. + phos.	1.84	2.06	2.27	2.06	0.092	0.129	0.118	0.113	3.16	3.20	3.31	3.22	18.7	19.6	20.6	19.6
$\bar{X}$	1.66	1.90	2.02		0.097	0.117	0.111		2.96	3.13	3.10		17.3	18.8	19.3	
L.S.D. (0.05)			**Sea. 1**	**Sea. 2**			**Sea. 1**	**Sea. 2**			**Sea. 1**	**Sea. 2**			**Sea. 1**	**Sea. 2**
Bio fertilizer			0.190	0.213			NS	NS			0.239	0.226			2.01	1.004
TiO_2			0.149	0.176			0.011	0.015			NS	NS			1.07	NS
Bio X TiO_2			NS	NS			NS	NS			NS	NS			NS	NS

the first season only. The positive effect of TiO_2 it increases the photosynthetic activities in plants and increases the uptake of nutrients (NPL, 2002 and Gao et al., 2008). They also reported that the application of TiO_2 significantly increase correspondent 20% in grain weight of rice and tomato due to the growth promoting effect of TiO_2 nano-particles.

4. Turnip Pickle Quality

Pickling is one of the most well-known appreciated method in preserving vegetables because it is an easy method used to slow down the decaying process and so, it could be kept for longer time. Besides, it offers a product which could be used as appetizer. It was important to estimate the effect of bio-fertilizer and TiO_2 nanoparticles spray best treatments on the quality of turnip pickle. Thus, texture analysis and sensory evaluation have been chosen to evaluate this quality. The pickling process was done for the best observed treatments as mentioned above which were as following:

- Treatment TNP: Nitroben + phosphorin + 2 mg/L TiO_2
- Treatment TN : Nitroben + 2 mg/L TiO_2
- Treatment TP : Phosphorin + 2 mg/L TiO_2

5. Texture Analysis of Turnip Pickle

Texture in pickled vegetables plays an important role in their general acceptability. Therefore, texture of turnip pickle was determined through measuring the hardness value (N). According to the data illustrated in fig. (1), it was found that the hardness value was significantly different among the three turnip pickle treatments, where the TP treatments observed the highest significant hardness value followed by TNP treatments, while the TN treatments had the lowest hardness value, which means the more softness.

6. Sensory Evaluation of Turnip Pickle

Consumer acceptability considered an important parameter to evaluate the success of any food product, therefore, sensory evaluation has been used to estimate this parameter. Appearance, color, taste, texture and overall acceptability of turnip pickle treatments under seeking were subjected to be evaluated by 10 trained panelist and the mean score values are given in fig. (2). Results reveal that, there was a significant difference between turnip pickle treatments for both texture and taste parameter, where the TN treatment observed a significant decrement in both taste and texture parameter, followed by TP and TNP treatments, respectively. There was no significant difference in both color and appearance among turnip pickle treatments. The TNP treatments showed a good sensory acceptability where the overall acceptability value was

9.8, followed by TP and TN treatments with overall acceptability values of 8.5 and 8.0, respectively.

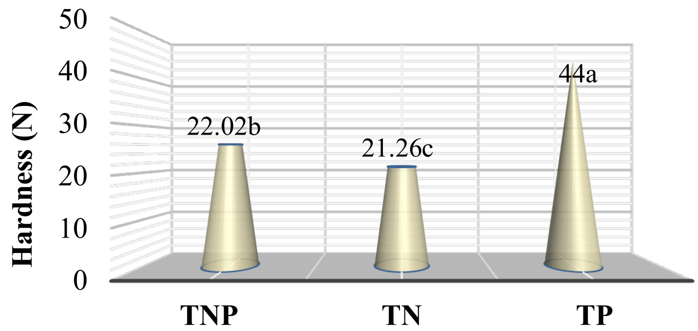

Fig. (1). Effect of bio-fertilizer and TiO_2 spray on turnip pickle texture.

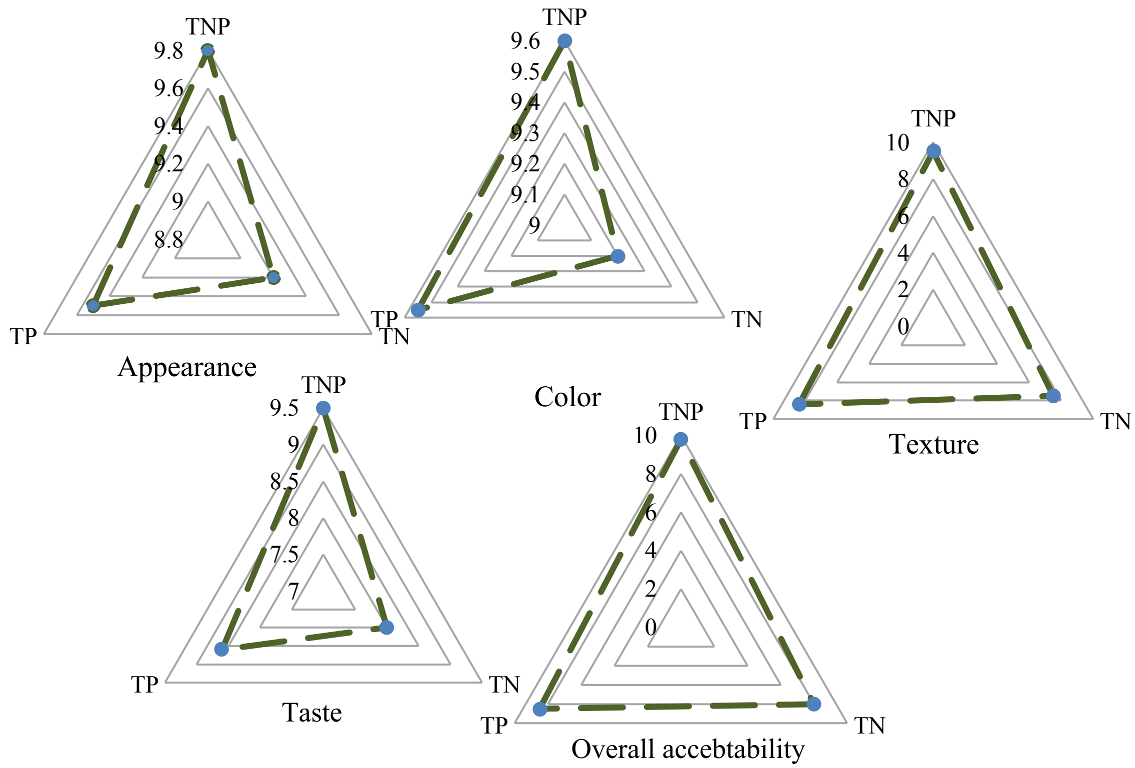

Fig. (2). Effect of bio-fertilizer and TiO_2 spray on sensory properties of turnip pickle.

The final goal of any agricultural application is to get profitable yield as gain from the invested cost. The agricultural process is mainly economic, especially if value for products was added as pickle process, so the net gain of each pound from the input is important to get the highest rate of revenue. Table (8) shows the calculation of fixed input for all fresh production treatments; fixed cost of one ton of pickle and the total output of one unit of production (fresh and pickle), while table (9) gives the total output for all treatments and investment ratio. It should be noticed that when investment ratio is calculated for pickle production, following equation is applied:

$$\text{Investment ratio for pickle} = \frac{(RY^{*}-L\%)^{*}P}{TI+(X^{*}N)}$$

RY = Total fresh root/fed
L = 20% lost in total weight, fixed lost for pickle processing *i.e.* Peeling... etc.)
P = price of one ton of pickle TI = total input/fed (for each treatment)
X = fixed cost of one ton pickle N = No. of tons

Table (8). Fixed input cost and output for fresh or pickled turnip production (LE/fed).

Fresh production cost					**Pickled production cost for 1 ton**				
Items	**Unit**	**Counts**	**Unit cost (LE)**	**Total (LE)**	**Items**	**Unit**	**Counts**	**Unit cost (LE)**	**Total (LE)**
Fixed cost/fed					**Fixed cost/ton**				
Land preparation	Hour	6	100	600	**Wash**	Worker/day	1	100	100
Organic fertilizer	M3	20	100	2000	**Peeling**		3	100	300
Chemical fertilizer				3500	**Chopping**		4	100	400
Seeds	Packet	3 kg	250	750	**Wash**		1	100	100
Labor cost					**Fill**		1	100	100
1- Fertilizer add	Worker/day	4	100	400	**Pickles special additions Salt + etc.**	kg	1	75	75
2- Planting seeds		5	100	500					
3- Seasonal labor		10	100	1000					
4- Harvest labor		5	100	500					
Pesticides	Liter	7	100	700	**Total**		**1075**		
Foliar fertilizer	Liter	3	100	300	**Output**	ton		**11000 LE**	
Total		**10250**							
Variable cost									
Bio-fertilizer	kg	1	50	50					
TiO_2 nanopartical	mg	1	150	150					
Output Fresh root yield	ton		**2500**						

Table (9). Effect of bio fertilizer and TiO_2 nanoparticles spray on investment ratio of fresh and pickled turnip during 2015/2016 and 2016/2017 growing seasons.

Seasons		1st season											
Characters		Total input (L.E/fed) Fresh production			Total input (L.E/fed) pickle production			Investment ratio Fresh production			Investment ratio pickle production		
Treatments		Cont.	TiO_2 1 mg	TiO_2 2 mg	Cont.	TiO_2 1 mg	TiO_2 2 mg	Cont.	TiO_2 1 mg	TiO_2 2 mg	Cont.	TiO_2 1 mg	TiO_2 2 mg
Bio fertilizer cost													
Trea. cost		+ zero	+150	+300									
Control	+zero	10250	10400	10550	20140	22440	22160	2.24	2.69	2.56	4.02	4.39	4.29
Nitroben	+ 75	10325	10475	10625	20075	23805	25675	2.20	2.96	3.29	3.98	4.58	4.80
Phosphorin	+75	10325	10475	10625	24193	25740	26428	3.12	3.39	3.46	4.69	4.85	4.89
Nitro. + phos.	+150	10400	10550	10700	23408	26353	26503	2.91	3.48	3.43	4.55	4.91	4.88
		2nd season											
Control	+zero	10250	10400	10550	19710	21473	21945	2.15	2.48	2.51	3.93	4.22	4.25
Nitroben	+ 75	10325	10475	10625	21075	22838	24278	2.42	2.74	2.99	4.18	4.43	4.60
Phosphorin	+75	10325	10475	10625	23225	25310	25030	2.91	3.29	3.15	4.55	4.80	4.71
Nitro. + phos.	+150	10400	10550	10700	23085	25815	25535	2.84	3.36	3.22	4.50	4.84	4.76

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تأثير التسميد الحيوي والرش بجزيئات التيتانيوم المتناهية في الصغر على نمو، إنتاجية وجودة المخلل لمحصول اللفت

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أجريت الدراسة بمحطة بحوث سيوة التابعة لمركز بحوث الصحراء بمحافظة مطروح خلال موسمين متتاليين ٢٠١٦/٢٠١٥ و٢٠١٧/٢٠١٦ لدراسة تأثير التسميد الحيوي نتروبين بمعدل (١.٥ كجم/فدان) وفسفورين بمعدل (١.٥ كجم/فدان) والخلط بينهما، وكذلك الرش بجزيئات التيتانيوم المتناهية في الصغر بتركيز (صفر، ١ و٢ جرام/لتر) على النمو، المحصول ومكوناته، التركيب الكيميائي وجودة نبات اللفت صنف بربل توب وايت تحت ظروف التربة الرملية. أظهرت النتائج أن أعلى القيم في صفات النمو، المحصول ومكوناته والتركيب الكيميائي سجلت مع التسميد الحيوي عند المقارنة بمعاملة الكنترول. لا يوجد فروق معنوية بين معاملات التسميد الحيوي في معظم الصفات. أعلى القيم في صفات النمو، المحصول ومكوناته والتركيب الكيميائي سجلت مع معاملة الرش بجزيئات التيتانيوم المتناهية في الصغر بمعدل ٢ جرام/لتر تبعها معدل ١ جرام/لتر لا يوجد فروق معنوية بين المعدلين في معظم الصفات. وبالإشارة إلى تأثير التسميد الحيوي والرش بجزيئات التيتانيوم المتناهية في الصغر على جودة مخلل اللفت، وجد أن معاملة الخلط بين الأسمدة الحيوية (النتروبين والفسفورين) والرش بجزيئات التيتانيوم المتناهية في الصغر كانت أكثر قبولًا في التقييم الحسي وأحسن في صفات القوام. كذلك تم دراسة معامل الإستثمار لمعاملات الدراسة.