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Evaluation responses of potato to salinity and nano nitrogen fertilizer

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IN ORDER to study the effect of nano fertilizer on growth of potatoes plants grown and pests infestations under salinity condition, a pot experiment conducted in the greenhouse of the National Research Centre, Dokki, Cairo, Egypt. The treatments were as follows: Salinity, irrigation by diluted sea water in the concentration of 2000 and 4000 ppm more than the tap water as a control. Nitrogen nano fertilizer sprayed in the rate of 100 and 200 ppm more than the distilled water as a control. A negative relationship was detected between salinity levels and stem, leaves and top dry weight and pests' infestations. The same relation also found for stem, leaves and top fresh weight. This data showed that showed that the nano fertilizer in the rate of increased the fresh weight by 3-fold compare to the control plants. The dry mass of leaves, stem or top weight treated with nano fertilizer improved by about 1.5-fold than that received distilled water. In spite of the decrement in plant height, fresh and dry weight of potatoes plants but on reverse, the nano fertilizer spraying increased these parameters. The improvement caused in growth characters as result of nano element was true under different levels of salt stress. The nano fertilizers significantly decreased the insect pests infestations under laboratory conditions. Results showed that under field conditions the yield significantly increased during season 2021 and 2022 after the nano fertilizers applications.

Keywords: Potatoes (*Solanum tuberosum L.*)-Salinity-Nano fertilizer- growth- Dry mater- pest infestations.

Introduction

Food production must increase markedly to feed the growing human population, but this needs to be achieved whilst simultaneously reducing adverse environmental impacts. In this regard, there is increasing interest in the use of nanomaterials as fertilizers for improving plant mineral nutrition (Kopittke, et al., 2019). For the huge increases in world population and in Egypt, it mists to increase the new cultivated areas and also increased its productivity. Thus, search about the new technologies for help in cultivating new areas and raising the productivity and quality of produces in the old lands.

Potato infested by a lot of harmful economic insects which attack potatoes and many other economically crops. The adults of female insects put eggs inside the tubers eyes. When larvae hatched, they feed on the tubers through tunnels; larvae coms out for pupation git rid their black residues and block the tunnels. These cause plant diseases on the leaves and shoots and decrease the crop quality and destroy the tubers. These insects controlled by the insecticides which pollute the surrounding and diseased the human with a malignant diseases and cause damage to plants, and act as a virus vector, thus causing significant yield loss to crops in the tropical and subtropical regions Hafez et al (1997) and Sabbour and Nayera (2020).

Salinity stress is a severe environmental stress that affects plant growth and productivity of potato, a strategic crop moderately sensitive to saline soils. Limited studies are available on the use of combined and magnesium nano-

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micronutrients to ameliorate salinity stress in potato plants (*Solanum tuberosum L.*). Salinity stress is one of the most severe environmental limitations to plant growth and productivity, particularly, in arid and semi-arid regions worldwide. Over 6% of the world land is affect by salinity, which accounts for more than 800 million hectares (FAO, 2008 and Negrao, et al., 2017). Plant growth is seriously affected by salt stress, and plants adapt to this abiotic stress, in order to survive, by adopting several strategies (Shabala, et al., 2012). For Potato tuber moth among the harmful pests infest the potatoes tubers and cause beat harmful damage lead to loss the crop (Sabbour and Nayera, 2020). Also tubers attacked by aphis *B. tabaci* which reduce the yield (Sabbour and Hany 2007).

The use of the new science, nanotechnology in agriculture has begun and will continue to have a significant effects in the main areas of breeding new crop varieties and increasing productivity of crops more than correct the deficiency, diminishing pollution; very helpful when the roots cannot provide necessary nutrients and development of new functional materials with smart delivery systems for agrochemicals like fertilizers (Qurashi 2018; Alshaal and El-Ramady,2017, Singh and Khushboo,2018 Hussein, et al 2019). Innovative research is needed to develop fertilizers so as to increase the crop yields, enhance nutrient use efficiency and to reduce environmental pollution (Sanchez-Barrios et al., 2017 and Muijeil and Aboud, 2018).. The achievement of sustainable agriculture and the application of innovative nano technology in agriculture, including fertilizer development, are the most promising approaches to significantly increase the crop production and feed the rapidly-growing global population (Khotet et al., 2012). Nanotechnology has been used in many agricultural fields such as production, processing, storing, packaging and transporting agricultural products (Mousavi and Rezaei,2011).

Production of potato (*Solanum tuberosum* L.) takes a very important place in world agriculture, with a production potential of about 324 million t harvested and 18.6 million ha planted area. Potato is one of the main crops in Egypt where the production is about million t harvested from million ha (Anonymous, 2010).

Potato (*Solanum tuberosum* L.) as a member of the family Solanaceae is the fourth important crop in the world in production volume. Potato tubers are excellent sources of carbohydrates, protein, mineral and vitamins B and C (Fabeiro, et al., 2001 and Muthoni and Nyamango, 2009).

Potato (*Solanum tuberosum L.*) is an herbaceous species grown for its tuber, a fleshy stem with buds in the axils of leaf-scars. Potato is ranked fourth by the Food and Agriculture Organization of the United Nations (FAO) as the most important food crop (FAO, 2012). Potato is classified as moderately sensitive to salinity, tolerating Ece values up to 1.7 dSm1 with 12% yield decrease with each increase in dSm□1 (Maas and Grattan, 1999).

In Egypt, potato considered as one of sources for popular foods and cultivated for two main purposes, the first for food security and the second for exportation. Potatoes exposure to infections of many harmful pests and diseases (Sabbour and Nayera, 2015). The potato production in Egypt amounted by from fed. Salinity stress is a severe environmental stress that acts plant growth and Productivity of potato, a strategic crop moderately sensitive to saline soils (Mahmoud, et al., 2019). Nano fertilizers considered as a new technological to response growth, yield and yield traits and this response tolerance of biotic and abiotic stress.

Searching for new ways and proper technologies is one of the main targets to increase its productivity and quality in the cultivated lands (soils in these areas mainly sandy, saline and calcareous).

The objective of this work is to evaluate the response of growth and quality of potato plants to Nano fertilizer, grown under salinity condition

Materials and Methods

In order to study the effect of nano fertilizer on growth of potatoes plants grown under salinity condition, a pot experiment conducted in the greenhouse of the National Research Centre, Dokki, Cairo, Egypt. The treatments were as follows: Salinity, irrigation by diluted sea water in the concentration of 2000 and 4000 ppm more than the tap water as a control. Nano fertilizer sprayed in the rate of 100 and 200 ppm more than the distilled water as a control. Potatoes (*Solanum tuberosum* L.) were sown in pots 60 cm length and 40 cm in diameter filled by 30 kg of clay loam soil.

In order to study the effect of nano fertilizers on the field biotic stress, and the field experiments was calculated the biotic stress.

The experiment included 9 treatments, three salinity combined with three nano fertilizer treatments. The design of the experiment was split plot in six replicates.

The experiment included 9 treatments which are 3 salinity treatments in combination with 3 nano fertilizer treatments. The design of the experiments was split plots in six replicates. Calcium super phosphate (15.5% P295) and potassium sulphate (48.5 % K0) broadcasted in the rate of 1.5 gr /pot of each before sowing.

Data subjected to proper statistical analysis according to the methods described by Snedecor and Cochran (1980).

Field experiments

The field experiments were executed, at Menia El-Kamh (Sharkia) during 2021 and 2022, the experiment starting in summer potato planting at 1st July till 31st August.3500 m2 divided into 15 areas each 100m2, five areas for nitrogen fertilizers, five for Potassium sulphate and five for Calcium super phosphate, five for nano nitrogen fertilizers, five for nano Potassium sulphate and five for nano Calcium super phosphate, five for control (untreated) sprayed with water only.

Nano nitrogen applied at 100 and 200 ppm, Potassium sulphate applied at 100 ppm, and Calcium super phosphate applied at 200 ppm, control sprayed by water only. Six potato tubers and leaves were collected randomly each week from each treatment areas. The infestations average numbers calculated every period 20,90 and 120 days. In the harvest time the potatoes weighted for each treatments.

The field experiments were executed, at Menia El-Kamh (Sharkia) for measurments during 2020 and 2021, the experiment starting in summer potato planting at 1st July till 31st August.1500 m2 divided into 15 areas each 100m2, five areas for Nano nitrogen, five for Nano Potassium sulphate and five for nano Calcium super phosphate.

Laboratory studied

Rearing Insects

Larvae of potato tuber moth reared in a Standard laboratory colony on small tubers of potatoes. Pupae collected till moths emergence, then put every male and female in glass jar 15×20 cm covered by muslin paper. Put a tissue paper in the top of the jar for egg laying. Eggs collected and kept in Petri dish 10×10 cm till the newly larvae hatched.

Pots experiments

Nano fertilizer sprayed in the rate of 100 and 200 ppm the percentages of infestation calculated after seven days. Control (non-treated) experiments made by feeding the newly hatched larvae by clean tubers (sprayed by water only). Experiments replicated four times. Mortality calculated after 7 days, the corrected mortality calculated due to Abbott's formula (Abbott, 1925) and the corrected mortality calculated according to (Finney, 1971) to determine the LC_{50} value.

Statistical analysis

The software SPSS program were used for all statistical calculations and LSD were calculated according to SSPS statistical methods and (Gomsez and Gomez, 1984)

Results and Discution

Growth and yield

Salinity

Data in Table (1) indicated that all growth parameter except tuber diameter decreased as salt concentration in irrigation water increased up to the highest level used. This depressions fresh weight of stem, leaves and top amounted by: 11.0, 44.49 and 35.65 % and dry weight of these parameters by :19.30, 26.21 and 44.93 % with subjection to 4000 ppm salts compared to that of plants received tap water, respectively. For tubers the depression were amounted by 38.07 and 98.74 % in fresh as well as dry weight.

Among major constraints to crop production, salt stress affects the morphological structure and yield in crop plants (Sasinne, et al 2020). In general, all the nano-treatments applications significantly increased plant height, shoot dry weight, number of stems per plant, leaf relative water content, leaf photosynthetic rate, leaf stomatal conductance, chlorophyll content, and tuber yield, as compared to the untreated control In general, all the nano-treatments applications significantly increased plant height, shoot dry weight, number of stems per plant, leaf relative water content, leaf photosynthetic rate, leaf stomatal conductance, chlorophyll content and tuber yield, as compared to the untreated control (Abdel Mahmoud, et al 2020).

Abdelaziz and Abdeldym (2019) mentioned that excess of salt ions in either water or soil causes significant changes in morphological, physiological and biochemical attributes of plants. In saline environments, plants take up an excessive amount of sodium (Na+) at the expense of potassium and calcium. As Na+ contents of leaves, stems, and other parts increase with the increasing salinity, this might lead to nutritional imbalance that causes decreased plant growth and dry matter production.

The adverse effect of salt stress could be attributed through different ways: availability and absorption of water (Wei, et al., 2019); osmotic adjustment (Khalil, et al., 2012 and Bekheta and Hussein,2014); Mineral absorption and uptake (Hussein et al 2008, Hussein and Abo Bakr, 2019 and Hussein, et al., 2018); photosynthesis retardation and carbohydrate building, (Hussein, et al., 2012; Hussein and El-Faham, 2018 and Hussein,et al., 2014) Protein building (Hussein, et al., 2004, Hussein, et al., 2008 and Hussein, et al., 2013); Enzymes activity (Hussein and Orabi, 2008 and Sarker and Oha, 2020); Hormonal disturbance (Hussein, et al., 2005 and Hussein and El-Greatly, 2007) and lowering oxidative defense (Hussein and Orabi, 2008; Taha, et al., 2015 and Neveed, et al., 2020).

Nano fertilizer water

Data for the effect of nano fertilizer on growth of potatoes plants were reported in Table (1). A positive relationship was detected between nano fertilizer application on growth parameters of potato plants Sprayed potato plants with 200 ppm nano fertilizer increased stem, leaves and top 38.07%, 92.06% fresh weight by:264.24,292.76, 277.6 % and for dry weight of these traits by 115.43, 54.46 and 59.51 % when added 200 ppm nano fertilizer compared to that received distilled water, respectively . Concerning tuber weights it increased by 23.36 and 19.30%, respectively. This data showed that the nano fertilizer in the rate of 200 ppm increased the fresh weight by 3 fold compare to the control plants. The dry mass of leaves, stem or top weight treated with 100 ppm nano fertilizer improved by about 1,5 fold than that received distilled water.

Farook, (2017) revealed that foliar application of bio stimulants and lithovit with or without boron application significantly increased potato growth parameters (i.e. Plant height, branch number per plant, shoot fresh and dry weights, and leaf area per plant), as well as the potato tuber number and total tuber yield per plant. Quality of potato tuber significantly increased with biostimulants and lithovit with boron application. Mijweil and Abood (2018) mentioned that fertilizers was added tp potatoes according to the recommended amount of 600 kg/ha solo F1 with chemical fertilizer quarter-recommended dosage+nano -fertilizer F2 of recommended half-dose chemical fertilizer+nano-fertilizer F3 of three-quarter chemical fertilizer dosage of recommended quantity+nano-fertilizer F4, a complete chemical fertilizer recommended dosage+nano-fertilizer F5, individual nano-fertilizer F6). They found that fertilizer combinations have been morally and positively influenced by the different parameters such as paper area/cm2,1% of dry matter of vegetative tuber, total number of tubers, weight rate of tuber (g), total yield of t/ha and % of starch. They also added that the combined dosage more affected than traditional fertilization. Al-juthery, et al., (2019) used Nano chelate silicon fertilizes (NSF) ,Nano chelated potato specific fertilizer (NPS) and Nano chelated complete micro(NCM) on growth and yield of potato variety Riviera as foliar applied at 50, 100, 150 and 200 g or ml of all nanofertilizer types 100 L-1 water or 2 kg nanofertilizers ha-1 (as recommended) dissolved in 400 liters of water ha-1.The experiment included spray of single (NSF) , (NPS), (NCM) , di (NS+NPS),(NS+NCM),(NPS+NCM) , and tri combinations (NS+NPS+ NCM), in addition to control (only water) using RCBD with 3 replicates showed that tri combination (NS+NPS+NCM) spray treatment was significantly higher followed by the di and single spray combinations . Fresh yield, dry tubers, vegetative yield and biological yield were (42.130, 9.327, 2.901 and 12.228 Mg ha-1), respectively , compared with the control (28.440, 5.453, 2.240, and 7.693 Mg ha-1), respectively. Tri combinations (NS+NPS+ NCM) starch content , crude protein and ascorbic acid concentration (vitamin C) were (17.10 % , 9.08% and 185.33 mg kg-1 f.w.), compared with the control treatment (12.22% , 7.79% and 136.33mg kg-1 f.w.). As the plants cell wall prevents the entrance of elements into cells, the nano particles which have diameters less than the cell wall pores size, therefore nano particles can easily cross the pores. Nano particles can enter the plants leaves through the stomata and transported to the different organs (Al-juthery and Saadoun, 2018). Abdel Mahmoud, et al., (2020) found that, in general, all the nano-treatments applications significantly increased plant height, shoot dry weight, number of stems per plant, leaf relative water content, leaf photosynthetic rate, leaf stomatal conductance, chlorophyll content, and tuber yield, as compared to the untreated control. Furthermore, soil application of these treatments increased the concentration of nutrients (N, P, K, Ca, Zn, and B) in plant tissues, leaf proline, and leaf gibberellic acid hormone (GA3).

It was hypothesized that soil application of Nano part, Nano- treatments applications significantly increased plant height, shoot dry weight, number of stems per plant, leaf relative water content, leaf photosynthetic rate, leaf stomatal conductance, chlorophyll content, and tuber yield, as compared to the untreated control. Furthermore, soil application of these treatments increased the concentration of nutrients (N, P, K, Ca, Zn, and B) in plant tissues, leaf proline, and leaf gibberellic acid hormone (GA3) in addition to contents of protein, carbohydrates, and antioxidant enzymes (polyphenol oxidase (PPO) and peroxidase (POD) in tubers. Compared to other treatments (Mahmoud, et al., 2019).

The results were in close conformity with Sabbour and Abdel-Raheem (2016) and Sabbour and Nayera (2016) who, said that imidacloprid causing insect paralysis and leas to death of the pests. The effect of the tested materials on larval period decreased by using the imidacloprid Sabbour (2015), supported our results on eggs the insecticide causes a decreasing in eggs hatching during the experiments. The malformed pupa observed during the experiments, the results were disagree with the findings

Interaction

In spite of the decrement in plant height, fresh and dry weight of potatoes plants but, on reverse, the nano fertilizer spraying increased this parameters. The improvement caused in growth characters as a result of nano element was true under different levels of salt stress (Table 2).

Results obtained by Saessine, et al., (2020) showed that increasing in salinity levels adversely affected all parameters in the control plants. The ameliorating effect of MNKP-fertilizer was prominent in plant height, stem diameter, number of fruits, fruit weight and yield/plant at 4 and 6S/m. Whereas, the effect of salinity was mitigated by LITHO-foliar regarding flowers number and total chlorophyll content at all salinity level. Leaf N, P and K contents were accumulated higher when MNKP-ferti was used whereas, Ca^{2+} and Mg^{2+} contents were accumulated higher in the plants treated with LITHO-foliar. The cellular leakage of electrolyte was reduced at 4, 6 and 10dS/m with MKP-ferti and at 8dS/m with LITHO-foliar application. Sajyan, et al., (2019) reported that exogenously applied nano-fertilizer counteracted the salt-induced adverse effects on plants. It improved plant height of salt-stressed plants compared to the control with a maximum effect at N2. Similarly, it increased leaf number and stem diameter in salt-stressed plants regardless of the application dose. Flowering characteristics were also improved by nano-fertilizer application under all salinity levels; average number of clusters and flowering capacity in N2/S2 (3.5 and 17), N2/S3 (3.1 and 15), N2/S4 (3.4 and 15) and N2/S5 (2.9 and 11) were higher than those in N0/S2 (2.2 and 12), N0/S3 (2.5 and 12), N0/S4 (2.1 and 10), N0/S5 (2 and 9). The product application induced amelioration in reproductive parameters; fruit set was improved in all treatments especially in N1/S1 (65%) compared to the control N0/S1 (26%).They added that although it did not enhance fruit diameter or individual weight of fruit (g), it did increase yields (g plant-1) due to the production of a higher number of fruits for all salinity levels with best yields obtained at N1 (N1/S1 (90 g), N1/S2 (110 g), N1/S3 (115 g), N1/S4 (100 g) and N1/S5 (55 g) and N2 (N2/S1 (100 g), N2/S2 (108 g), N2/S3 (122 g), N2/S4 (105 g) and N2/S5 (50 g) compared to control (N0/S1 (65 g), N0/S2 (75 g), N0/S3 (70 g), N0/S4 (25 g), N0/S5 (30 g). Consequently, salt tolerance of potato was ameliorated by nano-fertilizer application (Table 3).

Data in table 4 show that the nano fertilizers used affected on the insect infeststation after sprayed on the plant pots conditions. Also the lowest percentages of infestations recorded after Potassium sulphate applications (Table4).

The effect of the fertilizers and nano fertilizers shoes in (Table 5) , the weight of potatoes were significantly increased after fertilizers applications during the two successive seasons, the highest weight recorded after Nano Potassium sulphate to 14.17±24.67 ton/feddan as compared to 10.47±23.71 ton/feddan in the control during season 2021. The same results obtained during season 2022, the weight of potatoes increased to 14.99±64.21 tons/ feddan as compared to 10.17±63.81 in the control (Table 5). The same results obtained by Sabbour and Singer (2016), Sabbour and Nayera (2015), Sabbour (2015 a,b), Sabbour and Nayera (2020).

TABLE 1. Growth response of potatoes plant to salinity condition.

Salinity ppm	Plant Height	Leaves No	Tuber Length	Tuber dimt	Fresh weight				Dry weight				T/RR
					Tuber	Stem	Leaves	Top	Tuber	Stem	Leaves	Top	
Tap water	61.77	19.2	4.03	2.90	185.8	19.11	2 3.92	43.03	30.43	2.90	8.19	11.09	0.363
2000	60.60	15.7	3.33	2.92	145.5	16.34	18.21	23.36	29.83	2.59	5.29	7.88	0.275
4000	53.30	13.7	3.65	3.45	142.4	17.00	11.12	28.12	24.59	2.14	4.51	6.65	0.277
LSD	**N.S**	N.S	**N.S**	**N.S**	**N.S**	N.S	4.69	19,19	**N.S**	N.S	2.02	N.S	**……**

.TABLE 2. Growth response of potatoes plants to nano nitrogen fertilization

Nano Fert. ppm	Plant Height	Leaves No	Tuber Length	Tuber dimt	Fresh weight				Dry weight				T/RR
					Tuber	Stem	Leaves	Top	Tuber	Stem	Leaves	Top	
DW	56.27	14.3	3.28	2.80	128,2	7.41	6.92	14.33	19.65	1.75	5.16	7.36	0.346
100	60.23	16.8	3.37	2.92	168.5	16.13	19.22	35.35	27.46	2.11	4.87	6.98	0.254
200	58.57	17.3	4.35	3.45	177.0	26.99	27.11	54.11	37.74	3.77	7.97	11.74	0.315
L.S.D	**2.01**	N.S	**N.S**	**0.55**	**2.39**	4.66	9.05	7.00	13.62	1.40	1.35	N.S	**…..**

Table (3): Growth response of potatoes plant to nano nitrogen and salinity condition.

Salinity	F Ppm	Plant Height	Leaves No	Tuber Length	Tuber dimt	Fresh weight				Dry weight				T/RR
						Tuber	Stem	Leaves	Top	Tuber	Stem	Leaves	Top	
So	DW	60.0	17.0	3.65	2.50	156.4	9.65	8.94	17. 63	24.57	1.92	7.56	9.48	0.386
	100	64.2	18.5	3.50	3.00	181.4	18.86	7.84	46.70	29.32	2.66	5.97	8.68	0.296
	200	61.1	22.0	4.95	3.20	219.6	28.82	34.95	63.77	37.41	4.12	11.05	15.17	0.406
S1	Dw	53.4	15.0	3.00	2.75	118.3	9.41	6.05	14.46	17.38	1.89	3.86	5.74	0.330
	100	59.5	16.0	3.30	2.75	169.0	15.59	16.51	18.10	24.60	1.90	4.10	6.00	0.244
	200	68.9	16.0	3.70	3.25	149.3	24.02	32.07	27.29	47.52	3.97	7.91	11.88	0.250
S2	DW	55.4	11.0	3.20	3.15	109.9	9.18	5.74	14.92	17.01	1.44	4.05	5.49	0.323
	100	58.8	16.0	3.30	3.20	155.2	13.93	13.32	27.25	28.47	1.76	4.53	6.29	0.221
	200	45.7	14.0	4.40	4.00	162.1	28.14	14.31	42.53	28.29	3.23	4.96	8.14	0.288
LSD		2.84	N.S	N.S	N.S.	3.38	N.S.	N.S	9.90	N.S	N.S.	1.91	N.S	……

TABLE 4. Effect of usage the nano fertilizers on potato pests infestations in pots.

Tested materials	Eggs numbers/ female	Eggs hatchability	% mortality of larvae	% mortality of pupae	% mortality of adults
Nano nitrogen	33 ± 14.5	12	87	40	60
Potassium sulphate	28 ± 16.7	10	88	50	67
Calcium super phosphate	22 ± 41.5	8	89	60	78
Nano nitrogen	23 ± 40.5	12	87	40	60
Potassium sulphate	18 ± 46.7	11	80	53	55
Calcium super phosphate	20 ± 71.9	7	79	50	66
control	231 ± 24.2	100	3	5	4
LSD5%	12.5	7.1	5	8	8
F value	15.7	6.8	7	5	10

TABLE 5. Yield assessments of damage caused after treatment with the nano fertilizers in potato field.

Treatments	Season 2021 Wt of Potatoes (Ton/feddan)	Season 2022 Wt of Potatoes(Ton/feddan)
Nitrogen	12. 92±75.13[b]	13.82±85.11[c]
Potassium sulphate	13.79±44.28[c]	14.99±64.21[d]
Calcium super phosphate	10.07±53.41[a]	10.00± 40.59[a]
Nano nitrogen	13. 52±15.13[c]	13.82±85.11[c]
Nano Potassium sulphate	14.17±24.67[d]	14.99±64.21[d]
Nano Calcium super phosphate	13.77±93.2[c]	10.00± 40.59[a]
Control	10.47±23.71	10.17±63.81
F value	43.49	39.8
Lds5%	34.2	36.1

On other vegetable plants, Nami and Sasine, (2017) subjected tomato plants to salinity treatments as. They revealed that exogenous application of the product has counteracted the salt-induced adverse effects on plants. It improved plant height of salt-stressed plants compared to the control with a maximum effect at C2 especially atEC=8dS/m and EC=10dS/m. Similarly, it increased leaf number, stem diameter and number of flowers in salt-stressed plants despite the application dose. In specific, in C2- treated plants the average number of flowers was the most enhanced at EC=2, 4, 6 and 8dS/m. Fruit set was improved in all treatments especially in C1-treated plants at EC=2dS/m (41% improvement compared to C0). Yield (g/plant) in tomato salt-stressed plants was ameliorated as well by LITHOVIT mainly in C1- and C2- treated plants (76% and 40% improvement at EC=8dS/m and EC=10dS/m in C2-plants compared to C0). Also, LITHOVIT® application induced greater root biomass formation (mainly with C3) and dry matter accumulation in roots (mainly with C2 and C3). Finally, it enhanced chlorophyll content, leaf area and cell membrane stability under all s alinity. The study of Mahmoud, et al., (2019) and its findings suggest that soil addition of the aforementioned nanoparticles can be a promising approach to improving crop productivity in salt-affected soils.

Conclusion

To evaluate the response of nano fertilizer application on potato plants growing under saline conditions, a pot experiment was conducted. The obtained results led us to conclude that nano fertilizer one from the promising way to increase growth and productivity of potato plants. Moreover, diminishing the environmental pollution through less fertilizers use and lowering the coasts of fertilization practices. It could be recommend that use of nano fertilizer increase growth and yield of potatoes plants grown under saline condition. Also the results showed that the infestations with potato tuber moth decreased after Nano fertilizer applications. The fertilizers used and nan fertilizers increased the potato yield under field conditions and decreased the insect infestations under laboratory and field conditions.

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