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Effect of Foliar Application with Salicylic Acid (Potasal), Mineral Phosphorus Levels and Inoculation Tomato Plant with Soluble Phosphorus Bacteria on Growth, Productivity and Reducing Disease Infect with Tomato Curly Top Virus (TCTV)

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ABSTRACT

The objective of the present study is to investigate effect of phosphorus fertilizer levels and potassium salicylate spraying on tomato growth, yield, quality and curly top virus severity % (TCTV) and incidence. Two field experiments were conducted in a private farm at El-Shamarka, Kafr El-Sheikh district, Kafr El-Sheikh governorate during 2014 and 2015 seasons. Split split plot design was used with four replicates. The main plots were assigned with three phosphorus levels 0, 15 and 30 kg P_2O_5 fed^{-1}. The sub plots were assigned with two potassium salicylate treatments of without potassium salicylate but sprayed by potassium 20% K_2O 1 liter in 200 liter water fed^{-1} and spraying with potassium salicylate 20% K_2O, 12.5% salicylate at the rate 300 mg L^{-1} salicylic of the spraying solution. The sub sub plots were assigned with two biofertilizer treatments of without inoculation and inoculation with phosphate solubilizing bacteria. The results can be summarized as phosphorus at the level of 15 kg P_2O_5 fed^{-1} had the highest values of stem length, number of branches/plant, leaves area/plant, dry weight of shoot/plant and total yield (15.39, 16.15 ton fed^{-1}) and vitamin C. While, the phosphorus level of 30 kg P_2O_5 fed^{-1} had the highest values of early yield (4.51 and 4.39 ton fed^{-1}) fruit length, fruit diameter, average fruit weight, TSS, acidity, N%, K% in the shoot and fruits. Potassium salicylate spraying had the highest values of stem length, number of branches/plant, leaves area/plant, dry shoot, dry fruit/plant, early and total yield ton fed^{-1}, average fruit weight, TSS, acidity, vitamin C and K% in fruits. Phosphate solubilizing bacteria inoculation increased stem length, leaves area/plant, dry shoots and fruit weight, early and total yields, fruit length, fruit diameter, average fruit weight, TSS, acidity and vitamin C, N%, K% in the shoot and fruits. Phosphorus at the level 15 kg P_2O_5 fed^{-1} affected curly top virus (TCTV), decreased disease incidence %, disease severity % and increased reduction infection %. Disease severity comparing to the used rating scale (0-4) all the values of P levels from 12.21 up to 19.95% lies in class one (11-20%), this means that effect of P levels on (TCTV) was low. Potassium salicylate spraying decreased disease incidence %, disease severity % and increased reduction infection %. Comparing with the used rating scale clear that the values of K-salicylate (4.43, 9.75%) lies in the class zero (0-10%), while the control (21.79, 25%) lies in class two (21-30%), this means that K-salicylate spraying was effective in decreasing (TCTV) in tomato.

Keywords: salicylic acid application, phosphorus fertilizer, biofertilization, tomato curly top virus,

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is the most important vegetable crop. It is considered a major vegetable crop in many parts of the world including Egypt. Tomato is a rich source of lycopene and vitamins A and C. Lycopene may help counteract the harmful effects of the free radicals which are thought to contribute to number of types of cancer. Fertilization and plant pathogens are the major factors affect tomato production. Under the Egyptian conditions, only a small part of phosphorus is utilized by plants and the rest is easily precipitated and converted into insoluble fixed forms and this cannot be utilized by the plants.

Phosphorus is an essential component of nucleic acid, phospholipids and energy rich phosphate compounds, thus, it plays crucial role in root growth, fruit and seed development, disease resistance, utilization of sugar and starch and transporting of genetic traits (Khan., 2009). Tesfaye (2008) found that application of 120 kg P_2O_5/ha, resulted in superior tomato fruit yield, while Qiang and Monica (2017) concluded that 75 kg P_2O_5/ha was sufficient to grow tomato crop during the winter season in calcareous soil with 13-15 mg kg^{-1} DTPA extractable P. Multinutrients 20/20/20 increased tomato fruit yield, N% in shoots, N, P and K use efficiency (El-Hamdi., 2011).

Pigna . (2012) reported that phosphorus fertilization plays an important role in alleviating arsenic toxicity in tomato plants. It has allowed to reduce arsenic translocation towards tomato barriers and enhancing plant P status.

Biofertilizers is a substance which contains living microorganisms, when applied to seeds, plant surface or soil, colonizes and promotes growth by increasing the supply or availability of nutrients to the plant. It added nutrients through N fixation, solubilizing phosphates and stimulating plant growth.

Phosphate solubilizing bacteria in the plant rhizosphere plays a significant role in releasing P from its insoluble complexes to a form that is more readily usable by plant (Hamissa ., 2000, Nanis ., 2018).

Tomato plants inoculated with phosphate solubilizing bacteria caused an increase in growth in shoots, roots early formation, increased the quality of fruits and seeds (Deepika ., 2013; Sharon ., 2016 and Sreedevi Sarson, 2016).

Turan . (2007) observed that phosphate solubilizing bacteria application converted approximately 20% of less available P into labile forms.

Kamil . (2015) stated that, combination of growth promoting bacteria and triple super phosphate had significant effect and increased the yield and growth traits of tomato.

Plant pathogens are responsible for about 15-30% crop annual losses in Egypt as well as worldwide. Salicylic acid is a plant phenol and today it is in use as internal regulator hormone due to its role in the defensive mechanism against biotic and abiotic stresses (Khan ., 2003).

Virus chemotherapy due to interference with processes which are associated with the initial phases of viral replication or inhibition of virus, specific events that occur during viral maturation and assembly (james ., 1997; Dangl and Jones, 2001 and Leverson ., 2001). Salicylic acid is considered one of the key endogenous signals involved in the activation of numerous plant defense responses (Shah and Klessing, 1999 and Hayat ., 2010). Salicylic acid is an important signal molecule in plant that is required for the induction systemic acquired resistance against wide variety of pathogens including fungi, bacteria and virus (Danpsay ., 1999; Kobeasy and Salwa, 2005 and Karban and Chen, 2007). Salicylic acid can enhance the plant growth, yield and quality of tomato (Khodary, 2004 and Javaheri ., 2012).

The objective of the present study is to investigate effect of mineral, bio-phosphorus fertilization and potassium salicylate spraying on tomato growth, yield and yield quality as well as disease severity and incidence of tomato curly top virus (TCTV).

MATERIALS AND METHOS

Two field experiments were conducted in a private farm at El-Shamarka, Kafr El-Sheikh district, Kafr El-Sheikh governorate during two successive summer seasons of 2014 and 2015. Split split plot design with four replicates was used. The main plots were assigned with three phosphorus fertilizer levels of without, 15 kg P_2O_5 fed^{-1} and 30 kg P_2O_5 fed^{-1}. The sub plots were assigned by two salicylic treatments of without salicylic spraying and spraying with potassium salicylate at the rate of 300 mg L^{-1} salicylic at spraying solution (Potasal). The sub sub plots were assigned by two biofertilizer treatments of without biofertilizer inoculation, and inoculation with phosphate solubilizing bacteria (*Bacilus megatherium*). Tomato (*Lycopersicon esculentum* L.) variety 1077 was used. Seedling transplanted on 5th may in the first season and 7th May in the second season. The micro plot area was 19.5 m^2 (3 ridges, 5 m in length and 1.3 m in width). Composite soil sample was collected from (0-30 cm) of the experimental soil, air dried passed through 2 mm sieve. Soil ECe was determined in soil paste extract, pH measured in 1:2.5 soil:water suspension, cations and anions were determined in soil paste extract according to Jackson (1967). Particle size distribution, and bulk density were determined according to Black . (1965). Available N, P, K and OM were determined according to Cottene . (1982). Some physical and chemical properties of the experimental soil are shown in Table (1).

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

Season	Particle size distribution			Texture	OM %	BD g/cm^3	pH	ECe dS/m	Cations (meq/L)				Anions (meq/L)			Available nutrients		
	Sand	Silt	Clay						Ca^{++}	Mg^{++}	Na^+	K^+	HCO_3^-	Cl^-	$SO_4^=$	N	P	K
2014	6.6	32.5	60.9	Clayey	1.6	1.35	7.2	2.1	10	4.0	6	0.9	3.0	8.0	10	27	6	267
2015	7.0	32.5	60.5	Clayey	1.5	1.36	7.1	2.15	9	4.0	7.2	0.7	2.5	9.0	10	25	5	262

BD = Bulk density

Recommended N was applied as ammonium nitrate 33.5% in four doses, P was applied as calcium super phosphate 15.5% P_2O_5 before transplanting and incorporated in the soil, potassium was applied at the recommended dose in one dose with the first irrigation.

Salicylic was sprayed as potassium salicylate (20% K_2O and 12.5% salicylate) Potasal in the concentration of 300 ppm salicylate, the control (without salicylate) was sprayed by potassium (480 ppm) equal with the presence of potassium salicylate. Stem length cm, number of branches/plant, leaf area (cm^2), dry weight of shoots (g/plant), dry weight of fruits (g/plant), early yield (ton/fed.), total yield (ton/fed.), fruit length (cm), fruit diameter (cm), average fruit weight (g), TSS%, vitamin C (mg/100 g fresh weight) and acidity % were measured. Samples of shoots and fruits were oven dried at 70^{o}C and fine ground, wet digested using mixture of sulfuric and perchloric acids. Total N% was determined by Kjeldahl method, total K% was measured by flame photometer according to Jackson (1967). TSS was determined by using the hand refractometer. Vitamin C was determined by titration as the method mention in AOAC (1990). Also, total titratable acidity was determined according to the method described by AOAC (1990).

Disease incidence %, reduction of infection % and disease severity% were evaluated.

Disease severity was evaluated by visual observation of systemic leaf (fourth-fully expanded leaf from the top) following as rating scale of 0-4 as following:

0=No symptoms; 0-10% Infection

1=Vein, clearing after some time; 11-20%

2=Mild stant with curling; 21-30%

3=Very curling with severe stunting on infected plants; 31-60%

4=Pale leaves, flowering and fruits; >60%.

Disease incidence% =

$$\frac{\textit{Number of infected plants per treatment}}{\textit{Total number of plants per treatment}} x100$$

Disease severity (DS%) =

$$\frac{\sum(\textit{disese grade x number of plant each grade}}{\textit{Total number of plants x highest disease grade}} x\ 100$$

Reduction of infection (RI%) =

$$\frac{\textit{Control} - \textit{disease incidence x } 100}{\textit{Control}}$$

Statistical analysis was conducted according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Data presented in Table (2) show that phosphorus fertilization levels high significantly affected tomato stem length, number of branches/plant and leaves area/plant in both seasons. The highest values 73.88 and 70.31 cm of stem length, 15.5 and 13 of number of branches, 11440.3 and 10969.1 cm^2 of leaves area/plant in the first and second season, respectively were obtained with the moderate phosphorus level (15 kg P_2O_5 fed^{-1}). The lowest values were obtained with the treatment of without phosphorus fertilization. In respect to salicylic spraying as inducer or antioxidant, spraying led to significantly increases in stem length, number of branches and leaves area per plant in both seasons compared to the treatment without salicylic spraying. Inoculation with phosphate solubilizing bacteria significantly increased tomato stem length and leaves area/plant in both seasons. On the other hand, no significant difference in number of branches/plant due to inoculation. The interaction between phosphorus levels and salicylic spraying show 15 kg P_2O_5 and spraying with salicylic had the best stem length, number of branches and leaves area/plant (Table 2). The interaction between phosphorus levels and bioinoculation show that the best treatment of stem length, number of branches and leaves area/plant was 15 kg P_2O_5/fed. and biofertilizer inoculation in both seasons (Table 2). The interaction between salicylic spraying and biofertilizer inoculation, show the highest values were obtained with salicylic spraying and biofertilizer inoculation (Table 2).

The interaction between phosphorus levels, salicylic spraying and biofertilizer inoculation show that, the highest stem length, No. of branches and leaves area/plant were obtained with 15 kg P_2O_5 fed^{-1} + salicylic spraying + bioinoculation (Table 2). The previous data may be due to available P in the soil before transplanting was less than plant need and application of P fertilizer and P solubilizing bacteria increased their availability. These results are in agreement with those obtained by Khan . (2009) and Sharon . (2016). Salicylic acid may induce resistance against biotic and abiotic stress, these results enhanced by Kobeasy and Salwa El-Hamid (2005).

Table 2. Effect of salicylic acid foliar spraying, phosphorus fertilization and inoculation with solubilizing phosphate bacteria and their interaction on stem length, number of branches and leaf area of tomato plant at 70 days after transplanting during the two growing seasons of 2014-2015.

Treatments			Stem length (cm)		No. of branches		Leaves area/plant (cm^2)	
Phosphorus levels (kg/fed.)	Salicylic acid spraying	Inoculation bacteria	First season	Second season	First season	Second season	First season	Second season
30			65.00 b	66.63 b	14.56 b	12.50 a	8851.3 b	9325.2 b
0			64.25 b	66.38 b	12.63 c	11.81 b	7377.8 c	8071.7 c
15			73.88 a	70.31 a	15.50 a	13.00 a	11440.3 a	10969.1 a
F-test			**	**	**	**	**	**
	Spraying		69.04 a	68.00	14.54 a	12.50	9588.2 a	9719.6 a
	Without		66.88 b	67.54	13.92 b	12.38	8858.1 b	9191.1 b
F-test			**	NS	**	NS	**	**
		Inoculation	70.88 a	69.42 a	14.33	12.50	10059.1 a	9782.4 a
		Without	65.04 b	66.13 b	14.13	12.38	8387.2 b	9128.2 b
F-test			**	**	NS	NS	**	**
30	Spraying		64.38 d	66.00	14.50 bc	12.13	8818.0 c	9326.0 c
	Without		65.13 cd	67.25	14.63 a	12.88	8884.5 c	9324.4 c
0	Spraying		66.13 c	67.00	13.38 bc	12.13	7810.4 d	8373.6 d
	Without		64.38 d	65.75	11.88 c	11.50	6945.2 e	7769.8 e
15	Spraying		76.63 a	71.00	15.75 a	13.25	12136.2 a	11459.0 a
	Without		71.13 b	69.63	15.25 ab	12.75	10744.5 b	10479.2 b
F-test			**	NS	**	NS	**	**
30		Inoculation	64.25 d	65.63 c	13.63 c	11.88 cd	8172.9 d	9022.8 cd
		Without	65.25 c	67.63 b	15.50 ab	13.13 ab	9529.7 b	9627.5 bcd
0		Inoculation	66.88 b	67.75 b	13.38 c	12.33 bc	8055.3 d	8343.0 bc
		Without	63.63 d	65.00 c	11.88 d	11.25 d	6700.4 e	7800.5 e
15		Inoculation	81.50 a	64.88 a	16.00 a	13.25 a	13949.3 a	11981.5 a
		Without	66.25 b	65.75 c	15.00 b	12.75 ab	8931.4 c	9956.7 b
F-test			**	**	**	**	**	**
	Spraying	Inoculation	72.33 a	69.33	15.00 a	12.67	10777.4 a	10233.5 a
		Without	65.75 c	66.67	14.08 b	12.33	8398.6 c	9205.9 a
	Without	Inoculation	69.42 b	69.50	13.67 b	12.33	9340.4 b	9331.4 a
		Without	64.33 d	65.58	14.17 b	12.42	8375.7 c	9050.9 b
F-test			**	NS	**	NS	**	**
30	Spraying	Inoculation	64.00 f	64.75	14.25	11.50	8705.5	9437.5 e
		Without	64.75 ef	67.25	14.75	12.75	8930.6	9214.6 e
	Without	Inoculation	64.50 f	64.75	13.00	12.25	7640.2	8608.2 f
		Without	65.75 df	67.25	16.25	13.50	10128.8	10040.5 d
0	Spraying	Inoculation	67.25 c	68.00	14.25	12.75	8782.7	8780.5 f
		Without	65.00 ef	66.00	12.50	11.50	6838.2	7966.8 g
	Without	Inoculation	66.50 cd	67.50	12.50	12.00	7327.9	7905.4 g
		Without	62.25 g	64.00	11.25	11.00	6562.6	7634.1 f
15	Spraying	Inoculation	85.75 a	75.25	16.50	13.75	14845.4	12482.5 a
		Without	67.50 c	66.75	15.00	12.75	9427.1	10435.6 c
	Without	Inoculation	77.25 b	74.75	15.00	12.75	13053.2	11480.5 b
		Without	65.00 ef	64.50	15.00	12.75	8435.8	9477.9 e
F-test			**	NS	NS	NS	NS	**

****, * and NS indicate significant differences at $P<0.01$, <0.05 and not significant, respectively according to F-test.**
In the same column, means followed by the same letter are not significantly different at 5% level according to Duncan's test.

Data in Table (3) show that phosphorus fertilization levels high significantly affected tomato dry weight of shoot and fruits per plant in both seasons. The highest dry shoot values were obtained with 15 kg P_2O_5 fed^{-1} (240.5 and 235.69 g/plant). While the highest dry fruit weight values were obtained with 30 kg P_2O_5 fed^{-1}

(6.1 and 6.1 g/plant) in the first and second seasons, respectively. On the other hand, the lowest values were recorded with zero phosphorus. These results are in harmony with those obtained by Deepika Divya Kadiri . (2013). Spraying salicylic acid high significantly increased tomato dry shoot and fruits per plant (226.91, 209.85) and (5.9, 5.94 g/plant) compared to the treatment without salicylic spraying (213.78, 198.3) and (5.53, 5.64). These results are in harmony with those obtained by Khodary (2004). Inoculation with phosphate solubilizing bacteria high significantly increased dry shoot and fruits per plant (226.65, 213.86) and (6.09, 6.08) compared to (215.04, 194.28) and (5.34, 5.5) g/plant in the first and second seasons, respectively. These results are in agreement with those obtained by Sreedevi Sarsan (2016). The interaction effect between phosphorus levels and salicylic spraying was highly significant on tomato dry shoot weight (g/plant), where the highest values were obtained with 15 kg P_2O_5 + salicylic spraying. On the other hand, no significant differences in fruit dry weight were detected.

Table 3. Effect of salicylic acid foliar spraying, phosphorus fertilization and inoculation with solubilizing phosphate bacteria and their interaction on dry weight of shoot and dry matter of tomato fruits in the two growing seasons 2014-2015.

Treatments			Dry weight of shoot (g/plant)		Dry matter of fruits (g/plant)	
Phosphorus levels (kg/fed.)	**Salicylic acid spraying**	**Inoculation bacteria**	**First season**	**Second season**	**First season**	**Second season**
30			219.47 b	200.52 b	6.10 a	6.10 a
0			201.10 c	176.01 c	5.43 c	5.56 c
15			240.50 a	235.69 a	5.62 b	5.80 b
F-test			**	**	**	**
	Spraying		226.91 a	209.85 a	5.90 a	5.94 a
	Without		213.78 b	198.30 b	5.53 b	5.64 b
F-test			**	**	**	**
		Inoculation	226.65 a	213.86 a	6.09 a	6.08 a
		Without	215.04 b	194.28 b	5.34 b	5.50 b
F-test			**	**	**	**
30	Spraying		219.98 c	200.29 c	6.24	6.14
	Without		218.96 c	200.75 c	5.96	5.89
0	Spraying		206.31 d	182.58 d	5.64	5.65
	Without		195.83 e	169.44 e	5.21	5.46
15	Spraying		254.45 a	246.68 a	5.83	6.03
	Without		226.55 b	224.70 b	5.41	5.58
F-test			**	**	NS	NS
30		Inoculation	205.86 d	188.83 d	6.63 a	6.40 a
		Without	223.08 b	212.21 b	5.58 d	5.61 c
0		Inoculation	206.84 d	184.65 e	5.70 c	5.75 c
		Without	19530 e	167.36 f	5.15 f	5.36 d
15		Inoculation	267.27 a	268.10 a	5.95 b	6.09 b
		Without	213.74 c	203.28 c	5.29 e	5.51 c
F-test			**	**	**	*
	Spraying	Inoculation	236.57 a	223.92 a	6.30	6.16 a
		Without	217.08 b	195.78 c	5.50	5.72 b
	Without	Inoculation	216.57 b	203.80 b	588	6.00 a
		Without	210.99 c	192.79 d	5.18	5.28 c
	F-test		**	**	NS	*
30	Spraying	Inoculation	211.93 e	191.73	6.78	6.50
		Without	228.03 d	208.85	5.70	5.78
	Without	Inoculation	199.80 f	185.93	6.48	6.30
		Without	238.13 c	215.58	5.45	5.45
0	Spraying	Inoculation	216.60 e	196.20	5.98	5.78
		Without	196.03 f	168.95	5.30	5.53
	Without	Inoculation	197.08 f	173.10	5.43	5.73
		Without	194.58 f	165.78	5.00	5.20
15	Spraying	Inoculation	281.70 a	283.83	6.15	6.20
		Without	227.20 d	209.53	5.50	5.85
	Without	Inoculation	252.83 b	252.38	5.75	5.98
		Without	200.28 f	197.03	5.08	5.18
F-test			**	NS	NS	NS

****, * and NS indicate significant differences at P<0.01, <0.05 and not significant, respectively according to F-test.**
In the same column, means followed by the same letter are not significantly different at 5% level according to Duncan's test.

The interaction between phosphorus levels and bio-inoculation (Table 3) show high significantly increase in dry shoot and fruits weight/plant. The highest values were observed with 15 kg p2O5 + bio-inoculation in shoot weight, while in dry fruit weight the highest values with 30 kg P_2O_5 + bio inoculation. The interaction between salicylic spraying and bio-inoculation (Table 3) show that the highest dry shoot and fruits/plant were recorded with salicylic spraying + bio-inoculation in both seasons.

Early and total yield (ton fed^{-1}) significantly affected by phosphorus levels, salicylic spraying and phosphate solubilizing bacteria inoculation (Table 4). The highest early yield (4.51, 4.39) ton fed^{-1} were obtained with 30 kg P_2O_5 fed^{-1} in the first and second seasons, respectively. The highest total yield (15.38, 16.15) ton fed^{-1} were obtained with 15 kg P_2O_5 fed^{-1} in the first and second seasons, respectively. On the other hand the lowest values were recorded with the treatment without phosphorus application.

Table 4. Effect of salicylic acid foliar spraying, phosphorus fertilization and inoculation with solubilizing phosphate bacteria and their interaction on early and total yield of tomato in the two growing seasons 2014-2015.

Treatments			Early yield (ton/fed.)		Total yield (ton/fed)	
Phosphorus levels (kg/fed.)	Salicylic acid spraying	Inoculation bacteria	First season	Second season	First season	Second season
30			4.514 a	4.393 a	13.818 b	14.359 b
0			2.535 c	2.357 c	11.742 c	12.657 c
15			4.055 b	3.850 b	15.385 a	16.150 a
F-test			**	**	**	**
	Spraying		3.899 a	3.636 a	14.298 a	15.037 a
	Without		3.504 b	3.430 b	12.999 b	13.741 b
F-test			**	**	**	**
		Inoculation	3.793 a	3.628 a	13.781 a	14.470 a
		Without	3.610 b	3.439 b	13.516 b	14.307 b
F-test			**	**	**	*
30	Spraying		4.673	4.405	14.288 c	14.707 c
	Without		4.356	4.380	13.349 d	14.011 d
0	Spraying		2.709	2.494	12.589 e	13.489 e
	Without		2.362	2.221	10.896 f	11.824 f
15	Spraying		4.315	4.010	16.019 a	16.914 a
	Without		3.795	3.691	14.752 b	15.386 b
F-test			NS	NS	**	**
30		Inoculation	4.552 a	4.419 a	12.994 c	13.582 d
		Without	4.477 b	4.366 a	14.643 b	15.136 c
0		Inoculation	2.623 e	2.425 d	12.216 d	13.101 e
		Without	2.448 f	2.290 e	11.269 e	12.213 f
15		Inoculation	4.284 c	4.040 b	16.133 a	16.728 a
		Without	3.826 d	3.661 c	14.637 b	15.572 b
F-test			**	**	**	**
	Spraying	Inoculation	3.992	3.810 a	14.476	15.126
		Without	3.806	3.462 b	14.121	14.947
	Without	Inoculation	3.594	3.445 b	13.087	13.815
		Without	3.414	3.416 b	12.911	13.667
F-test			NS	**	NS	NS
30	Spraying	Inoculation	4.723 a	4.786 a	14.133 f	14.320 e
		Without	4.623 b	4.025 b	14.442 e	15.095 d
	Without	Inoculation	4.221 d	4.052 b	11.855 j	12.845 g
		Without	4.491 c	4.707 a	14.843 d	15.178 d
0	Spraying	Inoculation	2.780 g	2.544 d	12.940 h	13.880 f
		Without	2.638 h	2.443 de	12.237 i	13.099 g
	Without	Inoculation	2.467 i	2.305 ef	11.492 k	12.321 h
		Without	2.257 j	2.137 f	10.300 L	11.327 i
15	Spraying	Inoculation	4.472 c	4.101 b	16.353 a	17.179 a
		Without	4.185 de	3.919 b	15.684 c	16.649 b
	Without	Inoculation	4.095 e	3.979 b	15.913 b	16.277 c
		Without	3.495 f	3.402 c	13.591 g	14.795 e
F-test			**	**	**	**

****, * and NS indicate significant differences at P<0.01, <0.05 and not significant, respectively according to F-test.**
In the same column, means followed by the same letter are not significantly different at 5% level according to Duncan's test.

Spraying with salicylic led to high significantly increase of early and total yields ton fed^{-1} in both seasons, compared to without spraying one. Phosphate solubilizing bacteria inoculation high significantly increased early and total tomato yields (3.79, 3.63) and (13.78, 14.47) ton fed^{-1} compared with (3.61, 3.44) and (13.52, 14.31) ton fed^{-1} in the control. These results are in agreement with those obtained by Tesfaye (2008) who concluded that phosphorus application resulted in superior tomato fruit yield.

Javaheri . (2012) reported that application of salicylic acid had higher fruit yield of tomato. Kamil . (2015) found that combination treatment of biofertilizer and chemical fertilizer increased the yield and growth of tomato. The interaction between phosphorus levels and salicylic spraying had no significant effect on early yield and high significantly increased total tomato yield. The highest total yield values were with 15 kg P_2O_5 + salicylic spraying. The interaction between phosphorus levels and bio inoculation show that early yield high significantly increased with 30 kg P_2O_5 fed^{-1} + bio inoculation, while the total yield high significantly increased with 15 kg P_2O_5 + bio inoculation.

The interaction between phosphorus levels, salicylic spraying and bioinoculation show that the best treatment for early yield was 30 kg P_2O_5 + salicylic spraying + bioinoculation. While the best treatment for the total yield was 15 kg P_2O_5 fed^{-1} + salicylic spraying + bio inoculation.

Data tabulated in Table (5) show that, tomato fruit length, fruit diameter and average fruit weight high significantly affected by phosphorus levels in both seasons. The highest fruit length (7.41, 7.13 cm), high fruit diameter (5.48, 5.44) and highest average fruit weight (108.58, 109.81) g/fruit were obtained with 30 kg P_2O_5 fed^{-1} in the first and second seasons, respectively. On the other hand, the lowest values were observed with the control (without phosphorus treatment). These results are in line with those obtained by Qiang and Monica (2017). Spraying tomato with salicylic high significantly increased average fruit weight (102.0, 105.75 g/fruit) in the first and second seasons, respectively compared with (93.01, 94.53). These results are in line with Hayat . (2010). Data in Table (5) show that biofertilizer inoculation high significantly increased fruit length, fruit diameter and average fruit weight in both seasons compared to uninoculated one. These results are in harmony with those obtained by Sreedevi Sarsan (2016).

Table 5. Effect of salicylic acid foliar spraying, phosphorus fertilization and inoculation with solubilizing phosphate bacteria and their interaction on fruit physical quality of tomato during the two growing seasons of 2014-2015.

Treatments			Fruit length (cm)		Fruit diameter (cm)		Av. Fruit weight (g/fruit)	
Phosphorus levels (kg/fed.)	**Salicylic acid spraying**	**Inoculation bacteria**	**First season**	**Second season**	**First season**	**Second season**	**First season**	**Second season**
30			7.41 a	7.13 a	5.48 a	5.44 a	108.58 a	109.81 a
0			6.08 c	6.40 c	5.11 c	5.23 b	83.38 c	84.81 c
15			7.13 b	6.93 b	5.45 b	5.45 a	100.56 b	105.70 b
F-test			**	**	**	**	**	**
	Spraying		6.996 b	6.93	5.40 a	5.38	102.00 a	105.75 a
	Without		7.167 a	6.98	5.23 b	5.37	93.01 b	94.53 b
F-test			*	NS	**	NS	**	**
		Inoculation	7.24 a	6.98 a	5.47 a	5.43 a	100.86 a	103.18 g
		Without	6.92 b	6.66 b	5.23 b	5.32 b	94.15 b	97.09 b
F-test			**	**	**	**	**	**
30	Spraying		7.35	6.98	5.53	5.43	108.74	111.36 b
	Without		7.48	7.29	5.43	5.46	108.43	108.25 b
0	Spraying		6.51	6.48	5.15	5.24	89.25	89.53 d
	Without		6.89	6.33	5.06	5.21	77.54	80.29 e
15	Spraying		7.13	7.04	5.54	5.48	108.04	116.35 a
	Without		7.14	6.83	5.63	5.43	93.08	95.05 c
F-test			NS	NS	NS	NS	NS	**
30		Inoculation	7.55	7.28 a	5.63	5.54 a	116.43 a	117.83 a
		Without	7.28	6.99 b	5.33	5.35 c	100.74 b	101.79 c
0		Inoculation	6.94	6.48 d	5.21	5.30 c	87.05 c	86.65 d
		Without	6.46	6.33 d	5.00	5.15 d	79.71 c	83.16 e
15		Inoculation	7.24	7.19 a	5.58	5.44 b	99.11 b	105.08 b
		Without	7.03	6.68 c	5.33	5.46 b	102.00 b	106.33 b
F-test			NS	**	NS	**	**	**
	Spraying	Inoculation	7.21	6.95	5.52	5.46 a	104.77	106.69 a
		Without	6.78	6.71	5.29	5.30 c	99.23	104.80 b
	Without	Inoculation	7.23	7.01	5.43	5.39 b	96.96	99.68 c
		Without	7.06	6.62	5.14	5.34 bc	89.07	89.38 d
F-test			NS	NS	NS	**	NS	**
30	Spraying	Inoculation	7.60	7.08	5.68	5.55 a	112.50	114.48 b
		Without	7.10	6.88	5.38	5.30 d	104.98	108.25 c
	Without	Inoculation	7.50	7.48	5.58	5.53 ab	120.35	121.18 a
		Without	7.45	7.10	5.28	5.40 c	96.50	95.33 d
0	Spraying	Inoculation	6.78	6.58	5.23	5.30 d	92.90	87.13 f
		Without	6.25	7.18	5.08	5.18 e	85.55	91.93 e
	Without	Inoculation	7.10	6.38	5.20	5.30 d	81.20	86.18 f
		Without	6.68	6.28	4.93	5.13 e	73.88	74.40 g
15	Spraying	Inoculation	7.25	7.20	5.65	5.53 ab	108.90	118.48 a
		Without	7.00	6.88	5.43	5.43 bc	107.18	114.23 b
	Without	Inoculation	7.23	7.18	5.50	5.35 cd	89.33	91.68 e
		Without	7.05	6.48	5.23	5.50 ab	96.83	98.43 d
F-test			NS	NS	NS	**	NS	**

****, * and NS indicate significant differences at $P<0.01$, <0.05 and not significant, respectively according to F-test.**
In the same column, means followed by the same letter are not significantly different at 5% level according to Duncan's test.

No significant differences in fruit length, fruit diameter and average fruit weight except average fruit weight in the second season, due to the interaction between phosphorus levels at 15 kg P_2O_5 and salicylic spraying. The interaction between phosphorus levels and biofertilizer inoculation significantly affected fruit length in the second season, fruit diameter in the second season and average fruit weight in both seasons. The highest average in the second season and average fruit weight in both seasons.

The highest average fruit weight (116,43 and 117.83) g/fruit were obtained with 30 kg P_2O_5 + biofertilizer inoculation. Average fruit weight and fruit diameter in the second season, were significantly affected by the interaction between salicylic spraying and biofertilizer inoculation. The interaction between phosphorus levels, salicylic spraying and biofertilizer inoculation significantly affected average fruit weight in the second season only. The highest value was obtained with 15 kg P_2O_5 + salicylic spraying + biofertilizer inoculation.

Effect of phosphorus levels, spraying with salicylic and biofertilizer inoculation on tomato TSS %, vitamin C mg/100 g fresh weight and acidity% are presented in Table (6). Phosphorus levels high significantly affected TSS%, vitamin C and acidity % in both seasons. The highest values (5.36, 5.38) of TSS, (0.31, 0.33) of acidity were obtained with 30 kg P_2O_5 fed^{-1}, while the highest values of vitamin C (28.95, 27.37) mg/100 g fresh weight were obtained with 15 kg P_2O_5 fed^{-1}. These results are in line with those obtained by Khan . (2009).

Inoculation with phosphate solubilizing bacteria high significantly increased tomato TSS% (4.94, 5.18), vitamin C (27.12, 26.84) and acidity % (0.31, 0.33) comparing with the control, in the first and second seasons, respectively. The obtained results are in agreement with those obtained by Sreedevi Sarsan (2016).

Table 6. Effect of salicylic acid foliar spraying, phosphorus fertilization and inoculation with solubilizing phosphate bacteria and their interaction on fruit chemical quality of tomato during the two growing seasons of 2014-2015.

Treatments			TSS (%)		Vitamin C (mg/100 fresh weight)		Acidity (%)	
Phosphorus levels (kg/fed.)	Salicylic acid spraying	Inoculation bacteria	First season	Second season	First season	Second season	First season	Second season
30			5.36 a	5.38 a	23.00 c	25.05 b	0.310 a	0.326 a
0			4.10 c	4.49 b	26.23 b	25.08 b	0.266 c	0.303 c
15			4.75 b	5.35 a	28.95 a	27.37 a	0.294 b	0.314 b
F-test			**	**	**	**	**	**
	Spraying		4.87 a	5.11	29.23 a	27.14 a	0.307 a	0.317 a
	Without		4.60 b	5.04	22.89 b	24.52 b	0.273 b	0.310 b
F-test			**	NS	**	**	**	*
		Inoculation	4.94 a	5.18 a	27.12 a	26.84 a	0.314 a	0.333 a
		Without	4.53 b	4.97 a	25.01 b	24.82 b	0.266 b	0.294 b
F-test			**	**	**	**	**	**
30	Spraying		5.52	5.52 a	23.72 c	25.73 b	0.325 a	0.331
	Without		5.20	5.25 a	22.28 d	24.37 c	0.294 bc	0.321
0	Spraying		4.17	4.55 b	30.12 b	26.55	0.286 bc	0.307
	Without		4.03	4.43 b	22.35 d	23.60 c	0.245 b	0.296
15	Spraying		4.93	5.25 a	33.85 a	29.13 a	0.309 ab	0.313
	Without		4.57	5.45 a	24.05 c	25.60 b	0.279 c	0.315
F-test			NS	**	**	**	**	NS
30		Inoculation	5.67 a	5.60	23.63 d	26.42 b	0.331 a	0.348 a
		Without	4.05 b	5.17	22.37 e	23.68 e	0.289 b	0.303 d
0		Inoculation	4.30 e	4.63	25.22 c	25.12 d	0.289 b	0.313 c
		Without	3.90 f	4.35	27.25 b	25.03 d	0.242 d	0.291 e
15		Inoculation	4.85 c	5.30	32.50 a	28.98 a	0.323 a	0.338 b
		Without	4.65 d	5.40	25.40 c	25.75 c	0.265 c	0.289 e
F-test			*	NS	**	**	**	**
	Spraying	Inoculation	5.06	5.26 a	29.49 a	27.62 a	0.317 a	0.335
		Without	5.69	4.96 b	28.97 a	26.67 b	0.297 c	0.299
	Without	Inoculation	4.82	5.10 ab	24.74 b	26.06 b	0.311 b	0.330
		Without	4.38	4.99 b	21.04 c	22.99 c	0.234 d	0.290
F-test			NS	**	**	**	**	NS
30	Spraying	Inoculation	5.83	5.80	23.63 e	26.87 c	0.336 a	0.347 a
		Without	5.20	5.23	23.80 e	24.60 e	0.314 c	0.315 d
	Without	Inoculation	5.50	5.40	23.63 e	25.97 d	0.325 b	0.349 a
		Without	4.90	5.10	20.93 f	22.77 f	0.264 g	0.292 f
0	Spraying	Inoculation	4.33	4.57	26.67 a	25.77 d	0.292 d	0.322 c
		Without	4.00	4.53	33.57 b	27.33 bc	0.281 f	0.292 f
	Without	Inoculation	4.27	4.70	23.77 e	24.47 e	0.286 e	0.303 e
		Without	3.80	4.17	20.93 f	22.73 f	0.203 i	0.289 f
15	Spraying	Inoculation	5.00	5.40	38.17 a	30.23 a	0.323 b	0.337 b
		Without	4.87	5.10	29.53 c	28.08 b	0.296 d	0.289 f
	Without	Inoculation	4.70	5.20	26.83 d	27.73 b	0.323 b	0.339 b
		Without	4.43	5.70	21.27 f	23.47 f	0.235 h	0.290 f
F-test			NS	NS	**	**	**	**

**, * and NS indicate significant differences at P<0.01, <0.05 and not significant, respectively according to F-test.
In the same column, means followed by the same letter are not significantly different at 5% level according to Duncan's test.

The interaction between phosphorus levels and salicylic spraying significantly affect TSS% in the second season, the best value (5.45%), vitamin C in both seasons (33.85, 29.13) were obtained with 15 kg P_2O_5 fed^{-1} + spraying with salicylic.

The interaction between phosphorus levels and biofertilizer inoculation (Table 6) show that 15 kg P_2O_5 fed^{-1} + biofertilizer inoculation had the highest vitamin C, while the highest acidity in both seasons and TSS in the first season were observed with 30 kg P_2O_5 fed^{-1} + biofertilizer inoculation. The interaction between salicylic spraying and bioinoculation had the highest values of TSS, vitamin C and acidity. The interaction between P levels, salicylic spraying and bio-inoculation show that the best vitamin C, values with 15 kg P_2O_5 fed^{-1} + salicylic spraying + biofertilizer inoculation, while the highest acidity values with 30 kg P_2O_5 fed^{-1} + salicylic spraying + bioinoculation.

Data in Table (7) show that, phosphorus fertilization levels high significantly affected N%, and K% in tomato shoot and fruits. The highest values (0.64 and 0.68) N in shoot, (0.92 and 0.90) N in fruits in the first and second season, respectively. The highest values of K% (0.91 and 0.89) in the shoot and (2.86 and 2.68) in the fruits in the first and second season, respectively were obtained with 30 kg P_2O_5 fed^{-1}. On the other hand, the lowest values were detected without phosphorus treatment. These results are in agreement with those obtained by Kamil . (2015).

Table 7. Effect of salicylic acid foliar spraying, phosphorus fertilization and inoculation with solubilizing phosphate bacteria and their interaction on N and K% in tomato shoot and fruits during the two growing seasons of 2014-2015.

Treatments			N%				K%			
Phosphorus levels (kg/fed.)	Salicylic acid spraying	Inoculation bacteria	In shoot		In fruits		In shoot		In fruits	
			First season	Second season	First season	Second season	First season	Second season	First season	Second season
30			0.638 a	0.683 a	0.927 a	0.903	0.908 a	0.892 a	2.865 a	2.681 a
0			0.495 c	0.563 b	0.777 c	0.861	0.819 c	0.827 b	2.142 c	2.416 b
15			0.543 b	0.608 b	0.831 b	0.889	0.883 b	0.867 a	2.635 b	2.536 ab
F-test			**	**	**	NS	**	**	**	*
	Spraying		0.556	0.613	0.851 a	0.893	0.872	0.863	2.616 a	2.618 a
	Without		0.561	0.623	0.839 b	0.876	0.869	0.861	2.479 b	2.471 b
F-test			NS	NS	*	NS	NS	NS	**	**
		Inoculation	0.582 a	0.644 a	0.873 a	0.913 a	0.899 a	0.873 a	2.756 a	2.675 a
		Without	0.535 b	0.592 b	0.818 b	0.856 b	0.842 b	0.851 b	2.339 b	2.413 b
F-test			**	**	**	**	**	*	**	**
30	Spraying		0.632	0.652 b	0.925 a	0.897	0.900	0.890 a	3.042 a	2.793
	Without		0.643	0.715 a	0.930 a	0.910	0.917	0.893 a	2.688 b	2.568
0	Spraying		0.502	0.575 d	0.783 b	0.882	0.825	0.820 c	2.130 d	2.438
	Without		0.488	0.550 d	0.772 b	0.840	0.813	0.833 c	2.155 d	2.393
15	Spraying		0.535	0.605 c	0.845 b	0.900	0.877	0.898 a	2.675 b	2.628
	Without		0.552	0.612 c	0.817 c	0.878	0.890	0.855 b	2.595 c	2.450
F-test			NS	**	*	NS	NS	*	**	NS
30		Inoculation	0.668 a	0.707	0.960 a	0.943 a	0.937 a	0.902	3.110 a	2.870 a
		Without	0.607 b	0.660	0.895 b	0.863 e	0.880 c	0.882	2.260 c	2.492 c
0		Inoculation	0.508 e	0.598	0.795 d	0.888 c	0.843 e	0.840	2.188 e	2.467 c
		Without	0.482 f	0.527	0.760 e	0.833 f	0.795 f	0.813	2.097 f	23.365 c
15		Inoculation	0.570 c	0.627	0.863 c	0.908 b	0.917 b	0.877	2.970 b	2.688 b
		Without	0.517 d	0.590	0.798 d	0.870 d	0.850 d	0.857	2.300 d	2.383 c
F-test			**	NS	**	**	*	NS	**	*
	Spraying	Inoculation	0.572 b	0.637	0.884 a	0.934 a	0.907 a	0.876	2.796 a	2.789
		Without	0.540 c	0.589	0.818 c	0.851 d	0.837 d	0.850	2.436 c	2.447
	Without	Inoculation	0.592 a	0.651	0.861 b	0.892 b	0.891 b	0.870	2.717 b	2.561
		Without	0.520 d	0.596	0.818 c	0.860 c	0.847 c	0.851	2.242 d	2.380
F-test			**	NS	**	**	**	NS	**	NS
30	Spraying	Inoculation	0.647 b	0.660 bc	0.970 a	0.953	0.940 a	0.899	3.243	3.017
		Without	0.617 c	0.643 bcd	0.880 d	0.840	0.960 d	0.883	2.840	2.570
	Without	Inoculation	0.690 a	0.753 a	0.950 b	0.933	0.933 b	0.907	2.977	2.723
		Without	0.597 d	0.677 b	0.910 c	0.887	0.900 c	0.880	2.400	2.413
0	Spraying	Inoculation	0.520 g	0.623 de	0.810 f	0.927	0.850 e	0.840	2.143	2.490
		Without	0.483 j	0.527 g	0.757 h	0.837	0.800 g	0.800	2.117	2.387
	Without	Inoculation	0.647 b	0.573 f	0.780 g	0.850	0.837 f	0.840	2.233	2.490
		Without	0.617 c	0.527 g	0.763 h	0.830	0.790 h	0.827	2.077	2.387
15	Spraying	Inoculation	0.550 f	0.627 cde	0.873 d	0.923	0.930 b	0.890	3.000	2.860
		Without	0.520 g	0.597 ef	0.817 f	0.847	0.850 e	0.867	2.350	2.383
	Without	Inoculation	0.590 e	0.627 cde	0.853 e	0.893	0.903 c	0.863	2.940	2.517
		Without	0.513 h	0.583 f	0.780 g	0.863	0.850 e	0.847	2.250	2.383
	F-test		**	**	**	NS	**	NS	NS	NS

****, * and NS indicate significant differences at P<0.01, <0.05 and not significant, respectively according to F-test.**
In the same column, means followed by the same letter are not significantly different at 5% level according to Duncan's test.

Salicylic spraying high significantly increased K% in fruits in both seasons (2.62 and 2.62) compared with (2.48 and 2.47). On the other hand, no significant differences were detected in N% of shoot, fruits and K% of shoot.

In respect of phosphorus solubilizing bacteria inoculation. Inoculation high significantly increased N% and K% in tomato shoot and fruits in both seasons. These results are in harmony with those obtained by Turan . (2007) and Nanis . (2018). The interaction between phosphorus levels and biofertilizer inoculation significantly affected N% and K% of shoot and fruits. The highest values were recorded with 30 kg P_2O_5 fed^{-1} + phosphorus solubilizing bacteria inoculation. The interaction between salicylic spraying and bacteria inoculation high significantly affected N% in fruits in both seasons and K% in shoot and fruit in the first season only. The highest values were observed with (salicylic spraying + phosphate solubilizing bacteria inoculation).

The interaction between phosphorus levels, salicylic spraying and biofertilizer inoculation significantly affected N% in shoot, N% in fruit in the first season only, K% in shoot in the first season only. The highest N% in shoot (0.69, 0.75) were obtained with (30 kg P_2O_5 fed^{-1} + without salicylic spraying + biofertilizer inoculation) treatment. The highest N% in fruits (0.97) was observed with (30 kg P_2O_5 fed^{-1}+ salicylic spraying + biofertilizer inoculation) treatment. Potassium % in the shoot had the same sequence.

Effect of phosphorus fertilization levels and salicylic spraying and phosphate solubilizing bacteria inoculation on curly top virus (TCTV) of tomato plants are shown in Table (8).

From the tabulated data clear that, 15 kg P_2O_5 fed^{-1} had the lowest disease incidence % values (26.27 and 24.04%) in the first and second season, respectively. It had the highest reduction infection% values (49.0 and 48.39%) in the first and second season, respectively.

Table 8. Effect of salicylic acid foliar spraying, phosphorus levels and inoculation with solubilizing bacteria on disease severity and incidence of tomato curly top virus (TCTV).

Treatments			Disease incidence %		Reduction infection %		Disease severity %	
Phosphorus levels (kg/fed.)	**Salicylic acid spraying**	**Inoculation bacteria**	**First season**	**Second season**	**First season**	**Second season**	**First season**	**Second season**
0			29.3	33.90	38.49	27.97	13.83	19.95
15			26.27	24.04	49.00	48.39	12.21	12.23
30			28.16	29.10	40.93	39.04	13.30	19.21
	Spraying		18.02	18.42	62.02	60.02	4.43	9.75
	Without		37.79	39.58	23.59	16.04	21.79	25.17
0	Spraying	Inoculation	18.61	18.42	60.40	61.22	2.66	6.38
	Without	Without	37.70	39.70	21.45	16.85	23.93	34.04
15	Spraying	Inoculation	22.63	25.78	53.10	45.72	8.51	17.55
	Without	Without	35.97	42.02	23.87	10.21	19.14	22.34
30	Spraying	Inoculation	12.83	11.05	72.55	75.72	2.12	5.31
	Without	Without	39.70	37.03	25.44	21.05	22.30	19.14

Also, it had the lowest disease severity% values (12.21 and 12.23%) comparing with the other used phosphorus levels. On the other hand, treatment of without phosphorus had the highest disease incidence % (29.3 and 33.9), lowest reduction infection % (38.49 and 27.97%) and highest disease severity%. In respect to disease severity comparing with the used rating scale (0-4) all the values of phosphorus levels (0, 15 and 30 kg P_2O_5 fed^{-1}) from 12.21 up to 19.95% lies in class one (11-20%), this means that effect of phosphorus levels was less effect on tomato curly top virus (TCTV). These results are in same line with those obtained by Klopper . (2004); Rashid . (1995); Keinath and Loria (1996); Choudhary . (2007); Lanlcioni (2008); El-Borollosy and oraby (2012); Huber and Graham (1999) and Huber . (2012).

In respect to salicylic spraying, it was decreased disease incidence % from (37.79 and 39.58) to (18.02 and 18.42), increased reduction infection % from (23.59 and 16.04) to (62.02 and 60.02) and decreased disease severity % from (21.79 and 25.17) to (4.43 and 9.75) in the first and second season, respectively.

Comparing the disease severity values under salicylic spraying (with and without) with the used rating scale clear that the values with salicylic spraying (4.43 and 9.75%) lies in the class zero (0% to 10%), while the values of without salicylic spraying (21.79 and 25.17%) lies in the class 2 (21-30%). This means that salicylic spraying was effective in decreasing tomato curly top virus (TCTV). These results are harmony with those obtained by Shah and Klessig (1999); Kobeasy and Salwa El-Hamid (2005); Radwan . (2007); Radwan . (2008); Hayat . (2010), Aminalah . (2011) and Blaebler . (2011) who concluded that salicylic is an important signal molecule in plant that is an important signal molecule in plant that is required for the induction systemic acquired resistance against wide variety of pathogens including virus.

The interaction between phosphorus levels and salicylic spraying and bioinoculation show that the best treatment was 15 kg P_2O_5 fed^{-1} + salicylic spraying + bioinoculation in both seasons.

CONCLUSION

Under non-saline soil ECe 2.1 dSm^{-1}, moderate available phosphorus (5-6 ppm) 15 kg P_2O_5 fed^{-1} + inoculation with phosphate solubilizing bacteria produced tomato best growth parameters, yield, yield components and quality. Spraying with salicylic at the rate 300 ppm in the spraying solution induced resistance against curly top virus (TCTV) and decreased disease severity %.

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تأثير الرش الورقى بحامض السلسليك مع مستويات التسميد الفوسفاتى المعدنى و تلقيح نباتات الطماطم بالبكتيريا المذيبة للفوسفات على النمو والانتاجية وخفض الإصابة المرضية بفيروس تجعد القمة فى الطماطم

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تهدف الدراسة إلى تقدير تأثير مستويات التسميد الفوسفاتى والرش بسلسيلات البوتاسيوم على نمو ومحصول وجودة الطماطم وشدة الإصابة بمرض تجعد القمة. أجريت تجربتان حقليتان بمزرعة خاصة بالشمارقة ، مركز كفرالشيخ ، محافظة كفرالشيخ خلال الموسمين 2014 ، 2015. أستخدم تصميم القطع المنشقة مرتان فى أربعة مكررات شغلت القطع الرئيسية ثلاثة مستويات للفوسفور (صفر - 15 ، 30 وحدة فو$_{2}$أ$_{5}$ للفدان). كما شغلت القطع الشقية معاملتان للرش بسلسيلات البوتاسيوم الأولى الرش بالبوتاسيوم فقط 20% بو$_{2}$أ بكمية تساوى الموجود بسلسيلات البوتاسيوم والثانية الرش بسلسيلات البوتاسيوم 20% بو$_{2}$أ و 12.5% سلسيليك بحيث يكون التركيز 300 ملجم/لتر سلسيليك. وشملت القطع تحت الشقية بمعاملتين للتلقيح بالبكتيريا المذيبة للفوسفات ملقح وغير ملقح وتلخصت النتائج فى الآتى:* الفوسفور تحت المستوى 15 وحدة فو$_{2}$أ$_{5}$ /فدان أعطى أعلى قيم لطول الساق وعدد الفروع والمساحة الورقية والوزن الجاف للمجموع الخضرى والمحصول الكلى للثمار (15.38 و 16.15 طن/فدان) وفيتامين ج.* الفوسفور تحت المستوى 30 وحدة فو$_{2}$أ$_{5}$/فدان أعطى أعلى قيم وزن الثمار الجافة للنبات والمحصول المبكر (4.51 و 4.39 طن/فدان) وطول الثمرة وقطر الثمرة ومتوسط وزن الثمرة ومجموع الجوامد الكلية والحموضة وتركيز النتروجين والبوتاسيوم فى الثمار والخضرى.* الرش بسلسيلات البوتاسيوم أعطى أعلى قيم لطول الساق وعدد الأفرع للنبات ومساحة الأوراق للنبات والوزن الجاف للمجموع الخضرى والثمار للنبات والمحصول المبكر والمحصول الكلى ومتوسط وزن الثمرة ومجموع الجوامد الكلية والحموضة وفيتامين ج وتركيز البوتاسيوم بالثمار مقارنة بالكنترول.* التلقيح بالبكتيريا المذيبة للفوسفات أدى إلى زيادة طول الساق ومساحة الأوراق للنبات الوزن الجاف للمجموع الخضرى والثمار للنبات ومحصول الثمار المبكر والكلى للفدان وطول الثمرة وقطر الثمرة ومتوسط وزن الثمرة ومجموع الجوامد الكلية والحموضة وفيتامين ج.* الفوسفور فى المستوى 15 وحدة فو$_{2}$أ$_{5}$/فدان أعطى أثر على فيروس تجعد القمة فى الطماطم حيث أدى إلى تقليل النسبة المئوية للإصابة بالمرض والنسبة المئوية لشدة المرض كما أدى إلى زيادة النسبة المئوية لخفض العدوى وبمقارنة القيم المتحصل عليها لشدة الإصابة بالمرض مع المقياس المستخدم (صفر – 4) كل القيم المتحصل عليها مع مستويات الفوسفور تبدأ من 12.21% إلى 19.95% تقع فى الرتبة واحد (11-20%) وهذا يعنى أن تأثير الفوسفور على مرض تجعد القمة الفيروسى منخفض.* الرش بسلسيلات البوتاسيوم أدى إلى تقليل النسبة المئوية للإصابة بالمرض وتقليل النسبة المئوية لشدة الإصابة كما أدى إلى زيادة خفض العدوى. وبمقارنة القيم المتحصل عليها على المقياس المستخدم إتضح أن قيم شدة الإصابة مع سلسيلات البوتاسيوم (4.43 و 9.75%) تقع فى الرتبة صفر (صفر – 10%) بينما قيم الكنترول بدون سلسيلات (21.79 و 25%) تقع فى الرتبة 2 (21-30%) وهذا يعنى أن الرش بسلسيلات البوتاسيوم أدى إلى إنخفاض شدة الإصابة بمعدل واضح.