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EFFICACY OF FOLIAR APPLICATION OF PHOSPHATE SALTS IN CONTROLLING EARLY BLIGHT DISEASE ON TOMATO

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ABSTRACT: *Four isolates of Alternaria solani derived from naturally infected tomato plants were tested for their aggressiveness on six tomato (Lycopersicon esculentum) cultivars. All tested isolates were virulent to young tomato plants of different cultivars and they significantly differed in their aggressiveness. Some variability was evident, as the isolate of Nubariya was the most aggressive isolate. Significant differences were detected in the interaction among the isolates and cultivars.*

Different concentrations (250, 500 and 750ppm) of sodium and potassium phosphate solutions (NaH_2PO_4, Na_2HPO_4, KH_2PO_4 and K_2HPO_4) and the contact fungicide Cuproantracoal were applied on different cultivars of tomato grown under greenhouse conditions. They were applied twice at 15cm shoot length and at the beginning of flowering stage. Artificial inoculation was done one week before the first treatment. Both phosphate salts and the contact fungicide inhibited the disease severity as compared with the untreated check. Significant differences were detected in the interaction between phosphate salts and tomato cultivars. Host cultivars play an important role in determining the appropriate treatment for obtaining maximum disease control. It could be concluded that potassium phosphate salts were more effective in controlling early blight on tomato than sodium phosphate ones. The most effective treatments were K_2HPO_4 and KH_2PO_4 with significant differences with check. These followed by sodium salts, Na_2HPO_4 and NaH_2PO_4. Also, increasing the phosphate salts concentration decreased disease severity.

Phosphate salts treatment caused an increase of oxidative enzymes activity of non-infected tomato cultivars. A remarkable oxidative enzymes activity enhancement was detected from the phosphate–treated tomato cultivars. Results indicate that oxidative enzymes might be involved in the defense mechanism.

This study provides further evidence that phosphate salts can be used as foliar fertilizers for disease control in the field and could induce resistance with a curative effect against early blight of tomato.

Key words: *Tomato, early blight, Alternaria solani , aggressiveness, phosphate salts, oxidative enzymes.*

INTRODUCTION

Tomato (*Lycopersicon esculentum*, Mill) is considered one of the most important and widely distributed vegetable crops in Egypt which have an economic importance for both local consumption and exportation. The total cultivated area was approximately 490,000 feddan (Department of Agricultural Economic Statistics, Ministry of Agriculture, A.R.E., 2001).

Early blight of tomato caused by *Alternaria solani* Sorauer, has the potential to become one of the most serious diseases throughout the tomato-producing regions. The disease became a great problem for tomatoes growers when sprinkler irrigation system was introduced, and it causes significant yield losses (Pscheidt and Stevenson, 1986). Early blight of tomato starts to appear from the seedling stage till the last harvest of the fruits. It is also appears on leaves, stems and fruits; under favorable conditions; causing leaf defoliation, drying off of twigs and premature fruits drop depending on its severity (Waraitch *et al*., 1975). In Egypt, it occurs wherever tomatoes are grown and becomes destructive serious disease of tomatoes (El-Saman, 1986).

Control of early blight disease in commercial tomatoes is generally based on the use of fungicides (Devanathan & Ramanujan, 1995). The need of reducing fungicide residues on food crops, concern for a healthy environment and, often, the unavailability of commercially acceptable resistant plants emphasize the need for alternative methods for disease control. One of the potential methods is the use of inorganic salts in inducing local and systemic protection of the diseases (Reuveni *et al*., 1993). The use of phosphate salts in controlling plant diseases provides further evidence that may facilitate applying simple non-toxic chemical solutions. It has low costs, low toxicity, environmental safety and nutrient value which make them ideal foliar fertilizer, and can be used practically in the field for disease control (Reuveni *et al*., 1995).

Biochemical changes associated with induced systemic resistance have been investigated. Oxidative enzymes are a biochemical marker for resistance in several host–pathogen systems (Reuveni & Ferreira, 1985; Reuveni & Kuc, 1989 and Reuveni *et al*., 1991).

This investigation aimed to evaluate the practical use and the effect of foliar sprays of phosphate salts, and their potential for controlling early blight on tomato as a safety control method reduces the environmental pollution. In addition, the activity of oxidative enzymes in plants as a potential marker for resistance to early blight induced by foliar spray of phosphate salts was assayed.

This study aimed to minimize the use of fungicides and facilitate applying simple non-toxic chemical solutions as sodium and potassium phosphates for controlling early blight of tomato. This method of control has low costs, low toxicity and avoid the environmental pollution and human hazards.

MATERIALS AND METHODS:

Isolation and identification of the causal fungus:

Diseased tomato leaves were collected from the fields of Nubariya, Salhiya, Minufiya, Ismailiya and Fayoum localities. Lesions of the diseased leaves were washed with tap water, cut into small pieces, surface disinfected with sodium hypochlorite 3% for 2 min., and placed in autoclaved Petri dishes contained PDA medium .The plates were incubated at 25°C for 5 days. The developing colonies were purified by hyphal tip technique and identified according to Ellis (1971).

Preparation of the inoculum and inoculation:

Alternaria solani isolates were separately grown on liquid potato dextrose broth medium in 250 ml conical flasks for 10 days at room temperature. Mycelium mat of each isolate was mixed with sterilized distilled water and then blended for 3 min in a blender. Mycelium fragments were diluted with sterilized distilled water and adjusted to approximately 10 propagules / microscopic field, then used as inoculum. Inoculation had been carried out by spraying the prepared inoculum at the rate of 10 ml / plant. Inoculated plants were kept under a humid condition in isolated cages for each isolate in the greenhouse to enhance the fungal infection and the disease development.

Reaction of tomato cultivars to *A. solani* isolates:

Ten seeds of each of six tomato cultivars (Marmand, Super Marmand, Strain B, Super Strain B, Cal Ace and Castle Rock) were sown in 25 cm-diameter pots. Different tomato cultivars were individually inoculated with the different isolates of the fungus. Diseased plants were assessed weekly starting with the first symptom appearance till the end of the plant age. Disease severity was calculated according to Christ (1991) as follows:

0.1= a few (1 to 2mm) circular lesions, 0.5 = up to 5%, 0.75 = above 5 but below10%, 1= above 10 but below25%, 2 = above 25 but below50%, 3= above 50 but below75%, 3.5 = between 76 and 85%, 3.75 = 86 to 95% and 4= 96 to100% of the leaf area blighted.

Mean disease severity for a plant was calculated as the mean of disease severity values of all leaves of the plant. Experimental design used was a completely randomized with three replication. Analysis of variance of the data was performed with a computerized program (MSTATC).

Effect of phosphate salts on early blight:

Different concentrations (250, 500 and 750ppm) of sodium and potassium phosphates (NaH_2PO_4, Na_2HPO_4, KH_2PO_4 and K_2HPO_4) and the contact fungicide Cuproantracoal were applied on the different tomato cultivars grown under greenhouse conditions. They were applied twice at 15cm shoot length and at the beginning of flowering stage. Artificial inoculation was done one week before the first treatment. Diseased plants were assessed weekly starting with the first symptom appearance till the end of the growing period.

Assay of oxidative enzymes activities:

Extractions of the inoculated and non-inoculated as well as those treated with phosphate salts and non-treated leaves of the different tomato cultivars grown under greenhouse conditions were used for determining the activities of oxidative enzymes. Inoculation was carried out with the virulent pathogen, *A. solani* as previously mentioned. All check and inoculated as well as treated plants were kept under greenhouse conditions at 20 ± 2 °C. Samples were taken one week after the 2nd spray with phosphate salts.

Extracts of tomato leaf samples were obtained according to Manxweel and Deteman (1967) by fragmenting frozen tomato leaves in a warning blender. Samples of 10 grams leaves of each treatment were blended using 20 ml distilled water for 2 minutes. After blending the mixture was squeezed through several layers of cheesecloth, and centrifuged at 3000 r.p.m for 20 minutes to purify the obtained filtrates and then kept at 5°C until assaying.

Oxidative enzyme activities were determined as follows:

1- Polyphenol oxidase activity was determined using spectrophotometric procedure; as described by Matta and Dimond (1963).
2- Peroxidas activity was spectrophotometrically determined by measuring the oxidation of pyrogallol in the presence of H_2O_2 at wavelength of 425 nm, according to Allam and Hollis (1972).
3- Ascorbic acid oxidase activity was spectrophotometrically determined as the method described by Maxwell and Deteman (1967).

RESULTS AND DISCUSSION

Reaction of tomato cultivars *to A.solani* isolates:

Four isolates of *A. solani* were derived from naturally infected tomato plants at Nubariya, Minufiya, Salhiya and Fayoum regions during the period of 2001 and 2002. Isolates were tested for their virulence and aggressiveness on six commercial tomato cultivars depending on the percentages of early blight severity.

Isolates of *A. solani* were differed in their virulence to young tomato plants of the tested cultivars. Some variability was evident, as the isolates derived from Nubariya and Minufiya were virulent to all tomato cultivars tested. While, isolates derived from Salhiya and Fayoum were virulent to the cvs. Super Marmand, Marmand, Super StrainB and StrainB wile they were avirulent to Cal Ace, and Castel Rock cultivars.

At the same time, isolates of *A. solani* were differed significantly ($P > 0.05$) in their aggressiveness on the tested cultivars. Isolate of Nubariya was the most aggressive isolate followed by Minufiya one. Isolates of Salhiya and Fayoum seemed to be the lowest aggressive tested ones. Moreover, significant differences were detected in the interaction among isolates x cultivars (Table, 1).

Table (1): Interaction between four isolates of *Alternaria solani* and six tomato cultivars, on the severity of early blight on tomato under controlled environmental greenhouse conditions.

Cultivar	Isolates / Disease severity %			
	Nubariya	Minufiya	Salhiya	Fayoum
Super Marmand	25.97	17.17	00.35	00.10
Marmand	09.95	04.65	00.47	02.85
Super Strain B	20.38	05.63	02.78	00.42
Strain B	21.53	06.15	01.03	00.39
Cal Ace	31.18	03.44	00.00	00.00
Castel Rock	15.40	01.00	00.00	00.00
LSD at 5% between	Cultivars =1.36, Isolates =1.16, Cultivars x Isolates =2.85			

The obtained results indicate that virulence of isolates and resistance of host cultivars was the most important contributors in determining the variation in early blight incidence. It has been suggested that the means showed significant isolate x cultivar interaction in the analysis of variance is an evidence for a differential host-pathogen relationship (Vanderplank, 1984). Analysis of variance has been widely used to detect quantitative host–pathogen specificity in many pathosystems (Hamid *et al.*, 1982; Norelli *et al.*, 1984, Norwood *et al.*, 1984 and Vloutoglou *et al.*, 2000).

Effect of phosphate salts on early blight:

Symptoms of early blight on tomato were initially observed only on leaves of untreated control plants about one week after the second application of phosphates and the fungicide.

The disease was evident in all treatments in the disease ratings. Data indicated that the percentage of disease severity was (0.5 to 17.3% with average 6.8%) among the untreated controls compared with those inoculated with the pathogen and untreated (26.0 to 66.5% with average 44.38%). However, plants inoculated and treated with fungicide recorded (1.0 to 1.9% with average 1.32%) as shown in Table (2).

Table (2): The effect of four phosphate salts with three concentration and six tomato cultivars inoculated with *Alternaria solani* on the severity of early blight on tomato under controlled environment in a greenhouse.

Treatments (ppm)	Cultivars / Disease severity %						
	Super Marmand	Marmand	Super strain B	StrainB	Cal Ace	Castel Rock	Mean
NaH_2PO_4							
(250)	9.4	13.7	12.8	11.5	36.0	11.5	15.82
(500)	3.3	2.4	1.9	5.9	4.1	9.3	4.48
(750)	1.5	1.5	1.9	4.3	3.8	8.9	3.65
Na_2HPO_4							
(250)	11.3	1.7	37.6	15.1	17.9	26.9	18.42
(500)	11.5	1.7	9.6	10.5	8.9	18.9	10.18
(750)	4.4	1.5	8.2	9.9	2.9	3.2	5.02
KH_2PO_4							
(250)	32.3	40.0	37.3	14.4	13.8	13.0	25.13
(500)	7.3	10.3	9.2	11.5	12.9	11.7	10.48
(750)	1.8	4.0	3.8	7.5	8.9	6.6	5.43
K_2HPO_4							
(250)	4.9	9.0	21.5	3.8	2.1	1.5	7.13
(500)	5.7	4.6	8.9	1.9	2.1	1.1	4.05
(750)	1.5	1.9	1.5	1.7	2.0	1.1	1.62
Cuproantracoal	1.3	1.2	1.0	1.5	1.9	1.0	1.32
Inoculated and Untreated	66.5	52.0	33.0	26.0	41.0	47.8	44.38
Uninoculated and Untreated	17.3	4.6	5.0	3.9	5.0	5.0	6.80
Mean	12.00	10.01	12.88	8.63	10.89	11.17	
LSD at 5 % for	Phosphate salts				= 2.06		
	Tomato cultivars				= 2.32		
	Salts x cultivars				= 2.06		

The severity of early blight on phosphate-treated plants was similar to that of fungicide-treated plants but significantly less than that of control. Also, most of the early blight inoculated and treated plants were showed low levels of disease severity. Meantime, increasing the phosphate salts concentration decreased disease severity. Analysis of variance revealed that, interaction between cultivars and different treatments were significantly differed, Table (2).

The disease was more severe on phosphate-treated plants than that on fungicide treated ones, but much less than on the untreated control plants Table (2). In addition, disease had developed on leaves of the control plants, but was never seen on phosphate and fungicide treated leaves. It could be concluded that, both phosphate salts and the contact fungicide inhibited the disease development compared with untreated check. Significant differences were detected in the interaction between phosphate salts and tomato cultivars. Host cultivars play an important role in determining the appropriate treatment for obtaining maximum disease control. It could be concluded that potassium phosphates was more effective in controlling early blight on tomato than sodium phosphates. The most effective treatment was K_2HPO_4 and KH_2PO_4. These followed by sodium salts, Na_2HPO_4 and NaH_2PO_4 and the contact fungicide Cuproantracoal.

The present study clearly demonstrated that simple compounds such as, KH_2PO_4 and K_2HPO_4 effectively control early blight on plants of greenhouse grown tomato cultivars. Evidently, two foliar applications of phosphates, particularly of K_2HPO_4, were active in controlling the fungus. However, while disease severity at the last rating remained very low on plants receiving fungicide treatment (1.0 to 1.9% with average 1.32%), it was greater on plants treated with low dose of any of the used phosphate salts, but still much lower than those of control plants. It seems likely that application with higher doses of the phosphate salts, NaH_2PO_4, Na_2HPO_4, KH_2PO_4 and K_2HPO_4 gave good control (with average 3.65, 5.02, 5.43 and1.62, respectively).

The severity of early blight on phosphate-treated plants was similar to that on contact fungicide-treated plants but significantly less than that on check plants. Also, tomato plants inoculated and phosphate-treated showed low levels of disease severity. Meantime, increasing the phosphate salts concentration decreased disease severity. Many researchers confirmed the use of inorganic salts as biocompatible fungicides effectively controlled diseases on various crops (Reuveni & Ferreira, 1985; Reuveni & Kuc, 1989 Reuveni et al., 1991 and Reuveni *et al.*, 1993). Meanwhile, others indicate that solutions of different phosphate salts could induce systemic and local resistance in various plants to pathogens (Gottstein and Kuc, 1989; Walters and Murray, 1992; Gamil, 1995 and Mosa, 1997).

Results obtained revealed that the tested phosphate salts have post-infection curative activity against early blight on tomato. K_2HPO_4 was the most effective treatment and showed superior in its protective effect. The mode of action of phosphate salts for controlling early blight fungus is likely to be complex and clearly remain to be determined. There is a possibility that phosphate salts might increase the synthesis of host metabolites such as phytoalexins, and their production could induced by many chemicals

(Yoshikawa, 1978 and Hargreaves, 1979). It has been suggested that protection due to induced resistance triggers by a process involving the sequestration of calcium from the host (Doubrava *et al.*, 1988 and Walters and Murray, 1992). Phosphorus (phosphonic) acid (H_3PO_3) reduced incidence of downy mildew on grapevine and gave better protection than the fungicide, metalaxyl. The phosphonate is the hydrolysis product of H_3O_3 in plants and extremely mobile within plant tissues; it moves from leaf to leaf, both upward and downward (Wicks *et al.*, 1991).

Effect of phosphate salts on oxidative enzymes activities:

Data obtained in Tables (3, 4 and 5) show the effect of spraying four phosphate salts of both sodium and potassium with three concentrations on tomato cultivars inoculated with *A. solani* on the activities of oxidative enzymes under controlled environment under greenhouse.

Generally, data indicate that, the non-inoculated leaf tissues contained low levels of oxidative enzymes as compared with those in inoculated leaf tissues. Data also revealed that, the non-inoculated leaf tissues contain high levels of peroxidase > Ascorbic acid oxidase > polyphenoloxidase of all tested tomato cultivars.

Leaves inoculated with *A. solani* obviously increased the activities of oxidative enzymes. This explains one of the most noticeable results that infection with *A. solani* induced tomato plants to produce the highest levels of these oxidized enzymes.

Levels of these oxidative enzymes slightly increased in the leaf tissues as the plants treated with phosphate salts. Data also confirmed that leaves tissue of different tomato cultivars treated with phosphate salts contained relatively higher concentrations of all mentioned oxidative enzymes than those determined in the tissues of the non-treated cultivars.

Table (3): The effect of four phosphate salts with three concentration on six tomato cultivars inoculated with *Alternaria solani* on the activities of Peroxidase (expressed as the change in absorbency) under controlled environment in greenhouse.

Treatments (ppm)	Cultivars / Peroxidase activity					
	Super Marmand	Marmand	Super Strain B	Strain B	Cal Ace	Castel Rock
NaH_2PO_4						
(250)	0.901	1.106	0.219	0.947	0.644	0.421
(500)	1.658	1.106	0.994	1.827	0.522	0.598
(750)	1.091	0.149	1.161	0.959	0.830	1.677
Na_2HPO_4						
(250)	0.546	1.576	0.948	1.099	0.826	0.952
(500)	1.330	1.451	0.081	1.252	2.503	2.040
(750)	1.330	1.260	1.684	1.119	2.56	2.747
KH_2PO_4						
(250)	0.419	0.576	0.272	2.184	1.478	0.072
(500)	0.422	0.200	0.272	1.737	0.198	0.231
(750)	1.173	1.002	1.604	0.864	0.714	0.811
K_2HPO_4						
(250)	0.746	0.811	0.576	1.199	0.422	0.092
(500)	2.183	0.944	1.504	1.048	0.422	0.240
(750)	2.183	1.675	1.296	1.048	1.313	0.811
Cupraintracoal	0.320	0.156	1.452	1.875	0.100	0.938
Inoculated and Untreated	1.064	0.645	0.884	0.929	0.874	0.630
Uninoculated and Untreated	0.376	0.500	0.860	0.718	0.754	0.334

Table (4): The effect of four phosphate salts with three concentration on six tomato cultivars inoculated with *A. solani* on the activities of Polyphenol oxidase (expressed as the change in absorbency) under controlled environment in greenhouse.

Treatments (ppm)	Cultivars / Polyphenol oxidase activity					
	Super Marmand	Marmand	Super Strain B	Strain B	Cal Ace	Castel Rock
NaH_2PO_4						
(250)	0.245	0.017	0.647	0.171	0.256	0.339
(500)	0.391	0.236	0.212	0.087	0.330	0.306
(750)	0.173	0.022	0.579	0.263	0.425	0.362
Na_2HPO_4						
(250)	0.250	0.333	0.006	0.458	0.337	0.031
(500)	0.250	0.044	0.203	0.297	0.275	0.010
(750)	0.139	0.234	0.457	0.469	0.405	0.552
$K\ H_2PO_4$						
(250)	0.191	0.054	0.232	0.091	0.340	0.003
(500)	0.102	0.249	0.160	0.292	0.033	0.383
(750)	0.560	0.081	0.351	0.145	0.471	0.234
K_2HPO_4						
(250)	0.081	0.470	0.341	0.477	0.527	0.111
(500)	0.005	0.487	0.724	0.119	0.527	0.241
(750)	0.081	0.024	0.217	0.391	0.966	0.198
Cupraintracoal	0.272	0.150	0.120	0.310	0.253	0.335
Inoculated and Untreated	0.375	0.318	0.435	0.203	0.816	0.333
Uninoculated and Untreated	0.200	0.309	0.584	0.323	0.401	0.226

Table (5): The effect of four phosphate salts with three concentration on six tomato cultivars inoculated with *A. solani* on the activities of ascorbic acid oxidase (expressed as the change in absorbency) under controlled environment in greenhouse.

Treatments (ppm)	Cultivars / Ascorbic acid oxidase activity					
	Super Marmand	Marmand	Super StrainB	StrainB	Cal Ace	Castel Rock
NaH_2PO_4						
(250)	1.307	0.173	0.280	0.696	0.127	1.562
(500)	1.140	1.316	0.097	0.595	0.394	0.724
(750)	0.118	1.645	1.173	1.569	2.170	0.418
Na_2HPO_4						
(250)	1.055	0.788	0.173	0.13	2.110	0.558
(500)	1.055	0.656	0.323	0.145	0.134	0.395
(750)	0.117	0.322	0.518	0.523	0.132	0.031
$K H_2PO_4$						
(250)	0.670	0.100	0.187	1.093	0.900	0.267
(500)	0.081	0.764	0.862	0.355	0.165	0.549
(750)	0.869	0.281	0.443	0.827	0.494	1.730
K_2HPO_4						
(250)	0.551	0.303	1.164	1.157	0.949	0.271
(500)	0.271	0.859	1.894	0.771	0.628	1.128
(750)		0.547	1.452		1.867	0.481
Cupraintracoal	0.066	0.985	0.144	0.763	0.642	0.584
Inoculated and Untreated	0.823	1.999	0.540	0.308	1.139	0.087
Uninoculated and Untreated	0.298	0.698	0.422	0.024	0.216	0.206

The remarkable increase in oxidative enzymes activity in phosphate-treated plants as compared with healthy plants indicated that oxidative enzymes are a possible marker for resistance to early blight. Furthermore, the increase of activity in phosphate - treated plants, strongly indicates the possible active role of oxidative enzymes in the defense mechanism.

Increasing of oxidative enzymes activity in phosphate treated leaves indicates that these enzymes play an important role in defense mechanism of tomato plants to early blight. Reuveni, R. and Kuc, J. 1989; Irving and Kuc, (1990); Reuveni, R., Shimoni, M. and Crute, I. R. (1991); Gamil, (1995) Reuveni and Reuveni, (1995) and Mosa, (1997) reported that the increased accumulation of peroxidase in phosphate treated leaves strongly indicates the possible role of peroxidase in defense mechanism. Such researches will continue to possible use of Phosphate salts as an integral measure in management program to protect tomato plants against foliar pathogens that limit productivity.

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كفاءة الرش بأملاح الفوسفات فى مقاومة مرض الندوة البدريه على الطماطم

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أجرى هذا البحث بغرض دراسة مقاومة مرض الندوة البد ريه على الطماطم باستخدام الرش بأملاح فوسفات الصوديوم والبوتاسيوم كطريقه أمنه للمقاومة. حيث فى البداية تم دراسة التفاعل بين أربعة عزلات للفطر المسبب للمرض (*Alternaria solani*) وستة أصناف من الطماطم وذلك لدراسة العلاقة بين القدرة المرضية للعزلات وحساسية الأصناف. كذلك دراسة تأثير رش بعض أصناف الطماطم بأملاح فوسفات الصوديوم والبوتاسيوم الأحادية والثنائية على الأصابه بمرض الند وه البد ريه.

كانت جميع العزلات المختبرة ذات قدره على إحداث المرض وذلك على الأوراق الحديثة لأصناف الطماطم المختلفة تحت الاختبار وان اختلفت فى قدرتها المرضية حيث ظهرت بعض الاختلافات بين العزلات وبعضها فكانت أقواها هى العزلة المتحصل عليها من منطقة النوبارية والتى استكملت عليها الدراسة. كذلك قد كون التفاعل بين العزلات والأصناف مصدرا عالى المعنوية للتباين فى حدوث المرض.

تم رش نباتات أصناف مختلفة من الطماطم بأملاح فوسفات الصوديوم والبوتاسيوم الأحاديه والثنائية وبتركيزات مختلفة وقورنت بالمبيد الملامس (كوبرو انتراكول) تحت ظروف الصوبه. تم تنفيذ عملية الرش مرتين خلال حياة النباتات وذلك عندما كان طول النباتات ١٥ سم وكذلك عند مرحلة بداية تكوين الأزهار وتمت العد وى الصناعية بالفطر الممرض قبل أسبوع من أول رشه.

أوضحت النتائج أن جميع المعاملات بأملاح فوسفات الصوديوم والبوتاسيوم الأحادية والثنائية والمبيد الملامس كوبرو انتراكول قد قللت من شدة الأصابه بالمرض بالمقارنة بالنباتات الغير معامله. أيضا كان هناك اختلافات معنوية للتفاعل بين شدة الأصابه بالمرض

وأصـــناف الطمـــاطم تحـــت الد راسه. حيث كان لأصناف الطماطم دور هام فى اختيار أحسن المعـــاملات الـــتى أعطت أعلى مقاومه للمرض. أعطت المعامله بفوسفات البوتاسيوم الأحادية والثنائية أعلى مقاومه للمرض ولم يكن بينها وبين المبيد المستخدم أى فرق معنوى كذلك قلت شدة الأصابه بالمرض بزيادة التركيز المستخدم.

أوضـــحت الد راسه أن هناك زيادة واضحة فى نشاط الأنزيمات المؤكسدة فى النبات الســـليمة وكذلـــك فى النباتات المعد ية المعاملة بأملاح الفوسفات وأن هذه الأنزيمات لها د ور هام فى ميكانيكية المقاومه للمرض.

أكدت هذه الد راسه أن أملاح فوسفات البوتاسيوم ممكن استخدامها بكفاءه فى مقاومة مـــرض الند وه البد ريه على الطماطم وأنها تؤدى الى استحثاث النباتات على المقاومة وكذلك فأنهـــا تقـــوم بـــدور وقائى ضد المرض. كذ لك ممكن استخداما هذه الأملاح كسماد ورقى عن طريق الرش فى مقاومة مرض الند وه البد ريه على الطماطم تحت ظروف الصوبه أو الحقل.