J. Plant Production, Mansoura Univ., Vol. 4 (5): 787 - 807, 2013

EVALUATION OF SOME SAFETY TREATMENTS ON ROOT ROT DISEASES, GROWTH AND YIELD POD QUALITY OF PEA (*Pisum sativum*, L.)

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ABSTRACT

The present study was carried out during two winter seasons of 2009/2010 and 2010/2011 at Kaha Vegetable Research Station (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A R C), Egypt. Foliar and soil applications of several natural safety materials as sodium meta silicate ($Na_2SiO_35H_2O$) at 1g/L., salicylic acid (Dihydroxybenzoic acid) at 1 g/ L., Potassium bicarbonate ($KHCO_3$) at 5g/ L., Thyme oil (*Thymus vulgaris*) at 1.0 ml + 1.0 ml/ L. acetone. Synthetic fungicides as Sumi Eight 5 % (Diniconazole 5 %)-[(E)-(RS)-1-(2,4-Dichlorophenyl)-4,4-Dimethyl-2 (1H- 1,2,4-triazol-1-YL) Pent-1-en-3-ol.] at 0.325 ml/ L. and Topas 100 Ec 10 % (Penconazole 10 %)-[(1-(2,4-dichloro-B-Propylphenethyl)-1H-1,2,4-Triazole] at 0.25 ml/ L., on vegetative growth and yield and its components as well as study the impact of these materials on resistance of root diseases as *Rhizoctonia solani* and *Fusarium solani*. Fungi isolated from the site of the experiment were *Rhizoctonia solani and Fusarium solani*. The aforementioned treatments significantly decreased disease severity being more effective after Sumi Eight 5 %, Topas 100 Ec 10 % and Sodium meta silicate, the lowest effect, however, was recognized for Thyme oil. The results showed that spray foliar and soil treatments with Sodium meta silicate, Salicylic acid and Potassium bicarbonate produced the most promising effect on vegetative growth parameters (plant height, number of leaves, fresh and dry weights/ plant). Total green pod yield (ton/ fed.) and its components i.e. number of pods/ plant, average pod weight, number of seeds/ pod, fresh weight of 100 seeds, pod length and diameter, shell out % of fresh green pod and total soluble solids (%) as well as chemical composition of foliage content of the concentration of nitrogen, phosphorus, potassium (%) and leaf content of total chlorophyll followed by treating pea plants with Sumi Eight 5 % and Topas 100 Ec 10 %. Thyme oil produced poor effect over all parameters in two winter seasons in most of characters when compared to the control (Distilled water). Furthermore, the average increment of the total yield in two winter seasons could be attributed to foliar and soil applications in descending order by the treatments of (Sodium meta silicate, Salicylic acid, Potassium bicarbonate, Sumi Eight 5 %, Topas 100 Ec 10 % and Thyme oil,), total yield % was (36.37, 33.32, 29.09, 23.06, 8.36 and 6.03 %), respectively compared to the control treatment.

Resistance to root rot disease as shown in this study by various biotic and abiotic treatment was correlated to the pathogen related protein bands, or the so called PR protein, being visible at 52 KD. Molecular and biochemical detections show that Si can activate the expression of defense-related genes and may play important role in the transduction of plant stress signal such as salicylic acid, Potassium bicarbonate, Thyme oil, Sumi Eight 5 % and Topas 100 Ec 10 %.

Keywords: Pea, Sodium meta silicate, Salicylic acid, Potassium bicarbonate, Thyme oil, induced resistance, protein analysis, pathogen control, plant health, yield and pod quality.

INTRODUCTION

Pea (*Pisum sativum* L.) is a member of the fabace. Excellent source of carbohydrates, vitamins A, B_{12}, thiamine, Niacin and C plus several minerals including iron, zinc, copper, calcium, phosphorous, potassium, magnesium and selenium (Matheson, 2003).

The winter plantation of pea cropping the year 2010 was 53005 feddans that produced 222038 ton with an average yield 4.189 ton/fed.* Increasing the production of green pod and dry seed yield with high quality is very important objective to meet the increment in human population that may be achieved by increasing the total yield in the unit area as well as attempt to decrease seed infection of many fungi and number of plants in unit area.

Pea cultivars are subject to a number of diseases such as *Rhizoctonia* seedling blight, bacterial blight, *Ascochyta* root rot, Downy mildew, Powdery mildew, *Pythium* blight, *Aphanomyces* root rot, wilt and root rot diseases caused by *Fusarium* species. These diseases cause poor stands and reduce plant growth and yield (Hagedorn, 1991).

Agrie *et al.* (1992) pointed out that silicon reduced transpiration and increased water use efficiency in leaves, which in turn reduced the decline in photosynthesis and chlorophyll detraction in older leaves. High silica uptake has been shown to improve drought resistance, increase resistance to fungi and other pathogens, and increase plant growth rate and yield (Belanger *et al.*, 1995). However the beneficial effect of silicon in plant growth and disease prevention is recently emphasized (Epstein, 2000). Glazebrook (2005) who concluded that salicylic acid is effective in inducing tolerance to heat, drought and chilling stress in bean and tomato plants as being a key regulator of plant defense that primarily mediates responses to biotrophic pathogens. Hegazi and El-Shraiy (2007) proposed that salicylic acid applied as foliar spray to 30 and 45 day-old on common bean plants, considerably increased plant height and shoot dry weight as well as increase in total protein in leaves when applied salicylic acid at 10 M. Also, their inducers increased peroxides and chitinase (Anand *et al.*, 2009).

El-Habbasha *et al.* (1996) working on pea plants and Abdel-Aziz and Zakher (2010) mentioned that exogenous application of spraying Faster (containing high richness in potassium K_2O 30 %) 2 Cm^3 /L. as well as Potassium sulfate (48 % K_2O) as a rate of 30 g / L. caused significant increase in vegetative growth, pod quality and chemical composition in foliage and seeds of pea cv. Master B. Sangakkara *et al.* (2000). Found the effect of foliar application of Potassium bicarbonate, proved that Potassium increases the photosynthetic rates of crop leaves, CO_2 assimilation and facilitates carbon movement. The hazardous use of synthetic fungicides was critically considered and biological control instead of chemical control was suggested (Hadar *et al.*, 1984). Consequently, many authors suggest that triazole-induced protection from abiotic stress is an important factor in improving tree vitality that in turn allows the tree's own natural defense mechanisms to reduce subsequent pathogen attack (Fletcher *et al.*, 2000).

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However, only limited information that suggests fungicides directly act as activators of resistance. A reduction in disease severity as a result of direct fungicidal properties of penconazole is through inhibition of the C4-demethylase reactions in sterol biosynthesis of fungi (Allingham, 2005).

The main objectives of this research were to study the efficacy of some abiotic and biotic inducers on incidence of root rot disease in pea under greenhouse and field conditions, along with vegetative growth parameters, yield and its components and pod quality of pea.

MATERIALS AND METHODS

Two field experiments were conducted at Kaha Vegetable Research Station (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A. R. C.), Egypt during two winter growing seasons i.e., 2009/2010 and 2010/2011, to study the effect of foliar and soil applications by some nutrition materials as shown in Table (1). The experiment included seven treatments i.e. Sodium meta silicate, Salicylic acid, Potassium bicarbonate, Thyme oil as well as some of synthetic compounds as Sumi Eight 5 % and Topas 100 Ec 10 % and control (Distilled water) on the vegetative growth, yield and its components aiming to increase its production and improve pod quality. The soil type at the experimental location was clay-loam with pH 8.1 and 2.4 % organic matter. Seeds of pea (*Pisum sativum*, L.) cv. Master B were sown in hills on one side of ridges at 10 cm apart. Sowing was made on 21st of October and 1st of November in both seasons of 2009/2010 and 2010/2011, respectively. Farming practices such as irrigation, fertilization and pest management were conducted as usual.

A complete randomized block design with three replicates for each treatment was adopted. The plot area was 12 m^2 included 5 ridges each of 0.6 m width and 4.0 m length. A barrier row was left between each two experimental units to avoid drift sprays. The foliar and soil treatments were applied 20 days after sowing, three times during the vegetation growth at 10 days intervals. Tween (80) was added at 0.5 ml / L. as a wetting agent.

Table (1): List of materials name, chemical, fungicides and oil treatment used on pea plants during the two winter seasons of 2009/2010 and 2010/2011.

Materials name	Composition	Source	Concentration/ L.
1- Sodium meta silicate	($Na_2SiO_35H_2O$)	Import from Netherlands	1 g/ L.
2- Salicylic acid	(Dihydroxybenzoic acid)	Manufactured by; El Nasr pharmaceutical chemicals Co. Abu-Zabale).	1 g/ L.
3- Potassium bicarbonate	$KHCO_3$ (Extra Pure): Minimum assay: 99.5 %, Ph (1% water) 8.0 – 8.6, Max. Limits of impurities: Chloride (Cl): 0.007 %, sulfate (SO_4): 0.01 %, Arsenic (As): 0.0002 %, Iron (Fe): 0.001 % and Copper (Cu): 0.0005 %.	Importer: El-Goumhouria Co. For trading medicines, chemicals and medical appliances, 23 Elsswah St. Cairo – Egypt.	5 g/ L.
4- Thyme oil	A pure product extracted coldly of Thyme oil.	Manufactured by; Pyramids, Giza – Egypt.	1 Cm^3 oil + 1 Cm^3 Acetone / L.
5- Sumi Eight 5 %	Diniconazole 5 % - [(E)-(RS)-1-(2,4-Dichlorophenyl)-4,4-Dimethyl-2(1H- 1,2,4-triazol-1-YL)] -Pent-1-en-3-ol.	Manufactured by; Sumitomo – Japan.	0.325 Cm^3 / L.
6- Topas 100 Ec 10 %	Penconazole 10 % [(1-(2,4-dichloro-B-Propylphenethyl)-1H-1,2,4-Triazole).	Manufactured by; Syngenta Agro., Swiss.	0.25 Cm^3 / L.
Control (Distilled water)	---	---	---

These rates have been affixed to the soil and spraying on the shoot in the same time.

Isolation and identification:

Naturally infected pea plants (c.v Master B) showing root rot and wilt symptoms from Kaha research station, Qalubia Governorate were collected for the isolation of causal organisms. Roots were thoroughly washed with tap water, surface sterilized with sodium hypochlorite 0.5 % for one minute, washed several times with sterilized water and then dried. Infected pieces were then placed on PDA and incubated at 28 °C for 5 days. The developed fungal colonies were purified by hyphal tip and or single spore technique. The growing fungi were then transferred to Petri-dishes containing plain agar.

Pathogenicity tests:

Fungi isolated from the infected roots were tested for their pathogenicity on pea plants through soil infestation technique. Inocula were prepared by inoculating the isolates separately into autoclaved sand corn medium (25g washed sand, 75 g corn and enough tap water to cover the mixture in 500 ml bottles) using agar discs obtained from the periphery of 7 days old colony.

Incubation was made at 25 ±2 °C for two weeks. Pots (20 cm in diameter) were sterilized by immersing in a 5 % formalin solution for 15 minutes and then left for 7 days before use. Nile silt soil, then infested with the desired inoculums at the rate of 3 % of soil weight in each pot was used. Inocula were thoroughly mixed with the soil and watered regularly for one week before planting to ensure equal the distribution of the tested fungi. Pots used for control were filled with the same soil and mixed with similar sterilized amount of autoclaved uninoculated sand corn medium and treated in the same way. Sixteen pots were used for each particular treatment. Four replicates were considered, each consisted of four pots. Average severity of root rot and wilt plants under investigation were recorded 30 days after planting. The disease severity was determined according to Soliman *et al.* (1988) following formula where:

Disease index:

$$\Sigma (fv) / nx X100$$

F=number of roots tasted in each grade.
V= numerical rating of the scale (1-5), grade.
N=total number of tasted plants.
X=total number of roots tasted multiplied by (5) i.e. the highest grade.

Effect of different treatments on linear growth isolated fungi:

Three concentration of salicylic acid (0.1, 0.2 and 0.3), Potassium bicarbonate (0.5, 1.0 and 1.5 %), K_2SiO_3 (0.1, 0.2 and 0.3 %), Thyme (0.1, 0.05 and 0.02 %), Topas 100 Ec 10 % (0.01, 0.02 and 0.03 %) and Sumi Eight 5 % (0.01, 0.03 and 0.04 %) were added individually to conical flasks containing sterilized PDA medium to obtain the proposed concentrations then mixed gently and dispensed in sterilized Petri dishes (10 cm diameter). Dishes were individually inoculated at the center with equal disks (5-mm) and incubated at 25 ± 2 °C for 7 days. The medium with inoculums disc but without any treatment as control the average linear growth of fungus was estimated after 10 days. Percentage inhibition of mycelial growth by was calculated using the formula suggested by Topps and Wain (1957):

% Inhibition = A-B /A X100
A = diameter of control
B = diameter of test

Inducing resistance treatments:

Effect of treatment on pea under greenhouse:

Different materials (salts, oil and antioxidants) compared with the standard fungicide Sumi Eight 5 % and Topas 100 Ec 10 % were applied to evaluate their efficiency in controlling pea root rot diseases.

The efficiency of the treatment was calculated according to the following formula: Efficiency % = Disease severity in control – Disease severity in treatment / Disease severity in control **x** 100

Vegetative growth characters of pea plants:

Five guarded pea plants were taken randomly from each plot (3^{rd} row) after 10 days from the last treatment i.e. 50 days after sowing date (flowering and pod set stage) to measure the following vegetative growth characters i.e. plant height (cm), number of leaves per plant, fresh and dry weights of foliage per plant (g).

Total fresh green pod yield (ton/ fed.) and pod characters of pea plant:

At harvest time ten competitive fresh green pods randomly chosen from each plot (2^{nd} and 4^{th} rows) at the 2^{nd} picking to study yield components i.e. number of pods per plants, average weight of pod (g), number of green seeds per pod, fresh weight of 100 seeds (seed index), pod length and pod diameter (cm) as determined with clipper and shell out percentage of fresh green pod was calculated using the following equation:

$$\textbf{Shell out \%} = \frac{\text{Weight of green seeds}}{\text{Weight of green pods}} \times 100$$

Mature green pods were continuously harvested at suitable maturity stage in three picking rounds and calculated as green pods yield in (ton/ fed.).

Chemical composition in foliage and seeds of pea plants:

Total chlorophyll content was measured at 50 days after sowing date (flowering and pod set stage) in fresh leaves determined by using Minolta chlorophyll meter SPAD – 501 as SPAD units (Yadava, 1986). Total soluble solids (T. S. S. %) in fresh seeds was determined by using a hand Refractmeter according to (A.O.A.C., 1990).

Fresh weight of foliage and seeds of pea were dried in an electric forced-air oven at 70°C to constant weight then fractionated and sifting. The fine powder (at 0.2 g) of dry sample was digested in a mixture of sulphuric and Perchloric acids according to Piper (1947) to estimate total nitrogen in both foliage and seeds but phosphorus and potassium estimate in foliage only as wet digestion. Total nitrogen (%) was determined by using the modified "Micro-Kheldahl" method apparatus of Parnas and Wagner as described by Pergl (1945). Total protein % was calculated in seeds by multiplying nitrogen (%) content by 6.25. Phosphorus (%) was estimated spectrophotometrically using the chloraostannous reduced molybdophosphoric blue color method in sulphuric acid system as described by King (1951). Potassium (%) was determined using the Flamephotometry as described by Brown and Jackson (1955).

Protein extraction and electrophoritic analysis:

Sampled pods were collected from different treatments and kept frozen at (-80°c) till use, according to the method of Laemili (1970), however N,N,N,N-Tetra methyl ethylene diamine (TEMED) was reduced to 25ul and Ammonium per sulfate solution (APS) was reduced to 1.3 ml. Approximately 3g frozen pods sample was ground in a mortar and pestle in liquid nitrogen. Until complete homogenization, the homogenate was transferred to 1ml Eppendorf tube, brought to 200 ul with extraction buffer (50 mM Tris-HCl buffer, pH 6.8, glycerol 10 % w/v, ascorbic acid 0.1 %, cysteine hydrochloride 0.1w/v).

Centrifugation at 18000 rpm for about 30 min was carried out. Protein in the supernatant was estimated according to the method of Bradford (1979) using bovine serum albumin as a standard. Protein content was adjusted to 2mg/ml and then used for protein analysis on a 12.5% polyacrylamide slab gel in the presence of 0.1 % sodium dodocyl sulfate (SDS) as described by Okuno and Furusawa (1979). Gel was fixed with 10 % acetic acid in a 45 % methanol solution overnight. Protein was visualized by silver staining.

Molecular weight markers used in SDS- PAGE were (95, 72, 52, 42, 34, 26 and 17) KD.

Statistical analysis:

Statistical analysis of variance and treatment means were compared according to the Least Significant Differences (L.S.D. 0.05 %) test method as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Pea (*Pisum sativum*) is a major annual pulse crop of temperate region of the world and is originally cultivated in the Mediterranean basin.

Management of soil-borne disease is a continual challenge to growers. The structural, physical, and biological complexity of the soil micro-ecosystem in which pathogens interact with plant roots inherently limits the options available for disease control. Some of the most proven control measures include resistance in some situations and fungicide application.

Identification and Pathogenicity:

Fungi isolated from infected roots were identified according to (Booth, **1971** and **Ogoshi, 1975**) as *Fusarium solani* and *Rhizoctonia solani* that showed pathogenec potentials to pea plants under greenhouse conditions.

Data in Table (2) showed disease severity produced effect (s) on plant and weight produced by each fungus separately or in combination. It is observed that mixed inoculation with fungi caused the highest severity.

Table (2): Pathogenicity test of isolates on pea under greenhouse.

Isolates	Disease severity	Plant height (cm)/plant	Fresh weight g /plant
Rhizoctonia solani	54.7	20.5	9.0
Fusarium solani	45.5	23.7	11.5
Mixture of fungi	66.6	18.5	8.7
Control	0.0	29.7	14.5
LSD at 0.05 %	**1.85**	**3.02**	**1.09**

Effect of different treatment on linear growth *Rhizoctonia solani* and *Fusarium solani*:

Data in Table (3) indicate that all treatments significantly reduced linear growth of pathogens. The highest effect was produced by the high concentration of Sumi Eight 5 %, Topas 100 Ec 10 %, Sodium meta silicate, Salicylic acid and Potassium bicarbonate while the lowest one was achieved with the Thyme oil treatment.

Table (3): Effect of different concentrations treatments on linear growth of pathogens under laboratory conditions.

Treatment	Concent-%rations	*Rhizoctonia solani*		*Fusarium solani*	
		Linear growth (mm)	Reduction %	Linear growth (mm)	Reduction %
Sodium meta silicate	0.1	48.0	46.7	57.0	24.0
	0.2	17.0	78.9	16.0	78.7
	0.3	14.5	83.9	14.8	80.3
Salicylic acid	0.05	75.0	16.7	48.0	36.0
	0.1	39.0	56.7	45.0	40.0
	0.2	35.0	61.1	40.0	46.7
Potassium bicarbonate	0.5	75.0	16.7	72.0	4.0
	1.0	60.0	33.3	69.0	8.0
	1.5	28.0	68.9	43.0	42.7
Thyme oil	0.02	64.0	28.9	70.0	6.67
	0.05	60.0	33.3	68.0	9.33
	0.1	28.0	68.9	42.0	44.0
Sumi Eight 5 %	0.01	23.0	74.4	14.0	81.3
	0.03	21.0	76.7	13.0	82.7
	0.04	14.0	84.4	5.0	93.3
Topas 100 Ec 10 %	0.01	27.0	70.0	22.0	70.7
	0.02	25.0	72.2	20.0	73.3
	0.03	11.0	87.7	16.0	78.7
Control(Distilled water)	-----	90.0	0.0	75.0	0.0
L. S. D. at 5 %		2.89		2.34	

Greenhouse applications:

Data in Table (4) indicate that all treatments in consideration significantly reduced the percentages of disease severity. The most effective treatments were Sumi Eight 5 %, Topas 100 Ec 10 %, Sodium meta silicate followed by Salicylic acid as well as Potassium bicarbonate. The lowest effect, however, was recorded for Thyme oil.

Table (4): Effect of foliar and soil treatments of pea on root rot disease severity under greenhouse conditions.

Treatments	Disease severity	Efficiency %
Sodium meta silicate	24.0	35.7
Salicylic acid	28.0	24.9
Potassium bicarbonate bicarbonate	26.0	30.3
Thyme oil	30.7	17.7
Sumi Eight 5 %	21.3	42.9
Topas 100 Ec 10 %	22.7	39.1
Control (Distilled water)	37.3	0.0
LSD at 0.05 %	1.74	---------

Allingham (2005) found the reductions in disease severity as a result of direct fungicidal properties of penconazole are through inhibition of the C4-

demethylase reactions in sterol biosynthesis of fungi.It is widely accepted that in general, high K status in crops decreases the incidence of diseases and pests (Prabhu *et al.*, 2007). Jamiolkowska and Wagner (2007) found the effects of Thyme (*Thymus vulgaris*) essential oil at 0.02 and 0.03 % on fungi pathogenic to pepper (*Capsicum annuum*), Thyme essential oil was applied through spraying or drenching, the health status of roots and aboveground parts of the plants was evaluated and inhibited *Fusarium oxysporum* colonization of roots.

Field experiments:

1-Vegetative growth parameters of pea plants:

Data presented in Table (5) clearly showed that, there were significant increases between natural safety materials treatments over the respective control (Distilled water). The foliar and soil applications of the materials concern increased pea plants on vegetative growth i.e. plant height/ plant, number of leaves/ plant, fresh and dry weights of foliage per plant in the two successive winter seasons exception of Thyme oil treatment (except in the number of leaves/plant in the 2nd season only). Sodium meta silicate as well as Salicylic acid displayed superior plant height, number of leaves, fresh and dry weights during both seasons. Similar findings with Sodium meta silicate applications were obtained by Miyake and Takahashi (1985) on soybean plants, Lee *et al.* (1991) on cucumber, Gharibe and Hanafy Ahmed (2005) on pea plants cv. Master B as well as Abdel-Aziz (2007) commented that treated tomato plant cv. Super Strain B with Sodium meta silicate as exogenous application at g/ L. obtained significant increases in most vegetative growth characters when compared to the control. The obtained results with salicylic acid applications agree with those of Sanaa *et al.* (2001), Kananbala and Singh (2003),

Table (5): Effect of foliar and soil treatments on pea plants of vegetative growth parameters of pea plant during the two successive winter of 2009/2010 and 2010/2011.

Treatments	Plant height (cm)/ plant		Number of leaves/ plant		Fresh weight of foliage(g)/ plant		Dry weight of foliage (g)/ plant	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Sodium meta silicate	53.8	61.3	15.5	16.7	21.0	23.3	5.05	5.41
Salicylic acid	53.0	55.2	14.8	15.2	20.5	21.1	4.71	5.03
Potassium bicarbonate	51.6	54.3	14.0	14.6	19.2	20.7	4.39	4.47
Thyme oil	43.9	48.0	10.2	11.8	16.3	18.1	3.39	3.51
Sumi Eight 5 %	51.2	53.9	13.6	14.1	19.3	20.3	4.11	4.37
Topas 100 Ec 10 %	46.1	49.2	11.1	12.3	17.1	18.9	3.48	3.68
Control (Distilled water)	39.5	43.4	9.9	11.0	15.7	17.5	3.29	3.42
L.S.D. at 0.05 %	**5.7**	**5.0**	**0.50**	**0.30**	**1.20**	**1.03**	**0.13**	**0.10**

Hegazi and El-Shraiy (2007) on bean, Mady (2009), Yldrm and Dursun (2009) on tomato and Ali and Mahmoud (2013) concluded that spraying salicylic acid at the rate of 150 ppm concentration was more pronounced treatment significantly increased plant height and number of mungbean plant. As regarded treated pea plants with Potassium bicarbonate. Many researches proved that potassium plays an important role in the synthesis of endogenous plants hormones such cytokinin (Evenari, 1984, and Hanafy Ahmed, 1986) and gibberellins (Hanafy Ahmed, 1986). Abdel-Aziz and Zakher (2010) reveal that foliar application of Potassium sulfate at 30 g/ L. They obtained significant increase of plant vegetative growth i.e. plant height, number of leaves and fresh and dry weights/ plant of pea cv. Master B. Moreover, Manal *et al.* (2011) stated that foliar application of Potassium Dihydrogen Orthophosphate (PDO) at 5g/L. on faba bean was applied twice, at the beginning of flowering stage and at pod development stages showed significantly increased maximum plant height.

2- Total fresh green pod yield (ton/ fed.) and pod characters of pea plant:

With respect to the effect of the natural safety materials and synthetic compounds treatments of foliar and soil applications on yield and pod characters which presented in Tables (6 and 7) indicated that, there were significant differences among the treatments of foliar and soil applications, that increased in the number of pods per plants, average weight of pod (g), number of seeds per pod and fresh weight of 100 seeds (seed index). The only exception may be recognized in plants treated with Thyme oil though the significant increase in the average weight of pod in the 2nd season only. Moreover, the treatment in consideration caused a significant increase in mean values of pod length, pod diameter, the percentage of shell out % of fresh green pod and total green pod yield (ton/fed.) in the two successive winter seasons. The exception only was reported for the Thyme oil in pod diameter, in two seasons, and shell out percentage in the 1st season only. The results also, show that the foliar and soil applications increase in the average percentage of fresh green yield up to 36.37 % for Sodium meta silicate, and 33.32 % and 29.09 % for Salicylic acid as well as Potassium bicarbonate, respectively as compared to the control untreated plants. These results for adding Sodium meta silicate are in harmony with those obtained by Miyake and Takahashi (1983) on cucumber, Lu and Cao (2001) on melon plants, Gharibe and Hanafy Ahmed (2005) provided that foliar spraying of sodium meta silicate at the dose of 1 or 2 g/l cause significantly increment in shell out % of fresh pod, fresh weight of 100 seeds and total fresh yield per fed. of pea plants cv. Master B when compared to the non-treated control plants. Abdel-Aziz (2007) mentioned that spraying tomato plant with Sodium meta silicate at g/ L. significantly increased early, marketable and total fruit yield as well as average fruit weight. With regard to the stimulatory effect of salicylic acid on yield and its components, the same general trend were reported by Sanaa *et al.* (2001) on bean plants and Ali and Mahmoud (2013) declared that that application of salicylic acid at the rate of 150 ppm concentration was more superiority on number of pods/ plant, number of seeds/ pod and 1000-seed weight traits of mungbean plant.

Table (6): Effect of foliar and soil treatments on pea plants on number of pods/ plant, average pod weight (g), No. of green seeds/ pod and fresh weight of 100 seeds (g) of pea plants during the two successive winter of 2009/2010 and 2010/2011.

Treatments	Number of pods/ plant		Average pod weight (g)		No. of green seeds/pod		Fresh weight of 100 seeds (g) (seed index)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Sodium meta silicate	11.9	13.1	7.9	8.6	8.0	8.7	51.5	53.0
Salicylic acid	11.3	12.2	7.3	7.8	8.2	8.4	50.5	51.0
Potassium bicarbonate	10.1	11.5	7.0	7.5	7.8	7.9	45.0	49.0
Thyme oil	8.4	9.1	6.4	7.3	7.0	7.3	42.0	44.5
Sumi Eight 5 %	10.3	11.4	7.4	7.7	7.7	8.0	46.0	47.5
Topas 100 Ec 10 %	9.0	10.1	7.8	7.4	7.3	7.8	43.0	45.0
Control(Distilled water)	8.1	8.7	6.3	7.0	6.6	7.2	39.5	42.0
L.S.D. at 0.05 %	**0.72**	**0.56**	**0.33**	**0.20**	**0.24**	**0.20**	**3.15**	**2.75**

Table (7): Effect of foliar and soil treatments on pod length, diameter (cm), shell out % of fresh green pod and total fresh green pod yield (ton/ fed.) of pea plants during the two successive winter of 2009/2010 and 2010/2011.

Treatments	Pod length (cm)		Pod diameter (cm)		Shell out % of fresh green pod		Total fresh green pod yield (Ton/ fed.)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Sodium meta silicate	10.4	10.6	1.27	1.35	50.7	52.3	3.788	3.947
Salicylic acid	10.3	10.7	1.24	1.29	48.9	49.7	3.698	3.864
Potassium bicarbonate	10.4	10.6	1.25	1.27	47.5	50.1	3.595	3.726
Thyme oil	9.9	10.1	9.8	1.19	44.6	46.4	2.894	3.119
Sumi Eight 5 %	10.3	10.5	1.25	1.31	48.2	49.5	3.418	3.562
Topas 100 Ec 10 %	10.2	10.3	1.20	1.28	46.1	48.0	2.998	3.147
Control (Distilled water)	9.6	9.8	0.93	1.12	43.8	45.5	2.693	2.978
L.S.D. at 0.05 %	**0.24**	**0.23**	**0.11**	**0.13**	**1.15**	**0.84**	**0.163**	**0.093**

Adding potassium bicarbonate results coincided with that obtained by El-Habbasha *et al.* (1996) working on pea plants and Abdel-Aziz and Zakher (2010) investigated that application of Potassium sulfate at 30 g/ l, lead to significant increases of pod characters i.e. number of pods/ plant, average pod weight, number of seeds/pod and fresh weight of 100 seeds of pea plants plant as well as total green yield (ton/ fed.) of pea plants cv. Master B. similar results obtained with Mallarino (2009) concluded that foliar applications with potassium improve grain yield on soybean. Manal *et al.* (2011) postulated that foliar application of potassium at 5 g/ L. on faba bean significantly recorded the greatest stimulatory effect on increased all the yield parameters (number of pods/plant, weight of seeds/ plant and 100-seed weight) compared with control.

3- Chemical composition in foliage and seeds of pea plants:

Regarding nitrogen, phosphorus, potassium percentage in pea foliage as well as total chlorophyll (SPAD unit), data in Table (8) revealed that all applied treatments used in the two successive winter seasons significantly increased nitrogen, phosphorus, potassium (%) as well as total chlorophyll content in pea foliage. The exception may be observed in of treating plants with Thyme oil in the concentration of potassium content (%) in the 2nd season only and total chlorophyll content in the 1st season only when compared to the non-treated control (Distilled water) plants. Concerning the effect of different treatments it can be seen from

Table (8): Effect of foliar and soil treatments on nitrogen, phosphorus, potassium (%) and total chlorophyll (SPAD unit) of pea foliage plants during the two successive winter of 2009/2010 and 2010/2011.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)		Total chlorophyll (SPAD unit)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Sodium meta silicate	3.13	3.31	0.424	0.456	2.232	2.407	45.3	49.2
Salicylic acid	3.19	3.27	0.381	0.428	2.211	2.192	43.1	46.3
Potassium bicarbonate	2.88	3.09	0.367	0.408	2.015	2.162	42.0	43.8
Thyme oil	2.39	2.68	0.347	0.386	1.612	1.846	38.7	42.2
Sumi Eight 5 %	2.81	3.15	0.361	0.417	1.977	2.017	41.6	46.7
Topas 100 Ec 10 %	2.66	2.71	0.345	0.403	1.879	1.902	43.9	43.9
Control (Distilled water)	2.22	2.43	0.316	0.367	1.445	1.774	37.8	41.3
L.S.D. at 0.05 %	**0.10**	**0.19**	**0.019**	**0.012**	**0.095**	**0.074**	**1.00**	**0.93**

data in Table (9) the results clearly revealed that the different treatments significantly increased nitrogen, protein (%) and total soluble solids % (T.S.S. %) of seeds content with the exception of treating pea plants with Thyme oil in nitrogen (%) and protein (%) in the two seasons, respectively as well as in total soluble solids % in the 1st one. Topas 100 Ec 10 % showed non increases significant on nitrogen (%) in the 1st season only and protein (%) in the two seasons, respectively as well as Sumi Eight 5 % in protein (%) in the 2nd season only content of seeds of cv. Master B. Sodium meta silicate, Salicylic acid and

Table (9): Effect of foliar and soil treatments on nitrogen (%), protein (%) and total soluble solids (%) in seeds of pea plants during the two successive winter of 2009/2010 and 2010/2011.

Treatments	Nitrogen (%) of seeds		Protein (%) of seeds		Total soluble solids (%)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Sodium meta silicate	3.21	3.56	20.07	22.27	12.6	13.0
Salicylic acid	3.18	3.42	19.86	21.37	12.0	12.8
Potassium bicarbonate	3.11	3.36	19.47	20.83	11.8	12.3
Thyme oil	2.91	3.15	18.20	19.83	11.0	11.7
Sumi Eight 5 %	3.16	3.34	19.76	20.53	11.7	12.5
Topas 100 Ec 10 %	3.01	3.25	18.33	20.33	11.2	12.1
Control (Distilled water)	2.85	3.07	17.83	19.20	10.6	11.2
L. S. D. at 0.05 %	**0.26**	**0.14**	**1.44**	**1.38**	**0.47**	**0.32**

Potassium bicarbonate gave the highest values for plant content of nitrogen (%), protein (%) and total soluble solids % of seeds content compared to the control (Distilled water). These results for adding Sodium meta silicate are in agreement with those obtained by Gharibe and Hanafy Ahmed (2005) on pea plants and Abdel-Aziz (2007) on tomato. Similar findings with applications of salicylic acid were obtained by Sanaa *et al.* (2001), Kananbala and Sing (2003) and Hegazi and El-Shraiy (2007) on common bean suggested that significant increase in total protein in leaves was obtained with salicylic acid at 10 M. and Yan *et al.* (2008), Mady (2009) and Yldrm and Dursun (2009) stated that obtained the greatest chlorophyll content in leaves and total soluble solids (%) in fruit when treated tomato plants with foliar salicylic acid applications at 0.50 mM. Adding Potassium bicarbonate results coincided with that obtained by Mallarino (2009) on soybean, Abdel-Aziz and Zakher (2010) on peas and Manal *et al.* (2011) commented that foliar application of potassium at 5 g/ L. on faba bean significantly increased nitrogen, phosphorus and potassium in seed.

Disease control under field conditions:

Data in Table (10) indicate that all treatments significantly reduced the percentages of disease severity. The most effective treatments were Sumi Eight 5 %, Topas 100 Ec 10 %, Sodium meta silicate that gave the best control followed by Salicylic acid, Potassium bicarbonate. The lowest effect was recognized for Thyme oil treatment. Fauteux *et al.* (2005) found that Si favorable effects including growth increase and production, improvements in some morphological characteristics (height, root penetration into the soil, exposure of leaves to light, resistance to lodging), reduced transpiration and resistance to stress, resistance to salinity and toxic metal toxicity, effects on enzyme activity, and increased resistance to pathogens. Shirasu *et al.* (1997) demonstrated that Salicylic acid has received much attention after the discovery of its ability to induced resistance to pathogens.

The chemically synthesized compounds, probenzol (Midoh and Iwata 1996) also induced acquired disease resistance in plants and one of the probenzol induced proteins was identified as intercellular PR proteins. However, only limited information that suggests fungicides directly act as activators of resistance.

Table (10): Effect of foliar and soil treatments on disease severity and total green pod yield (ton/ fed.) of pea plants during the two successive winter seasons of 2009/2010 and 2010/2011.

Treatments	Disease severity		Efficiency %		Total fresh green pod yield (Ton/ fed.)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Sodium meta silicate	38.7	37.3	35.3	30.0	3.788	3.947
Salicylic acid	40.0	38.7	31.9	27.4	3.698	3.864
Potassium carbonate	41.3	40.0	29.6	24.9	3.595	3.726
Thyme oil	44.0	42.7	25.0	19.9	2.894	3.119
Sumi Eight 5 %	32.0	30.6	45.5	42.6	3.418	3.562
Topas 100 Ec 10 %	34.7	32.0	40.9	39.9	2.998	3.147
Control (Distilled water)	58.7	53.3	0.0	0.0	2.693	2.978
L. S. D. at 0.05 %	2.41	1.71	-------	------	0.163	0.093

Protein extraction and electrophoretic analysis:

Data in Table (11) and (Fig.1) sampled for protein analysis composite pods extracts was subject to electrophoresis for 6 hours. The experiment was carried out in seven treatments including Sodium meta silicate, Salicylic acid, Potassium bicarbonate, Thyme oil, Sumi Eight 5 %, Topas 100 Ec 10 % and control. Showed that Sodium meta silicate resulted in a versatile development of bands compared to the control spraying sodium meta silicate at the used concentration caused a development of bands at 115, 93, 52 and 34 KD.

The same treatment however caused a complete absence of bands at (114, 94, 51, 40, 38, 36, 31, 27 and 16 KD.) compared to control. Moreover, spraying salicylic acid at the used concentration caused a development of bands at (93, 61, 57, 54, 52, 44 and 34 KD). The same treatment, however, caused a complete absence of bands at (94, 51, 43, 40, 38, 36 and 16 KD.) compared to control. Potassium bicarbonate on the other hand, caused development of bands at (93, 61, 54, 52, 44, 28, 26 and 20 KD.)The same treatment, however, caused apparent absence of band at (94, 51, 43,37,30,27 and 12 KD.) compared to the control. The Thyme oil treatment developed a protein bands at (113, 92, 67, 65, 61, 58, 55, 52, 44 and 28 KD.) compared to the control. The absence of bands in the same treatment, however, was noticed at (114, 94, 51, 43, 39, 25 and 16 KD.) with regard to the used fungicides, a versatile protein band development, was noticed between both of them, and compared to the control. Sumi Eight 5 % caused a development of band at (113, 92, 83, 78, 64, 66, 52, 50, 45, 42, 26, 20 and 14 KD.). The absent bands in the same treatment was recorded at the (114, 94, 51, 39, 35, 30, 27, 25, 19 and 12 KD.) compared to the control. A slight difference between both Sumi Eight 5 % and Topas 10 % treatments may be recognized. The latter fungicide developed bands at (113, 92, 84, 80, 61, 55, 52, 50, 45, 42, 24 and 14 KD.) The absence of bands was noticed at (114, 94, 51, 41, 38, 35, 31, 30, 29, 25, 19, 16 and 12 KD.) It could be concluded that the abovementioned treatments caused a versatile qualitative band development compared to the control, though the non significant band differences that ranged between 17 to 23 bands compared to 21 bands developed at the control.

Table (11): Electrophoritic analysis of soluble proteins of plants in different treatments.

Bands No.	Amount %							
	MW(KDa)	Sodium meta silicate	Salicylic acid	Potassium bicarbonate	Thyme oil	Sumi Eight 5 %	Topas 100 Ec 10 %	Control Distilled water
1	115	16.36	0	0	0	0	0	0
2	114	0	14.76	14.46	0	0	0	11.87
3	113	0	0	0	12.30	10.73	11.38	0
4	94	0	0	0	0	0	0	6.92
5	93	12.87	7.56	7.16	0	0	0	0
6	92	0	0	0	6.55	7.83	7.41	0
7	84	0	0	0	0	0	1.18	0
8	83	0	0	0	0	0.94	0	0
9	80	0	0	0	0	0	3.74	0
10	78	0	0	0	0	3.47	0	0
11	67	0	0	0	2.14	0	0	0
12	65	0	0	0	0.76	0	0	0
13	64	0	0	0	0	4.76	0	0
14	61	0	1.78	1.96	2.16	0	6.82	0
15	60	0	0	0	0	2.03	0	0
16	58	0	0	0	0.96	0	0	0
17	57	0	0.75	0	0	0	0	0
18	55	0	0	0	0.78	0	3.06	0
19	54	0	1.45	2.38	0	0	0	0
20	52	3.45	2.98	3.20	6.06	4.82	1.39	0
21	51	0	0	0	0	0	0	2.04
22	50	0	0	0	0	1.79	2.46	0
23	48	2.75	2.77	2.91	2.63	2.88	2.44	2.68
24	45	0	0	0	0	7.37	2.96	0
25	44	0	6.33	6.58	5.98	0	0	0
26	43	5.76	0	0	0	5.85	3.94	6.11
27	42	0	0	0	0	0.80	4.73	0
28	41	2.44	2.96	3.25	3.20	0.26	0	2.73
29	40	0	0	2.13	3.48	3.27	0.90	0.96
30	39	2.39	3.05	2.27	0	0	11.84	4.23
31	38	0	0	12.47	8.30	19.02	0	18.19
32	37	11.77	8.03	0	1.07	0	2.54	2.89
33	36	0	0	3.71	9.44	4.91	8.47	10.18
34	35	9.36	9.14	8.96	5.36	0	0	5.16
35	34	3.15	2.70	0	0	0	0	0
36	32	5.56	4.81	2.90	2.38	1.99	1.27	2.18
37	31	0	2.97	2.61	4.21	1.47	0	0.74
38	30	2.89	1.54	0	0	0	0	3.09
39	29	5.77	9.14	5.55	1.55	5.34	0	4.15
40	28	4.05	0	1.48	3.21	0	0	0
41	27	0	3.55	0	11.62	0	15.88	2.79
42	26	0	0	9.84	0	4.99	0	0
43	25	6.57	6.47	0	0	0	0	7.97
44	24	0	0	0	0	0	4.82	0
45	20	0	0	3.49	0	3.09	0	0
46	19	2.61	2.54	0	2.55	0	0	2.62
47	16	0	0	0	0	0	0	0.85
48	14	0	0	0	0	2.40	2.77	0
49	12	2.27	2.72	2.69	3.30	0	0	1.68

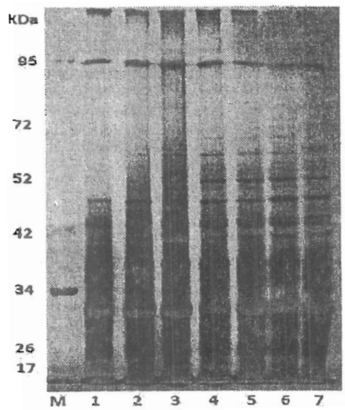

Fig (1): Electrophoritic analysis of soluble proteins of plants in different treatments.
1- Sodium meta silicate 2- Salicylic acid 3- Potassium bicarbonate 4- Thyme oil 5- Sumi Eight 5 % 6- Topas 100 Ec 10 % 7- control

Plant samples for protein analysis assayed different number of separated bands being more evident for sprayed treatments. Molecular masses of polypeptides were shown to range in size from (49 to114) K. D on SDS- PAGE. Moreover, the polypeptides accumulation and pattern were changed by treatment. It is observed that the Thyme oil, fungicide, Potassium bicarbonate, Salicylic acid and Sodium Meta silicate treatments resulted in larger number of bands, respectively. The defense response of plants or as an activator of protein-mediated cell signaling, may interact with many key components of stress signaling systems in plants and direct induced resistance against fungal pathogens. As regard to the favorable effects by Sodium meta silicate, Similar results were reported by many workers, Chérif *et al.* (1994) demonstrated that, regardless of Si accumulation several enzymes including chitinases, peroxidases and polyphenol oxidazes had increased activity in cucumber plants treated with Si and challenged by Pythium ultimum or Sphaerotheca fuliginea (Schlechtend.:Fr.). Seehaus *et al.* (2003) showed that during the induction of systemic acquired resistance (SAR) mediated by silicon in cucumber, the express of a gene encoding a novel proline-rich protein was enhanced, this protein was associated to cell wall reinforcement at the site of the attempted penetration of fungi into epidermal cells.

This benefit of K has been explained by its effect on primary metabolism by favoring the synthesis of high molecular weight compounds (proteins, starch and cellulose) thereby depressing the concentrations of soluble sugars, organic acids, amino acids and amides in plant tissues. These low molecular weight compounds necessary for feeding pathogens and insects are thus more vulnerable disease and pest attack (Marschner, 1995).

The phenomenon of inducing resistance in plants by biologic and/or natural compounds such as sodium salicylate, salicylic acid (aspirin), phosphates, fatty acids, and so on, potentially offers an alternate, more environmentally benign approach to tree protection (Sticher *et al.*, 1997). Induced systemic response (ISR): It is defined as the process of active resistance dependent on the host plant's physical and chemical barriers, activated by biotic and abiotic agents (inducing agent), this response involves production of many pathogenesis related proteins (PR-proteins) which mainly include (a) phenol oxidases, peroxidases and polyphenol oxidases, (b) enzymes like _-1,3 glucanases, chitinases, _-1,4 glucosidases and Nacetly glucose aminidases (Heil and Bostock, 2002).

CONCLUSION

It could be concluded in principal that all treatments significantly reduced the percentages of disease severity and the most effective treatments were Sumi Eight 5 %, Topas 100 Ec 10 % and Sodium meta silicate that gave the best control, followed by Salicylic acid and Potassium bicarbonate. The lowest effect was recognized for Thyme oil treatment. On the other meaning the study showed that the possibility of using some safety materials such as Sodium meta silicate, salicylic acid and Potassium bicarbonate instead of fungicides as Sumi Eight and Topas for resistance to *Fusarium solani* and *Rhizoctonia solani* on peas plant.

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J. Plant Production, Mansoura Univ., Vol. 4 (5), May, 2013

تقييم بعض المعاملات الآمنة على أمراض عفن الجذور والنمو وجوده محصول القرون فى البسله

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أجريت هذه الدراسة خلال الموسمين الشتويين ٢٠٠٩/٢٠١٠ و٢٠١٠/٢٠١١ في المزرعة البحثية بقها (محافظة القليوبية)، معهد بحوث البساتين، مركز البحوث الزراعية ، مصر. وذلك لدراسة تأثير الاضافة الارضية والرش ببعض المواد الامنة على مكافحة بعض امراض الجذور فى البسلة صنف ماستر بى مقارنة بمبيدى السومى ايت وتوباز اضافة الى اثرها على درجة الاصابة بالامراض المدروسة (الفيوزاريوم والريزوكتونيا) وكانت المواد المستخدمة هي : صوديوم ميتا سليكات , حمض السلسليك , بيكربونات البوتاسيوم وزيت الزعتروكذلك تأثير هذه المواد أيضا على النمو الخضرى والمحصول الكلي ومكوناتة وجودة القرون الخضراء الناتجة وكذلك التركيب الكيماوي للمجموع الخضري والبذور.

وقد تم تعريف الفطريات وكانت ريزوكتونيا سولانى وفيوزاريوم سولانى وكان للمواد المستخدمة المذكورة أعلاه تأثير واضح فقد انخفضت بشكل ملحوظ شدة المرض وكانت أكثرها فعالية هو مبيد سومي ايت ٥ ٪ يليه مبيد توباز ١٠ ٪ ثم صوديوم ميتا سليكات وحمض السلسيليك وبيكربونات البوتاسيوم وكان اقلها تأثيرا هو زيت الزعتر. وكانت أهم النتائج المتحصل عليها هى كما يلى:-

١- تم استخدام التركيز الافضل للمواد المختبره لمقاومة عفن جذور البسله تحت ظروف الصوبة والحقل حيث أظهرت المواد المستخدمة انخفاضا واضحا في نسبة الإصابة بعفن الجذور خلال الموسمين مما ادى إلي زيادة معنوية في الصفات المحصولية.

٢- كما أدت معاملة الرش على المجموع الخضرى والاضافة الارضية لكل من مركبات صوديوم ميتا سليكات، حامض السلسليك، بيكربونات البوتاسيوم الى الحصول على أفضل النتائج لصفات النمو الخضرى متمثلة فى أرتفاع النبات وعدد الأوراق والوزن الطازج والجاف للنبات مقارنة بمعامله الكنترول.

٣- حدثت زيادة معنوية فى قيم المحصول الأخضر الطازج الكلى ومكوناته المتمثلة فى عدد القرون/ نبات – متوسط وزن القرن – عدد البذور الخضراء/ قرن – الوزن الطازج لعدد ١٠٠ بذرة خضراء بالاضافة الى بعض مواصفات القرون كمتوسط طول وقطر القرن ومعدل التفريط % وكانت أقل المعاملات أستجابة هى المعاملة بالرش بزيت الزعتر مقارنة بمعامله الكنترول.

٤- أظهرت معظم المعاملات زيادة محتوى بذور البسلة من تركيز كل من عنصر النتروجين (%) وكذلك زيادة نسبة البروتين (%) والمواد الصلبة الذائبة (%) وكانت افضل النتائج المتحصل عليها من مركب صوديوم ميتا سليكات، وحامض السلسليك ، بيكربونات البوتاسيوم وأقل النتائج زيت الزعتر مقارنه بمعامله الكنترول.

٥- زاد تركيز محتوى أوراق نباتات البسلة من النتروجين والفوسفور والبوتاسيوم كنسبة مئوية وكذلك زاد محتوى الأوراق من الكلورفيل لمعظم المعاملات المختلفة من مركبات صوديوم ميتا سليكات، حامض السلسليك، بيكربونات البوتاسيوم مقارنة بأوراق معامله الكنترول.

٦- تم التفرقه بين المعاملات عن طريق البصمه البروتينيه حيث اظهرت النتائج وجود اختلاف بين المعاملات فى عدد البروتينات ونسبه تكونها مقارنه بالنبات الغير معامل.

٧- كما وجد ان جميع المعاملات لها تاثير على تكوين او غياب بروتينات لم تتواجد فى النباتات المصابه و هذه البروتينات ذات الوزن الجزئى (٥٢) حيث ان هناك احتمال ظهور بعض البروتينات قد تعمل على تحفيز نباتات البسلة على زياده المقاومه للمرض مما يقلل من شده الاصابه وينعكس ذلك على انتاجيتها وجودة القرون الخضراء الناتجة.

الخلاصة : اثبتت الدراسة أمكانية أستخدام بعض المواد الامنة مثل صوديوم ميتا سليكات وحمض السلسليك وبوتاسيوم بيكربونات بديلا عن المبيدات الفطرية مثل سومى ايت ٥ ٪ وتوباز ١٠ ٪ لمكافحة أمراض الجذور(الفيوزاريوم والرزوكتونيا) فى نبات البسلة.

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