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POTENTIAL THE BIOLOGICAL AND CHEMICAL CONTROL OF LETTUCE WHITE ROT AND MAINTAIN PRODUCTIVITY

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ABSTRACT

The experiments were conducted on the autumn and winter of (2016 /2017, 2017/2018) seasons at Qalyub area, EL-Qalyubia governorate, Egypt. The main objective for this study to find out the efficacy of several biological and the chemical controls on growth and productivity of lettuce crop and management on white rot disease caused by *Sclerotinia sclerotiorum*. Biological control includes three treatments, namely *Trichoderma asperellum* (85 g/100L^{-1}), Salicylic acid (100 g/100L^{-1}) and Calcium chloride (200 g/100L^{-1}) were applied with chemical control, Iprodione (250 g/100L^{-1}) , Fluopyram with Tebuconazole (50 ml/100L^{-1}) and Tebuconazole (188 mg /100 L^{-1}). Which they tested for their ability for increasing the lettuce crop productivity and reduce disease severity and incidence growth of *white rot* by treatment were sprayed in two times on plants at 3 - 6 leaves from planting or (15-19 BBCH) stages by using knapsack sprayer by 250 L./Fed.). Results indicated that, Iprodione applications significantly gave the highest indications of total and the Marketable yield in compared with the other experimental treatments for both seasons. Moreover, the two times of spray by Iprodione and Salicylic acid treatments had significantly lowered the disease incidence and disease severity and increasing the control efficiency in both seasons. Furthermore, the other treatments like Tebuconazole with Fluopyram, Tebuconazole solo or *T. asperellum* had a moderate efficacy on the lettuce crop productivity or the disease severity and incidence of *S. sclerotiorum* in compared to the control treatment. In the contrast, applying by Calcium Chloride had a little effect on the marketable yield or final yield and marketable plant in both seasons and had an insignificant effect on the disease severity and incidence of *S. sclerotiorum* despite low to medium recovery following applications. Finally, the non-treated control treatment was the lowest of crop productivity and control of disease efficacy.

Keywords: Lettuce, Productivity, Biological control, Chemical control, *S. sclerotourium,* White rot, *BBCH monograph.*

INTRODUCTION

Lettuce (*Lactuca sativa*) was an annual plant which cultivated since 4500 BC in Egypt. Whereas, the lettuce production area was about 11,352 feddan. give 113,185 tons by an average yield of 9.97 tons/fed according to **(FAO, Stat., 2016).** It considered one of the most important vegetables for the human diet and the 26th among 39 vegetables and fruits of nutrition value and is a fourth of consumption. Leaves of lettuce are a good source of vitamins, minerals or iron, folic acid, and vit. C, much of fibers that facilitates colon peristalsis and several bioactive compounds which are very good for health. Moreover, it contains lactocin and lactucopicrin which improve the sleep.

White rot caused by *Sclerotinia sclerotiorum* was consider one of a destructive disease in lettuce crop. Moreover, the challenges which look over the management programs of vegetables. White rot caused by *S. sclerotiorum* has a broad host of plants reach out 400 species, alongside it was known that was very difficult to totally eliminate all sclerotia produced by this pathogen. Lettuce plant damping-off can appear in November with disease incidence and severity are very effective from December to

March on cool conditions. However, high relative humidity leading to disease development **(Anonymous. 1985).**

Provided that *S. sclerotiorum* reproducing by asexually or sexually (myceliogenic or carpogenic germination of sclerotia). **Ordonez-Valencia et al (2014)** revealed that the fungus forms a white fluffy mycelium and after several days, it produces survival sclerotia on diseased plants. Explaned that the sclerotia black, melanized structures of different size which depending on the host, range from a few millimeters (bean) to a few centimeters (sunflower) in length. Sclerotia can germinate myceliogenically or carpogenically **(Williams and Stelfox 1980)**; by forming hyphae or producing apothecia and ascospores. Sclerotia is consist from two or layers as following rind, cortex and medulla thats contain the black compound melanin**.** This is a macro-molecule composed of several types of phenolic and indolic monomers which protects fungi from harsh environmental conditions**.**

Support the progress of nonchemical methods and want control of disease than provided by fungicides presently out there with promoted concern over fungicides residue on lettuce plants. Moreover, **Peng and Yueming (2006)** mentioned that salicylic acid or calcium used are safe regarding human health and increase the standard of crops quality.

Hayat et al (2010) and **Raskin (1992).** referred that Salicylic acid is an internal growth regulator from phenolic nature, as it produced normally in plants by very small quantities and regulates many different physiological or biochemical processes in plants as follow plant growing, nutrient transport, membrane permeability or ethylene synthesis, photosynthesis and enzyme activities. Whereas, **Spoel et al (2003)** provided that, Salicylic acid (SA) performing an important role in regulating defenses of plants with biotrophic or hemi-biotrophic pathogens. **Godoy et al (1990)** stated that calcium is necessity in the structure of the middle lamella in plant cells or preserve a cell plasma lemma therefore, it considers a serious factor in the defenses of plants with *S. sclerotiorum*. **Zhou & Boland (1999)** reported that Oxalic acid which produced within the infestation by Sclerotinia decayed the plant cell walls plus it is necessary for disease developing. While, **Cessna et al (2000)** provided that the function of oxalate on Sclerotinia pathogenicity can be clarified by its similarity for Ca^{2+} which might decay plant barriers by filtrate the stabilizing cation for the host plant cell wall.

On the other hand, Trichoderma spp. may be the most widely used mycoparasites or many commercial formulations exist and attacking both of sclerotia and mycelia of Sclerotinia species. Therefore, it has been used with varying degrees of success.

Duff et al (2001) revealed that fungicide like Fluopyram is one of a new group of fungicide chemistry called pyridiny ethylbenzimidies that's a new active substance for penetrating and translaminar properties and clarified a mode of action by succinate dehydrogenase inhibitor (SDHI) in fungi mitochondrial chain thus blocking electron transport. Furthermore, Tebuconazole have offered hope to controlling the white rot on infested fields which showed better control than the best dicarboximide fungicide or procymidone on some compares. Despite **Fullerton et al (1995)** reported that tebuconazole is the best suitable for foliar spraying. showed that phytotoxicity on plants when applied a seed treatment and might be good control with white rot. **Duah-Yentumi and Johnson (1986)** stated that impact of frequent applications on iprodione and gathering that this fungicide had little effect on microbial biomass; as it affects of germ tubes by preventing mycelial growth. Whereas, Iprodione is necessary against *Sclerotinia sp.*

The long-term aim of this study is assessing growth and productivity on lettuce plants by using foliar applications with biological and fungicide agents for management white rot infestation on field conditions.

MATERIALS AND METHODS

The experimental treatments were prepared as a randomized complete block design (RCBD) through three replications for each treatment at lettuce plants (Baladi) under clay soil conditions. Lettuce seedlings were transplanted at the 1st week of December at two successive growing (2016/2017) & (2017/2018) seasons. The field plots were (10.8 m^2) through 3 rows, each row was 4 m at length and 0.9 m width. Seedling distance was 20 cm apart at the two sides of ridge. Soil was naturally infested with white rot disease. Three replicates of soil were selected for sampling which located in winter lettuce production area on Qalyub region El-Qalyubia governorate, Egypt and analysis results performed confirmed that soil contains a sclerotinia at pathology lab in faculty of agriculture Ain Shams Univ. All agricultural procrdures were carried out depending on references of the Agriculture and Land Reclamation Ministry in Egypt.

2- Treatments as a foliar spray were as follows:

1. The control (sprayed with tap water).
2. *Trichoderma asperellum* (10^7 spores/g) (85g/100 L^{-1}) (Shoura Chemicals Co. Sorce).

3. Salicylic acid ($C_7H_6O_3$) (100g/100 L^{-1}) (Algomhouria Chemicals Co. Sorce).
4. Calcium Chloride (200g/100 L^{-1}) (Algomhouria Chemicals Co. Sorce).
5. Iprodione 70-DF (250g /100 L^{-1}) obtained from (Shoura Chemicals Co., sorce).
6. Fluopyram + Tebuconazole (50 ml /100 L^{-1}) (Bayer crop sciences Co. Sorce).
7. Tebuconazole (188 ml /100 L^{-1}) (Bayer crop sciences Co. Sorce).

These treatments were tested for their ability to preserve the productivity and inhibit mycelial growth of S. *sclerotiorum* treatments were applied two times at 15-19 (BBCH) Scale over the plants with a knapsack sprayer (250 L/Fed.).

Data Recorded

Vegetative growth: Sex plants of the inner rows on every experimental plot were selected on random at 45 BBCH Scale (50% of the expected head size reached) **(Meier, 2001)** (60 days after planting) to record the following parameters: plant length (cm) was assessed from the bottom level to the top living point of plant, leaf area per plant, number of leaves per head, leaf fresh and dry weight **(A.O.A.C., 2005).** Leaf area (cm^2) was specified using the newly full expanded fourth leaf of the plant top as linking between unit area plus leaf fresh weight **(Koller, 1972).**

$$\textit{Leaf area } (cm^2) = \frac{\textit{Disk area} \times \textit{Num. Disks} \times \textit{Leaf FW}}{\textit{Disk FW}}$$

Yield, at harvest time plants were removed and then trimmed according to market standards; six plants on each plot per block was harvested once a lot of 80% of lettuce heads on a minimum of one treatment has reached suitable firmness and weighing of the market the standing head diameter on each individual plant was measured. The fresh weight of lettuce heads was assessed per treatment and calculated total yield per feddan.

Chemical composition: Leaf chlorophylls contents on lettuce plants were determined using SPAD meter (SPAD-502, Minolta Camera Co., Osaka, Japan) according to **Minolta (1989),** total carbohydrate was measured on dried leaves according to **(A.O.A.C., 2005).**

Diseases index parameters

After 30 days of planting, plants were assessed for disease index parameters. Percentages of disease incidence were calculated according to formula suggested by **Crowe et al (1994):**

$$\textit{Disease incidence (DI)\%} = \frac{\textit{Num. of infected plants} \times 100}{\textit{Num, of total plants in plots}}$$

The percentage of efficiency was calculated as follows:

$$\textit{\% Efficiency} = \frac{C - T}{C} \times 100$$

where: C = % disease incidence in control treatment, T = % disease incidence in different treatments.

Plants were assessed for disease severity index by means of "quarter scale" as clarify by where zero = no disease present, 1 = 1% - 25% of the plant by white rot symptoms, 2 = 26% - 50% of the plant by white rot symptoms, 3 = 51% - 75% of the plant by white rot symptoms, and 4 = 76% - 100% of the plant by white rot symptoms. DSI was calculated on a percentage according to as follow formula:

$$\textit{Disease severity index \%} = \frac{\sum \textit{(scores of all plants)} \times 100}{4X \textit{ Total num. of plants}}$$

Statistical Analysis

Data of two seasons were sorted and statistically analyzed by using Mstatic (M.S.). The compare among means of the various treatments was determined, as clarify by **Snedecor and Cochran (1982).**

RESULTS AND DISCUSSION

Vegetative growth parameters

Data presented on **Table (1)** showing that treatments under this study improved lettuce plants as a vegetative for both seasons. *T. asperellum*, Salicylic acid, calcium chloride, iprodione, Tebuconazole/fluopyram and Tebuconazole significant effect by increased plant length comparison with control in

1st season. But, iprodione and salicylic acid in the 2nd season significantly showed the highest values on plant length. While, iprodione in the 1st season plus Salicylic acid in the 2nd season significantly increased number of leaves. Whereas, iprodione in the both seasons showed significantly gave the highest values for fresh or dry weights on leaves. But, Salicylic acid on both seasons significant effect by showed the highest values on leaf area in compared with control treatment .The same results was obtained by **Shakirova (2007), Mady (2009)** whom stated that stimulatory impact of salicylic acid for vegetative parameters could be refer to the positive effect for salicylic acid on the endogenous phytohormones especially the growth promoters like auxins or gibberellins and cytokinins. On the other hand, demonstrated that growth promotion by Trichoderma species was inconsistent, unreliable and only occurred under certain circumstances.

Nevertheless, **Petit et al (2012),** revealed that application with fungicides may restrict growth and development of the reproductive organs by alternating the carbon and nitrogen metabolism. They added that the plant sensitivity against high application rates of fungicides may increase during the critical reproduction state. Generally, **Van Iersel and Bugbee (1996)** illustrated that fungicides caused plant damage which called phytotoxicity that appeared in a form of growth reduction and visual damage in plant, in addition to decrease photosynthesis and caused an interveinal chlorosis.

Yield characteristics

As for lettuce crop production aspects under this study data tabulated in **Table (2)** cleared that most of treatments improved its. Salicylic acid present significant impact on Plant head Dia. in the 1st season but Salicylic acid and iprodione in the second season compared to control. Whereas, iprodione significantly indicates the highest values for plant weight, total yield plus Marketable yield in compared with the other experimental treatments for both seasons. Also, data in **Table (2)** indicated that lettuce plants treated by Tebuconazole and calcium chloride had a moderate effect on the average yield, final yield as a mass and marketable plant in the both seasons. Finally, the control treatment was the lowest .This results were agreement with those found by whom referred that the increment on the final yield as a mass production and marketable quality by using iprodione may be due to non-infected plants with white rots symptoms. Doubtless, plants treated with the recommended dose of fungicide exhibited significantly higher marketable yield than untreated plant.

Yildirim et al (2008) and **Khodary (2004)** whom noticed that salicylic acid application stimulatory effect on vegetative growth could be assigned to the positive effect of internally phyto-hormones specially, growth promoters such as auxins and gibberellins which causes increasing of the yield. **Hepler (1994)** illustrated that the stimulatory effect of calcium chloride on lettuce growth may be regarding to the fact of calcium ions (Ca^{2+}) appeared to share in the regulation of various aspects on cell division. Calcium is a necessary ion in the formation of the mitotic spindle which directly affects cell division. **Venette (1998)** stated that the foliar-applied Ca was found to enhance both disease control and dry bean yield. The author approached that Ca may be a nutritional supplement that increases the plant resistance to white rot. furthermore, Nutritional effect is particularly remarkable in the case of Ca compounds with high water solubility, like $CaCl_2$. suggested that plants resistant to *S. sclerotiorum* have higher Ca levels than susceptible ones. Also, **Paula Júnior (2009)** recorded that incidence and severity of white mold on dry bean were significantly reduced with application of calcium chloride and calcium silicate. On the other hand, **Duff et al (2001)** mentioned to tebuconazole was efficient in decrease the incidence or developing the disease plus increasing the yield when treated a garlic clove treatment. **Wysocki (2014), Saladin and Clément (2005)** justified this reduction caused as a reason of the hazard effect of fungicide on targeting specific cellular processes such as respiration and sterol biosynthesis and the density of the stress caused by the application with pesticide caused growth reduction after the agrochemical exposure.

Chemicals characteristics

Regard to lettuce leaves total chlorophylls contents (SPAD) and carbohydrates data showed in **Table (3)** cleared that lettuce plants treated by tebuconazole plus fluopyram in the 1st season and Calcium Chloride in the 2nd season significantly increased total chlorophylls contents when compared with the control treatments. Moreover, tebuconazole /fluopyram application in the 1st season and Tebuconazole in the 2nd season significantly gave the highest carbohydrates contents in the lettuce dry leaves. These results are in harmony with those

Table 1. Effect on biological and chemical control of White rot disease on vegetative growing characteristics on lettuce plants, during the two seasons (2016/2017 and 2017/2018)

Treatments	Plant length (cm)		Number of leaf / heads		Leaf fresh weight (g)		Leaf dry weight (g)		Average leaf area (cm^2)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**30.18b**	**31.13c**	**36.83e**	**41d**	**260.36e**	**249.75e**	**24.06e**	**28.8a**	**195.27f**	**202.40f**
Trichoderma asperellum	32.83a	32.9b	38.83d	48.16b	285.91bc	288.31b	20.85f	23.53d	232.31bc	231.57cd
Salicylic acid	32.33a	35.16a	45.33b	53.16a	288.93b	287.68b	25.55d	27.03ab	247.8a	255.61a
Calcium Chloride	31.9a	30.41c	41.83c	46.33c	250.98f	265.48d	23.73e	28.81a	239.4b	244.21b
Iprodion	32.68 a	35.38 a	51.66 a	46.16c	296.11 a	314.23 a	32.26 a	28.78 a	240.1ab	238.2c
Tebuconazole /Fluopyram	31.91a	30.2c	39.5d	47.33bc	264.73d	250.29e	30.18b	25.23c	227.31c	229.2cd
Tebuconazole	32.2a	33.3b	46.5b	51.83ab	282.24c	275.7c	27.56c	23.88d	218.52e	222.23e

* Values within the column followed by the same latter (s) are not statistically different; at the 0.05 level (Duncan's multiple range test), small letters (interac

Table 2. Effect of biological and chemical control of White-rot disease on yield characteristics of lettuce plants, during the two seasons (2016/2017 and 2017/2018)

Treatments	Head Diameter (cm)		Average yield per plant (g)		Total yield per feddan(ton)		Marketable yield per feddan (ton)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**59.35c**	**67.28c**	**281.03g**	**277.2f**	**7.38g**	**7.27g**	**6.09g**	**5.57f**
Trichoderma asperellum	65.86ab	70.91b	328.36d	334.6c	8.62d	8.78c	7.39e	7.87d
Salicylic acid	66.18 a	73.51 a	344.85c	358.45b	9.05c	9.41b	7.69c	8.26b
Calcium Chloride	64.38b	70.28b	290f	330.06de	7.61f	8.66e	7.07f	8.03c
Iprodion	65.13ab	72.41a	387.38 a	370.81 a	10.16 a	9.73 a	9.61 a	8.99 a
Tebuconazole /Fluopyram	58.55c	64.35d	375.1b	326.93e	9.84b	8.69d	9.28b	8.20b
Tebuconazole	59.11c	64.08d	317.03e	331.18cd	8.32e	8.58f	7.49d	7.72e

* Values within the column followed by the same latter (s) are not statistically different; at the 0.05 level (Duncan's multiple range test), small letters (interaction).

Table 3. Effect of biological and chemical control of White rot disease on chemical characteristics of lettuce plants, during the two seasons (2016/2017 and 2017/2018)

Treatments	Leaf Chlorophyll (SPAD)		Total of carbohydrates (g/100g D.W.)	
	1st season	2nd season	1st season	2nd season
Control	**37.23f**	**34.2e**	**4.05c**	**5.88c**
Trichoderma asperellum	39.81d	45.16b	5.52b	6.58ab
Salicylic acid	43.98c	42.65c	5.71b	6.11bc
Calcium Chloride	44.83b	48.03 a	4.43c	5.88c
Iprodion	39.16de	35.46e	5.42b	4.44d
Tebuconazole /Fluopyram	49.1 a	36.9d	8.51 a	4.65d
Tebuconazole	38.01e	41.45c	5.56b	6.90 a

* Values within the column followed by the same latter (s) are not statistically different; at the 0.05 level (Duncan's multiple range test), small letters (interaction).

obtained by cowpea **Mohamed & Basalah (2015)** whom indicated that calcium chloride increased chlorophyll content in cucumber leaves. Previous studies as **Sun et al (2018)** confirmed that primarily chlorophylls the main central component in the plant cell used as an indicator of biomass. On the other hand, **Stiborova et al (1986).** Illustrated that fungicides containing copper inhibits both of the synthesis of chlorophylls and protochlorophyllide by reducing activity of "an enzyme catalyzes" which it responsible of the chlorophyllide from protochlorophyllide formation during the biosynthesis of chlorophyll.

Furthermore, **Untiedt and Blanke (2004)** revealed that the attributed in the negative effect of pesticides on photosynthesis to disturbance in CO-independent Hill reaction or to the uncoupling for photosynthetic electron that flow of phosphorylation and inhibit energy by prevent ATP formation or render the dissociation of ATP into ADP + Pi.

Diseases assessments

Data presented on **Table (4)** showing that lettuce plants treated by iprodione and salicylic acid in the both seasons respectively reduction of disease incidence by (10.7, 22.5, 15.7, 24.9 %), disease severity by (3.2, 6.8, 4.6, 7.7 %) and increase percent control efficiency of lettuce plants (89.3, 77.5, 84.3, 75 %) so reflected on increases of total yield per feddan (10.1, 9.7, 9, 9.4, ton/feddan). **El-Tayeb (2005)** referred that many numerous studies have indicated that a wide range of responses might be appear after salicylic acid application as following on yield increases **(Khodary, 2004; Yildirim et al 2008)** inhibiting ethylene biosynthesis may be necessary for synthesis of auxin or cytokinin (**Metwally et al 2003)**.

Subbarao (1998) revealed that iprodione generally had a positive effect on disease parameters in both seasons because iprodione supresses DNA plus RNA synthesis in the germinating fungal spores also it well as inhibiting the enzyme NADH cytochrome - c reductase, thus preventing lipid, membrane synthesis or ultimately mycelium growth

Melero-Vara et al (2000) mentioned that tebuconazole was effeicient in reducing the incidence and develop of the disease plus increasing the yield when applied as a garlic crop. Whereas, **Thomas Veloukas et al (2012)** revealed that the mode of action for fluopyram against fungi has been determined to be a succinate dehydrogenase inhibitor (SDHI) within the fungal mitochondrial respiratory chain, therfore blocking electron transport, While fluopyram prevent spore's germination or germ tube elongation plus mycelium growth and sporulation, whearase on plants fluopyram showing translaminar activity and some movement within the xylem.

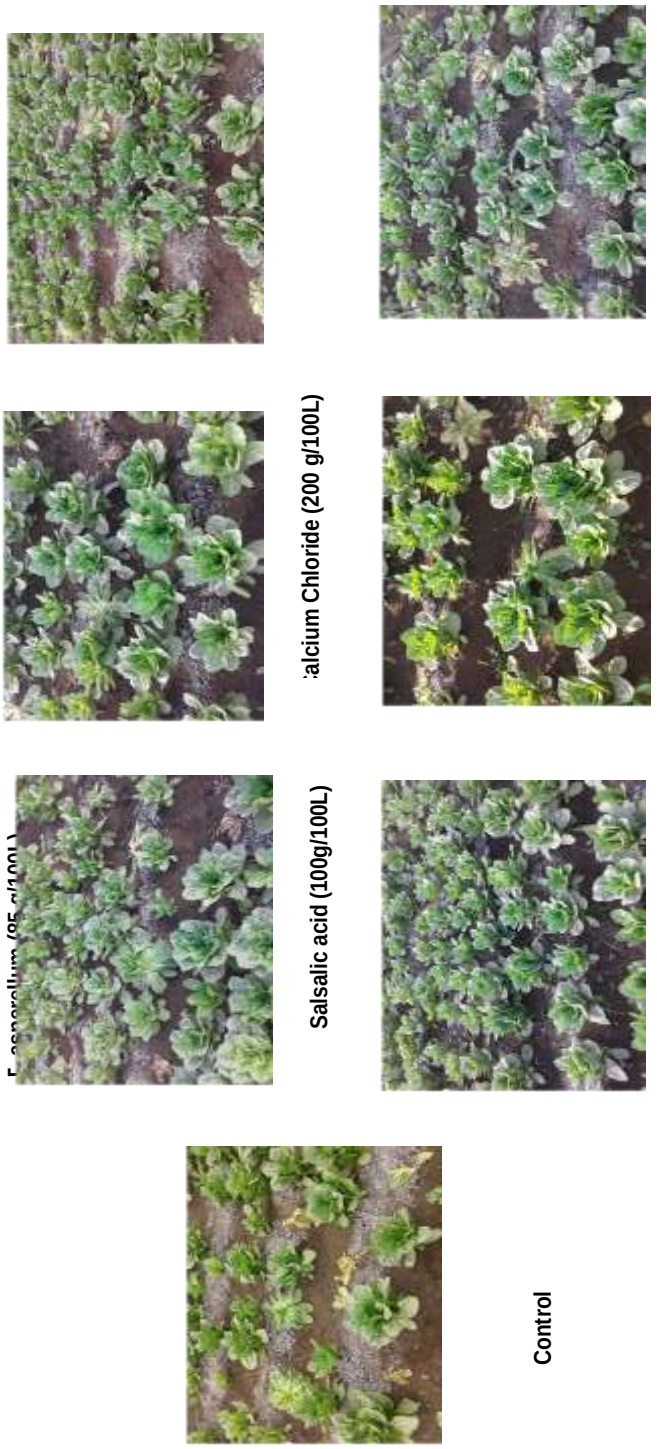

Fig. 1. Effect of biological and chemical treatments on lettuce plants against Sclerotinia sclerotiorum compared with control.

Table 4. Effect of biological and chemical control of White rot disease on disease assessment of lettuce plants, during the two seasons (2016/2017 and 2017/2018)

Treatments	Disease incidence		Disease severity		Present of control efficiency		Total yield / feddan (Ton)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Control	**38.39a**	**41.23a**	**11.55a**	**12.12a**	**61.60f**	**58.76e**	**7.38g**	**7.27g**
Trichoderma asperellum	22.49c	27.42e	6.65c	8.38de	77.50d	72.57bc	8.62d	8.78c
Salicylic acid	15.72e	24.99f	4.64d	7.71ef	84.27b	75ab	9.05c	9.41b
Calcium Chloride	26.16b	32.12c	8.21b	9.61c	73.83e	67.89cd	7.61f	8.66e
Iprodion	10.74 f	22.51 g	3.21 e	6.81 f	89.25 a	77.49 a	10.16 a	9.73 a
Tebuconazole /Fluopyram	17.72d	30.01d	5.43d	9.22cd	82.27c	69.98cd	8.32e	8.58f
Tebuconazole	23.42c	35.48b	6.98c	10.77b	76.57d	64.51d	9.84b	8.69d

* Values within the column followed by the same latter (s) are not statistically different; at the 0.05 level (Duncan's multiple range test), small letters

(interac

While**, Hoitink et al (2006)** mentioned that *Trichoderma* sp. can inhibit growing of plant pathogen, but the trials gave indications that many trichoderma strains could promt production of defense concerning compounds on plants plus enhance plant resistance. Furthermore supposed that direct impact on plant pathogens is only one mechanism to control or perhaps less important than induced localized and systemic resistance **(Yedidia et al 2003).**

CONCLUSION

Results demonstrated that lettuce plants treated by Iprodione, Salicylic acid were the most effective to increasing total and marketable yield and reducing the disease incidence and diseases severity, as iprodione inhibits DNA and RNA synthesis in the germinating fungal spore was well as inhibiting the enzyme NADH cytochrome-c reductase, thereby preventing lipid and membrane synthesis and mycelium growth, While, Salicylic acid SA, induces SAR in plants which can result in resistance to certain pathogens. However, the dominant effect Fluopyram affects the fungi at all growth stages as it can been inhibition of succinate dehydrogenase (complex II) within the fungal mitochondrial respiratory chain. thus, blocking electron transport. Fluopyram inhibits spore germination, germ tube elongation, mycelium growth and sporulation and tebuconazole was effective in reducing the incidence and progress of the disease and in increasing the yield. Furthermore, in the present study, Iprodione and Salicylic acid showed that increasing of total and marketable yield and showed the most efficient in reduction disease incidence and diseases severity, in addition *T. asperellum*, calcium chloride was able to cause a moderate increasing of total and marketable yield and moderate reduction of white rot disease on lettuce. Whereas, fluopyram clarified potentially curative activity with white rot, but only when it treated 2 times resulted in lower disease control. However, despite this curative activity from fluopyram, it should be applying preventive or on early stages of disease infestation to get a higher level of control efficient.

REFERENCES

A.O.A.C. 2005. Official methods of analysis. 15Th ed. Association of Official Agricultural Chemists. 12th Ed., Washengton, D.C. USA.

Anonymous. 1985. Integrated pest management for cole crops and lettuce. University of California I.P.M. Project. Publ. 3307.

Butler M.J., Gardiner R.B. and Day A. 2009. Melanin synthesis by Sclerotinia sclerotiorum. **Mycologia 101, 296-301.**

Cessna S.G., Sears V.E., Dickman M.B. and Low P.S. 2000. Oxalic acid, a pathogenicity factor for Sclerotinia sclerotiorum, suppresses the oxidative burst of the host plant. **The Plant Cell 12, 2191-2199.**

Crowe F.J., Debons J., Darnell T., McGrath D., Koepsell P., Laborde J. and Redondo J. 1994. Control of Allium white rot with DADS and related products. In: Entwistle AR, Melero-Vara JM (eds) Proceedings of the fifth international workshop on Allium white rot, Cordoba, Spain, April 1999. Wellesbourne HRI, Warwick, UK. **pp. 15-19.**

Duah-Yentumi S. and Johnson D.B. 1986. Changes in Soil Microflora in Response to Repeated Applications of Some Pesticides. **Soil Biology and Biochemistry, 18, 629-635.** http://dx.doi.org/10.1016/0038-0717(86)90086-6.

Duff A.A., Jackson K.J. and O'Donnell W.E. 2001. Tebuconazole (Folicur®) shows potential in the control of white rot *(Sclerotium cepivorum)* in garlic in subtropical queensland, Australia. Proceedings of the 2nd International Symposium on Edible Alliaceae. **pp. 247-250.**

El-Tayeb M.A. 2005. Response of barley grains to the interactive effect of salinity and salicylic acid. **Plant Growth Regul., 45, 215-224.**

FAOSTAT. 2016. Food and Agriculture organizations of the United Nations. Statistics Division. http://www. fao.org/faostat/en/#data/QC (accessed 12, March 2017).

Fullerton R.A., Stewart A. and Slade A. 1995. Use of dethylation inhibiting fungicide (DMIs) for the control of onion white rot (Sclerocium cepivorum Berk.). **New Zealand J. of Crop and Horticultural Sci., 23, 121-125.**

Godoy G., Steadman J.R., Dickman M.B. and Dam R. 1990. Use of mutants to demonstrate the role of oxalic acid in pathogenicity of Sclerotinia sclerotiorum on Phaseolus vulgaris. **Physiological and Molecular Plant Pathology 37, 179-181.**

Hayat, Q.; S. Hayat; M. Irfan and A. Ahmad. 2010. Effect of exogenous salicylic acid under changing environment: A review. Environ. Exp. Bot., 681, 14-25. DOI: 10.1016/j.envexpbot.2009.08.005.

Hepler P.K. 1994. The role of calcium in cell division. **Cell Calcium, 16(4), 322-330.**

Hoitink H.A.J., Madden L.F. and Dorrance A.E. 2006. Systemic resistance induced by Trichoderma spp.: Interactions between the host, the pathogen, the biocontrol agent, and soil organic matter quality. **Phytopathology 96, 186-189.**

Khodary S.E.A. 2004. Effect of salicylic acid on the growth, photosynthesis and carbohydrate metabolism in salt-stressed maize plants. **J. Agric. Biol., 6, 5-8.**

Koller H.R. 1972. Leaf area-leaf weight relationships in the Soybean canopy. **Crop Sci., 12(3/4), 180-183.**

Mady M.A. 2009. Effect of foliar application with salicylic acid and vitamin E on growth and productivity of tomato (Lycopersicon esculentum Mill.) plant. **J. Agric. Sci. Mansoura Univ., Mansoura, Egypt, 34, 6735- 6746.**

Meier U. 2001. BBCH-Monograph.Growth stages of mono-and dicotyledonous plants. Federal Research Centre for Cultivated Plants (BBCH-Code), **pp. 121-124.**

Melero-Vara J.M., Parados-Ligero A.M. and Basallote U.M.S. 2000. Comparison of physical and chemical and biological methods of controlling garlic white rot. **Eur. J. Plant Pathol.166, 581-588.**

Metwally A., Finkemeier I., Georgi M. and Dietz K.J. 2003. Salicylic acid alleviates the cadmium toxicity in barley seedlings. **Plant Physiol., 132, 272-281.**

Mohamed A.K. and Basalah M.O. 2015. The active role of calcium chloride on growth and photosynthetic pigments of cowpea "Vigna unguiculata L. (Walp)" under salinity stress conditions. **American-Eurasian J. Agric. & Environ. Sci., 15(10), 2011-2020.** DOI: 10.5829/idosi.aejaes.2015.15.10.12805.

Ordonez-Valencia C., Ferrera-Cerrato R., Quintanar-Zuniga R.E., Flores- Ortiz C.M., Guzman G.J.M., Alarcon A., Larsen J. and Garcia-Barradas O. 2014. Morphological development of sclerotia by Sclerotinia sclerotiorum: a view from light and scanning electron microscopy. **Ann Microbiol., 65, 765-770.**

Paula Júnior T.J., Vieira R.F., Teixeira H., Carneiro J.S. 2009. Foliar application of calcium chloride and calcium si-licate decreases white mold intensity on dry beans. **Tropical Plant Pathology, 34(3), 171-174.**

Peng L. and Yueming J. 2006. Exogenous salicylic acid inhibits browning of fresh-cut Chinese water chestnut. **Food Chem., 94, 535-540.** DOI: 10.1016/j.foodchem.2004.11.047.

Petit A.N., Fontaine F., Vatsa P., Cle´ment C. and Vaillant-Gaveau N. 2012. Fungicide impacts on photosynthesis in crop plants. **Photosynth Res., 111, 315-326.**

Raskin I. 1992. Role of salicylic acid in plants. Annu. Rev. Plant Physiol. **Plant Mol. Biol., 43, 439-463.** DOI: 10/1146/annurev.pp.43.060192.002255.

Saladin G. and Clément C. 2005. Physiological effects of pesticides on cultivated crops. In: Livingston JV (ed) Agriculture and Soil Pollution New Research. **Nova Science Publishers, USA, pp. 53-86.**

Shakirova F.M. 2007. Role of hormonal system in the manifestation of growth promoting and antistress action of salicylic acid. In: Hayat, S., Ahmad, A. (Eds). Salicylic Acid. A Plant Hormone. Springer. Dordrecht. Netherlands, **pp. 69-89.**

Snedecor G.W. and Cochran W.G. 1982. Statistical methods. 7th ed. Iowa State Unv., Press, Iowa, U.S.A.

Spoel S.H., Koornneef A., Claessens S.M.C., Korzelius J.P., Van Pelt J.A., Mueller M.J., Buchala A.J., Metraux J.P., Brown R. and Kazan K. 2003. NPR1 modulates crosstalk between salicylate- and jasmonate-dependent defense pathways through a novel function in the cytosol. **Plant Cell 15, 760-770.**

Stiborova´ M., Doubravova´ M., Brezinova´ A. and Friedrich A. 1986. Effect of heavy metal ions on growth and biochemical characteristics of photosynthesis of barley *Hordeum vulgare* L., **Photosynthetica, 20, 418-425.**

Subbarao K.V. 1998. Progress toward integrated management of lettuce drop. **Plant Dis. 82, 1068-1078.**

Sun T., Yuan H., Cao H., Yazdani M., Tadmor Y. and Li L. 2018. Carotenoid Me th tabolism in Plants: The Role of Plastids. **Mol. Plant 11, 58-74.**

Thomas V. and Karaoglanidis G. 2012. Biological activity of the succinate dehydrogenase inhibitor fluopyram against Botrytis cinerea and fungal baseline sensitivity. **Pest Management Sci., 68(6), 858-864.**

Untiedt R. and Blanke M.M. 2004. Effects of fungicide and insecticide mixtures on apple tree canopy photosynthesis, dark respiration and carbon economy. **Crop Prot., 23, 1001-1006.**

Van Iersel M.W. and Bugbee B. 1996. Phytotoxic effects of benzimidazole fungicides on bedding plants. **J. Am. Soc. Hortic., Sci., 121(6), 1095-1102.**

Venette J.R. 1998. Calcium micronutrient may reduce white mold of dry beans**.** Proceedings of the Sclerotinia Workshop, Minnesota ND, In-Service Extension Worksho, Fargo.

Williams J.R. and Stelfox D. 1980. Influence of farming practices in Alberta on germination and apothecium production of sclerotia of Sclerotinia sclerotiorum. **Can. J. Plant Pathol., 2, 169-172.**

Wysocki K. and T. Banaszkiewicz. 2014. The effect of selected fungicides on the chemical composition of strawberry fruits and contamination with dithiocarbamate residues. **Folia Hort., 26(2), 125-132.**

Yedidia I., Shoresh M., Kerem Z., Benhamou N., Kapulnik Y. and Chet I. 2003. Concomitant induction of systemic resistance to Pseudomonas syringae pv. lachrymans in cucumber by Trichoderma asperellum (T-203) and accumulation of phytoalexins. **Appl. Environ. Microbiol. 69, 7343-7353.**

Yildirim E., Turan E. and Guvenc M. 2008. Effect of foliar salicylic acid application on growth, chlorophyll and mineral content cucumber grown under salt stress. **J. Plant Nutr., 31, 593-612.**

Zhou T. and Boland G.J. 1999. Mycelial growth and production of oxalic acid by virulent and hypovirulent isolates of Sclerotinia sclerotiorum. **Canadian J. of Plant Pathology 21, 93-99.**

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المكافحة البيولوجية والكيميائية للعفن الابيض فى الخس والحفاظ على الانتاجية

[43]

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الموجـــــــــز

أجريت هذه التجارب في مزرعة خاصة فى قليوب، محافظة القليوبية، مصر، خلال موسم خريف وشتاء عامى (2016 / 2017 – 2017/ 2018) والهدف الرئيسي من هذه الدراسة تحديد مدى فعالية عدد من المعاملات البيولوجية والكيميائية على نمو وإنتاجية الخس ومكافحة مرض العفن الأبيض الناجم عن فطر سكليروتينيا اسكليروتورم. وكان التصميم المتبع هو قطاعات كاملة العشوائية مع استخدام ثلاث مكررات فى تجارب محصول الخس، حيث تم استخدام ثلاثة معاملات بيولوجية: الماء (مقارنة)، ترايكوديرما اسبيريلليم (85 جم/ 100 لتر)، وحمض الساليسيليك (100 جم/ 100 لتر) وكلوريد الكالسيوم (200 جم/ 100 لتر) ومقارنتها بثلاث مبيدات فطرية : ابروديون Iprodione (250 جم/ 100 لتر)، (تيبوكونازول / فلوبايرام)، (تيبوكونازول) بمعدلات (50 ، 100 مل / 100 لتر على التوالي) وكان عدد الخطوط للوحدة التجريبية 3 خطوط بطول (4 m) وعرض (0.9 m) ومسافة زراعة (0.2 m) على خطين وبلغت مساحة الوحدة التجريبية (10.8 m^2). وقد تم الرش مرتين عند عمر النبات 3 و6 ورقات من الزراعة (BBCH 19-15) باستخدام الرشاشة الظهرية (250 لتر للفدان). وأظهرت النتائج ان المعاملة بإستخدام كلا من المعاملة ب ابروديون Iprodione يليها حمض الساليسيليك افضل المعاملات من حيث المحصول الكلى او القابل للتسويق من الخس. بالإضافة إلى ذلك، أدت كلا من معاملتى Iprodione، يليها حمض الساليسيليك إلى إنخفاض نسبة حدوث المرض وشدة المرض، وزيادة كفاءة التحكم فى المرض، بينما لم تؤدي المعاملة بواسطة كلوريد الكالسيوم إلى زيادة كبيرة في المحصول أو تقليل نسبة حدوث او شدة المرض على الرغم من تأثيره المنخفض او المتوسط بعد الرش.

الكلمات المفتاحية: الخس، الإنتاجية، المكافحة البيولوجية، المكافحة الكيميائية، العفن الابيض

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