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Effect of Biological and Chemical Control of Onion White Rot and Maintain Productivity

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FIELD experiments were conducted during winter seasons of 2016/2017 and, 2017/2018 at Qalyub, Qaluobia Governorate, Egypt. The main objective of this study to find out the efficacy of several biological and chemical treatments on controlling onion white rot disease caused by *Sclerotium cepivorum* as well as on the growth and productivity of onion plants. Three biological treatments including control (water application), *Trichoderma asperellum* (85 g/100 L^{-1}), *Pseudomonas fluorescence* (500 ml/100 L^{-1}), were applied respectively. These treatments were combined with five chemical treatments (commercial fungicides) and applied as follows: Control, Iprodione (250 g/100 L^{-1}), Tebuconazole with Fluopyram (50 ml/100 L^{-1}), Tebuconazole (188 ml/100 L^{-1}), Azoxystrobin plus Mefenoxam (200 ml/100 L^{1}). The ability for growing onion crop productivity was tested and decrease disease severity and incidence growth of white rot by the treatments were sprayed three times on plants at (40-55-70) days after planting or (19-41 BBCH) stages by using knapsack sprayer by (300 L./Fed). Results indicated that combination dipping onion seedling by *T. asperellum* significantly gave the highest indications of total and the marketable yield in comparison to *P. fluorescence* for both seasons. Moreover, the three times of spray by Iprodione applications combined with *T. asperellum* was increased onion crop productivity in comparison to the control treatment significantly, and the disease was lowered, disease severity, and increasing the control efficiency in both seasons. Whereas, the three times of spray by Tebuconazole applications had a moderate effect on onion crop productivity or the disease severity and incidence of *Sclerotium cepivorum* in comparison to the control treatment despite low to medium recovery following applications. Finally, the non-treated control treatment was the lowest of crop productivity and control of disease efficacy of onion crop.

Keywords: Onion, Productivity, Biological control, Chemical control, *Sclerotium cepivorum*, White rot, BBCH monograph *Biologische Bundesanstalt, Bundessortenamt and Chemische Industrie*.

Introduction

Onion (*Allium cepa* L.) is an important vegetable crop in Egypt and all over the world. Whereas, the onion production area was about 200 thousand fed., in 2014/2015 season, produced 2,888,791 tons with an average of 14.67 tons/fed., as mentioned by the yearly book of Economics and Statistics Sector of the Agriculture Ministry of Egypt. Samuel and Ifeanyi (2015) referred that highly valued for onion as one of flavoring agents. Onion plants are submitted to several pathogens that cause great loss in quantity and quality of onion yield.

White rot disease caused by *Sclerotium cepivorum*, is one of the most essential and effective disease around the world that causes a huge yield loss (Yesuf, 2013). However, sclerotia cause the infection exceptionally particular to Allium species as they penetrate onion plants causing white rot disease (Maude, 2006). Also,

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disease symptom appears as a white fluffy mycelial growth at the base of the stem plate as a soft mold. Ahmed and Ahmed, (2015) The fungus produces long-lived survival structures named sclerotia that can stay in the soil without having a host plant for over 20 years. Abd El-Moity (1976 and 1981) stated that this pathogen starting to be appeared in Egypt after the construction of high dam, as the recent agriculture production system depends mainly on the permanent surface irrigation instead of the temporary irrigation system. In addition, Embaby (2006) mentioned that this condition helped the onion white rot disease to be more settled in the Egyptian soil as a soil-borne disease mostly in upper Egypt in onion and garlic producing fields and now the disease moved to the northern part of Egypt (El-Sheshtawi et al., 2009).

Pung, (2008) found that control of white rot disease has been complemented by chemical fungicides like folicur, due to the concerns of health and environmental hazards, and many pathogens could develop resistance against most recommended fungicides. So, biological control is gaining greater attention due to low cost and eco-friendly applications. Gupta et al., (2009) revealed that *Pseudomonas fluorescens* have antagonistic capacity against plant pathogens which enhancing systemic acquired resistance and plant growth-promoting character, as it plays an important role in phosphate solubilization by improving the soil and plant health. Parke, et al., (1991) and King, and parke, (1993) mentioned that *P. fluorescens* applied to pea seeds to reduce diseases incidence for damping-off caused by Pythium .Whereas, Elad, (2000) stated that Trichoderma sp attributed to induce to resistance against these pathogens as it's producing anti-fungal compounds such as water-soluble phenols and flavones appear to constitute an important resistance factor preventing spore germination and penetration of potential fungal pathogens.

Duff et al. (2001) revealed that fungicide like Fluopyram is one of a new group of fungicide chemistry called pyridinyl 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 has offered hope to controlling the white rot on infested fields which showed better control than the best dicarboximide fungicide or procymidone on some compares. Fullerton et al. (1995) reported that Tebuconazole compound is the best suitable for foliar spraying. Clarkson et al. (2006) showed that phytotoxicity of onion plants when applied as a seedling treatment and might be a good control with white rot. Duah-Yentumi and Johnson (1986) stated the impact of frequent applications of Iprodione and gathering that this fungicide had a little effect on microbial biomass; as it affects germ tubes by preventing mycelial growth. Whereas, Iprodione is necessary against *Sclerotinia sp.*

The long-term objective of this study is to assess growth and productivity of onion plants by using foliar applications with biological and chemical agents for management of white rot infestation under field conditions.

Materials and Methods

Field experiments

The experimental treatments were applied in a split-plot design with three replicates for each treatment. Seedlings of onion cv. Giza-20 were transplanted on 25th of December in both successive growing seasons of 2016/2017and 2017/2018. The field plot was 12 m^2 in area, consists of 3 rows, each row was 4 m length and 1 m width. Seedlings were transplanted on both sides of the ridge with 10 cm apart the soil was naturally infested with white rot disease. Three soil samples were randomly selected from winter onion production field located in Qalyub region, Qalyubia Governorate, Egypt. Then soil samples were transferred to The Plant Pathology Lab., Plant Pathology Dept., Faculty of Agriculture, Ain Shams Univ. to perform analysis confirmed that soil contains sclerotiniaof white rot. All agricultural procedures for onion production under clay soil conditions were carried out according to recommendations of Agriculture and Land Reclamation Ministry.

- Biological treatments were assigned in the main plot and applied as a dipping treatment as follows:
- The control (sprayed with tap water).
- *Trichoderma asperellum (10**7** spores/g) (85g/100 L-1) (Biocontrol Technologies SL, Co. Spain)*
- *Pseudomonas fluorescens* (2x10**8** Cfu g-1) (500 ml /100 L^{-1}) obtained from (Mersin unit faculty of Agri. ASU).

Whereas the five commercial fungicides treatments were assigned in the sub-plot and applied as as a foliar sprayed treatment as follows:

- The control (sprayed with tap water).

- Iprodione 70-DF (250g/100 L^{-1}) obtained from (Shoura Chemicals Co.).
- Fluopyram + Tebuconazole (50 ml/100 L^{-1}) (Bayer Crop Sciences Co.).
- Tebuconazole (188 ml/100 L^{-1}) (Bayer Crop Sciences Co.).
- Azoxystrobin + Mefenoxam (200 ml/100L^{-1}). (Syngenta Agro Chemicals Co.).

These treatments were tested for their ability to preserve the productivity and inhibit mycelial growth of *S. cepivorum,* treatments were applied three times 40, 55 and 70 days after planting using backpack sprayer (Knapsack sprayer 20 L). 19-41 (BBCH) Scale according to (Meier, U. 2001) or 40-55-70 days after planting over the plants with a knapsack sprayer (300 L/Fed).

Data Recorded:

Vegetative growth characteristics: Six plants from the inner rows of each experimental plot were randomly selected after 70 days from transplanting date to record the following parameters: plant length (cm), leaf fresh and dry weight (g)

Yield: At harvesting time, (140 days after transplanting date), bulbs were harvested. Then bulbs were weighted in kg per plot to determine yield as kg/lpot, Afterwards, yield as ton/fed was estimated. Moreover, marketable bulb yield was recorded as kg/plot and then marketable bulb yield as ton/fed.was estimated and bulb diameter was measured also.

Chemical compositions: Leaf total chlorophyll contents on onion plants were determined in the third leaf from the top by using SPAD meter (SPAD-502, Minolta Camera Co., Osaka, Japan) according to Minolta (1989) and total carbohydrate was measured in dried leaves samples according to A.O.A.C. (2005).

Diseases index parameters

At 100 days after planting, plants were assessed for disease index parameters. Percentages of white rot disease incidence was studied based on the formula proposed by Crowe et al. (1994):

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

The percentage of efficiency was calculated as follows:

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

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

Infected bulbs were selected from harvested bulbs, and the disease severity was rated on 0–5 scale where 0 = healthy bulb; 1 = bulb covered with mycelium, but not rotted ; 2 = 1–25% of the bulb rotted ; 3 = 25–50 % of the bulb rotted 4 = 50–75 % of the bulb rotted and 5 = 75–100 % of bulb rotted (Tian and Bertolini, 1995).

Disease severity scores were converted into percentage as follows.

$$\text{Disease severity (\%)} = \frac{\text{Total points score}}{\text{Total Number of bulbs in plots x highest score}} \text{ x } 100$$

Statistical Analysis

The two seasons generated data were sorted and statistically analyzed using MStat software. The comparison among means of various treatments was employed using Duncan's multiple range test at $p \leq 0.05$ level of significance according to the procedures reported by Snedecor and Cochran (1982).

Results and Discussion

Vegetative growth characteristics

Data presented in Tables 1 and 2 showed that biological treatments by *Pseudomonas fluorescence* and *Trichoderma asperellum* for controlling onion white rot improved onion plants as a vegetative growth in both seasons of study. Whereas, Iprodione as a chemical treatment significantly increased the plant length, plant fresh weight in comparison to the other treatments in both seasons. Also, the obtained results showed that combination of dipping onions seedling into T. *asperellum* before planting followed byfoliar spraying with Iprodione for three times significantly showed the highest values of plant length, fresh weight of leaves. These results agree with the findings with El-Khateeb (2004) who stated that onion transplants treated before planting with *Trichoderma* sp. led to high foliage fresh and dry weights in addition to a notable increase in a bulb crop yield compared to that obtained using the chemical fungicide Iprodione. The reason for increasing the plant height could be due to Vinale et al., (2012), who reported that Trichoderma spp. produced the Several secondary metabolites like koninginins, trichocaranes A-D, harzianopyridone, cyclonerodiol, harzianolide and harzianic acid affect and increaseing of plant growth. Moreover, Contreras-Cornejo et al. (2009) reported that Trichoderma spp. produce auxins that can stimulate plant growth development.

TABLE 1. Effect of chemical and biological control of white rot disease on plant length of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	73.73bf	73.86bf	71.66eg	72.91B	76.26fg	73.75h	83bd	77.67C
Iprodione	71.65eg	78.81 a	72.03dg	74.16 A	79.56de	86.58 a	80.03de	82.06 A
Tebuconazole / Fluopyram	72.55cg	73.8be	74.91bd	73.76A	79.58de	76.06fg	77.55ef	77.73C
Tebuconazole	71.38fg	69.86g	75.25bc	72.17B	72.03h	84.83ab	81.26cd	79.37B
Azoxy strobin/ Mefenoxam	72.78cg	72.36cg	76.16ab	73.76A	75.26fg	83.86ac	81.6cd	80.24B
Mean	72.42B	73.74A	74.00A		76.54B	81.02A	80.69A	

* 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 2. Effect of chemical and biological control of whiterot disease on leaf fresh weight of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	104.03cd	102.13ce	93.98fg	100.05B	114.15de	107.43fg	126.91b	116.16C
Iprodione	100.08df	130.6 a	105.8cd	112.16 A	126.25b	152.26 a	102.78g	127.09 A
Tebuconazole / Fluopyram	85.26h	107.65bc	113.18b	102.03B	120.28c	108.18fg	110.45ef	112.97D
Tebuconazole	89.93gh	95.11fg	112.43b	99.16B	103.5g	130.36b	116.83cd	116.9C
Azoxy strobin/ Mefenoxam	86.11h	104.35cd	97.1ef	95.85C	118.31cd	115.93ce	130.68b	121.64B
Mean	93.08C	103.01B	104.49 A		116.5B	112.94B	117.53 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).

Swain et al. (2007) reported that the reason for increasing the plant fresh weight could be due to *P. flourescens* have ability to improve plant growth and increase production which attributed to their ability as growth promoter by producing active metabolic compounds and organic compounds, as well as the production of IAA and degrading enzymes of pathogen cell walls, Also , Khakipour et al. (2008). Revealed that the increase of plant growth indicators should be due to the presence of biological control agents as. *P. flourescens* was found to produce growth regulators, as well as Auxine, which help to increase the growth and yield of the treated plants

Yield characteristics

Data showed in Tables 3 and 4 asserted that the combnation of dipping application for onion seedlings by *T. asperellum* and *P. fluorescence* increased the total yield as well as marketable yield per feddan, respectively, compared to untreated plants (control). These results are in accordance with Gupta et al. (2009) who revealed that the improvement in bulb diameter, size index and yield attributes due to phosphate solubilizes may be due to the ability of *P. fluorescens* to solubilize of phosphate and increase availability fixed soluble or readily available phosphorus. In addition, he mentioned that the favorable nutritional environment in the root zone created by the addition of organic manures and bio fertilizers resulted in an increase of absorbed nutrients from the soil which was responsible for enhancing the yield of onion bulbs. While, Borowicz et al. (1992) observed that the ability of plant growth-promoting *P. fluorescence* inactivate cell wall degrading enzymes of plant pathogenic fungi should be considered as an additional mechanism explaining the bio-control properties of this group.

The differences detected among chemical treatments indicated that the percentage of total yield of onion per feddan was significantly increased by Iprodione, Azoxystrobin plus Mefenoxam in the first season and Iprodione, Tebuconazole plus Fluopyram in the second season. As for the effect of interaction between biological and chemicals treatments, *T. asperellum* combined with Iprodione, Azoxystrobin + Mefenoxam in the first season and *T. asperellum* combined with Iprodione and Tebuconazole plus Fluopyram in the second season, gave the highest significant values of the percentage of total yield of onion per feddan comparison with control treatment.

Apparently, the increments of vegetative growth parameters as responded to *Trichoderma* spp. as it is not merely the result of protection against minor pathogens. On the other hand, Harman et al., (2004) mentioned that The antifungal activity of *Trichoderma* spp. could be attributed to these lytic enzymes, which also acting as fungal cell-wall degrading agents fir instance N–acetyl-β-D–gluocosedeaminidase, chitinase, endochitinase, β-1,3gluocose, β-1,4gluocose, β 1,6gluocose, chitobiosidase and protease. Moreover, Contreras-Cornejo et al. (2009) reported that *Trichoderma* spp. produce auxins that are able to stimulate plant growth and root development .Vargas et al. (2009) observed that plant-derived sucrose is an important resource provided to *Trichoderma* cells to facilitate root colonization, the coordination of defense mechanisms and increase rate of leaf photosynthesis. These findings are in line with those obtained by Picinini and Goulart (2002) reported that Iprodione paralyzes the growth of hyphae, causing swell, bursting the cell wall, ejecting the cytoplasmic contents, and inhibiting nucleic acid, protein, lipid synthesis and spore germination.

In addition, Duff et al., (2001) mentioned that the tebuconazole was efficient to decrease the incidence or developing the disease plus increasing the yield when treated a garlic clove treatment. Wysocki and Banaszkiewicz (2014) justified this reduction caused as a reason for 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.

Meanwhile, chemical treatments, Iprodione gave the highest percentage of marketable bulb yield compared to other treatments in both seasons. The interaction between biological and chemical treatments indicated that the treatment of *T. asperellum* combined with Iprodione gave significantly the highest values of the percentage of marketable yield of onion bulbs per feddan (8.77 and 9.22 ton/feddan in the first and second season, respectively) compared with the control treatment. These findings are in harmony with those of Hermosa et al. (2013) and Harman et al. (2004) they noted that *Trichoderma* spp. increases root growth promotion, also have been observed in the aboveground vegetative growth such as leaf area, chlorophyll content and yield (size and number of flowers or fruits). Moreover, Shoresh et al. (2010) referred that these processes not only improve plant growth, but also stimulate plant respiration, thus promoting photosynthesis or

photosynthetic efficiency, in addition, Picinini and Goulart (2002) reported that Iprodione paralyzes the growth of hyphae, causing swell, bursting the cell wall, ejecting the cytoplasmic contents, and inhibiting protein, nucleic acid, and lipid synthesis and spore germination.This results agree to Reis, (2010) who mentioned that dicarboximide fungicide may be using for another mechanism including peroxidized lipids interacting with cytochrome-c flavin reductase. The transport of NAD-PH electrons to cytochrome-c is blocked by the fungicide's action, and NAD-PH and essential phospholipids that surround the center of the flavin enzyme.

Chemicals characteristics:

Regarding to onion leaf total chlorophyll and carbohydrate contents, data presented in Tables (5 and 6) cleared that onion plants treated by *P. fluorescence* in both seasons and Azoxystrobin/ Mefenoxam in the first season and Iprodione in the second season, significantly increased leaf total chlorophyll content compared with the other treatments. Whereas, there were insignificant differences among biological, chemicals and their interaction on carbohydrate content in the onion dry leaves in both seasons. These results are in accordance with Gupta et al. (2009) who revealed that the improvement of yield attributes due to phosphate solubilizes may be due to the ability of *P. fluorescent* to solubilize and increase availability of fixed soluble or insoluble phosphorus.

Diseases assessments:

Results shown in Tables 7, 8 and 9 demonstrated that biological treatments with *T. asperellum* reduced the disease incidence by about 28.4, 23.8% and disease severity by about 4.9, 5.5% in the first and second season, respectively, and increased the percent of control efficacy of onion plants by about 71.5, 76,1%, respectively, when compared with untreated control. On the other hand, the differences detected among the chemical treatments indicated that the Iprodioneand Tebuconazole reduced disease incidence by about 29.5, 28.8%, disease severity by about 5.2, 6.2% and increasing the percent of control efficiency of onion plants by about 70.4, 71.1% in the first and second seasons, respectively, but Tebuconazole and Azoxystrobinplus Mefenoxam significantly gave the moderated values as decreased of disease incidence, disease severity and increase the percent of control efficiency of onion plants in both seasons. While, Tebuconazole is a systemic 1,2,4-triazole compound that inhibits demethylation at C-14 and thus curtails biosynthesis of sterols, which are essential for the maintenance of fungal membrane integrity. It is absorbed and translocated upwards in the tissue and provided effective control of white rot in the present studies.

The interaction between biological and chemical treatments had a significant effect. Treatment of *T. asperellum* combined with Iprodione led to a significant reduction in disease incidence by about 25.6, 21.5 %, disease severity by about 4.4, 4.3% and increase the percent of control efficiency of onion plants by about 74.3,78.4 %, in the first and second seasons, respectively. These results agreed with those of McLean and Stewart (2000), they found that strong antagonistic impacts of *Trichoderma* spp. depending on one or more of the following mechanisms: competition for nutrients or space, mycoparasitism, antibiosis, or antibiotic excretion.

Melero-Vara et al. (2000) found that Tebuconazole was effective in reducing the incidence and progress of the disease and in increasing the yield when applied as garlic cloves treatment. According to Duff et al. (2001) application of Tebuconazole as seed treatment resulted in better yields. Applying of fungicides could be integrated with another disease management components more effective control of garlic white rot. Fullerton et al. (1995) revealed that 85% reduction of disease incidence was reported in Tebuconazole treated plots compared with untreated plots in onion. Other researchers also, Clarkson et al. (2006) revealed that integration of Tebuconazole with biocontrol agent promoted the control of onion white rot.

Previously, Costa and Costa (2004) tested the efficacy of several fungicides applied to the soil to inhibit myceliogenic and carpogenic germination of sclerotia, Iprodione resulted in 85% inhibition of apothecia, of *S. sclerotiorum* , as Iprodione inhibits DNA and RNA synthesis in the germinating fungal spore was well as inhibiting the enzyme NADH cytochrome reductase, thereby preventing lipid and membrane synthesis and ultimately mycelium growth. Moreover, Picinini and Goulart (2002) found that Iprodione paralyzes the growth of hyphae, causing swell, bursting the cell wall, ejecting the cytoplasmic contents, and inhibiting protein, nucleic acid, and lipid synthesis and spore germination, According to Reis, (2010) dicarboximide fungicides probably also use another mechanism involving peroxidized lipids interacting with cytochrome-c flavin reductase. The transport of NAD-PH electrons to cytochrome-c is blocked by the fungicide's action, and as a result, NAD-PH and essential phospholipids that surround the center of the flavin enzyme are oxidized, perhaps by a flavin enzyme or free radicals.

TABLE 3. Effect of chemical and biological control of whiterot disease on total yield (ton/feddan) of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	7.55e	8.38be	8.14ce	8.02B	8.25e	8.34de	8.43ce	8.34B
Iprodione	7.68e	10.14 a	9.28ac	9.03 A	8.95ce	10.77 a	9.08be	9.60 A
Tebuconazole / Fluopyram	7.66e	9.12ad	7.85e	8.21B	8.95ce	10.67a	8.93ce	9.55A
Tebuconazole	8.49be	9.41ab	7.93de	8.61AB	8.88ce	10.52ab	9.46bc	9.47A
Azoxy strobin/ Mefenoxam	7.63e	9.72a	9.21ac	8.85A	8.84ce	9.45bd	9.14be	9.12A
Mean	7.80C	9.35 A	8.48 B		8.78B	9.95 A	9.01B	

* 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 4. Effect of chemical and biological control of white-rot disease on marketable yield (ton/feddan) of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	6.48f	7.25bf	7.01cf	6.91C	7.03e	7.20ce	7.19de	7.14B
Iprodione	6.62f	8.77 a	8.03ad	7.81 A	7.64ce	9.22 a	7.76ce	8.21 A
Tebuconazole / Fluopyram	6.61f	7.89ae	6.77ef	7.09BC	7.69ce	9.15a	7.15de	8.00A
Tebuconazole	6.86df	8.15ac	7.34bf	7.45AC	7.58ce	8.85ab	8.16bc	8.20A
Azoxy strobin/ Mefenoxam	6.59f	8.41ab	7.95ae	7.65AB	7.58ce	8.09bd	7.81ce	7.83A
Mean	6.63B	8.09 A	7.43B		7.50B	8.50 A	7.62B	

* 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 5. Effect of chemical and biological control of whiterot disease on leaf chlorophyll reading (SPAD) of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	31.68fh	31.25gh	33.05eg	31.99C	29.06f	33.43de	37.23 bc	33.24D
Iprodione	34.25df	39.05b	38bc	37.1 AB	39.46ab	35.86cd	40.46a	38.57 A
Tebuconazole / Fluopyram	38.66b	29.65h	36.41bd	34.91BC	37.78bc	35.41ce	34.5de	35.9B
Tebuconazole	29.6h	34.06df	41.93a	35.2B	33.75de	33.5de	38.38ab	35.21BC
Azoxy strobin/ Mefenoxam	34.75de	41.83a	35.9cd	37.49 A	29.63f	39.15ab	33.25e	34.01CD
Mean	33.78C	35.15B	37.05 A		33.93C	35.47B	36.76 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).

TABLE 6. Effect of chemical and biological control of whiterot disease on total carbohydrate (g/100g F.W.) in dried leaf of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	6.86b	8.14ab	7.93ab	7.64B	9.49ac	7.12de	6.60de	7.74A
Iprodione	9.31a	8.50ab	8.16ab	8.66A	9.60ab	7.96ad	7.33be	8.29A
Tebuconazole / Fluopyram	8.69ab	7.48ab	7.35ab	7.84AB	8.12ad	6.82de	8.18ad	7.70A
Tebuconazole	7.78ab	8.53ab	8.61ab	8.30AB	5.36e	7.25ce	6.70de	6.44B
Azoxy strobin/ Mefenoxam	7.50ab	7.88ab	8.73ab	8.04AB	6.57de	7.09de	10.18a	7.94A
Mean	8.03A	8.11A	8.16A		7.83A	7.25A	7.80A	

* 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 7. Effect of chemical and biological control of whiterot disease on disease incidence of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	First season				Second season			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	46.65a	33.37ce	38.18b	39.40 A	48.35a	27.82h	41.12cd	39.09 A
Iprodione	29.16fg	25.64 h	33.76ce	29.52 C	36.55e	21.53 i	28.47gh	28.85 E
Tebuconazole / Fluopyram	35.36bc	25.73h	35.35bc	32.15 B	42.60bc	24.08i	29.72gh	32.13 C
Tebuconazole	34.80bd	27.53gh	31.14ef	31.16 BC	44.13b	24.15i	33.43f	33.90 B
Azoxy strobin/ Mefenoxam	34.07ce	29.70fg	31.82df	31.86 B	39.62d	21.76i	30.69g	30.69 D
Mean	36.00A	28.40 C	34.05B		42.25A	23.87 C	32.69B	

* 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 8. Effect of chemical and b control of white-rot disease on disease severity of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	8.70a	5.95ce	8.06ab	7.57A	11.31a	6.46ef	8.76bd	8.84A
Iprodione	5.33df	4.49 f	6.00ce	5.28 C	6.97de	4.37 g	7.26de	6.20 C
Tebuconazole / Fluopyram	7.05bc	4.43 f	6.55cd	6.01B	9.30bc	6.02eg	5.67eg	7.00BC
Tebuconazole	6.03ce	4.78ef	5.43df	5.41BC	9.27bc	6.04eg	7.50ce	7.60B
Azoxy strobin/ Mefenoxam	6.00ce	5.08ef	5.56df	5.55BC	10.08ab	4.85fg	7.38ce	7.44B
Mean	6.62A	4.94 B	6.32A		9.38A	5.55 C	7.31B	

* 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 9. Effect of chemical and biological control of white-rot disease on a percent of control efficiency of onion plants, in the two seasons (2016/2017 and 2017/2018).

Chemical Treatments	Biological Control							
	Season (2016/2017)				Season (2017/2018)			
	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean	Control	*Trichoderma asperellum*	*Pseudomonas fluorescence*	Mean
Control	53.34h	66.62df	61.81g	60.59C	51.64i	72.17b	58.87fg	60.89E
Iprodione	70.83bc	74.35 a	66.23df	70.47 A	63.44e	78.46 a	71.52bc	71.14 A
Tebuconazole / Fluopyram	64.63fg	74.26a	64.64fg	67.84B	57.39gh	75.91a	70.27bc	67.86C
Tebuconazole	65.19eg	72.46ab	68.85cd	68.83AB	55.86h	75.84a	66.56d	66.09D
Azoxy strobin/ Mefenoxam	65.92df	70.29bc	68.17ce	68.13B	60.37f	78.23a	69.30c	69.30B
Mean	63.98C	71.59 A	65.94B		57.74C	76.12 A	67.30B	

* 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).

Conclusions

Results demonstrated that the combination between dipping onion seedlings by *T. asperellum* and Iprodione was the most effective treatment to increase total and marketable yield and reduction of disease incidence and disease severity, as antagonistic effects of *Trichoderma* spp. against most pathogenic fungi and reported that *Trichoderma* effect depends on one or more of the following mechanisms: competition for nutrients or space, mycoparasitism or antibiosis and antibiotic excretion, Moreover, Iprodione inhibits DNA and RNA synthesis in the germinating fungal spore was well as inhibiting the enzyme NAD-H cytochrome-c reductase, thereby preventing lipid and membrane synthesis and mycelium growth.

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المكافحة البيولوجية والكيميائية للعفن الابيض فى البصل والحفاظ على الانتاجية

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أجريت هذه التجارب في مزرعة خاصة فى مدينة قليوب ، محافظة القليوبية ، مصر، خلال موسم الشتاء من عامى) ٢٠١٦ / ٢٠١٧ –٢٠١٧ / ٢٠١٨) لتحديد مدى فعالية عدد من المعاملات البيولوجية والكيميائية على نمو وإنتاجية البصل ومكافحة مرض العفن الأبيض الناجم عن فطر سكليروشيوم سيبوفورم. وكان التصميم المتبع هو قطع منشقة مرة واحدة من ثلاث مكررات ، تم استخدام ثلاثة معاملات بيولوجية (غمسا للشتلات) : الماء (مقارنة) ، *Trichoderma asperellum* (٨٥ جم / ١٠٠ لتر) ، *Pseudomonas fluorescence* (٥٠٠ مل / ١٠٠ لتر) يتبعها الرش الورقى ب خمسة مبيدات فطرية : ابروديون Iprodione (٢٥٠ جم /١٠٠لتر) ، (تيبوكونازول / فلوبايرام ٥٠ مل/ ١٠٠لتر) ، (تيبوكونازول ١٨٨ مل/ ١٠٠لتر) ، (فلودوكسنيل/ مفينوكسام ٢٠٠ مل/ ١٠٠لتر) و تم الرش ثلاث مرات عند عمر النبات ٤٠ و٥٥ و٧٠ يوم من الزراعة باستخدام الرشاشة الظهرية (بمعدل ٣٠٠ لتر للفدان).

وأظهرت النتائج ان المعاملة باستخدام كلا من المعاملة الحيوية بـ *Trichoderma asperellum* كانت افضل المعاملات البيولوجية حيث تفوقت على المعاملة الحيوية بـ *Pseudomonas fluorescence* من حيث المحصول الكلى من الابصال للفدان. بالإضافة إلى ذلك ، زادت كلا من معاملتى Iprodione ، يليها فلودوكسنيل/ مفينوكسام فى الموسم الاول و Iprodione ويليها (تيبوكونازول/ فلوبايرام) فى الموسم الثانى من المحصول الكلى والقابل للتسويق من البصل وقللت من نسبة حدوث المرض وشدة المرض ، وزيادة كفاءة التحكم فى المرض .