



Impact of the Biological and Chemical Control of White Rot on Green Bean Productivity

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THE experiments were conducted on the autumn and winter of 2016 /2017 and 2017/2018 seasons at KafrAlzayaat area in EL-Gharbia, Egypt. The main objective of this study determines the efficacy of several biological and chemical controls on the growth and productivity of green bean crop and the management of white rot disease caused by *Sclerotinia sclerotiorum*. Five biological control treatments, namely *Trichoderma asperellum* (85 g/100L⁻¹), *Bacillus megaterium* (250 g/100L⁻¹), *Trichoderma album* (250 g/100L⁻¹), Chitosan (200 g/100L⁻¹), and Hydrogen peroxidase (250 g/100L⁻¹) were applied and compared with three fungicides, namely Flutolanil (100 g/100L⁻¹), Tebuconazole with Fluopyram (50 ml/100L⁻¹) and Tebuconazole (188 ml/100L⁻¹) as well as control treatment for their ability in increasing green bean crop productivity and reducing disease severity and incidence growth of *white rot* by spraying two times on plants; at 35-45 days after emergence or 59-61 BBCH stages (*Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie*) using knapsack sprayer at 300 L./Feddan. Results indicated that Tebuconazole with Fluopyram applications significantly gave the highest indications of total and marketable yield compared with the other experimental treatments in both seasons. Moreover, the two times of spraying by Tebuconazole with Fluopyram, and Hydrogen peroxidase treatments had significantly lowered disease incidence and disease severity and increasing control efficiency in both seasons. Furthermore, other treatments like *T. asperellum*, Tebuconazole or Flutolanil had a moderate efficacy on green bean crop productivity, disease severity and incidence of white rot compared to the control treatment. Finally, the control treatment was the lowest values of crop productivity and disease efficacy.

Keywords: *Phaseolus vulgaris*, Yield, Bio control, Chemical control, *S. sclerotiorum*, Faba Bean, BBCH monograph.

Introduction

Green bean (*Phaseolus Vulgaris* L.) was considered one of the most important economic vegetable crops in Egypt for both local consumption and exportation to Europe or different countries. (FAO Statistics, 2004) reported that expansion in green bean cultivation has exhibited impressive growth in Egypt during the past several years with a cultivated area of 2.4% of total world cultivated area of green bean, producing about 3.5% of total world production. Green bean seeds or pods are

considered richness by calcium, many vitamins, proteins, mineral salts and some amino acids especially lysine and others.

White rot caused by *Sclerotinia sclerotiorum* is considered one of a destructive disease in green bean crop. Moreover, *S. sclerotiorum* has a broad host of plants roundly 400 species (Figueiredo et al., 2010), alongside it is known that it is very difficult to eliminate all sclerotia produced by this pathogen. Green bean plant damping-off can appear in November with disease incidence and

severity which are very effective from December to March, on cool and high relative humidity conditions.

Williams and Stelfox (1980) stated that sclerotia can germinate myceliogenically or carpogenically by forming white hyphae or producing apothecia and ascospores, while Butler *et al.* (2009) referred that sclerotia consists of two or three layers as following the rind, cortex, and medulla that contain the black compound melanin. In addition, Butler and Day (1998) found that sclerotia is a macro-molecule composed of several types of phenolic and indolic monomers which protect fungi from harsh environmental conditions. Bolton *et al.* (2006) explained that the black sclerotia, melanized structures of different sizes, depend on the host, ranged from a few millimeters (bean) to a few centimeters (sunflower) in length. Valencia *et al.* (2014) revealed that the fungus forms a white fluffy mycelium and after several days, it produces survival sclerotia on infected plants. Wolfe *et al.* (2015) demonstrated that *S. sclerotiorum* reproduced by asexually or sexually (myceliogenic and carpogenic germination of sclerotia).

Cassiolato *et al.* (1997) and Koch (1999) referred that *Trichoderma* spp. is considered as one of the most widely used mycoparasites or many commercial formulations exist and attacking both sclerotia and mycelia of *Sclerotinia* species. Therefore, it has been used with varying degrees of success. Although, Geremia *et al.* (1993) and Haran *et al.* (1995) reported that this process is further supported by the secretion of extracellular enzymes such as chitinases or beta glucanases and proteinases, whereas, Harman *et al.* (2004) referred to the effects of these compounds in phytopathogenic fungi include degradation of the cell walls.

Also, Shibuya and Minami (2001) revealed that chitosan has been shown to induce a considerable defensive reaction on plants with several pathogens. So, Benhamou and Theariault (1992) mentioned that chitosan can inhibit the growth of a few pathogenic fungi such as *Fusarium oxysporum*. On the other hand, Slesak *et al.* (2007) stated that hydrogen peroxide (H_2O_2) is an environment friendly compound where it is predominantly produced in plant cells within photosynthesis or photorespiration. So, during photosynthesis the plants using carbon dioxide (CO_2) and water (H_2O) and produced carbohydrate ($C_6H_{12}O_6$), released oxygen

(O_2) as by-product, while within respiration carbohydrate are converted into energy as the energy used in process of building new tissues.

Duff *et al.* (2001) revealed that fungicide like Fluopyram is one of a new group of fungicides called pyridinylethylbenzimidies 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. Despite Fullerton *et al.* (1995) reported that tebuconazole is the best suitable for foliar spraying. Clarkson *et al.* (2006) 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 the 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 to assess growth and productivity of green bean plants by using foliar applications with biological and fungicide agents for management white rot infestation on field condition

Materials and Methods

Field experiments

The experimental treatments were prepared as a randomized complete block design (RCBD) with three replications under clay soil conditions. Seeds of green bean were sown on 1st of October during two successive growing seasons (2016/2017 and 2017/2018). The field plots were 12 m² containing three rows, each row was 4 m in length and 1 m² in width. Two seeds/hill were sown with 20 cm apart at the two sides of the ridge. The soil was naturally infested with white rot disease. Three replicates of soil were selected for sampling which located in the winter green bean production area on Kafr Al-Zayaat, EL-Gharbia Governorate in Egypt. Analysis performed in the Pathology Lab. in the Faculty of Agriculture, Ain Shams University confirmed that the soil contains *Sclerotinia*. All agricultural procedures were carried out according to the Egyptian Ministry of Agriculture and Land Reclamation.

Treatments as a foliar spray were as follows:

- The control (spraying with tap water).
- *Trichoderma asperellum* (10^7 spores/g) ($85\text{g}/100\text{ L}^{-1}$) (Shoura Chemicals Co.).
- *Bacillus megaterium* (2.5×10^7 CFU/g) ($250\text{g}/100\text{ L}^{-1}$) (Kafr EL-Zayaat Chemicals Co.).
- *Trichoderma album* (10^7 spores/g) ($250\text{g}/100\text{ L}^{-1}$) (Kafr EL-Zayaat Chemicals Co.).
- Chitosan ($200\text{g}/100\text{ L}^{-1}$) (Bio green Chemicals Co.)
- Hydrogen peroxide (H_2O_2) at $250\text{g}/100\text{ L}^{-1}$ (EL-Etihad Agro Chemicals Co.).
- Flutolanil ($100\text{g}/100\text{ L}^{-1}$) (Shoura Chemicals Co.).
- Fluopyram + Tebuconazol ($50\text{ ml}/100\text{ L}^{-1}$) (Bayer crop sciences Co.).
- Tebuconazole ($188\text{ ml}/100\text{ L}^{-1}$) (Bayer crop sciences Co.).

These treatments were tested for their ability to maintain the productivity and inhibit mycelial growth of *S. sclerotiorum* and the treatments were applied two times at (35 and 45 days after emergence (DAE) (early bloom) over the plants with a knapsack sprayer ($300\text{ L}/\text{feddan}$).

Data Recorded

Vegetative growth: Six plants from the inner row on each experimental plot were selected at random at (59-61) BBCH stages (*Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie*) (10-50% of the expected flowers) according to Meier (2001) to record the following parameters: plant length (cm) measured from the bottom level to the top living point of the plant, number of leaves per plant, leaf fresh and dry weights (A.O.A.C., 2005).

Yield: fresh pod yield was harvested on the ideal marketable stage of pod growth. The yield was recorded at each harvesting date to calculate total yield per feddan. Pods were submitted to visual scoring process to discard defected and deformed pods; the remained pods were weighed to record the marketable yield fresh weight.

Chemical composition: leaf chlorophyll contents of green bean plants were determined using SPAD meter (SPAD-502, Minolta Camera Co., Osaka, Japan) according to Minolta (1989). Pod total carbohydrate was assessed on fresh

pod according to A.O.A.C. (2005) and protein content was determined in fresh pods according to A.O.A.C. (2005)

Disease index parameters

At 60 days after planting, plants were assessed for disease index parameters. Percentages of disease incidence were calculated according to the formula suggested by Crowe et al. (1994):

Disease incidence =

$$\frac{\text{Number of infected plants}}{\text{Number of total plants in plots}} \times 100$$

The percentage of efficiency was calculated as follows: % Efficiency = $\frac{C - T}{C} \times 100$

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

Plants were assessed for disease severity index by means of "quarter scale" as clarify by Hall and Phillips (1996), 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 following formula:

Disease severity index % =

$$\frac{\sum (\text{scores of all plants})}{4 \times \text{Total number of plants}} \times 100$$

Statistical Analysis

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

Results and Discussion

Vegetative growth characteristics

Data presented in Table 1 showing that treatments under this study improved the vegetative growth of green bean plants in both seasons. *T. asperellum* increased the plant length, fresh and dry weight of leaves in both seasons, while Tebuconazole with Fluopyramin the first season, and *T. asperellum* in the second season significantly gave the highest number of leaves.

Bell (1996) revealed that growth promotion by *Trichoderma* strains was inconsistent, uncertain or only occurred based on certain circumstances. On the other hand, data indicated that hydrogen peroxide treatment was the second best one affected on number of leaves, and leaf fresh and dry weights. These findings are in line with those obtained by Slesak et al. (2007) who referred that hydrogen peroxide plays a critical role as a signaling molecule in all physiological processes for instance photosynthesis, translocation, respiration and transpiration as hydrogen peroxide is most stable reactive oxygen species (ROS). Thus, these processes will be a reflection of the marked increases in the vegetative growth parameters due to H₂O₂ applications which gave a chance to the plant to carry more flowers and hence more fruits.

Moreover, Tebuconazole and Flutolanil, in both seasons, had a moderate value of the plant length, and leaf fresh and dry weights. Nevertheless, Petite et al. (2012) revealed that application with fungicides may restrict the 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 the growth reduction and visual damage in plants, and decreased photosynthesis and caused chlorosis.

Yield characteristics

Data tabulated in Table 2 show that Tebuconazole with Fluopyram significantly gave the highest values of number of pods per plant in the first season and, yield per plant, and total, and marketable yields per feddan compared with the other experimental treatments in both seasons, while hydrogen peroxide gave the highest number of pods per plant in the second season. This result agrees with Duff et al. (2001) who mentioned that tebuconazole was effective in reduction of incidence and progress of disease and promoting the yield when applied as a garlic treatment. Petite et al. (2012) revealed that application by the fungicides may restrict the growth and development of the reproductive organs by

alternating the carbon or nitrogen metabolism. In addition, hydrogen peroxidase application significantly improved yield per plant, total and marketable yield per feddan during the two seasons. These findings are in harmony with those of Slesak et al. (2007) who suggested that H₂O₂ plays a crucial role as a signaling molecule in various physiological processes, including photosynthesis, respiration, and transpiration so hydrogen peroxide is considered as one of the most stable reactive oxygen species. Thus, these processes will lead to the increment of crop yield and productivity; these increases in yield components of green bean could be a reflection of the marked increases in the vegetative growth parameters due to H₂O₂ applications which gave a chance to the plant to carry more flowers and hence more fruits.

Also, data in Table 2 indicated that green bean plants treated by both *Trichoderma asperellum* or Tebuconazole had a moderate effect on the yield/plant, and total and marketable yields in both seasons. Finally, the control treatment was the lowest. These findings are in harmony with those of Harman (2004) and Hermosa (2013) who noted that *Trichoderma* spp. increased root growth and aboveground vegetative growth such as stem length and thickness, leaf area, chlorophyll content, and yield (size or a number of flowers or fruits). Whereas, the mechanism of *Trichoderma* was a complex process as its help to synthesis extracellular enzymes such as chitinases, β -glucanases, and proteinases which promoted the plant vigor and effected on phytopathogenic fungi include degradation of the cell walls, so reflected on the increase of total and marketable yield on a green bean. On the other hand, Duff et al. (2001) mentioned to Tebuconazole was efficient to decrease the incidence or developing the disease plus increasing the yield when treated garlic clove treatment. Saladin (2005) and Wysocki (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 biochemical exposure. Doubtless, plants treated with the recommended dose of fungicide exhibited significantly higher marketable yield than the untreated plant.

TABLE 1.Effect of chemical and biological control of white-rot disease on vegetative growth characteristics of green bean plants in 2016/2017 and 2017/2018 seasons.

Treatments	Plant length (cm)		Number of leaves		Leaf fresh weight (g)		Leaf dry weight(g)	
	1 st season	2 nd season						
Control	62.60 cd	69.50 b	18.83 b	16.33 cd	33.60 bc	39.18 c	8.20 b	9.88 de
<i>Trichodermaasperellum</i>	70.63 a	79.30 a	17.33 bd	23.33 a	47.20 a	53.25 a	9.33 a	13.91 a
<i>Bacillus megaterium</i>	68.16 ab	62.85 c	12.50 f	15.83 d	30.51 bc	28.70 ef	6.50 d	10.45 cd
<i>Trichoderma album</i>	66.45 bc	59.21 d	15.16 e	15.83 d	33.03 bc	27.45 f	8.28 b	8.60 e
Chitosan	62.61 cd	68.81 b	16.33 ce	17.83 c	31.45 bc	34.00 d	7.73 bc	10.10 d
Hydrogen peroxidase	63.31 c	63.96 c	17.50 bc	22.66 a	33.85 b	46.63 b	8.10 b	12.15 b
Flutolanil	64.25 bc	63.61 c	18.16 bc	17.50 cd	34.28 b	33.06 de	8.03 bc	10.00 d
Tebuconazole /Fluopyram	65.33 bc	63.01 c	21.33 a	20.33 b	27.36 c	50.10 ab	7.33 bd	12.31 b
Tebuconazole	58.96 d	63.23 c	15.50 de	20.66 b	28.06 bc	47.00 b	7.13 cd	11.45 bc

* Values within the column followed by the same letter (s) are not statistically different at the 0.05 level (Duncan's multiple range test).

TABLE 2.Effect of chemical and biological control of white-rot disease on yield characteristics of green bean plants in 2016/2017 and 2017/2018 seasons.

Treatments	Number of pods per plant		Yield per plant (g)		Total yield per feddan (Ton)		Marketable yield per feddan (Ton)	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
Control	17.50 c	13.50 e	60.50 g	61.41 f	3.51 f	3.24 g	3.015 h	2.970 i
<i>Trichodermaasperellum</i>	15.66 d	13.16 e	87.08 e	96.25 c	5.13 b	6.21 ab	4.725 c	4.545 d
<i>Bacillus megaterium</i>	11.16 f	11.00 f	92.58 c	86.16 d	4.68 c	4.14 f	4.230 f	3.565 h
<i>Trichoderma album</i>	11.16 f	15.83 d	73.33 f	69.66 e	3.78 e	4.95 de	3.015 h	4.275 f
Chitosan	12.66 e	16.83 c	72.41 f	61.41 f	4.05 d	4.14 f	3.42 g	3.600 g
Hydrogen peroxidase	20.50 b	20.83 a	110.00 b	112.75 b	6.03 ab	5.58 bc	5.535 b	5.400 b
Flutolanil	16.00 d	17.00 c	89.83 d	87.08 d	4.59 c	4.59 ef	4.275 e	4.410 e
Tebuconazole /Fluopyram	22.16 a	20.00 b	115.50 a	121.91 a	6.33 a	6.66 a	5.670 a	5.990 a
Tebuconazole	15.83 d	16.33 cd	93.50 c	88.00 d	4.95 c	5.40 cd	4.320 d	4.590 c

* Values within the column followed by the same letter (s) are not statistically different at the 0.05 level (Duncan's multiple range test).

Chemicals characteristics

Data presented in a Table 3 cleared that green bean plants treated by *Bacillus megaterium* in the 1st season and chitosan in the 2nd season significantly increased total chlorophylls contents when compared with the control treatment. Moreover, Flutolanil, *B. megaterium*, *T. album*, and chitosan application in the 1st season and *Trichoderma album* in the 2nd season significantly gave the highest carbohydrates contents in the green bean dry leaves. Also, data in a table (3) indicated that green bean plants treated by *B. megaterium* in the 1st season and tebuconazole in the 2nd season significantly increased the total content of protein in the green bean dry pods. The impact of *B. megaterium* on chlorophyll content was stated by Marulanda *et al.* (2008) who observed that increased level of chlorophyll content in Lettuce when compared to control could be indicating the positive interaction of *B. megaterium*. The interaction of bacteria might trigger the chlorophylls related enzymes to increasing the chlorophyll content or the photosynthesis. Therefore, plant bacteria interaction changes the carbohydrate metabolism in plants. The mono and disaccharides sugar are a major source

of energy for all living organisms. The soil living bacteria aid to plants in different ways including uptaking nutrients and water from the soil. It activities different metabolic pathways to sucrose, glucose, or synthesis of fructose. On the other hand, Nguyen Van *et al.* (2013) mentioned that the increase of the chlorophyll content on coffee seedlings as a result of the application of chitosan may be promoted plants enhanced uptake of nutrients.

Stiborova *et al.* (1986) illustrated that fungicides containing copper inhibited both synthesis of chlorophylls and protochlorophyllide by reducing the activity of “an enzyme catalyzes” which it responsible of the chlorophyllide from protochlorophyllide formation during the biosynthesis of chlorophyll. Furthermore, Untiedt and Blanke (2004) attributed the negative effect of pesticides on photosynthesis to a disturbance in CO-independent Hill reaction or to the uncoupling of the photosynthetic electron that flows from phosphorylation and inhibits energy by preventing ATP formation or render the dissociation of ATP into ADP+ Pi.

TABLE 3. Effect of chemical and biological control of white-rot disease on chemical characteristics of green bean plants in 2016/2017 and 2017/2018 seasons.

Treatments	Chlorophyll content		Total of carbohydrates		Total content of protein	
	(SPAD)		(G/100g D.W.)		(G/100g D.W.)	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
Control	31.65 f	28.65 e	7.17 ab	6.67 b	5.29 c	5.67 b
<i>Trichodermaasperellum</i>	39.55 c	28.11 e	6.19 b	6.40 bc	5.67 c	6.06 b
<i>Bacillus megaterium</i>	44.08 a	40.70 c	7.93 a	6.58 b	6.93 a	5.67 b
<i>Trichoderma album</i>	34.71 d	29.72 e	7.67 a	8.05 a	6.06 ac	6.16 ab
Chitosan	33.28 e	44.76 a	7.55 a	5.53 cd	6.64 ab	6.06 b
Hydrogen peroxidase	31.41 f	42.66 b	6.22 b	5.45 d	6.16 ac	6.16 ab
Flutolanil	30.05 g	32.36 d	8.07 a	4.57 e	6.16 ac	5.67 b
Tebuconazole /Fluopyram	41.28 b	39.46 c	7.39 ab	6.58 b	5.77 bc	5.87 b
Tebuconazole	43.08 ab	44.05 ab	6.16 b	6.41 bc	6.93 a	6.64 a

* Values within the column followed by the same letter (s) are not statistically different at the 0.05 level (Duncan's multiple range test).

Disease assessments

Data in Table 4 show that Tebuconazole with Fluopyram treatment was the most effective on reduction of white rot disease incidence (10.14 and 0.35% in both seasons, respectively) caused by *S.sclerotiorum* than Tebuconazole (15.97 and 10.91% in both seasons, respectively), or hydrogen peroxide (24.66 and 30.54% in both seasons, respectively) and these values were lower than the other treatments. In addition, the same trend was obtained as for the disease severity.

Melero-Vara et al. (2000) found that tebuconazole was efficient in decreasing the incidence or developed the disease plus increasing the yield when applied as a garlic crop. Whereas, Thomas et al. (2012) revealed that the mode of action of fluopyram against fungi has been specified to be a succinate dehydrogenase inhibitor (SDHI) during the fungal mitochondrial respiratory chain, therefore blocking electron transport. While, Fluopyram prevent spore's germination or germ tube elongation and mycelium growth. Therefore, it found in plants that fluopyram showed translaminar activity or some movement within the xylem.

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 promote the production of defense concerning compounds on plants plus enhance plant resistance. Furthermore, Harman et al. (2004) supposed that the direct effect on plant pathogens be only one mechanism of control and perhaps less important than induced localized or systemic resistance.

On the other hand, Amin et al. (2007) stated that hydrogen peroxide is considered as one of these catalysts which play an important role in stimulating the plant's resistance to several fungal diseases, including *Fusariumoxysporum*, as the chemical's two oxygen atoms attach to the fungus and oxidize or burn it so its reflected these effects on growth and the amount of production is the effect of the participation of stimuli in the plant physiological operations for such as elongation and sections of the cell, addition to synthesis of enzyme and protein. Gharib et al. (2010) and Jarvis (1988) considered some stimuli chemical internal as organizations grow in nature phenolics, which affected a range of different, processes of plants, which include ions absorption and transfer, the permeability of the membrane, and photosynthesis and growth rate promotion.

TABLE 4. Effect of chemical and biological control of white-rot disease on disease assessments of green bean plants in 2016/2017 and 2017/2018 seasons.

Treatments	Disease incidence (%)		Disease severity (%)		Control efficiency (%)	
	1 st season	2 nd season	1 st season	2 nd season	1 st season	2 nd season
Control	53.61 a	46.02 a	12.49 a	10.99 a	46.38 e	53.97 g
<i>Trichodermaasperellum</i>	35.38 bc	25.25 e	7.82 cd	5.64 c	64.61 cd	74.74 c
<i>Bacillus megaterium</i>	37.36 bc	35.07 b	9.04 bc	7.85 b	62.63 cd	64.92 f
<i>Trichoderma album</i>	40.37 b	35.64 b	9.20 b	7.34 b	59.62 d	64.35 f
Chitosan	39.45 bc	31.31 cd	9.03 bc	7.28 b	60.54 cd	68.68 de
Hydrogen peroxidase	24.66 d	30.54 d	7.08 d	7.54 b	75.33 c	69.45 d
Flutolanil	38.43 bc	34.31 bc	8.76 bc	7.93 b	61.56 cd	65.68 ef
Tebuconazole /Fluopyram	10.14 f	0.35 g	3.38 f	0.12 e	89.85 a	99.64 a
Tebuconazole	15.97 e	10.91 f	5.32 e	2.29 d	84.02 b	89.08 b

* Values within the column followed by the same letter (s) are not statistically different at the 0.05 level (Duncan's multiple range test).



Fig. 1. Effect of biological and chemical treatments on green bean plants against *Sclerotinia sclerotiorum* compared with the control.

Conclusion

In conclusion, this study Results demonstrated positive effects of foliar applications of Tebuconazole/Fluopyram, and Tebuconazole alone on green bean growth, productivity and some disease parameters. Moreover, foliar applications with Hydrogen peroxidase and T. asperellum increasing the yield and control efficiency of disease. So, Spraying of Tebuconazole/Fluopyram, was the most effective treatment to increasing total, marketable yield and control efficiency of disease, in addition, Hydrogen peroxidase in the 1st season and T. asperellum in the 2nd season were able to cause a clear increase of total and marketable yield and

moderate Control efficiency of disease which can be used as an applicable practice in romaine green bean cv. Giza 6 cultivation.

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المكافحة البيولوجية والكيميائية للعفن الأبيض في الفاصوليا الخضراء والحفاظ على الإنتاجية

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أجريت هذه التجارب في مزرعة خاصة في كفرالزيات، محافظة الغربية، مصر خلال موسم خريف وشتاء عامي ٢٠١٦/٢٠١٧ ، ٢٠١٧/٢٠١٨ والهدف الرئيسي من هذه الدراسة تحديد مدى فعالية عدد من المعاملات البيولوجية والكيميائية على نمو وإنتاجية الفاصوليا ومكافحة مرض العفن الأبيض الناجم عن فطر سكليروتينيا اسكليروتورم. وكان التصميم المتبع هو قطاعات كاملة العشوائية مع استخدام ثلاث مكررات في تجارب محصول الفاصوليا الخضراء، حيث تم استخدام ستة معاملات بيولوجية: الماء (مقارنة)، ترايكوديرما اسبيريليم (٨٥ جم/ ١٠٠ لتر)، باسلس ميجاتيرم (٢٥٠ جم/ ١٠٠ لتر)، ترايكوديرما البيوم (٢٥٠ جم/ ١٠٠ لتر)، شيتوزان (٢٠٠ جم/ ١٠٠ لتر)، هيدروجين بيروكسيد (٢٥٠ جم/ ١٠٠ لتر) ومقارنتها بثلاث مبيدات فطرية:فلوتولانيل (١٠٠ جم/ ١٠٠ لتر)، تيبوكونازول / فلوبايرام (٥٠ مل/ ١٠٠ لتر)، تيبوكونازول (188 مل/ ١٠٠ لتر) على التوالي وكان عدد الخطوط للوحدة التجريبية ٣ خطوط بطول ٤ متر وعرض ١ متر ومسافة زراعة ٢٠ سم على خطين وبلغت مساحة الوحدة التجريبية ١٢ متر مربع. وقد تم الرش مرتين (٣٥ و 45 يوماً بعد الزراعة) (الإزهار المبكر) (59-61BBCH) باستخدام الرشاشة الظهرية (300 لتر للفدان). وأظهرت النتائج أن المعاملة باستخدام (تيبوكونازول / فلوبايرام) قد أدت بشكل ملحوظ لزيادة الإنتاجية مقارنة بالكنترول وخفضت نسبة وشدة الإصابة بالمرض وزيادة كفاءة التحكم بالمرض، في حين أن الرش بكلاً منهيدروجين بيروكسيد وترايكوديرما اسبيريليمكان له تأثير جيد أو معتدل على إنتاجية محصول الفاصوليا الخضراء وشدة وحدوث المرض على الرغم من التأثير المتوسط بعد الرش.