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ORIGINAL ARTICLES

Effect of Different Types of Compost in Combination with Some Biological Agents and Folicur Fungicide on Onion White Rot Disease

[1]Nawal, A. Eisa, [1]Hafez, M.A., [2]Khalifa, M.M.A., [1]Eid, Kh.E. and [2]Mahdy, Hala A.M.M.

[1]*Agric. Botany Dept., Pl. Pathology Branch, Fac. Agric., Moshtohor, Benha Univ., Egypt.*
[2]*Plant Pathology Res. Inst., Agric. Res. Center, Giza, Egypt.*

ABSTRACT

Onion white rot (OWR) is a serious disease of *Allium* spp. caused by the sclerotium-forming fungus *Sclerotium cepivorum*. In this study, the efficacy of soil amendment with vegetarian or animal manure compost and mixed of them with or without adding bioagents *i.e. T. harzianum* and *P. fluorescens* compared with Folicur fungicide under greenhouse and field conditions were evaluated. Dipping onion transplants in *T. harzianum* or *P. fluorescens* before transplanted in amendment soil with vegetarian compost at the rate of 10 and 20% reduced the percentage of the OWR incidence and increased both bulbs fresh and dry weight more than animal and mixed composts under greenhouse conditions. The combination between vegetarian compost (10%) and dipping treatment of either *T. harzianum* or *P. fluorescens* were the most suppressive in this regard. Under field conditions combining *T. harzianum*, *P. fluorescens* and Folicur with or without compost enhanced control of white rot disease and bulbs yield of onion compared with using biological agent alone. The combination of *T. harzianum, P. fluorescens* and/or Folicur fungicide alone or combined with vegetarian compost applied as soil amendment or foliar spraying of compost extract (10%) twice for two months from planting exhibited a decrease on white rot disease incidence and increased the bulbs yield in Gharbiya and Qalubiya locations.

Key words: Onion white rot, *Sclerotium cepivorum*, soil amendment, compost, biological agents, *T. harzianum*, *P. fluorescens* and Folicur fungicide.

Introduction

Onion (*Allium cepa* L.) is the world's third most economically important vegetable crop after potatoes and tomatoes. Onion white rot (OWR), a fungal disease caused by *Sclerotium cepivorum* Berk. is a predominant disease of onion crop worldwide. Onion white rot, allium root rot is caused by the pathogen *Sclerotium cepivorum* that destroys the roots, killing the plant. It then produces resting bodies that can last for many years in the soil (Jones, 2010). The fungus produces long-lived survival structures (sclerotia), which are specifically induced to germinate in the presence of Allium root exudates, in particular alkyl cysteine sulphoxides (Coley-Smith *et al.*, 1990).

Coventry *et al.* (2002) investigated the possibility of composting onion waste to destroy any sclerotia present and then applying the composted waste to soil to stimulate sclerotial germination to disinfest the soil of the white rot fungus. They also, demonstrate the potential use of composted onion waste as a method for white rot control, and as a means of disposing of onion wastes.

Folicur (Tebuconazole) was still shown to be the more effective and persistent fungicide in suppressing the white rot fungus compared to other fungicides such as triadimenol (Bayfi-dan™) and boscalid (Filan™). It also provided longer direct inhibition of the pathogen. This still makes tebuconazole the prime candidate for use at sowing to prevent early crop infections by the white rot pathogen. Laboratory studies indicate that tebuconazole suppresses fungal growth and prevents it from spreading, but does not kill it. Complete fungal inhibition was recorded at 1 ppm. At lower fungicide levels, it only causes partial inhibition of the pathogen (Pung, 2008).

Khalifa *et al*. (2013) tested four biofungicides *i.e.,* Bio Arc® (*Bacillus megaterium*), Bio Zeid® (*Tricoderma album*), Bio Nagi {under registration (*Tricoderma asperellum*)}and Bio 4 {under registration (mixture of four *Bacillus* spp. *i.e. B. megaterium, B. subtilis, B. lechnifrmes* and *B. pumolis*} as well as the recommended treatment of Folicure fungicide for controlling onion white rot disease incidence and reported that application of mixture of all four tested biofungicides, Bio Nagi and mixture of Bio Zeid and Bio Arc used as dipping and soil drenching six times as well as the recommended treatment of Folicure fungicide were the most effective treatments for decreasing white rot disease incidence and increasing onion bulb yield. Shalaby *et al*. (2013) tested the action of some microbial isolates and Topsin-M against the most pathogenic isolate (Sc_2) of *Sclerotium cepivorum* causing onion white rot was tested. *Bacillus subtilis* B_4, *B. subtilis* B_5, *Trichoderma koningii* and *Trichoderma harzianum* were the most antagonistic isolates of the causal fungus. In pots, disease

Corresponding Auther: Khalifa M. M. A., Plant Pathology Res. Ins., Agric. Res. Center, Giza., Egypt
E-mail: mamdouh_khalifa2003@yahoo.com

incidence was decreased to 8.33% by the use of Topsin-M followed by *T. koningii* (29.17%) compared with 95.83% for the control, *i.e*., a remarkable reduction in severity was obtained. Under field conditions, disease incidence was decreased to 2.78% by Topsin-M and to 11.11% by *T. harzianum*. Both agents caused a sharp reduction in disease severity, reaching 1.39 and 9.72%, respectively, with 11.80% being achieved by *T. koningii* and *B. subtilis* B_5.

The objectives of the current work were to assess controlling onion white rot (OWR) and increasing onion bulb yield by studying the ability of different types of compost in combination with biological agents and Folicur fungicide in the greenhouse and field conditions.

Materials and Methods

I- Greenhouse experiments:

Folicur (Tebuconazole, alpha-[2-(4-chlorophenyl) ethyl]-alpha-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol) was used as recommendation label by Bayer for control onion white rot.

This study was carried out in pots infested with *Sclerotium cepivorum* under greenhouse conditions**.** Three types of compost (vegetarian, animal manure and their mixture at two rates 10 and 20% (w/w), Folicur fungicide, *Trichoderma harzianum* and *Pseudomonas fluorescens* alone and/or in combinations were used to evaluate their effects on onion white rot incidence and fresh & dry weight of plants.

1. Preparation of fungal inoculum and soil infestation:

Pots (∅25 cm) were sterilized by dipped in 5.0% formalin solution for 15 minutes, left to dry for two days to get rid of formalin residues, then filled with soil previously autoclaved for two hours at 121°C. Fungal inoculation of *S. cepivorum* (previously isolated from diseased onion plants and confirmed their pathogenic capabilities by the authors) was prepared using sorghum-coarse sand water (2:1:2 v/v) medium. The autoclaved media in glass bottles were inoculated separately using agar discs obtained from the periphery of 5-day old colonies of the tested fungi and incubated at (20±2°C) for two weeks and used for soil infestation. Fungal propagules of *S. cepivorum* were added to the sterilized potted soil (3 kg soil/pot) at the rate of 10.0 g/kg soil (w/w), mixed thoroughly with the soil surface of each pot then irrigated with water and left for one week for the inoculum establishment and left until used at the following trials.

Seven days after the inoculation with the pathogen, pots were sown with onion healthy seventy days old transplants Giza-20 cv. Five transplants/pot and three replicates for every treatment were used. Untreated infested pots with soil only were used as a control.

All plants were watered regularly to near field capacity with tap water and pots did not receive any fertilizers in this study.

2. Compost preparations:

Three types of compost (of animal manure, vegetarian and their mixed (Table, 1) produced by Agriculture Service Center Compost Production Unit, Fac. Agric. Moshtohor, Benha Univ. Egypt were used at two rates 10 and 20% (w/w) in these experiments. Sixteen days before sowing, composts were sterilized by autoclaved at 1.5 kg for 90 minutes, and left to aerated for 7 days and used through the trials.

Table 1: Chemical analyses of the used compost types (animal, mixed and vegetarian) produced by Agriculture Service Center Compost Production Unit, Fac. Agric., Moshtohor, Benha Univ., Egypt.

Characters	Unit	Animal manure	Vegetarian	Mixed
Bulk density	kg/m^3	753	460	610
pH	--	7.91	8.00	7.2
EC	ds/m	2.1	2.71	2.1
Organic carbon	%	16	25.1	20.7
Organic mater	%	21.6	49	35.5
Total of nitrogen	%	0.93	1.27	1.13
C/N ratio	-	17.2	14.5	18.3
Total phosphorus	%	0.22	0.39	1.03
Total potassium	%	0.31	2.5	2.11
Weed germination	-	Nil	Nil	Nil
Pathogenic	-	Nil	Nil	Nil
Root feeding nematodes	-	Nil	Nil	Nil

Ds/m=dices mines per meter

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3. Inoculum preparations of biological agents:

The tested biological agents included *Trichoderma harzianum* and *Pseudomonas fluorescens* (obtained from Onion, Garlic and Oil Crops Diseases Res. Dept., Plant Pathology Res. Inst. Agric. Res. Center, Giza, Egypt), were prepared as follow:

T. harzianum was grown on PDA plates for 10 days at 26°C then its growth was flooded with sterile-distilled water, scraped with a camel hair brush then filtered through sterilized filter papers. The resulted spore suspensions were found to contain approx. 5×10^8 conidia/ml. While, *P. fluorescens* was grown on nutrient broth (NB) for 2-4 days and centrifuged at 3000 rpm for 10 min., the supernatant was discarded, and the precipitate was re-suspended in 100 ml sterilized distilled water. The suspension was centrifuged again for 5 min. and the precipitate was finally suspended in sterilized distilled water. Bacterial population adjusted to 1×10^8 cfu/ml according to dilution plate assay of Callan *et al.* (1990). Bacterial concentrations were determined according to its turbidity using spectrophotometer at 400 nm. Onion transplants were dipped into spore suspension of both *T. harzianum* at the rate of 5ml/L (modified from Harman *et al*., 2004) and *P. fluorescens* at the rate of 5ml/L (Park *et al.*, 1991) with 1% Arabic gum solution as sticker for 15 minutes before planting. Untreated transplants were used as control.

Three greenhouse trials included different treatments were conducted to evaluate their effects on onion white rot disease incidence and onion fresh and dry weight under greenhouse conditions as follow:

The first trial in this experiment, onion transplants Giza 20 cultivar were planted in pots amended with three types of compost (animal, vegetarian and their mixed) at two rates 10 and 20% (w/w) to evaluate their efficiency in controlling white rot disease incidence compared to dipping transplants in Folicur fungicide at the recommended rate (25 ml/L) and untreated plants.

The second trial was conducted to study the effect of combined treatments of soil treatment with three types of compost (animal, vegetarian and their mixed) at two rates 10 and 20% (w/w) and dipping transplants with T. harzianum compared to dipping transplants only in T. harzianum and untreated plants.

The third trial was conducted to study the effect of combined treatments of soil treatment with three types of compost (animal, vegetarian and their mixed) at two rates 10 and 20% (w/w) and dipping transplants with Ps. fluorescens compared to dipping transplants only in Ps. fluorescens and untreated plants.

All the above-mentioned treatments were replicated three times in a randomized complete block design.

4. Disease assessment:

White rot incidence as a percentage of bulbs with symptoms was assessed at harvest by uprooting and observing all onion bulbs in each pot of different treatments. The number of plants having specific white rot disease symptoms were counted after 90 days from planting and their percentage were calculated;

$$\text{Infection (\%)} = \frac{\text{No. of transplants infected with white rot}}{\text{Total No. of planted transplants}} \times 100$$

Also, fresh weight of onion plants from each pot of different treatments were recorded directly after harvest as g/pot and dried in an oven held at about 70°C for two days, the plants were weighed directly after their removal from the oven as g/pot.

II- Field Experiments:

This experiment was carried out at two different locations, Al-Gemmieza (Gharbiya Governorate) and Aldair (Qalubiya Governorate) in a field with fine texture soil heavily natural infested with *S. cepivorum*. This experiment was done in the period from the first of January to June 2011 and involved 17 treatments with three replicates. Each treatment plot consisted of one bed of rows x 2 of onion with spacing of 42 cm between rows (1.7 m/bed). Onion transplants were planted at 25 plants/m, to provide 200 onions plants/plot. Onions were grown to maturity using irrigation, fertilizer and pest management practices consistent with commercial production in the area.

All the above-mentioned treatments were replicated three times in a randomized complete block design.

White rot incidence as a percentage of bulbs with symptoms was assessed at harvest by pulling and observing all onion bulbs in each plot. Onion bulbs from each plot were harvested and weighed (kg/plot) for yield assessment.

Statistical analysis:

Statistical analyses of all the previously designed experiments have been carried out according to (ANOVA) procedures which reported by Snedecor and Cochran (1999). Treatment means were compared by the least significant difference test “LSD” at 5% level of probability.

Results:

I- Greenhouse experiments:

Three types of compost (vegetarian, animal manure and their mixture) at two rates 10 and 20% (w/w), Folicur, *T. harzianum* and *P. fluorescens* alone and/or in combination were used to evaluate their effects on onion white rot incidence and fresh and dry weight of plants.

1. Effect of different types of compost in comparison with the fungicide Folicur:

Data in Table (2) reveal that the vegetarian compost at the rate of 20% and dipping seedlings in the fungicide Folicur was the best for suppressing white rot disease incidence producing disease-free plants compared with the control 46.67%. followed by the vegetarian compost 10% and the mixed compost at rate 10% which resulted in 6.67% infection. Furthermore, soil amendment with all compost types at 10 and 20% specially vegetarian compost induced an increase in the fresh and dry weight of bulbs compared with the non-amended control. In general, soil amendment with vegetarian compost at the rate 20 and 10% and mixed compost at the rate 10% especially suppressed onion white rot disease and increased both fresh and dry weight. The highest fresh and dry weight was recorded in case of adding vegetarian compost at the rate of 20 and 10% and mixed compost at the rate of 10% resulted in 69.88, 62.12 and 61.02 g/pot for the fresh weight respectively and 18.79, 16.48 and 17.22 g/pot for the dry weight respectively, however, dipping seedlings in the fungicide Folicur recorded the least fresh weight in this regard compared to control treatment.

Table 2: Effect of different types of compost compared with the fungicide Folicur on onion white rot disease incidence and onion fresh and dry weight under greenhouse conditions.

Treatment	Rate of adding %	Inoculated with *S. cepivorum*		
		% infection	Fresh weight g/pot	Dry weight g/pot
Soil treated with vegetarian compost	10	6.67	62.12	16.48
	20	0.00	69.88	18.79
Soil treated with animal compost	10	13.33	59.63	11.83
	20	20.00	50.64	17.87
Soil treated with mixed compost	10	6.67	61.02	17.22
	20	20.00	55.47	13.06
Seedling dipped in Folicur	25 ml/L	0.00	45.61	17.02
S. cepivorum alone	-	46.67	41.82	12.27
LSD at 0.05		12.572	3.875	1.874

2. Effect of different types of compost amendments with T. harzianum on white rot incidence:

Data in Table (3) reveal that soil amendment with vegetarian compost at the rate 10 and 20% combined with adding *T. harzianum* reduced the percentage of infection with onion white rot more than animal and mixed composts. In this respect, the combination between vegetarian compost and *T. harzianum* produced disease-free plants at the two rates as they recorded 0.00% infection compared with the control 60.0%. Also, the vegetarian and mixed compost in combination with *T. harzianum* induced suppression to infection more than using animal compost. On the other hand, the combination between compost and *T. harzianum* induced an increase in the fresh and dry weight especially in the case of adding the mixed compost which resulted in 52.70 and 20.58 g/pot respectively.

Table 3: Effect of different types of compost with *T. harzianum* on onion white rot disease incidence and onion fresh & dry weight under greenhouse conditions.

Treatment	Rate of adding %	% infection	Fresh weight g/pot	Dry weight g/pot
T. harzianum dipping + Vegetarian compost	10	0.00	49.67	16.27
	20	0.00	51.06	15.72
T. harzianum dipping + Animal compost	10	6.67	46.92	18.09
	20	13.33	42.50	12.92
T. harzianum dipping + Mixed compost	10	0.00	52.70	20.58
	20	6.67	27.76	10.43
T. harzianum dipping alone	-	6.67	41.87	14.91
S. cepivorum alone	-	60.00	30.95	9.14
LSD at 0.05	-	11.157	3.853	1.239

3. Effect of different types of compost amendments in combination with P. fluorescens on white rot incidence:

Data in Table (4) reveal that soil amendment with vegetarian compost at the rate 20 and combined with dipping treatment with *P. fluorescens* and dipping treatment in *P. fluorescens* only reduced the percentage of infection with onion white rot resulted in 0.00%, followed by vegetarian and mixed composts at the rate 10% 13.33 and 6.67%, respectively. In this respect, the combination between the animal compost at the rate 10 and 20% exhibited slight reduction of infection with onion white rot (20.0 & 26.67%, respectively). It can be concluded from Table (4) that soil amendment with *P. fluorescens* alone or in combination with vegetarian compost led to suppress incidence with onion white rot (OWR). On the other hand, *P. fluorescens* alone or combined with soil amendment with vegetarian compost at 20 % exhibited an increase in both fresh and dry weight of onion bulbs.

Table 4: Effect of different types of compost with *P. fluorescens* on onion white rot disease incidence and onion fresh and dry weight under greenhouse conditions.

Treatment	Rate of adding %	% of infection	Fresh weight g/pot	Dry weight g/pot
P. fluorescens dipping + Vegetarian compost	10	13.33	36.55	11.31
	20	0.00	69.11	15.83
P. fluorescens dipping + Animal compost	10	20.00	57.35	14.70
	20	26. 67	44.81	13.75
P. fluorescens dipping + Mixed compost	10	6.67	49.52	14.37
	20	20.00	34.17	10.74
P. fluorescens dipping alone	-	0.00	63.43	13.11
S. cepivorum alone	-	60.00	36.40	10.28
LSD at 0.05		10.173	4.926	1.281

II. Field experiments:

Effect of compost soil treatment and foliar spraying with compost extract in combination with different biological agents or Folicur under field conditions in Gharbiya and Qalubiya Governments in 2011 season:

Two biological agents, *i.e., T. harzianum* and *P. fluorescens*, Folicur fungicide, vegetarian compost amendment and foliar spraying vegetarian compost extract at 10% applied once or twice for two month of planting alone and/or in combination were applied. Their effect on onion white rot disease incidence and onion bulb yield was tested under field conditions at two different governorates, Al-Gharbiya (Al-Gemmiza location) and Qalubiya (Al-Dair location) during 2011 season.

1- On onion white rot disease incidence:

Data in Table (5) show that all treatments in the two locations exhibited significant reduction in the percentage of onion white rot disease (OWR) incidence compared with the untreated control. At Gharbiya location, combined treatment of spraying vegetarian compost extract twice (after 1&2 months from planting) with either Folicur or *T. harzianum* dipping and Folicur dipping with spraying after 6 and 12 weeks of planting exhibited the lowest percentage of infection without significant differences between them (7.68, 10.42 and 10.20%, respectively) followed by combined treatment of spraying vegetarian compost extract once (after 1month from planting) with either Folicur dipping (12.18%) or *P. fluorescens* once and twice (12.33 and 12.88%, respectively) as well as mixture of *T. harzianum* and *P. fluorescens* combined with vegetarian compost as soil treatment (12.88%) without significant differences in-between compared to the untreated control treatment (42.41%). However, applying vegetarian compost only as soil treatment on planting date recorded the highest percentage of OWR incidence followed by *P. fluorescens* dipping only with high significant differences in between (24.45& 18.68%, respectively).

On the other side, at Qalubiya location percentage of OWR significantly decreased in all treatment compared to untreated control treatment. Combined treatment of spraying vegetarian compost extract twice (after 1 & 2 month from planting) with either *T. harzianum* or Folicur dipping and mixture of *T. harzianum* and *P. fluorescens* combined with vegetarian compost as soil treatment on planting date were the best treatments. As, they exhibited the highest significant reduction in the percentage of OWR incidence without significant differences in between (8.54, 10.41 and 9.40%, respectively) compared to untreated control treatment (37.39%), while, the other treatments followed the above treatments except for *P. fluorescens* combined with spraying vegetarian compost extract after one month and combined treatment of compost soil treatment on planting date with spraying vegetarian compost extract twice after 1&2 months which recorded the highest percentage of OWR incidence without significant differences in-between (18.12 & 17.79%, respectively) in comparison with the other treatments.

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2- On onion bulb yield:

Data in Table (6) show that all treatments exhibited significant increase in bulb yield in Gharbiya location, however there was slight enhancement in the bulb yield production in Qalubiya location compared to untreated control in the two locations. The best treatment that enhanced bulb yield in Gharbiya location was transplant dipping in the mixture of *T. harzianum* and *P. fluorescens* combined with the vegetarian compost as a soil treatment on planting date (16.08 kg) followed by Folicur dipping combined with spraying vegetarian compost extract twice after 1&2 month from planting (15.74 kg), *T. harzianum* dipping only (15.58 kg), combined treatment of vegetarian compost as soil treatment with spraying vegetarian compost extract once and twice after 1&2 month (15.55 & 15.05 kg, respectively) Moreover, *T. harzianum* dipping combined with either vegetarian compost as soil treatment (15.24 kg) or spraying vegetarian compost extract twice for two month (15.19 kg) without any significant difference in between. Meanwhile, there was a slight increase in bulb yield (8.85 kg) with vegetarian compost as soil treatment on planting date compared with other treatments in the same location as well as, compared to untreated control treatment (5.58 kg).

Table 5: Effect of compost soil treatment and foliar spraying with compost extract in combination with different biological agents or Folicur on onion white rot disease incidence under field conditions in Gharbiya and Qalubiya Governments during season 2011.

Treatments**	White rot incidence %	
	Gharbiya	Qalubiya
Folicur dipping only	13.90	13.39
Folicur dipping and Spray 6, 12W*.	10.20	11.50
Folicur + vegetarian compost extract 1M**.	12.18	12.25
Folicur + vegetarian compost extract 2M.	7.68	10.41
Vegetarian compost soil treatment on planting date	24.45	12.72
Compost on planting date + veg. compost extract 1M	15.67	11.87
Compost on planting date + veg. compost extract 2M	13.56	17.79
T. harzianum dipping only	15.76	10.59
T. harzianum + veg. compost extract 1M	15.40	12.03
T. harzianum + veg. compost extract 2M	10.42	8.54
T. harzianum + veg. compost soil treatment	15.34	11.91
P. fluorescens dipping only	18.68	11.94
P. fluorescens + veg. compost extract 1M	12.88	18.12
P. fluorescens + veg. compost extract 2M	12.33	14.32
P. fluorescens + veg. compost soil treatment	14.79	12.86
T.h.+P. f.+ veg. compost soil treatment	12.88	9.40
Untreated control	42.41	37.39
LSD 0.05	3.962	2.237

6,12 w*= 6 and 12 weeks of planting M**= once and twice after 1&2 months from planting

Table 6: Effect of compost soil treatment and foliar spraying with compost extract in combination with different biological agents or Folicur on onion bulb yield under field conditions in Gharbiya and Qalubiya Governments in 2011 season.

Treatment	Onion bulb yield kg/plot	
	Gharbiya	Qalubiya
Folicur dipping alone	12.01	12.76
Folicur dipping and Spray 6, 12W*.	13.41	13.29
Folicur + vegetarian compost extract 1M**.	11.23	11.03
Folicur + vegetarian compost extract 2M.	15.74	14.57
Vegetarian compost soil treatment on planting date	8.85	15.60
Compost on planting date + veg. compost extract 1M	15.55	14.17
Compost on planting date + veg. compost extract 2M	15.05	12.50
T. harzianum dipping only	15.58	13.57
T. harzianum + veg. compost extract 1M	14.52	12.52
T. harzianum + veg. compost extract 2M	15.19	12.33
T. harzianum + veg. compost soil treatment	15.24	13.82
P. fluorescens dipping only	11.35	13.80
P. fluorescens + veg. compost extract 1M	14.40	15.67
P. fluorescens + veg. compost extract 2M	14.68	11.73
P. fluorescens + veg. compost soil treatment	12.68	14.85
T.h.+P.f.+ veg. compost soil treatment	16.08	13.93
Untreated control	5.58	10.43
LSD 0.05	1.148	1.682

6,12 w*= 6 and 12 weeks of planting M**= once and twice after 1&2 months from planting

Moreover, data in Table (6), illustrate that in Qalubiya location *Pseudomonas fluorescens* combined with spraying vegetarian compost extract after one month of planting and soil treatment of vegetarian compost on planting date (15.67 and 15.60 kg, respectively) were the best treatments in this regard, followed by *P. fluorescens* combined with vegetarian compost as soil treatment (14.85 kg). Moreover, no significant differences were found between Folicur dipping combined with spraying vegetarian compost extract twice after

1 & 2 month of planting (14.57 kg), and vegetarian compost as soil treatment on planting date with spraying vegetarian compost extract after one month of planting (14.17 kg). On the other hand, the treatments that reduced bulb yield were dipping in before planting *P. fluorescens* combined with spraying vegetarian compost extract twice after 1&2 month of planting (11.73 kg), Folicur dipping combined with spraying vegetarian compost extract after one month of planting (11.03 kg) and untreated control (10.43 kg) without any significant difference in between.

Discussion:

Root diseases are a major cause of economic loss in onions and allied crops throughout the world. White rot disease of onion caused by the fungus *Sclerotium cepivorum* Berk is one of the most important root diseases (Jones, A. 2010). The disease occurs in many areas of the world where alliums are cultivated and the environmental conditions are favorable to the pathogen. Being a soil-borne pathogen, its control measures are not easy to carry out because of its inaccessibility to fungicides and because until now, resistant genotypes have not been found (Khalifa *et al*.. 2013).

Effect of soil amendment with compost alone or with fungicide and some biological agents under greenhouse and field conditions was evaluated in this study for controlling onion white rot disease incidence. Three types of compost (*i.e*. vegetarian, animal manure and their mixture), the Folicur fungicide, *T. harzianum*, and *P. fluorescens* in alone and in combination were used to evaluate their effect on onion white rot disease incidence and fresh and dry weight of bulbs. In general, soil amendment with compost vegetarian and its mixture with animal manure compost, especially at the rate of 20 and 10% suppressed onion white rot disease and increased both fresh and dry weight under greenhouse conditions.

In 1995 to 1999, field trials in Tasmania, Australia have demonstrated that Folicur-lime super granules applied in seed furrow gave superior white rot control compared to in-furrow spray or as basal stem spray applications. The early Folicur application appeared to help prevent primary infections that originated from the fungal sclerotia (Pung, 2008).

Several studies under controlled conditions have demonstrated a suppressive effect of composts on soil-borne (Ros *et al*. 2005). The composting process normally consists of three phases that can be more-or-less distinct: an initial mixing period with mesophilic growth; a high-temperature thermophilic phase (or sanitization); and a longer and lower temperature mesophilic phase (maturation or stabilization) (Day & Shaw, 2001). The success of composting in eliminating pathogens is not solely a result of the heating process, but also depends on the many and complex microbial interactions that may occur, as well as other compost parameters such as moisture content (Bollen, 1985). According to Bollen (1985), the eradication of pathogens from organic wastes during composting is primarily due to: (i) heat generated during the thermophilic phase of the composting process; (ii) the production of toxic compounds such as organic acids and ammonia; (iii) lytic activity of enzymes produced in the compost; and (iv) microbial antagonism, including the production of antibiotics and parasitism. Other factors involved in eradication are: (v) competition for nutrients (Ryckeboer, 2001); (vi) natural loss of viability of the pathogen with time (Coventry *et al*., 2002); and (vii) volatiles released from immature composts such as sulphur-containing compounds and organic acids may be responsible for disease suppression in some instances, also stimulate the germination of resting structures of pathogens such as the sclerotia of *S. cepivorum*, the pathogen that causes onion white rot, but, such composts are more likely to cause phytotoxicity than stabilized compost (Coventry *et al*., 2002).

Combined vegetarian compost at the rate of 10 and 20% as a soil amendment with *T. harzianum* or *P. fluorescens* dipping treatment reduced the percentage of infection of onion white rot under greenhouse conditions more than animal and mixed composts and the rate 10% was better than 20% in most cases. From the obtained results it can be concluded that the combination between compost especially vegetarian compost and *T. harzianum* could remarkably suppress the infection with *S. cepivorum.* From the obtained results it can be concluded that the combination between compost especially vegetarian compost and *T. harzianum* or *P. fluorescens* could remarkably suppress the infection with *S. cepivorum.* The effects of organic amendments, suggests that both chemical and biological components of compost-amended soils can contribute to disease suppression (Abbasi *et al*., 2002 and Metcalf *et al*. 2004)

Under field conditions combining *T. harzianum*, *P. fluorescen*s and the fungicide Folicur with or without compost has enhanced the control of white rot of onion and bulb yield compared with using biological agent alone. In Gharbiya location the combination of *T. harzianum*, and *P. fluorescens* with compost exhibited a decrease in infection with white rot and increased the bulb yield more than in Qalubiya location. These control measures, therefore have great potential for use in an integrated control strategy for onion white rot. It has been also demonstrated that the use of biological agents, *in vivo* as *T. harzianum* and *P. fluorescens* in treating transplants or compost were effective control measures for disease. These findings are in accordance with those of Hoitink and Boehm, (1999), Metcalf *et al*., (2004) and Clarkson and Whipps (2004).

It appears from the present study that *P. fluorescens* alone or combination with compost gave a slight effect in reducing the percentage of disease incidence or bulb yield production almost in the two tested locations, compared with fungicide and/or compost treatments. In general, it was concluded that soil amendments with compost or spraying with compost extract in combination with *P. fluorescens* induced suppression of OWR and an increase in the production of onion bulb yield. This result is in agreement with Ahmadzadeh *et al.* (2007). This antifungal action of *Pseudomonas* in greenhouse related to other mechanisms which occurred and accumulated together in soil occurring competition for carbon, competition for iron mediated by siderophores, producing antibiotics, hydrogen cyanide (HCN), lytic exoenzymes and induced systemic resistance, the fast growth and its ability to colonization in roots and utilizing a range of easily metabolizable organic compounds, this due to competition for space and carbon source (Bonsall *et al.*, 1997).

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