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Management of onion root-rot diseases caused by soil born fungi under Middle Sinai conditions

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ABSTRACT

Some factors were evaluated for controlling the root-rot of onion plants (cv. Mohasan 6) causing economic losses in plant stand and yield in Egypt. Two pot experiments were conducted on onion during two winter seasons of 2014/2015 and 2015/2016 at Middle Sinai, North Sinai Governorate, Egypt.

Fungi belonging to 4 genera were isolated from diseased plants. The survey showed differences in the frequency of the isolated fungi. In general, *Aspergillus niger*, *Alternaria tenius*, *Rhizoctonia solani*, *Fusarium semitectium* and *Fusarium moniliforme* were found to be the most frequently isolated fungi, as well as the commercial bio-fertilizers, *i.e.* Microbin, Phosphoren and Potassiumag, biocides *i.e.* Biozeid, BioArc, Plantguard, Rhizo N and clean root and chemical fungicides, *i.e.* Mancoxyl, Previcur N, Vitvax, Nando and Akoby, compared with check treatments. The percentage of post emergence damping-off caused by the tested fungi was decreased in response to the effect of all tested treatments.

Bio-fertilizers (Microbin) caused increase of plant height, bulb diameter, bulb weight and total bulb yield compared with other bio-fertilizers treatments while, the treated with fungicide Rhizo-N decreased the bulb diameter, bulb weight) and total bulb yield. On the other hand, treated with bio-fertilizers the most effective on the growth parameters especially bulb weight and total bulb yield.

Key words: Onion, Bio-fertilizers, Bio-control, Chemical control and Root-rot diseases.

Introduction

Onion (*Allium cepa* L .) is a species of the alliaceae family of great economic importance and it's the second most important vegetable crops in the world with a world production of about 55 million tons (FAO, 2012). In Egypt, it's the second important cash crop after rice. The increasing of yield with consequent economic return is a major concern of the farmers and it is making a significant nutritional contribution to human diet. Also, it's has medicinal and functional properties (Lanzotti, 2006).

The consumption is attributed to several factors, which mainly heavy promotion that links flavor and health and the popularity of onion-rich ethnic foods. This low production of onion is due to effects of fertilizers, growing unsuitable varieties and different root-rots fungi diseases under the agro climatic conditions of an area.

Onion plants suffer from different root-rots fungi diseases such as *Aspergillus niger*, *Alternaria tenius*, *Rhizoctonia solani*, *Fusarium semitectium* and *Fusarium moniliforme* (Lewis and Lumsden, 2001 and Abdel-Kader *et al.,* 2012), as well as bacterial diseases, nematodes and insects. In Egypt, it suffered from most of these diseases especially the fungal root-rots are the most prevalent and dangerous root disease all over the country and worldwide (Abo El-Ela, 2003 and Khedher *et al.,* 2015). However, yield losses reached 75-80% in case of soil born fungi (Tjamos *et al.,* 2010).

Several attempts were done upon fungicides as the main strategy for control in order to manage these diseases and increase quantity and quality of onion yield in Egypt and other countries (Abo El-Ela, 2003 and Gupta and Gupta, 2014). Harmful side effects fungicides were reported on humans (Kondoh *et al*., 2001) and environment (Abolmaaty and Fawazy, 2016). Furthermore, fungicides may

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increase incidence and severity of non-target diseases (Burrows, *et al.,* 2007 and Gupta and Gupta, 2014).Thus, the development of nontoxic alternatives to fungicides such as natural plant products would be useful in reducing these undesirable effects. Fortunately, many bio-fertilizers and biocides as environmental, friendly bio-pesticides were found during the last two decades to be useful in controlling plant diseases.

In Egypt, no previous studies concerning evaluation to effectiveness of the Egyptian bio-fertilizers and biocides in controlling on onion root–rot. Therefore field experiments were conducted during two seasons (2014/2015 and 2015/2016) at Seder El-Hitan, Bir Grid and El-Necela villages (Nekhl Center) in Middle Sinai (North Sinai Governorate) in order to investigate efficiency of bio-fertilizers and biocides in comparative with the recommended fungicide for checking these diseases. Also, onion bulb yield weights were calculated to determine the values of these treatments as safe and effective control means.

This work aimed to study the effect of some bio-fertilizers and bio-chemical fungicides to controlling root-rot of onion plants.

Materials and Methods

Disease survey of plant onion root-rots:

Survey for root-rot diseases were conducted during two seasons (2014/2015 and 2015/2016) in different regions of Seder El-Hittan, Bir Grid and El-Necela villages, Middle Sinai on onion plants. Samples of diseased plants were taken into the laboratory to isolate the causal pathogens. The average percentage of disease incidence was calculated as the number of rotted onion plants relative to the total number of examined plants.

Isolation and identification of the causal pathogens:

The infected roots were excised and carefully washed with tap water to remove any adhesive soil. Small segments of the infected roots were superficially sterilized in sodium hypochlorite 5% for two minutes. Then, the fragments were rinsed several times in sterilized distilled water, blotted to dry on sterilized filter papers then placed on PDA plates and incubated at 27 ^{0}c for seven days. The developed colonies were recorded as frequency percentage for each of the isolated fungi. The isolated fungi were purified using the single spore or the hyphae tip technique (Dhingra and Sinclair, 1985). Colony characteristics, spore morphology were described and identified, according to the description of (Plats and Vandler, 1981). The identification was confirmed by the fungal taxonomy Department of Plant pathology, N.R.C., Dokki, Giza.

Pathogenicity test:

Pathogenicity test was carried out using the more frequent five isolated fungi, i. e. *Aspergillus niger*, *Alternaria tenius*, *Rhizoctonia solani*, *Fusarium semitectium* and *Fusarium moniliforme.* This experiment was conducted in the greenhouse of N.R.C. plant pathology. Pots (40 cm diameter) were sterilized by immersing in 5 % formalin for 15 minutes, then left to dry for 10 days. A mixture of clay soil and sand (1:1 w/w) was also sterilized with the same solution and covered with polyethylene sheet for 15 days then left uncovered to evaporate formation for 10 days. The pots were filled with the sterilized soil (5 kg/pot). Data were recorded as percentages of post emergence damping-off and survival plants.

Inoculation:

Inoculate of the tested fungi were prepared by growing each fungus in 500-ml glass-bottle containing sterilized potato dextrose broth (PDB). The bottles were incubated for 15 days at 27^{o}C. Soil infestation was achieved by mixing inoculum of each fungus with the upper layer of soil at the rate of 5 % of soil weight, seven days before planting. The infested soil was regularly irrigated to simulate fungal growth to ensure its homogenous distribution in the soil. Control treatment was prepared using the same amount of sterilized PDB medium. Five plants were sown in each pot and a set of three replicates were used for each particular treatment. The disease assessment was estimated.

In vivo effect of bio-fertilization on disease incidence:

The experiment was carried out in winter seasons of 2014/2015 and 2015/2016 using three different types of bio-fertilizers as a substitution of chemical fertilization namely; Microbin, Potassiumag and Phosphoren. These bio-fertilizers were obtained from the bio-fertilization Centre, Agric. Res. Inst., Ministry of Agriculture, Giza as microorganisms in peat moss carrier substrate. The sterilized pots used in this experiment were filled with the sterilized soil of clay and sand, (1:1 v/v). The inoculate of *Aspergillus niger*, *Alternaria tenius*, *Rhizoctonia solani*, *Fusarium semitectium* and *Fusarium moniliforme* fungi were added at the rate of 5 % of soil weight and mixed with the upper surface of the soil, irrigated and left 7 days for fungal growth, then the fresh preparation of each bio-fertilizer was mixed separately in the soil at the rates of 0 and 4 g/pot. The plants of onion were prepared and immediately covered in the infested or non-infested soil with the tested fungi (5 seedling / pot). Three pots were used for each treatment. Disease incidence was assessed as the percentages of diseased plants.

Table 1: Bio-fertilizers used to control root rot diseases.

Bio-fertilizers	Containing
Microben	*Azotobacter sp., Pseudomonas sp.* and *Bacillus megaterium*
Potassiumag	*Bacillus verculanes*, *Bacillus megaterium var. phosphaticum*
Phosphoren	As phosphorus solubilizing bacteria at (10^8 cfu/g)

Effect of bio-agents on onion root-rot incidence under greenhouse conditions:

Five commercial bio-products, i.e. Bio-Zeid, Plant guard, Bio-Arc, Rhizo-N and Clean-root were used to evaluate their efficiency on controlling root rots. Plants were dipped in Bio-Zied, Bio-Arc (2.5 g/ liter of water), Plant guard, Rhizo-N (4.0 g/ liter of water) and Clean-Root (5.0 ml/ liter of water), for 2 hours before planting. Five plants were planted in each pot contained infested soil. The control pots contained infested soil used without treated plants. Three pots for each treatment were used. All the pots were irrigated as usual. Percentages of post-emergence damping–off and survival plants were recorded at 75 days after planting.

Table 2: Biocides used as bio-agents against five causals pathogens.

Biocides (Trade name)	Bio-agent (density/ml)	Dose	
		(1L. /medium)	Seedling dipping (1L. of water)
Bio-Zeid	*Trichoderma album*, 3×10^7 spores/ml	2.5 g/ L.m.	2.5 g/ L.w.
Plant guard	*Trichoderma harzianum,* 3×10^7 spores/ml	4.0 ml/ L.m.	4.0 ml/ L.w.
Bio-Arc	*Bacillus megaterium,* 2.5×10^7 cfu/ml	2.5 g/ L.m.	2.5 g/ L.w.
Rhizo-N	*Bacillus subtilis,* 3×10^7 cfu/ml	4.0 g/ L.m.	4.0 g/ L.w.
Clean-root	*Bacillus subtilis,* 3×10^8 cfu/ml	5.0 ml/ L.m.	5.0 mg/ L.w.

In vivo effect of using fungicides on root rot incidence:

One concentration of five fungicides namely, Mancoxyl, Previcur-N, Vitavax, Nando and Akoby were tested against the aforementioned pathogenic fungi causing root rots. These five fungicides were used in treating plants to evaluate their efficiency against onion root rots under the greenhouse conditions.

Plants were separately treated with each fungicide by soaking in solution of recommended dose of each tested fungicide for two hours. Ten treated plants were planted in the infested or non-infested soil (control) in sterilized pots (40 cm diameter). Non treated plants were used in the same way. Three replicates were used for each treatment. Disease readings were recorded at 75 days after post planting as mentioned before.

Table 3: Different chemical fungicides used as a control on onion root-rot diseases

Trade name	Active ingredient	Dose
Mancoxyl 72%	Mancozeb + Metalaxyl-M	
Previcur-N 72.2%	Propano carb Hcl	
Vitavax (200) 75%	Carboxin + Thiran	2.5 g/L
Nando 50%	Fluazinam	
Akoby 50%	Kresoxim-Methyl	

Effect of different control approaches on growth and yield parameters

Natural infected plant, showing typical symptoms of onion soil borne disease were investigated of or measuring plant height, bulb diameter and bulb weight were estimated at harvest time at 90 day from sowing.

Statistical analysis:

Data obtained were statistically analyzed when necessary using L.S.D. procedure outlined by Snedecor and Cochran, (1981).

Results and Discussion

1- Survey, isolation and identification

Data in Table (4) reveal that no great differences in the infection percentage during two successive seasons in the inspected fields of the three villages. The natural infection ranged from 10% at El-Nethiela to 21% at Seder El-Hittan village. Naturally infected plants exhibited some variation in the symptoms according to the sample and/or village. The infection of adult plants showed wilt and dry off from plant top to down wards. Most of the infected plants were characterized by cankers and/or soft rot in the basal part of their stems at soil surface. The infected plants were usually easy to pull out the soil.

Table 4: Percentage of naturally infected onion plants in three villages during two seasons (204/2015-2015/2016).

Villages	Root-rot incidence (%)		Mean
	First season	Second season	
Seder El-Hitan	21.0	19.0	20.0
Bir Grid	18.0	15.0	16.5
El-Necela	10.0	10.0	10.0

Generally, the average (%) of infection is varied from season to another and from locality to another one. The percentage of naturally infected onion plants was higher in first season followed by second season. Seder El-Hittan village was highest infected one followed by Bir Grid and El-Necela villages. The corresponding values of the infection (%) were 20.0, 16.5 and 10.0 %, respectively.

2- Frequency of fungi isolated from diseased plants

Data in Table (5) indicate that the highest percentage of occurrence was recorded for *F. semitectium* being (20.0 %) followed by *A. niger* (19.8 %), *R. solani* (19.6 %) and *A. tenius* (18.5 %), while *F. moniliforme* was the least frequency being (16.9 %). The average percentage of occurrence for other fungi was between (0.5 - 1.7 %). The isolated fungi were purified and identified and the most frequently isolated fungi, i. e. *A. niger, F. moniliforme*, *F. semitectium, R. solani* and *A. tenius* were used for further studies. Most of fungi were isolated with different frequencies from the infected root and crowns of plants collected from the inspected villages. The isolated fungi were found to belong to 4 genera i.e. *Aspergillus*, *Fusarium*, *Rhizoctonia* and *Alternaria*.

Table 5: Frequency of isolated fungi from naturally infected onion plants collected from three villages in Middle Sinai.

Isolated fungi	Frequency (%)			Mean
	Seder El-Hitan	Bir Grid	El-Necela	
Fusarium solani	1.2	2.5	1.3	1.7
Aspergillus niger	21.0	18.1	20.2	19.8
Rhizoctonia solani	20.2	18.0	20.5	19.6
Macrophomni phaseolina	1.0	0.5	1.5	1.0
Pythium ultimum	0.5	1.3	0.2	0.8
Fusarium semitectium	19.7	20.3	20.0	20.0
Fusarium oxysporium	0.5	1.0	1.0	0.5
Fusarium moniliforme	17.3	15.0	18.5	16.9
Stemphylium spp	1.2	1.8	0.0	1.0
Alternaria tenius	17.4	21.5	16.8	18.5
Mean	**10.0**	**10.0**	**10.0**	**10.0**

The obtained data are in agreement with those recorded by (Kim and Park, 1999). The highest percentage of occurrence was noticed with *Rhizoctonia* sp., followed by *Fusarium* and *Macrophomina* sp., while the least occurrence was recorded for leaf spot and saprophytic fungi, *Alternaria* sp., *Chaetomium* sp., and *Stemphylium*.

3- Pathogenicity test

The isolated fungi were screened for their capabilities to infect onion plants and the percentages of the disease incidence were recorded after 75 days. Data in Table (6) show a wide variation in the percentages of infection depending on the causal pathogenic agent and the source of isolate, *F.moniliforme* and *R.solani* isolated from El-Necela village, *F. semitectium* and *A.tenius* isolated from Bir Grid village, while *A.niger* isolated from Seder El-Hittan village. *R.solani* which caused the highest infection percentage (52.0 %) followed by *A.niger* (47.33 %), *A.tenius* (43.33 %), *F. semitectium* (40.60 %), while, the lowest value was recorded in case of *F.moniliforme* (22.50 %). *R.solani* from El-Nethiela as well as *A.niger* (from Seder El-Hittan) were the most aggressive fungi followed by *A.tenius* and *F. semitectium* (from Bir Grid), respectively. The infection (%) significantly varied among the pathogens.

Table 6: Pathogenicity test of isolated fungi from damping-off seedlings onion expressed as post emergence damping-off and survivals.

Tested fungi	Source of isolate	Post emergence damping-off	Plant survival
Aspergillus niger	Seder El-Hittan	47.33	52.67
Fusarium moniliforme	El-Necela	22.50	77.50
Fusarium semitectium	Bir Grid	40.60	59.40
Rhizoctonia solani	El-Necela	52.00	48.00
Alternaria tenius	Bir Grid	43.33	56.67
Control	-	0.00	100.00
Mean	**-**	**34.29**	**65.71**

L.S.D at 5 % for: Fungi (F) = 9.42

The disease incidence of these fungi on the plants grown in the infested soil was also affected by the source of isolates. Isolate of E-Necela village seemed to be more aggressive than the other ones. A similar trend was obtained by (Weber, 2004 and Olfat *et al.,* 2009).

4- Effect of bio-fertilizers on the root-rot disease incidence.

Data in Table (7) indicate that Microbin has significantly decreased disease incidence (3.2%), followed by Potassiumag (6.8%) and phosphoren (25.4%) compared with the control (43.04%). The same results recorded that *A.tenius* was less affected with phosphoren since it gave (25.4%). Disease symptoms caused by all the tested fungi were completely inhibited by using Microbin for all tested fungi (except *A. niger* and *A. tenius*) compared with *F. moniliforme* (39.4%), *F. semitectium* (46.4%) and (32.0%) for *R. solani* in control treatment.

Bio-fertilization was recently recommended to be effective mean controlling soil-borne fungal diseases on the ornamental plants as reported by Abo El-Ela (2003) who mentioned that, the benefit of bio-fertilization might due to its cumulative effects such as supplying the plant with nitrogen in addition to growth promoting substances produced by microorganisms.

Table 7: Effect of bio-fertilizers on the disease incidence (%) of onion plants in soil infested with the tested fungi

Tested fungi	Disease incidence (%)							
	Control		Microbin		Phosphoren		Potassiumag	
	Post.	Survival	Post.	Survival	Post.	Survival	Post.	Survival
A. niger	52.7	47.3	4.6	95.4	25.0	75.0	6.3	93.7
F. moniliforme	39.4	60.6	0.0	100.0	15.4	84.6	12.5	87.5
F. semitectium	46.4	53.6	0.0	100.0	11.0	89.0	18.7	81.3
R. solani	32.0	68.0	0.0	100.0	7.3	92.7	20.0	80.0
A.tenius	44.7	55.3	3.2	96.8	25.4	74.6	6.8	93.2
Mean	**43.04**	**56.96**	**1.56**	**98.44**	**16.82**	**83.18**	**12.86**	**87.14**

*L.S.D at 5 % for: Fungi (F) = 3.57, Bio-fertilizers (B) = 4.82, F*B=9.22.*
Post. = Post emergence damping – off

Also, data revealed that the bio-fertilizers reduced disease incidence caused by the tested fungi. Under greenhouse conditions, Microbin was more effective on *R.solani* where it prevented the infection of them and reduced it in both *F. semitectium* and *F.moniliforme*. In this respect, Hassouna *et al.,* 1998; Bhardwaj *et al.,* 2014 and Dhir, 2017 stated that, *Azotobacter brasilensis* and *A. chrococcum* were very effective against the infestation with *R.solani* and *F. oxysporum*. Phosphoren was effective than Microbin in reducing pod of peanut. This effect was attributed to the decrease of population density in the Rhizosphere (Zeidan, 2000). The same trend was recorded by Emara (2005) using Rhizobacterin and Phosphrene.

Also, Brown (2012 and Zaghloul *et al.,* 2007) observed that *Azotobacter* besides the N-fixation was able to produce growth substances and fungal antibiotics, and the response of the crops to the inoculation could be attributed to the substances produced by the organisms. Also, Chung and Wu, 2000 recorded the efficiency of *Bacillus megaterium* var. *phosphaaticum* to control root-rot caused by *R.solani* and the mycelia growth was generally reduced, where some isolates were able to cause a significant reduction in the damping-off of the plants. Also, Potassiumag containing *Bacillus verculanes* was suppressive compared with the control.

The results are in agreement with the findings of Hilal *et al.,* (2003). The same effect was found by Zeidan, 2000 and Emara, 2005. These findings could be interpreted in light that *Bacillus* and Rhizobia increase the plant P uptake, water status inside the plant tissues and hence increases the plant amino acids and activate its rates and enhance the action of succinic and lactic acids which induce the root growth.

5- Effect of bio-agent on onion root-rot incidence

Data presented in Table (8) reveal that the bio product (Bio-zeid, plant guard, Bio-Arc, Rhizo-N and clean root) treatments were effective in decreasing the percentage of disease incidence caused by the root-rot pathogenic fungi. The percentage of disease incidence ranged between 10.5% and 31.3% compared with the control (48.0% to 53.3%). Rhizo-N was most effective which gave 16.46% of post emergence damping-off followed by plant guard which gave 18.56%, while clean-root scored gave 25.68% compared to the control 50.66%.

Recently, chemical control is faced with many difficulties especially what concerned with their efficacy, selectivity, toxicity and general impact on the environment (Nawar, 2005 and Burrows *et al*., 2007). As well as the harmful side effects of the fungicides on human and environment led to searching new means or bio-agents with low toxicity and side effects that can effectively replace the fungicides in controlling plant diseases. Therefore, Bio-Arc (*Bacillus megaterium*), Bio-Zeid (*Trichoderma album*) as biocides play a very useful role as effective and safe means in controlling root-rots. In this respect, similar results were obtained by Chavan *et al.,* (2004) on the positive efficacy of treating with bio-agents, *i.e.* several strains of bacterial bio-agents including *Bacillus megaterium* and also by *Trichoderma* spp., to control damping-off of safflower.

Table 8: Effect of bio-agents on the onion root – rot incidence under greenhouse conditions

Tested fungi	Bio-agents											
	Control		Bio-zied		Plant guard		Bio-Arc		Rhizo-N		Clean root	
	Post.	Sur.	Post.	Sur.	Post.	Sur.	Post.	Sur.	Post.	Sur.	Post.	Sur.
A. niger	50.0	50.0	21.3	78.7	20.2	79.8	25.5	74.5	12.7	87.3	20.3	79.7
F. moniliforme	48.0	52.0	10.5	89.5	15.0	85.0	21.3	78.7	10.8	89.2	28.6	71.4
F. semitectium	52.5	47.5	23.6	76.4	25.6	74.4	28.3	71.7	20.5	79.5	18.0	82.0
R. solani	49.5	50.5	20.3	79.7	18.5	81.5	15.5	84.5	23.3	76.7	31.3	68.7
A.tenius	53.3	46.7	18.2	81.8	13.5	86.5	20.6	79.4	17.5	82.5	30.2	69.8
Mean	**50.66**	**49.34**	**18.78**	**81.22**	**18.56**	**81.44**	**22.24**	**77.76**	**16.96**	**83.04**	**25.68**	**74.32**

*L.S.D at 5 % for: Fungi (F) = 5.23, Bio-agents (B) = 6.33, F*B=12.46.*

6- Effect of different fungicides on onion root-rot disease incidence

The effectiveness of Mancoxyl, Previcure-N, Vitavax, Nando and Akoby on post emergence damping-off was studied by sowing treated plants in the infected soil. Data in Table (9) show that plants treated with Akoby were the least in post emergence damping-off (4.7 %) in case of the inoculated soil with *A.niger* and *A.tenius* (6.5 %) and (6.6%) with *R.solani*.

Table 9: Effect of different fungicides on post-emergence damping-off and survival plants of onion

Tested fungi	Fungicides											
	Control		Mancoxyl		Previcur-N		Vitavax		Nando		Akoby	
	Post.	Sur.	Post.	Sur.	Post.	Sur.	Post.	Sur.	Post.	Sur.	Post.	Sur.
A. niger	48.3	51.7	6.6	93.4	18.2	81.8	20.0	80.0	20.0	80.0	4.7	95.3
F. moniliforme	46.6	53.4	12.5	87.5	21.0	79.0	12.2	88.0	15.6	84.4	10.2	89.8
F. semitectium	49.5	50.5	16.2	83.8	7.3	92.7	13.5	86.5	12.3	87.7	8.8	91.2
R. solani	53.0	47.0	20.3	79.7	20.0	80.0	8.0	92.0	19.5	80.5	6.6	93.4
A.tenius	50.0	50.0	20.0	80.0	16.5	83.5	6.5	93.5	13.3	86.7	6.5	93.5
Mean	**49.48**	**50.52**	**15.12**	**84.88**	**16.60**	**83.40**	**12.0**	**87.96**	**16.14**	**83.86**	**7.36**	**92.64**

L.S.D at 5 % for: Fungi (F) = 2.23, fungicides (Fu) = 3.65, F Fu =8.73.*

Acoby was also highly effective fungicides in managing the tested fungi where damping-off reached (7.36%) followed by Vitavax (12.04 %) and Mancoxyl which gave (15.12%). Treating the onion plants with each one of the five tested fungicides before sowing reduce greatly fungi. Akoby was the best fungicide against all tested fungi, where it gave (4.7%) of post emergence damping-off whereas, the other fungicides were less effective where they gave a post emergence damping-off ranging between 12.04 % and 16.60 % compared with the control.

These results could be attributed to that the fungicides act as a disinfectant around treated plant roots. The systemic properties of the tested fungicides permit the germination plants the ability to absorb the giving fungicides to protect roots of plants against penetration and invasion by fungi. In addition to, the direct effect of the fungicide on the mycelia in the soil around plant. The reduction in the disease incidence using such fungicides might be attributed to less permeability of pathogen cells membrane and to the metabolization of other compounds into toxic product (Olfat *et al*., 2009).

7- Effect of different control approaches on growth and yield parameters of onion plants

The obtained data in Table (10) show that treated with bio-fertilizers (Microbin) caused increase of plant height (72.5 cm), bulb diameter (22.5 cm), bulb weight (162.0 g) and total bulb yield (648 g/pot) compared with other bio-fertilizers treatments while, the treated with fungicide Rhizo-N decreased the bulb diameter (16.0 cm), bulb weight (110.3 g) and total bulb yield (441.2 g/ pot).

Table 10: Some plant growth parameters and yield of onion grown under stress of different control approaches and under natural infection after 90 days.

Control approaches	Plant Height		Bulb diameter		Bulb weight		Total bulb yield (g/pot)
	(cm)	Increase (%)	(cm)	Increase (%)	(g)	Increase (%)	
Physical control							
Microbin	72.5	42.2	22.5	66.7	162.0	72.0	648.0
Phosphoren	65.3	28.0	20.3	50.4	157.4	67.1	629.6
Potassiumag	69.3	35.9	19.1	41.5	123.4	31.0	493.6
Biological control (Biocides)							
Bio-Zied	63.2	23.9	17.1	26.7	120.0	27.4	480.0
Plant guard	61.3	20.2	16.6	23.0	118.0	25.3	472.0
Bio-Arc	55.5	8.0	18.2	34.8	115.2	22.3	460.8
Rhizo-N	62.6	22.7	16.0	18.5	110.3	16.8	441.2
Clean root	65.0	27.5	19.0	40.7	119.0	26.3	476.0
Chemical control (fungicides)							
Mancoxyl	65.0	27.5	20.0	48.1	130.2	38.2	520.8
Previcur-N	28.2	33.1	18.5	37.0	118.3	25.6	473.2
Vitavax	67.0	31.4	16.6	23.0	123.5	31.1	494.0
Nando	70.3	37.8	16.9	25.2	130.0	38.0	520.0
Akoby	69.2	35.7	17.3	28.1	128.3	36.2	513.2
Untreated (control)	51.0	---	13.5	---	94.2	---	377.5
L.S.D. at $_{0.05}$	**3.30**	---	**5.60**	---	**6.70**	---	**22.8**

Natural infection = with the most comment soil borne onion disease

The results show also that, the treated with all treatments, that reflect on the increase in plant height, bulb diameter, bulb weight and total bulb yield compared with untreated after 90 days from sowing. On the other hand, treated with bio-fertilizers the most effective on the growth parameters especially bulb weight and total bulb yield. These results are in harmony with obtained results of (Behroozin and Asad, 1994; Somkuwar *et al*., 1996 and Embaby, 2003).

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