

## COMPARISON BETWEEN THE EFFECT OF SOME PESTICIDES , BIOCIDES AND BIOAGENTS IN CONTROLLING ONION WHITE ROT DISEASE CAUSED BY *Sclerotium cepivorum* (BERK)

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### ABSTRACT

This study was carried out to compare effect of some pesticides and bioagents or biocides in controlling onion root rot disease caused by *Sclerotium cepivorum* (Berk) . In the experiment field four fungicides (triflumizole , benomyl , thiophanate-methyl and dimethomorph) , two herbicides (pendimethalin and butralin) , one insecticides (KZ oil) , four bioagents (*Trichoderma harzianum* , *T. viride* , *Bacillus subtilis* and *Bacillus pumilus*) and four commercial biocides (Plant guard , Biozeid , Bio Arc and Rhizo -N )were applied to control this disease under naturally infested field .The tested compounds were treated as seedling treatment and as spray treatment .The results indicated that fungicides in general were the most effective in reducing disease incidence followed by commercial biocides , herbicides and insecticide (KZ oil) . Also fungicides used were the most effective in increasing plant height , bulb diameter , total soluble solids and yield .The best effective biocides was Plant guard followed by Biozeid, Bio Arc and Rhizo -N in controlling onion white root rot disease . The lowest effect was obtained by KZ oil which used mainly as insecticide and herbicides had moderate effect in controlling the disease.

### INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important crops in Egypt . Onion occupies the third grade among exporting crops to European countries because its high quality . Onion is planted mainly in middle and upper Egypt and recently is planted in northern governorates. Onion plant is attacked by several fungus diseases such as white root rot (caused by *Sclerotium cepivorum* ), basal rot (caused by *Fusarium oxysporium* ) , black mold rot (caused by *Aspergillus niger* ) , purple blotch (caused by *Alternaria porri* ) and others . The white root rot disease considered the most dangerous fungal disease for onion crops because it causes a great damage for onion production . Fungicides were and will be still the most effective method to control this disease (El-Shehaby *et al* .,1992) . But fungicides possessed a risk to the environment and human health . Recently biological control of onion white root rot has been achieved by using numerous micro organisms , (Abd-EL Moity 1976 , Abd-EL Razik *et al* ., 1985 , and Clarkson *et al* ., 2002 ) such as fungi , bacteria and others . In view of hazardous impact of pesticides and other agrochemical on the ecosystem , the biocontrol of plant disease as an alternate strategy received increasing attention in recent years ( Papavizas and Lumsden , 1985; Baker, 1987 and Lookwood , 1988) . About 35 genera of fungal and bacteria species have been used as biocontrol agents against various plant pathogens ( Cook and Baker, 1983). *Trichoderma* spp., *Gliocladium* spp., *Bacillus* spp., and

*Pseudomonas* spp. represent the most thoroughly studied antagonistic microorganisms. The fungal species of *Chaetomium globosum*, *T. harzianum* and *T. virens* were confirmed as antagonists of *Sclerotium cepivorum*. Mclean and Stewart (2000). Ibrahim *et al.*, (2004) used both *Trichoderma* sp. and *Bacillus* sp. to control white root rot disease. Radwan *et al.*, (2006) investigated the antagonistic potential of forty seven local *Trichoderma* strains against the phytopathogenic *S. rolfsii* in dual culture and bioassay on bean plants. They revealed that application of tested strains greatly reduced the disease incidence. Perazzolli *et al.*, (2008) demonstrated the capability of *Trichoderma harzianum* T39 to protect susceptible grapevine cultivars (*Vitis vinifera* cv). Sureyya Altinats, Ugar Bal (2008) studied the effect of commercial based on *Trichoderma harzianum*. On plant, blub and yield characteristics of onion. Pertot *et al.*, (2008) evaluated the efficacy of alternative to chemical fungicide against strawberry powdery mildew to reduce pesticide residues on fruits effective. Biocontrol agents (BCAs), like *Ampelomyces quisqualis*, *Bacillus subtilis* and *Trichoderma harzianum* T39, controlled the disease, but to a lesser extent than chemical fungicides.

This experiment aims :-

- 1-To protect the plants from infestation by onion white root rot disease.
- 2-To control the disease when the plants were infected by *Sclerotium cepivorum*.
- 3-to compare the effect of biocides in controlling the disease by the effect of fungicides, herbicides and other pesticides in this field.

## MATERIALS AND METHODS

### A- Pesticides used:-

Different fungicides, herbicides, mineral oil, isolated microorganisms and commercial biocides were tested to control onion white root rot disease (OWRR) at the farm of Agriculture Faculty, Tanta, Tanta University.

The tested compounds were :

#### (1) Fungicides:

##### a- Triflumizole. (15% E.C)

Chemical Name: 1-((4-Chloro-2-(trifluoromethyl)phenyl)imino)-2-propoxyethyl-1H-imidazole

Common Name : triflumizole

Trade Name : Trifmine.

Molecular Weight : 345.7

Basic Manufacturer: Nippon Soda Co., Ltd, Japan.

##### b- Benomyl. (50% W.P)

Chemical Name: methyl-1-[(butylamino)carbonyl]-H-benzimidazol-2-ylcarbamate

Common name : benomyl.

Trade Name : Benlate.

Molecular Weight : 290.62

Basic Manufacturer: DuPont Agricultural Products

c- Thiophanate-methyl. (70 % W.P)

**Chemical Name:** dimethyl{1,2-phenylenebis (iminocarbonothioyl)  
}bis(carbamate).

**Commen Name** : thiophanate-methyl.

**Trade Name** : Topsin-M.

**Molecular Weight** : 342.4

**Basic Manufacturer** : Nippon Soda Co., Ltd e- Dimethomorph. (50% W.P)

**ChemicalName** : 4-{3-(4-chlorophenyl)- 3- (4,3-dimethoxyphenyl) -1-oxo-2-propenyl}- morpholine.

**Commen Name** : dimethomorph.

**Trade Name** : Acrobat

**Molecular Weight** : 387.9

**Basic Manufacturer:** Cyanamid

(2)Herbicides:-

a- Pendimethalin.( 50% E.C)

**Chemical Name** :N-(1-ethylpropyl)-2,6-dinitro-3,4-xylidine

**Commen Name** : pendimethalin

**Trade Name** : Stomp.

**Molecular Weight** : 281.31

**Basic Manufacture** : American Cyanamid

b- Butralin. ( 48 % E.C)

**Chemical Name:** 4- (1,1-dimethylethyl) -N- (1-methylpropyl) -2,6-dinitrobenzenamine

**Commen Name** : butralin.

**Trade Name** : Amexine

**Molecular Weight** : 295.33

**Basic Manufacture** : Nufarm – Capi company .

B-Biocides used:-

a- Plant guard :

Liquid (30 X 10<sup>5</sup> spores / 1 ml)

Spores of fungi *Trichoderma harzianum*

Rate 3/L 50L water Fed.

Introduced by El-Nasr for biopesticides and fertilizers company (Bio).

b- Biozeid 2.5% , W.P . (30 X 10<sup>6</sup> spores / 1 ml) ,

*Trichoderma album*

Rate 3/L 50L water Fed.

Introduced by El-Nasr for biopesticides and fertilizers company (Bio).

c-Bio Arc. 6% wp containing (32 X10<sup>6</sup> lu / mg) of bacteria *Bacillus megaterium*.

Rate 3/L 50L water Fed.

Introduced by El-Nasr for biopesticides and fertilizers company (Bio).

d- Rhizo –N *Bacillus subtilis* .( E.C 6 %)

Rate 3/L 50L water Fed.

Introduced by El-Nasr for biopesticides and fertilizers company (Bio).

C- Bioagents used :- (fungal and bacterial isolates); include :-

a-Fungi: both *Trichoderma harzianum* and *T. viride* were hindly obtained as culture slants from Department of plant pathology , Faculty of Agriculture at Kafer El- Sheikh, University of Kafer El- Sheikh.



planting . Herbicides pendimethalin was sprayed before onion transplanting, followed by planting and followed by irrigation. Herbicides butralin was directly sprayed on the soil at the recommended dose after onion transplanting followed by irrigation.

In both the two previous experiments , weeds were controlled handly two times (70 and 110 days after transplanting). Random sample of 10 plants were obtained from each plot at 130 days to determine plant height , bulb diameter and total soluble solids (T.S.S) estimated by hand refractometer . At the harvest , the blubs from each plot were collected and weighted . The reduction percent (R%) of each parameter was calculated from the following equation (Topps and Wein , 1957) .

$$R\% = \frac{a - b}{a} \times 100$$

where

a=the measurement of parameter in untreated plot (control).

b= the measurement of parameter in treatment.

Diseases incidence percent (D.I%) was calculated by equation (El-Shafey *et al* , 1988).

$$D.I\% = \frac{\text{No. of infected plants}}{\text{No. of the total plants}} \times 100$$

Disease reduction percent (R%) was calculated by equation:- (El-Shemi , 2003)

$$R\% = \frac{(D.I)_c - (D.I)_t}{(D.I)_c} \times 100$$

Where

(D.I)<sub>c</sub>= disease incidence in control.

(D.I)<sub>t</sub>=disease incidence in treatment .

**Statistical analysis:-**

Data were analyzed statically according to (Steel and Torrie , 1960) . Duncan's multiple range test (DMRT) was applied for comparing mean .

## RESULTS AND DISCUSSION

Results in Tables (1&2) shown the effect of different substances on disease incidence (D.I%) and disease reduction percent (R%) in seedling treatment and spray treatment respectively .

Table (1) Effect of fungicides , herbicides ,mineral oil, bioagents and biocides on disease reduction percent (R%) compared with control in seedling treatments.

Parameters Treatments	Concentrations	Infected plants No.	Healthy plants No.	Disease incidence D.I%	Disease reduction percent (R%)
Control:-	0	85	15	85	---
Fungicides:-					
1- Triflumizole	20 ml/1L water	10.3	89.7	10.3	87.88
2- Benomyl	20 gm/1L water	12.6	87.2	12.6	85.17
3- Thiophanate-methyl	20 gm/1L water	10.3	89.7	10.3	87.88
4- Dimethomorph.	20 gm/1L water	15.9	84.1	15.9	81.13
Herbicides:-					
1- Pendimethalin	20 gm/1L water	40.6	59.9	40.6	52.22
2- Butralin	20 ml /1L water	38.3	61.7	38.3	54.94
Oil:-					
1- KZ oil	20 ml /1L water	53.3	36.7	53.3	37.30
Bioagent:-					
1- <i>T. harzianum</i>	10 <sup>7</sup> spor/1ml	30.3	69.7	30.3	64.35
2- <i>T. viride</i>	10 <sup>7</sup> spor/1ml	35.6	64.4	35.6	58.11
3- <i>B. subtilis</i>	10 <sup>7</sup> cell/1ml	40.9	59.1	40.9	51.88
4- <i>B. pumilius</i>	10 <sup>7</sup> cell /1ml	38.3	61.7	38.3	54.94
Biocides:-					
1- Plant guard	20 ml /1L water	25.6	74.4	25.6	69.88
2- Biozeid	20 gm/1L water	24.9	75.1	24.9	70.70
3- Bio Arc	20 gm/1L water	30.3	69.7	30.3	64.35
4- Rhizo -N	20 ml /1L water	35.3	64.7	35.3	58.47

Table (2) Effect of fungicides , herbicides ,mineral oil, bioagents and biocides on disease reduction percent (R%) compared with control in spray treatments.

Parameters Treatments	Concentrations	Infected plants No.	Healthy plants No.	Disease incidence D.I%	Disease reduction percent (R%)
Control:-		85	15	85	---
Fungicides:-					
1- Triflumizole	1 L / fed.	14.3	85.7	14.3	83.18
2- Benomyl	1 kg / fed.	16.6	83.4	16.6	80.47
3- Thiophanate-methyl	1 kg / fed.	13.6	86.9	13.6	84
4- Dimethomorph.	1 kg / fed.	13.9	86.1	13.9	83.65
Herbicides:-					
1- Pendimethalin	1 kg / fed.	44.3	55.7	44.3	47.88
2- Butralin	1 L / fed.	42.6	57.4	42.6	49.88
Oil:-					
1- KZ oil	1 L / fed.	60.6	39.4	60.6	28.70
Bioagents:-					
1- <i>T. harzianum</i>	3 L / fed.	27.3	72.7	27.3	67.88
2- <i>T. viride</i>	3 L / fed.	32.3	67.7	32.3	56.12
3- <i>B. subtilis</i>	3 L / fed.	35.9	64.1	35.9	57.76
4- <i>B. pumilius</i>	3 L / fed.	32.6	67.4	32.6	61.65
Biocides:-					
1- Plant guard	3 L / fed.	23.6	76.4	23.6	72.24
2- Biozeid	3 kg / fed.	21.9	78.1	21.9	74.24
3- Bio Arc	3 kg / fed.	26.9	77.1	26.9	68.35
4- Rhizo -N	3 L / fed.	31.3	68.7	31.3	63.18

All compounds reduce disease incidence by different ratio . Also (1&2) revealed that triflumizole and thiophanate-methyl were the most effective in controlling onion white root rot disease (OWRR) , were they gave the lowest disease incidence (10.3%) and the highest efficiency percentage (87.88%) in case of seedling treatment . In case of spray treatment thiophanate-methyl was the most effective where (D.1%=13.6) and disease reduction percent was (84%). The lowest effect was obtained by KZ oil which caused disease incidence by (53.3% and 60.6%) and disease reduction percent were (37.3% and 28.7%) in seedling and spray treatments respectively. All tested fungicides were very effective in controlling disease followed by commercial biocides , spore suspension of bioagents , herbicides and kz oil respectively . Among commercial biocides , Biozeid was the most effective where caused disease incidence (24.8% and 21.9%) and disease reduction percent were (70.7% and 74.24%) in both seedling and spray treatments respectively . The effect of bioagents were higher than the effect of herbicides and KZ oil in controlling onion white root rot disease (OWRR), in generally.

The results in Table(3) represent the effect of different treatments on onion plant height and blub diameter in seedling treatment. Data shown that fungicides gave the highest effect in increasing plant height and blub diameter followed by commercial biocides , then bioagents , herbicides and KZ oil respectively. Benomyl increased plant height by (112.81%) and blub diameter by (165.12%) compared with control , while thiophanate-methyl caused increased in plant height (107.38%) and blub diameter (176.44%) compared with control . Plant guard increased plant height and blub diameter by( 83%) and (137.20) respectively compared with control . The lowest effect in increasing plant height and blub diameter was obtained by KZ oil (51.23% and 60.47%).

**Table (3) Effect of fungicides , herbicides ,mineral oil, bioagents and biocides on plant height and bulb diameter in seedling treatment compared with control.**

Parameters	Plant height		Bulb diameter	
	Mean in (cm)	Increasing Plant height percent I%	Mean in (cm)	Increasing Percent I%
Control:-	20.3	----	4.3	----
Fungicides:-				
1- Triflumizole	40.5	99.51	12.6	193.02
2- Benomyl	43.2	112.81	11.4	165.12
3- Thiophanate-methyl	42.1	107.38	11.9	176.44
4- Dimethomorph.	38.3	88.66	10.6	146.51
Herbicides:-				
1-Pendimethalin	36.8	81.28	7.7	79.07
2- Butralin	30.9	52.15	8.9	106.98
Oil:-				
1- KZ oil	30.7	51.23	6.9	60.47
Bioagent:-				
1- <i>T. harzianum</i>	33.3	64.03	9.6	123.25
2- <i>T. viride</i>	34.6	70.44	8.9	106.98
3- <i>B. subtilis</i>	30.9	52.16	9.9	130.23
4- <i>B. pumilus</i>	30.9	52.16	8.8	104.65
Biocides:-				
1- Plant guard	37.3	83.74	10.2	137.20
2- Biozeid	36.6	80.29	9.9	130.23
3- Bio Arc	32.9	62.06	9.4	118.60
4- Rhizo -N	31.9	57.14	11.1	158.13

The results in Table (4) indicate effect of the different treatments on plant height and bulb diameter in spray treatments. The highest effect were obtained by fungicides followed by biocides, bioagents, herbicides and KZ oil. Thiophanate-methyl increased plant height by (104.92%) and bulb diameter by (155.81%). Plant guard increased plant height by (73.17%) and bulb diameter by (123.25%) compared with control, while KZ oil increased plant height by (42.36%) and bulb diameter by (48.83%).

Table (4) Effect of fungicides, herbicides, mineral oil, bioagents and biocides on plant height and bulb diameter in spray treatments

Parameters	Plant height		Bulb diameter	
	Mean in (cm)	Increasing Plant height percent %	Mean in (cm)	Increasing Percent %
Control:-	20.3	-----	4.3	-----
Fungicides:-				
1- Triflumizole	38.3	88.66	11.5	167.44
2- Benomyl	40.4	99.01	11.1	158.13
3- Thiophanate-methyl	41.6	104.92	11	155.81
4- Dimethomorph.	35.3	73.89	9.6	116.27
Herbicides:-				
1-Pendimethalin	34.5	69.95	7.2	67.44
2- Butralin	35.4	74.38	8.1	88.37
Oil:-				
1- KZ oil	28.9	42.36	6.4	48.83
Bioagent:-				
1-T. harzianum	31.6	55.66	8.9	106.98
2-T. viride	30.3	49.26	8.2	90.69
3-B. subtilis	29.3	44.33	9.1	111.62
4-B. pumilius	28.2	38.91	8.1	88.37
Biocides:-				
1- Plant guard	35.5	73.17	9.6	123.25
2- Biozeid	34.4	69.45	9.2	113.95
3- Bio Arc	31.4	55.66	8.9	106.96
4- Rhizo -N	30.9	52.21	10.3	139.53

The results in Table (5) revealed that all treatments increased both total soluble solids and bulb yield in seedling treatment. Triflumizole, benomyl, thiophanate-methyl, dimethomorph, Plant guard, Biozeid and KZ oil were increased yield by 301%, 289.52%, 283.80%, 274.28%, 269.52%, 249.52% and 158.38% respectively in seedling treatment.

The results in Table (6) were indicated that the highest yield obtained by triflumizole (291.92%) followed by benomyl (274.28%), thiophanate-methyl (274.28%) .... Etc. and KZ oil (130.47%) compared with control in spray treatments.

**Table (5) Effect of fungicides , herbicides , mineral oil, bioagents and biocides on total soluble solids and bulb yield in seedling treatment.**

Parameters	T. SS		Yield	
	mg	Increasing Percent I%	Kg/plot	Increasing Percent I%
Control:-	6.3	---	10.5	---
Fungicides:-				
1- Triflumizole	11.3	79.36	42.2	301.90
2- Benomyl	12.4	96.82	40.9	289.52
3- Thiophanate-methyl	12.6	100	40.3	283.80
4- Dimethomorph.	10.5	66.66	39.3	274.28
Herbicides:-				
1-Pendimethalin	8.7	38.09	35.5	238.09
2- Butralin	9.3	47.61	30.5	190.47
Oil:-				
1- KZ oil	7.1	12.69	26.5	152.38
Bioagent:-				
1- <i>T. harzianum</i>	8.9	41.26	36.9	251.42
2- <i>T. viride</i>	8.8	39.68	33.8	221.90
3- <i>B. subtilis</i>	7.5	19.04	31.6	200.95
4- <i>B. pumilius</i>	7.6	20.63	32.9	213.33
Biocides:-				
1- Plant guard	9.8	55.55	38.8	269.52
2- Biozeid	10.3	63.49	36.7	249.52
3- Bio Arc	9.9	57.14	35.9	241.90
4- Rhizo -N	10.4	65.07	35.3	236.19

**Table (6) Effect of fungicides , herbicides , mineral oil, bioagents and biocides on total soluble solids and bulb yield in spray treatments**

Parameters	T. SS		Yield	
	mg	Increasing Percent I%	Kg/plot	Increasing Percent I%
Control:-	6.3	---	10.5	---
Fungicides:-				
1- Triflumizole	11.1	76.19	41.1	291.42
2- Benomyl	11.2	77.77	39.3	274.28
3- Thiophanate-methyl	10.9	73.01	38.2	263.80
4- Dimethomorph.	10.2	61.90	37.6	258.09
Herbicides:-				
1-Pendimethalin	8.1	28.57	33.5	219.04
2- Butralin	8.9	41.26	28.9	175.23
Oil:-				
1- KZ oil	6.8	7.93	24.2	130.47
Bioagent:-				
1- <i>T. harzianum</i>	8.1	28.57	33.6	220
2- <i>T. viride</i>	8.3	31.74	31.9	203.80
3- <i>B. subtilis</i>	7.1	12.69	30.2	193.13
4- <i>B. pumilius</i>	6.9	9.52	30.9	194.28
Biocides:-				
1- Plant guard	9.6	52.38	36.5	247.61
2- Biozeid	9.7	53.96	34.2	225.71
3- Bio Arc	9.4	49.20	34.5	228.67
4- Rhizo -N	10.1	60.31	33.9	222.85

In general the effect of all treatments on disease incidence and phytotoxicity (plant height , bulb diameter , total soluble solids and yield) as seedling treatment was higher than the effect of all treatments when used as spray treatment.

In conclusion fungicides were the most effective in controlling onion white root rot disease hence they gave the the lowest disease incidence and the highest efficiency percentage , also , increased plant height , bulb diameter , total soluble solids and yield compared with other treatment and control .Commercial biocides comes after fungicides in its effect . Biocides such as Plant guard , Biozeid , Bio Arc and Rhizo -N were effective in controlling disease and in increasing plant height , bulb diameter , T.S.S and yield compared with herbicides ,K Z oil , fungal and bacterial isolates and control , but less than fungicides.

Biocontrol agents (BCAS) may act directly on plant pathogens by one or more mechanisms (Narayanasamy , 2001):

- 1-Antibiosis is the ability to inhibit or destroy the pathogen by producing toxic metabolites.
- 2-Competition between the antagonist and the pathogen for essential food material such as carbohydrates , nitrogen or growth factors may occur , resulting in retarded development of the pathogen.
- 3-Parasitism of the pathogen by an antagonist may result in necrosis or death of the pathogen .
- 4-Disease suppression may be due to prevention of colonization by the pathogen.
- 5-Induction of resistance in host plants by biocontrol agents.

(Bilal 1963) reported that *Trichoderma* spp could secrete antibiotic (gliotoxin) able to affect the pathogen without any hyphal contact *Trichoderma* spp. are known to affect the host pathogen by more than one mechanism . It may hyperparasitize invading the host and causing lyses to the inside cells (El-Assiuty *et al.*,1986) . This antagonist can also affect the host by producing the antifungal substance ; gliotoxin the posions and inhibits the growth of the pathogen remotely. This substance probably affects the respiratory sites of the host fungus and causes reduction in the mycelial growth as suggested by (Hadler *et al.*, 1973) ; *B.Subtilis* produces several antibiotics such as subtilin , bacilin , abacillomycin , subtenplin ..... etc . which may affect the growth of pathogens (Loeffler *et al.*, 1986).

Kowall *et al.*, (1998) mentioned that *Bacillus subtilis* and *Bacillus pumilius* are produced antibiotics such as surfactin , fengycin , mycosubtilin and bacillomycin . Naruse *et al.* , (1992) suggested that *Bacillus pumilius* secrete antibiotics such as surfactin and bacillomycin.

Finally , fungicides remaine and will remaine the strongest in it effect in controlling onion white root rot disease in spite of its problems . The commercial biocides are active in controlling the disease but need to more time and more studies to increase its efficiency in controlling disease .

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مقارنة بين تأثير بعض المبيدات الكيميائية والمبيدات الحيوية وبعض المواد الحيوية في مكافحة مرض العفن الأبيض في البصل الناشئ عن فطر

### *Sclerotium cepivorum*

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حررت هذه التجربة لمقارنة تأثير بعض المبيدات الكيميائية والمبيدات الحيوية التجارية أو العوامل الحيوية في مكافحة مرض العفن الأبيض في البصل الناشئ عن فطر *Sclerotium cepivorum* . وقد استخدمت في هذه المقارنة أربعة مبيدات فطرية و اثنين من مبيدات الحشائش ومبيد حشري وأربعة عزلات فطرية وبكتيرية وأربعة مبيدات تجارية حيوية بغرض مكافحة مرض العفن الأبيض في البصل وبغرض دراسة السمية النباتية لها عن طريق معاملة الشتلات بالغمر أو عن طريق الرش في حقول مصابة بالقطر بطريقة طبيعية . اوضحت النتائج المتحصل عليها أن جميع المبيدات الفطرية كانت الأعلى تأثير في خفض نسبة الإصابة بالقطر وزيادة أعداد النباتات السليمة وزيادة ارتفاع النبات وقطر البصلة ونسبة المادة الصلبة الكلية الذاتية وكذلك المحصول . واحتلت المرتبة الثانية جميع المبيدات الحيوية التجارية وكان تأثيرها أعلى من جميع المعاملات الأخرى فيما عدا المبيدات الفطرية . واحتلت العزلات الميكروبية والفطرية والبكتيرية المرتبة الثالثة تليها مبيدات الحشائش ثم الزيت المعدني KZ oil كان أقل المواد المستخدمة تأثيراً.