Egyptian J. Desert Res., 52, No.1 , 113-126 (2002)

EFFECT OF N_2-FIXING BACTERIA AND ACTINOMYCETES AS BIOFERTILIZERS ON GROWTH AND YIELD OF CUCUMBERS IN SANDY SOILS IN EGYPT

Amer M.M.; M.A. Swelim; Bouthaina F. Abd El-Ghany* and Amal M. Omar*

Bot. Dept., Fac. of Sci., Benha, Zagazig Univ., Egypt.

*Soil Fertility and Microbiology Dept., Desert Research Center, El-Matareya, Cairo, Egypt.

A greenhouse experiment was carried out to study the effect of inoculation with the most active strains of *Azotobacter*, *Azospirillum* and *Streptomyces* on the total microbial counts, growth parameters of cucumbers, disease severity pre and post emergence damping off and survival of the plants.

Generally, inoculation with these strains increased the soil microbial activities, decreased the harmful effect of *Rhizoctonia solani* on both microbial and growth parameter of cucumbers (plant height, root length, fresh and dry weight, number of flowers and fruits, weight of fruits, chlorophyll content and nitrogen and protein percent in fruits).

Streptomyces lydicus (N_{cul}) gave the highest reduction in disease severity pre and post emergence damping off but *Azotobacter chroococcum* (R_f) and *Azospirillum lypoferum* (K_{cul}) gave the highest effect on the improvement of the growth parameter and survival of cucumber plants.

The used strains as a tri mixture also exhibited high reduction of disease severity together with an increase of the growth and yield of the plants.

Keywords: *azotobacter chroococcum, azospirillum lipoferum, streptomyces lydicus, rhizoctonia solani,* root-rot, damping off.

Desert soils are generally poor in their organic matter content which serves as a source of energy for the development of microorganisms and supplying them with essential nutrients (Bear, 1965 and Ishac, *et al.*, 1986 b).

In Egypt, plant production is carried out in reclaimed soils, particularly in sandy soils which suffer from structural, nutritional problems, water scarcity and alkaline pH values. The use of organic manure can improve such soils. Also, much attention was given to biofertilizer

technology for increasing agricultural production in order to limit the use of chemical fertilizers and the pollution. In particular seed inoculation by different types of bacteria has been discussed (Abd El-Ghany, 1994 and Hassouna, *et al.*, 1998).

Micro organisms that colonize roots are ideal as biocontrol agent of soil borne disease (Nemme, *et al*,. 1996 and Schloter and Hartmann, 1998).

Biofertilization techniques either by single or mixture of N_2-fixing bacteria, led to maximize the count and activity of such microorgansims for organic decay and mineralization, which is essential for nutrient availability for plants which inturn enhances plant growth in desert soil (Vlassak and Reynders, 1980 and Abd El-Ghany, 1994 and 1996).

Actinomycetes also act as a biofertilizer agent and soils treated with *Streptomyces* showed better development of cucumber, with plants healthier in appearance and higher in fruit yield compared with controls (Turhan, 1981 b and Tahvonen and Avikainen, 1990).

The objective of this study is to evaluate the effect of rhizospheric microorganisms as biofertilizers on the growth and yield of cucumbers grown in sandy soils.

MATERIALS AND METHODS

The experiment had been done in pots under greenhouse conditions in the year 2000 at Desert Research Center, Cairo, by using sandy soil as described in table (1) (Richards, 1954). Sheep manure as organic fertilizer was mixed with the experimental soil month before cultivation at the rate of 1.0 % (100 g pot^{-1}).

TABLE (1). The analysis data of the applied soil and organic manure.

Treatment	Depth (cm)	Coarse sand	Fine Sand	Silt	Clay	soil texture
	0-15	59.00%	40.00%	0.57%	0.43%	Sandy

							Cation meq$^{l/L}$				Anion meq$^{l/L}$			
10^{th} Ramadan soil	pH	E.C mmohs/cm	O.M.%	O.C.%	T.N.%	C/N ratio	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl	So_4^{--}
	7.6	1.7	0.09	0.052	0.014	3.7	5.7	1.8	9.8	0.7	0.0	3.4	11.4	3.1
Organic Manure	7.8	-	29.82	17.23	1.32	13.0	Moisture content % 29							

E.C. = Electric conductivity. O.M. = Organic matter.
O.C. = Organic carbon. T.N. = Total nitrogen.

For each treatment, 12 pottery pots (40cm diameter) were filled with 10 kg air dried sheep manured soil. Superphosphate (15.5%P_2O_5) was applied at the rate of 150 Kg/fed (1.5 g pot^{-1}). All treatments received the same rates of N and K fertilizers at the rates of 300 Kg N/fed (39 pot^{-1}) in the form of NH_4NO_3 (33.5% N) at 3 equal doses after 15, 30 and 50 days of sowing. Potassium was added at the rate of 100 Kg K_2SO_4 / fed (19 pot^{-1}) before flowering stage.

The fungal inoculum *(Rhizoctonia solani)* isolated from rotted roots of cucumber plants was added to the soil at the rate of 5% (500 g pot^{-1}). The infected soil was watered and mixed thoroughly for two weeks before cultivation to ensure growth and distribution of the inoculant fungus. Control pots were treated with the same amounts of sterilized sandy soil water medium without fungal inoculation.

Fresh liquid culture of pure local strain of either *Azotobacter chrococcum, Azospirillum lipoferum* or *Streptomyces lydicus* isolated from rhizosphere of different plants at different localities, purified and identified according to Bergy's Manual (1974 and 1984) was used as a biofertilizer in the form of single strain, or mixture of two or three strains at the rate of $\simeq 10^8$ colony forming unit (cfu)/ml. Cucumber seeds provided from Agriculture Research Center (cuccumis stivus – Pathandra f. Hybrid Japan) were washed and immersed for 30 minutes in liquid culture of the tested bacteria and actinomycetes as mentioned before. C.M.C. (0.5%) was used as an adhesive agents. Seeds were then dried at 30°C for two hours.

A number of ten treated cucumber seeds were sown in each pot and also untreated seeds sown by the same manner and used as control. After seedling, each pot was thinned later into 5 seedlings. Pots were directly irrigated to provide a suitable moisture for *inocula.*

Treatments under this study can be summarized as follows:

I- Uninoculated and uninfected soil (control)

Treatments and uninfected soil

1- *Azospirillum lipoferum* K_{cl} with the capacity of N_2- fixation (133 ppm).
2- *Azotobacter chrococcum* R_f with efficiency of N_2- fixation (210 ppm).
3- Mixture of 1 +2.
4- *Streptomyces lydicus* N_{cul}
5- Mixture of 1 +4.
6- Mixture of 2+4.
7- Mixture of 1 + 2+ 4.

II- Uninoculated and infected soil with *Rhizoctonia solani* (control).

All previous treatments (1-7) were applied with soil infected with *R. solani.*

The same treatments were made in plastic cups (10 cm diagmeter) to record the percentage of pre - and post - emergence damping off and number of survival plants 30 days after planting.

Microbial analysis of the soil and morphological characteristics of cucumber plants were determined at intervals of 30, 50, 70 and 90 days of planting, these periods represent vegetating, flowering, fruiting and harvesting stages of plant growth, respectively.

Microbial Counts

Modified Ashby's, semi solid malate and starch nitrate media were used for isolation of *Azotobacter*, *Azospirillum* and *Streptomyces*. isolates respectively from rhizosphere samples collected at different stages of plant growth to determine their densities for cucumber plants.

Disease Severity Index (DSI)

It was determined using the formula applied by Meshram and Jager (1983).

Parameters Measured of Cucumber Plants

- Shoot and root length (cm plant^{-1}).
- Fresh weight of shoots and roots (gm/plant^{-1}).
- Dry weight of shoots and roots were recorded after oven drying at 70°C until reaching a constant weight following Black *et al.* (1965).
- Number of flowers and fruits per plant.
- Fruit fresh weight.
- Chlorophyll content was measured with a Minolta chlorophyll meter (SPAD-502) to determine the total chlorophyll in fresh leaves.
- Total nitrogen and total protein percentage of fruit were measured by the application of the Kjeldahl method as described by Jackson (1958).

Statistical Analysis

Data were subjected to statistical analysis using the method described by Snedecor (1966). The least significant difference (LSD) was used to differentiate means (Waller and Duncan, 1969).

RESULTS

Total Microbial Counts

It was observed from the results given in table (2) that the microbial count increased gradually towards the fruiting stage then decreased at harvesting stage of cucumber plant. Inoculation with biofertilizer agents individual or in a mixture di - or tri - stimulated the microbial growth in both infected and uninfected cultivated sandy soil to a considerable extents. The highest total microbial count was noticed in inoculated treatment with a bacterial mixture in uninfected and infected soil being 276, 240 x 10^4 cfu/gm dry soil, respectively comparing with controls being 128, 112 x 10^4 cfu/gm dry soil at fruiting growth stage, respectively.

TABLE (2). Effect of inoculation with biofertilizer agents and infection with *R. solani* on total microbial counts *(Azotobacter, Azospirillum and Streptomyces)* in the rhizosphere of cucumber plants (counts x 10^4 CFU g^{-1} dry soil).

Biofertilizer agents	Stages of plant growth							
	vegetating		flowering		fruiting		harvesting	
	uninfec.	infected	uninfec.	infected	uninfec.	infected	uninfec.	infected
Control*	77	70	108	100	128	112	118	106
Azospirillum	130	90	136	120	160	148	148	134
Azotobacter	124	94	152	128	188	180	170	154
Azospirillum + *Azotobacter*	188	162	180	174	276	288	227	201
Streptomyces	133	96	148	118	152	140	150	129
Azospirillum + *Streptomyces*	152	148	176	154	232	200	204	177
Azotobacter + *Streptomyces*	140	113	177.2	140	192	148	184.6	144
*Mixture***	192	180	240	196	276	240	258	218

* Control : Uninoculated

** Mixture : *Azotobacter* + *Azospirillum* + *Streptomyces.*

Effect of Biofertilizer Agents on Disease Severity Index (DSI) of Cucumber Plants Infected with *R. Solani*

The results obtained from table (3) show that the highest reduction for DSI was giving by *Streptomyces lydicus* (55.5%) followed by *Azospirillum lipoferum* 61.1 and *Azotobacter chroococcum* (63.8%). For *Azotobacter* + *Azospirillum* , the reduction of DSI was 58.3%. Addition of *Streptomyces* strain to *Azotobacter* or *Azospirillum* singly or in a mixture decreased DSI between 52 – 50% (Fig. 1).

TABLE (3). Effect of inoculation with biofertilizer agents and infection with *R. solani* on the disease severity index (%) of cucumber plants.

Biofertilizer agents	#DSI (%)	
	Value	% of control
Control*	75	100
Azospirillum	61.1	81.4
Azotobacter	63.8	85
Azospirillum + *Azotobacter*	58.3	77.7
Streptomyces	55.5	74
Azospirillum + Streptomyces	50	66.6
Azotobacter + Streptomyces	52	69.3
*Mixture***	50	66.6

*Control : Uninoculated

**Mixture : *Azotobacter* + *Azospirillum* + *Streptomyces.*

#DSI : Disease severity index.

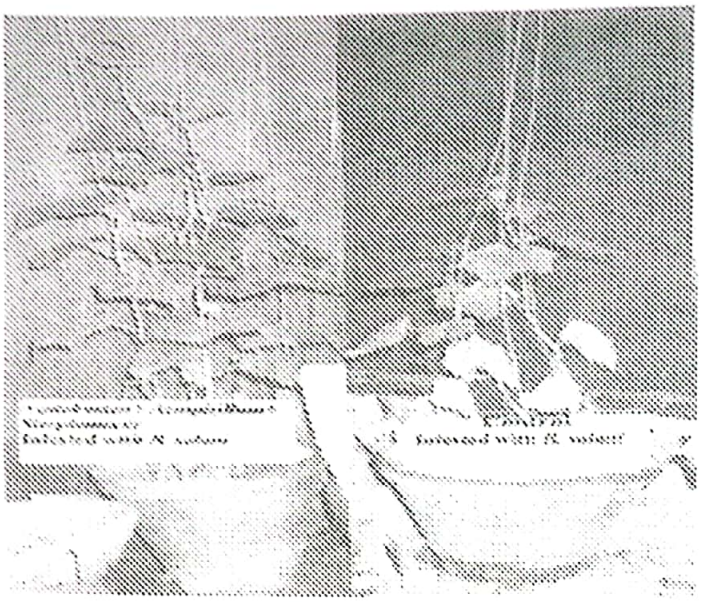

Fig. (1). Effect of inoculation with a biocontrol agents on the cucumber plant infected with *R. solani*

Effect of Inoculation on Percentage of Pre - and Post- Emergence Damping off and Survival Plant

The obtained results from table (4) proved that *R. solania* gave the highest pre- and post- emergence damping off (60 and 20%, respectively) and the lowest survival plants (20%). Biofertilization with N_2-fixers individual or as a mixture with *Streptomyces lydicus* strains reduced the harmful effect of the pathogenic fungus on cucumber plants by reducing the pre - and post - emergence damping off, root rot diseases to reach the lowest value of zero and 20% and increase survival plant to 60-70% compared to control.

TABLE (4). Effect of inoculation with biofertilizer agents and infection with *R. solani* on the percentage of pre - and post - emergence damping off and survival of cucumber plants.

Biofertilizer agents	Pre-emergence damping off	Post- emergence damping off	Survival plants
Control*	60	20	20
Azospirillum	20	30	50
Azotobacter	50	10	40
Azospirillum + Azotobacter	20	30	50
Streptomyces	40	5	55
Azospirillum + Streptomyces	10	20	70
Azotobacter + Streptomyces	20	20	60
*Mixture***	20	10	70

*Control : Uninoculated

**Mixture : *Azotobacter + Azospirillum + Streptomyces.*

Plant Characteristics

Shoot and root length

The obtained results in table (5) indicated that the effect of *R. solani* can be significantly reduced by inoculation. Treated cucumber plants with mixed inoculation generally produced significantly higher length of shoot and root followed by *Azotobacter* and *Azospirillum* and the lowest with *Streptomyces*. The maximum root length was obtained at harvesting stage of plant growth.

TABLE (5). Statistical mean effects of stages, infection with *R. solani* and inoculation with biofertilizer agents on shoot and root length of cucumber plants.

Factors		Shoot Length	Root Length
Stages	Vegetative	32.939 d	15.764 d
	Flowering	69.604 c	21.818 c
	Fruiting	94.710 b	28.412 b
	Harvesting	119.995 a	34.268 a
Uninfected	Control	68.583 g	20.291 fg
	Azospirillum	83.925 de	26.533 cd
	Azotobacter	85.133 d	27.916 cd
	Azospirillum + Azotobacter	99.633 b	30.133 b
	Streptomyces	73.425 f	26.316 d
	Azospirillum + Streptomyces Azotobacter	97.658 b	30.608 b
	+ Streptomyces Mixture	92. 091 c	28.141 c
		103.99 a	33.308 a
Infected	Control	55.016 i	15.875 h
	Azospirillum	65.175 gh	20.5 f
	Azotobacter	66. 757 gh	20.991 f
	Azospirillum + Azotobacter	80.716 e	26.708 cd
	Streptomyces	63.6 h	18.783 g
	Azospirillum + Streptomyces Azotobacter	76.3 f	24.541e
	+ Streptomyces Mixture	74.116 f	23.041 e
		83.058 de	26.736 cd

Mean representing the effect of each factor on a particular parameter and not followed by the same letter are significantly different by Duncan's multiple range test ($P < 0.05$).

Shoot and root weight

Data in table (6) showed that shoot and root fresh or dry weights significantly increased towards harvesting stage of plant growth. Application of biofertilizer agents (especially mixed of *Azotobacter* and *Azospirillum)* significantly reduces the negative effect of *R. solani* on plant growth. These treatments recorded significantly the highest weights and the lowest ones with the single inoculation.

Flowering and fruiting

The results given in table (7) obviously revealed that inoculation with a mixture of the studied strains increased cucumber flowers and fruits number in uninfected soil comparing with infected one 54.6 and 39.3 flowers/plant and 22.7 and 16 fruits/ plant. Data showed the positive effect

of such organisms as biofertilizers on number of flowers and fruits of cucumber plants in the same time.

TABLE (6). Statistical mean effects of stages, infection with *R. solani* and inoculation with biofertilizer agents on fresh and dry weight of shoot and root of cucumber plants.

Factors		Shoot F.W.	Shoot D. W.	Root F.W.	Root D. W.
Stages	Vegetative	11.077d	1.140 d	2.344 d	0.451d
	Flowering	23.947c	2.564 c	3.129 c	0.563 c
	Fruiting	29.258b	3.025 b	3.739 b	0.689 b
	Harvesting	34.802a	3.507 a	4.364 a	0.822 a
Uninfected	Control	20.558 gh	2.205 ij	2.916 f	0.501 h
	Azospirillum	25.633 e	2.522 efg	3.466 de	0.628 ef
	Azotobacter	25.991e	2.667 e	3.358 e	0.695 d
	Azospirillum + Azotobacter	32.95 a	3.340 b	4.408 ab	0.843 ab
	Streptomyces	22.618 f	2.246 ij	3.219 e	0.565 g
	Azospirillum + Streptomyces	31.358 b	3.155c	4.25 b	0.801 bc
	Azotobacter + Streptomyces	28.891 c	2.951 d	3.808 c	0.780 c
	Mixture	34.091 a	3.599 a.	4.641 a	0.895a
Infected	Control	16.417 l	1.725 l	2.202 h	0.365 j
	Azospirillum	19.791 h	2.12 jk	2.651 fg	0.487 h
	Azotobacter	21.2 g	2.304 hij	2.657 fg	0.466 hi
	Azospirillum + Azotobacter	25.391 e	2.583 ef	3.675 cd	0.674 def
	Streptomyces	19.725 h	1.993 k	3.275 e	0.420 I
	Azospirillum + Streptomyces	22.875 f	2.481 fgh	3.275 e	0.641 def
	Azotobacter + Streptomyces	21.358 g	2.372 ghi	2.608 g	0.625 f
	Mixture	27.291 d	2.692 e	3.758 c	0.685 de

Mean representing the effect of each factor on a particular Parameter and not followed by the same letter are significantly different by Duncan's multiple range test ($P < 0.05$).
D.W.= Dry Weight
F.W. = Fresh Wieght

For cucumber fruit weight, the lowest one was 83.9 gm in control infected soil significantly increased to 201.6 gm using a mixture of such organisms. For the uninfected one, the fresh weight significantly increased from 165.2 gm to 297.3 gm in control and using a mixture biofertilizer treatment, respectivley. Weight of fruits significantly decreased under single inoculation as indicated in table (7).

Chlorophyll content

Chlorophyll contents in fresh leaves were determined at different stages of cucumber plant growth (Table 8). The highest chlorophyll content was at flowering stage in uninfected soil (47.9%) using a mixture of inoculation but the lowest one was 44% with *Streptomyces* inoculation comparing with control (35.6%) but infected control soil was 33.3%.

TABLE (7). Effect of inoculation with biofertilizer agents and infection with *R. solani* on the number of flowers, fruits and weight of fruits of cucumber plants.

Biofertilizer angents	Number of flowers Plant^{-1}		Number of fruits Plant^{-1}		Weight of fruits Plant^{-1} (g)	
	uninfected	infected	uninfected	infected	uninfected	infected
Control	35f	52.2 g	14de	7.3 f	165.2 e	83.9 f
Azospirillum	42.3bc	33.3 f	20.3 b	13.3 e	243.6 be	155.6 e
Azotobacter	43b	34 f	20b	13.2 e	246 cd	153 e
Azospirillum + *Azotobacter*	54.5a	39 cde	22.6a	15.7 cd	289.2 a	188.5 de
Streptomyces	41.3 bc	33.3f	17 c	13.2 e	212.5 cd	158.4 de
Azospirillum + *Streptomyces*	52a	36.9def	22ab	14.6 de	286 a	185.4 de
Azotobacter + *Streptomyces*	43 bc	35.3ef	20 b	14.3 de	264 ab	180 de
Mixture	54.6a	39.3cd	22.7 a	16 cd	297.3a	201.6 d
L.S.D. 0.05	3.89		1.909		32.561	

Total nitrogen and total protein of fruits

It is obvious from the data presented in table (9) that biofertilizer agents singly or as a mixture significantly increased total N and total protein comparing with control and reduced the negative effect of *R. solani.*

The highest total N and protein of cucumber fruits cultivated in uninfested soil treated with mixture strains were 1.52 and 9.5% but the lowest ones were 1.18 and 7.37% with *Streptomyces* inoculation as compared with controls (1.15 and 7.18%) for total N and protein, respectively.

In contrast, in infected soil, total N and total protein percentages decreased to 1.4 and 8.75% in a mixture treatment comparing with control infected soil (0.09 and 6.87%) and the lowest effect was 1.1 and 6.25% under *Streptomyces* inoculation, respectively.

DISCUSSION

Root rot and damping off diseases are considered to be one of the most dangerous problems facing cucumber growers due to the great damage of infecting seedlings.

In this work, application of biofertilizer was conducted with cucumber in order to control such diseases and improve the growth and production.

The obtained results proved that N_2-fixers *Azotobacter chroococcum* and *Azospirillum lipoferum* and *Streptomyces lydicus* strains significantly reduced the harmful effects of the pathogenic fungus *(Rhizoctonia solani)* on cucumber plant and disease severity of infected plant. The highest significant

reduction in disease severity was obtained in the presence of *Streptomyces lydicus* and also the survival plant increased more than those treated with *Azotobacter chroococcum* and / or *Azospirillum lipoferum* or as a mixture. In this respect, Song *et al.* (1998) and Chamberlain and Crawford (1999) reported that *Streptomyces* sp. produced antibiotics which controlled root-rot diseases caused by *R-solani*. Also, Kundu and Nandi (1984) stated that the reduction of damping off caused by *R. solani* with *Streptomyces arenae* and *Streptomyces chibaensis* is due to increase population of the *Streptomyces* spp. leading to lower population of *R. solani*.

TABLE (8). Many effects of stages, infection with *R. solani* and inoculation with biofertilizer agents on total chlorophyll content of cucumber plants.

Factors		Total Chloorophyll content
Stages	Vegetative	37.170 bc
	Flowering	41.112 a
	Fruiting	38.2b
	Harvesting	35.869 c
Uninfected	Control	34.016 f
	Azospirillum	41.925 ab
	Azotobacter	41.658 ab
	Azospirillum + Azotobacter	40.908 abc
	Streptomyces	38.616 cd
	Azospirillum + Streptomyces	41.791 ab
	Azotobacter + Streptomyces	41.794 ab
	Mixture	43.791 a
Infected	Control	29.875 g
	Azospirillum	25.075 ef
	Azotobacter	36.233 def
	Azospirillum + Azotobacter	37.141 de
	Streptomyces	36.975 def
	Azospirillum + Streptomyces	34.55 ef
	Azotobacter + Streptomyces	36.175 def
	Mixture	38.88 bcd

Mean representing the effect of each factor on a particular parameter and not followed by the same letter are significantly different by Duncan's multiple range test ($P < 0.05$).

TABLE (9). Effect of inoculation with biofertilizer agents and infection with *R. solani* on the total nitrogen and total protein percentage of fruits cucumber plants.

Biofertilizer agents	Total N% of fruits		Total protein % of fruits	
	uninfected	infected	uninfected	infected
Control	1.15 fgh	1 h	7.18 fgh	7.25 h
Azospirillum	1.47 ab	1.22 efg	9.18 ab	7.62 efg
Azotobacter	1.3 def	1.26 efg	8.12 def	7.87 efg
Azospirillum + Azotobacter	1.5 ab	1.4 cde	9.37 ab	8.75 cde
Streptomyces	1.18 fgh	1.1 gh	7.37 fgh	6.87 gh
Azospirillum + Streptomyces	1.42 bcd	1.36 def	8.87 bcd	8.5 def
Azotobacter + Streptomyces	1.47 ab	1.16 fgh	9.18 ab	7.25 fgh
Mixture	1.52 a	1.4 cde	9.5 a	8.75 cde
L.S.D. 0.05	0.2113		1.312	

With respect to the microbial count, the results showed that the rhizospheric organisms increased during plant growth reach its maximum at flowering stage, then decreased towards harvesting. This may be due to the shortage of biological nitrogen during the maturity stage of plant growth these results were in agreement with that obtained by Nelson (1983).

The results also exhibited that "biofertilizers biocontrol agents" protect plants from the pathogen infection to different extents and in the same time shows a considerable increase in plant growth and yields e.g. plant height, root length, fresh and dry weight, number of flowers and fruits and weight of fruits, chlorophyll content, nitrogen and protein percent at vegetative, flowering, fruiting and harvesting stages of the plant growth. These results are in line with the finding of Tahvonen (1988) who found that seed treatment with powdery preparation of *Streptomyces* not only control root diseases but also increase yield of cucumber and carnation (10 – 30%).

The positive influence of N_2-fixers (*Azotobacter* and *Azospirillum*) on plant development can be atributed not only to the N_2-fixation process but also to the production of growth promoting substances and the production of antifungal antibiotics (Chet *et al.* 1990 and Kloepper 1992).

REFERENCES

Abd El-Ghany, Bouthaina F. (1996). Influence of different bacterial strains as biofertilizers on wheat crop production in new cultivated land. *Desert Inst. Bull., Egypt*, 46: 235 – 247.

Abd El-Ghany, Bouthaina F. (1994). Effect of biofertilization and chemical fertilizers on soil microbial properties and fodder beet production under calcareous soil conditions. *Desert Inst. Bull., Egypt.*, 33(2): 247 – 262.

Bear, F. E. (1965). In "*Chemistry of the Soil*". Reinhold publishing corporation, New York.

Bergey's Manual of Systematic Bacteriology (1984). In "*Gram Negative Aerobic Rodsand Cocci*". (Krieg N.R. and J.G. Holt, eds), Williams & Wilkins, Baltimore, U.S.A. Vol. 1, section 4. p220-229.

Bergey's Manual of Determinative Bacteriology (1974). 8th ed. (Buchanan, R.E. and N.E. Gibbons, eds). Williams and Wilkins Company, Baltimore, USA. 748, 752, 781, 794, 800-801, 303, 818-819.

Black, C.A.; D.D. Evans; L.E. Ensminger; J.L. White and F.E. Clarck (1965). In "*Methods of soil analysis: water capacity*" part 1. Chap. 18. (Klute A., ed.). ASA Monograph series No. 9, Amer. Soc. Agron. Madison, Wisconson, U.S.A.

Chamberlain, K. and D.L. Crawford (1999). In vitro and in vivo antagonism of pathogenic turfgrass fungi by *Streptomyces hygroscopicus* strains YCEDg and WYE 53. *Journal of Industrial Microb. and Biotech.*, 23 (1): 641 – 646.

Chet, I.A.; R. Ordentich and A. Oppenheim (1990). Mechanisms of biocontrol of soil borne plant pathogen by *Rhizobacteria. Plant and Soil,* 129: 85 – 92.

Hassouna, M.G.; M.A.M. El-Saedy and H.M.A. Saleh (1998). Biocontrol of soilborne plant pathogens attacking cucumber (cucumis) sativus by *rhizobacteria* in a semi arid environment. *Arid soil Research and Rehabilitation*, 12 (4): 345 – 357.

Ishac, Y.Z.; M. El-Haddad; M.A. L. Borollosy; Wedad, M.G.Z. E-Eweda and Girgis (1986 b). Studies on *Azospirillum* in Egypt densities as affected by some ecological factors. *2nd Conf. of the AABNF, Cairo, Egypt*, 450 – 468.

Jackson, M.L. (1958). *Soil-chemical analysis.* Prentice-Hall, Inc., England, Cliffs, p 219 – 221.

Kloepper, J.W. (1992). In "*Soil Microbial Technologies: Plant growth promoting rhizobacteria as biological control agents*". (Mutting B., ed), p142 – 152. Marcel Dekker, New York. (Cited from *Soil biol. Biochem.*, 27 (8): 1051, 1995).

Kundu, P.K. and B. Nandi (1984). Control of cauliflower damping off by using antagonist coated seeds. *Pedobiologia*, 27: 43 – 48.

Meshram, S.U. and G. Jager (1983). Antagonism of *Azotobacter chroococcum* isolates to *Rhizoctonia solani. Neth. J. Plant Pathol.*, 89 (5): 191 – 197.

Nelson, L.M. (1983). Variation in ability of *Rhizobium leguminosarum* isolates to fix dinitrogen symbiotically in the presence of ammonium nitrate. *Can. J. Microbiol.*, 29 (12): 1626 – 1633.

Nemee, S.; L.E. Dantoff and J. Strandberg (1996). Effecacy of biocontrol agents in planting mixes to colonize plant roots and control root diseases of vegetables and citrus. *Crop production*, 15 (8): 735 – 742.

Richards, L.A. (1954). In "*Diangosis and improvement of saline and alkaline soils*". U.S.A. Dept. Agric. Handbook, No. 60 : 17-133.

Schloter, M. and A. Hartmann (1998). Endophytic and surface colonization of wheat roots (*Triticum sativum*) by different Axo *spirillium brasilense* strains studied with strain-specific monoclonal antibodies symbiosis. *Rehovot.*, 25 (1 : 3): 159 –179.

Snedecor, G.W. (1966). In "*Statistical Methods*". The State Univ. Press. Ames, Iowa, U.S.A. 534 pp.

Song, J.H.; H.T. Yang; Q.A. Gao and J.P. Wang (1998). Preliminary studies on a strain of Streptomyces used in biocontrol. *Chiness Journal of biological control*, 14 (1): 18 – 20.

Tahvonen, R. (1988). Microbial control of plant diseases with Streptomyces species. EPPO Bulletin, 18: 55 – 59.

Tahvonen, R. and H. Avikainen (1990). Effect of *Streptomyces* species on seed borne root rot diseases of wheat and barley. I. Pot experiments. *Ann. Agric. Fenn.*, 29: 187 – 194.

Turhan, G. (1981 b). A new race of *Streptomyces ochraceiscleroticus* in the biological control of some soil borne plant pathogen. II. in vivo studies on the possibilities of using C/2- 9 against some important disease. *J.P. Disease. protect.*, 88 (7): 422- 434.

Vlassak, K. and L. Reynders (1980). *Azospirillum rhizocoenoses* in agricultural practice. *Int. Symp. On N_2-fixation, Camberra. December* (1980).

Waller, R.A. and B.D. Duncan (1969). A way for the symetric multiple comparison problem. *Amer. Stat. Assoc. J.*, 3: 1485 – 1503.

Received: 29/01/2002
Accepted: 08/04/2002

تأثير البكتيريا المثبتة للنتروجين والأكتينومايسيتات كتسميد حيوى على نمو وانتاجية نبات الخيار فى التربة الصحراوية فى مصر

محمود مصطفى عامر، محمود عبد المحسن سويلم، بثينة فتحى عبد الغنى* وأمل محمد عمر*
قسم النبات – كلية علوم بنها – جامعة الزقازيق – مصر.
* قسم خصوبة وميكروبيولوجيا الأراضى – مركز بحوث الصحراء بالمطرية – القاهرة – مصر.

تم إجراء تجربة أصص تحت ظروف الصوبة لدراسة تأثير التلقيح بسلالات ذات كفاءة عالية من جنس *الأزوتوباكتر* وجنس *الأزوسبيريللم* وجنس *الأستربتوميسس* على العدد الكلى للميكروبات، الأجزاء المختلفة للنبات وشدة الإصابة بمرض التعفن الجذرى وكذلك الأعداد السليمة للنبات.

وبصفة عامة كان لاستخدام هذه العزلات فى معاملة بذور الخيار تأثيرا واضحا على زيادة أعداد الميكروبات المستخدمة وذلك فى منطقة الريزوسفير للنبات خلال مراحل نموه المختلفة وكذلك تحسنا واضحا فى نمو النبات وإنتاجيته حيث كان هناك زيادة ملحوظة فى طول النبات والجذر والوزن الجاف والرطب للساق والجذر ونسبة الكلوروفيل فى الأوراق وعدد الأزهار والثمار لكل نبات وأوراق الثمار لكل نبات وكذلك نسبة محتوى النتروجين والبروتين فى الثمار وفى نفس الوقت أدت إلى خفض تأثير الفطر الممرض (*الريزوكتونيا سولانى*) على النبات وزيادة اعداد النباتات السليمة.

أعطى التلقيح بعزلة *الأستربتوميسس لايبيكس* N_{cal} أعلى انخفاضا فى شدة المرض بينما عزلتى *الأزوتوباكتر كروكوكم* R_f و*الأزوسبيريللم ليبوفيرم* K_e أعلى تأثيرا على تحسن نمو وإنتاجية النبات وزيادة أعداده السليمة.

اظهر المخلوط الثلاثى من السلالات المستخدمة أيضا تأثيرا عاليا فى خفض شدة الأصابة بالمرض وفى نفس الوقت زيادة واضحة فى نمو وإنتاجية النبات.