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Biological Control of Damping-off and Pod Rot Diseases of Peanut (*Arachis hypogaea* L.) using *Saccharomyces cerevisiae*

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Seventeen fungal species were isolated from peanut roots and stems as well as external surfaces of pods. The high frequency percentages were recorded with *Rhizocotoni solani, Aspergillus niger, A. flavus, Fusarium oxysporum, Alternaria alternata* and *Macrophomina phaseolina*. They recorded values ranged between 7.7 to 14.3% and 6.0 to 11.7% from roots and stems as well as pods, respectively. The *in vitro* linear growths of *M. phasoeolina, R. solani* and *F. oxysporum* on PDA amended with 5ml/ L of the *Sacharomyces cerevisiae* were inhibited by 59.67, 51.89 and 86.67%, respectively. Under greenhouse condition, the application of *S. cerevisiae* at concentration of 5 ml/L was the most effective treatment in decreasing damping–off incidence caused by *M. phaseolina*, *R. solani* and *F. oxysprum* to 25, 15 and 20%, respectively compared with 50, 65 and 45% of their control treatments. While, decrease in means of damping–off incidence (%) with the same concentration (5 ml/L) reached to 5.45% and 3.75% under field conditions in case of soaking seed and soil application, respectively and 16.6% in the control. Concentration of *S. cerevisiae* was positively correlated with decreasing in damping–off and pod rot disease incidence (%); and increasing pod yield and total chlorophyll (a and b) content in peanut leaves.

Keywords: *Arachis hypogaea*, biological control, peanut, *Saccharomyces cerevisiae* and soil borne fungi.

Peanut (*Arachis hypogaea* L.) is one of the exported and locally consumed crops in Egypt. Damping-off, root and pod rot diseases are destructive diseases attacking peanut in Egypt. The importance of these diseases lies not only in affecting the yield and causing quantitative and qualitative losses, but also in increasing soil infestation with the causal pathogens year after year. Therefore, growing peanuts in this soil has become unprofitable (El-Deeb, 1982 and Morsy, 2013). *Aspergillus niger, A. flavus, Alternaria alternata, Macrophomina phaseolina, Fuarium* spp. and *Rhizoctonia solani* are known to cause many plant disease symptoms, *i.e.* root and pod rots, damping-off, charcoal rot, blight and/or stem rot.

Biological control focus on the possibility of using natural and safe agents for promoting growth of peanut and inducing resistance against different diseases. *Saccharomyces cerevisiae* is considered a new promising plant growth promoting yeast for different crops. It could be a positive alternative to chemical fertilizers in the last few years due to its safety to be used for human, animal and environment

(Omran, 2000). Application of *S. cerevisiae* as biocontrol agents acts as a new trend against different pathogens. Potential use of yeasts as biocontrol agents for soil borne pathogens and as plant growth promoters was recently investigated by El-Tarabily (2004) and El-Tarabily and Sivasithamparam (2006). Also, application yeast of 5ml/L to sugar beet plants resulted in a reduction of the pre-and post-emergence damping-off, increasing chlorophyll contents and yield production (Hassan and Abd El-Rehim, 2002 and Shalaby and El-Nady, 2008).

The main objective of the present investigation was to study the effect of yeast application on incidence of damping-off and pod rot diseases under greenhouse and field conditions as well as to determine its beneficial effect as biofertilizer on chlorophyll content and yield production.

Materials and Methods

Isolation and identification:

Peanut plants showing symptoms of root and stem rots as well as pod rots were collected from different locations at South El–Tahrir, Behera governorate. After removing the adhering soil particles with running water, the infected tissues of samples were cut into small pieces, surface sterilized with sodium hypochlorite (0.25%) for 4 min. washed several times with sterile distilled water, blotted between two sterilized filter papers and finally placed onto potato dextrose agar in Petri plates (PDA). Inoculated plates were incubated at 25±2°C for 3-7 days. Fungal isolates were microscopically examined and purified using the single spore and/or the hyphal tip techniques. The purified fungi were maintained on PDA slants at 4°C. Cultural, morphological, microscopic and pathological properties were considered to identify the fungal isolates according to Ellis (1976), Booth (1985) and Gillman (1998).

In vitro effect of Saccharomyces cerevisiae on the linear growth of the fungi tested:

After PDA solidification, yeast at 0, 1, 2 and 5 ml/ L concentration was added to medium. The sterilized PDA media, with or without yeast, were poured into 9–cm sterilized Petri-dishes. Petri-dishes were inoculated at the center with discs (3mm diameter) taken from the edge of 7-day-old culture of any of the following fungi: *R. solani*, *M. phaseolina* and *F. oxysporum*. Diameter of the colonies inocubated at 25°C was measured when growth of the fungal isolate had just covered the untreated plates. Percentage of inhibition (I %) was calculated according to the formula of Topps and Wain (1957):

$I\ \% = [(A-B)/A] \times 100$

Where, I % = percentage of inhibition.

A= Mean diameter of linear growth in the control.

B= Mean diameter of linear growth in a given treatment.

Effect of S. cerevisiae on root and pod rot diseases:

The experiments were carried out in greenhouse and field during two successive seasons (2014 and 2015) at South El-Tahrir, Behera governorate. The biocontrol agent used was the active dry yeast of *S. cerevisiae*. Yeast application were seed soaking in different concentration of yeast for 15 min. before sown while, soil application was carried out after 30 days from planting by spraying yeast solutions

on soil before irrigation. This was regularly repeated about four weeks intervals during the season using three concentrations of 1, 2 and 5 ml/L. Dry yeasts (10 gm) were well suspended firstly in 200 ml sterilized water and inoculated at 20°C for 12 hours after adding 10 gm slight sugar (Saccharose). Just before application, the suspensions were diluted to the required concentrations using sterile distilled water. Peanut seeds (Giza 6) were soaked in defined yeast concentrations and were left overnight before sowing. Soaked seeds in only sterile water were acted as control.

Greenhouse experiment:

Three concentrations *i.e*., 1, 2 and 5 ml/ L of *S. cerevisiae* were used for seed soaking and soil infestation. The treated seeds (Giza 6) were then planted in 25 cm – diameter pots previously infested with *M. phoseolina, R. solani* or *F. oxysproum* (grown on sand barley medium for 15 days at 27°C). However, each fungal growth was added to the formalin – sterilized soil at the rate of 20 gm/kg of soil weight (w/w). The uninfested soil and the untreated seeds were served as control. Five seeds were sown per each pot and four pots were used as replicates for each treatment.

Field experiments:

Seed soaking and soil infestation were carried out as mentioned before using three concentrations *i.e.,* 1, 2 and 5 ml/L of *S. cerevisiae* throughout the experiments. The treated seeds (Giza 6) were planted in naturally infested soil at South El – Tahrir, Behera governorate during 2014 and 2015 seasons. Each experiment, however, was carried out in a complete randomized block design with three plots (2×0.75 meter). Three plots were left without treatment to serve as control. Each plot consisted of four rows. Seeds of Giza 6 were sown in holes at alternately in holes within each row. Each hole was approximately at 20 cm distance and sown with a single seed. Each row has 10 holes (20 cm apart). Percentages of pre - and post – emergence damping–off for seedlings were recorded at 20 and 45 days after sowing. Whereas, percentage of pod–rot for each treatment was counted at the harvest time.

Biochemical changes:

Chlorophyll content (a and b) of plant leaves was estimated 60 days from planting in green house experiment for each season according to Moran (1982) and absorbance was measured at 647 and 664 nm using spectrophotometer (Jenway 6105 UV-VIS). Chlorophyll contents a and b were calculated according to the following equation:

ChL. a (ug mL^{-1}) = 12.46 (A 664) – 2.49 (A 647).

ChL. b (ug mL) = 5.6 (A 664) + 23.26s (A647).

Statistical analysis:

The data were statistically analysed by analysis of variance (ANOVA) using the Statistical Analysis System (Anonymous, 1996). Means were compared by least significant difference (L.S.D.) test at $p \leq 0.05$ levels.

Results

Fungi associated with root and pod rot of peanut:

Seventeen fungal species were isolated from roots and stems as well as pods of peanut plants showing damping-off, root-rot, and pod rot symptoms (Table, 1). *Alternaria alternata, A. flavus, A. niger, F. oxysporum, M. phaseolina* and *R. solani* recorded high frequencies ranged between (7.7 - 14.3%) and (6.0 - 11.7%) in isolation trials from roots and stems and pods, respectively. Frequency of other fungi however, ranged between (2.0 % - 5.3 %) and (1.7% - 7 .3%) on roots, stems and pods, respectively.

Table 1. Frequency percentages of fungi isolated from rotted roots, stems and pods of peanut

	Fungus	Frequency of fungi isolated from peanut plants (%)	
		Roots and stems	Pods
1.	*Alternaria alternata* (Friek) Keissler.	12.3	11.3
2.	*Aspergillus flavus* (Link) Fr.	10.0	7.3
3.	*A. niger* van Tieghem	11.7	11.7
4.	A. *parasiticus* Spear.	3.0	4.3
5.	*A. terreus* Thom	2.3	2.3
6.	*Chaetomium* sp.	2.7	1.7
7.	*Fusarium acuminatum* EII. & Ev.	5.3	5.7
8.	*F. moniliforme* Shel.	4.3	4.0
9.	*F. oxysporum* Schlecht.	8.3	6.0
10.	*F. solani* (Mart.) Sacc.	3.7	4.7
11.	*F. semitectum* Berk. Rav.	2.0	3.0
12.	*Macrophomina phaseolina* (Maubl.) Ashby	7.7	8.7
13.	*Mucor* sp.	4.0	4.7
14.	*Penicillium* sp.	2.7	4.0
15.	*Rhizoctonia solani* Khun.	14.3	11.6
16.	*Rhizopus* sp.	2.0	4.7
17.	*Sclerotium rolfsii* Sacc.	3.7	4.3
Total		100.0	100.0

The in vitro effect of S. cerevisiae on linear growth (cm) of M. phaseolina, R. solani and F. oxysporum:

The effects of different concentrations of *S. cerevisiae* on linear growth (cm) and reduction potential (%) of fungi after 5 days of growth on PDA medium amended with different concentrations of yeast and incubated at 25± 1°C are shown in Table (2). Concentration of 5ml/L caused the maximum inhibitory effect on linear growth of all fungi and the maximum reduction potential percentages were 59.67, 51.89 and 86.67% for *M. phaseolina, R. solani* and *F. oxysporum*, respectively.

On the other hand, concentrations of 1 and 2 ml/L gave less effect on linear growth and the reduction (%) was increased as the yeast concentration was increased. The efficacy of yeast at 5 ml/L concentration showed the lowest reduction on linear

growth (cm) of *M. phaseolina, R. solani*, and *F. oxysporum*, 54.11 %, 46.67 % and 63.33, respectively.

Table 2. Effect of *S. cerevisiae* on linear growth (cm) of *M. phaseolina, R. solani* and *F. oxysporum* and reduction potential (%) after 5 days of growing on PDA medium

Conc. Ml / L	Linear growth (cm) of:					
	M. phaseolina		*R. solani*		*F. oxysporum*	
	Linear growth (cm)	Reduction (%)	Linear growth (cm)	Reduction (%)	Linear growth (cm)	Reduction (%)
1	4.13	54.11	4.80	46.67	3.3	63.33
2	4.06	54.89	5.83	35.22	2.9	67.78
5	3.63	59.67	4.33	51.89	1.2	86.67
Mean	3.94		4.99		2.47	
0 (control)	9.0	-	9.0	-	9.0	-
L.S.D. (0.05)	0.71	-	0.95	-	0.84	-

Effect of seed soaking or soil application of different concentrations of S. cerevisiae on percentages of damping-off (pre- and post) on peanut seedlings grown in artificially infested soil, under greenhouse conditions:

Data presented in Table (3) show that percentages of damping off (pre- and post-emergence) incidence varied according to yeast concentration, kind of fungi and method of application. Significant reduction in incidence percentages of damping-off caused by *M. phaseolina, R. solani* and *F. oxysporum* were achieved on seedlings developed from seeds soaked in 1, 2 and 5 ml/L yeast concentrations or as soil application.

Table 3. Effect of seed soaking or soil application of three concentrations of *S. cerivisiae* on percentages of damping-off (pre- and post) on peanut seedlings, grown in artificially infested soil under greenhouse conditions

Treatment	Conc. ml/L	Percentage of damping-off			Conc. mean	Over all mean
		M. phaseolina	*F. oxysporum*	*R. solani*		
Seed soaking	1	35	30	20	28.33	26.11
	2	30	35	25	30.00	
	5	25	20	15	20.00	
Mean		30	28.3	20		
Soil application	1	40	35	40	38.33	28.89
	2	30	20	30	26.67	
	5	30	10	25	21.67	
Mean		33.3	21.7	31.7		
Control (untreated)	0.0	50	45	65	53.3	53.33
Fungi mean		34.29	27.86	31.43	-	-
L.S.D. 5 %	App. (A) = 10.0		Conc. (C) = 8.45		Fungi (F) = NS	
	A×C = 14.38		A×F = 12.46		C×F = 17.61	
	A×C×F = 24.91					

The best reduction in damping-off disease incidence was noted when peanut seeds were soaked in yeast than soil treatments. The rate of 5 ml/L of *S. cerevisiae* was the most effective against tested fungi. The lowest percentages of damping off caused by *R. solani* (15%) and *F. oxysporum* (20%) were achieved when peanut seeds soaked before plantation in the highest concentration of *S. cervisiae*. Meanwhile, in case of soil application with *S. cervisiae* the highest reduction in damping off caused by fungi tested occurred when concentration of *S. cervisiae* was 5 ml/L.

Field experiments:

All treatments in both experimental seasons 2014 and 2015 significantly decreased percentage of pre - and post-emergence damping-off than the control (Table 4). *S. cerevisiae* seed soaking at concentration of 5ml / L gave the least percentage of pre-emergence damping-off (2.5%) followed by soil application at concentration of 5ml/L (4.6%) as compared with the control non-treated (18.35%). Other concentrations of *S. cerevisiae* showed different variations in disease incidence in post-emergence damping-off. Also, data in Table (4) show that soil application at concentration of 2 or 5ml / L gave the best reduction in post-emergence damping-off followed by seed soaking at concentration of 1ml/L. Other treatments of *S. cerevisiae* showed variation in disease incidence.

Table 4. Effect of *S. cerevisiae* application on pre and post-emergence damping-off on peanut under field conditions in 2014 and 2015

Treatments	Conc. ml/L	% Pre-emergence at season of:		Mean	% Post- emergence at season of:		Mean
		2014	2015		2014	2015	
Control	0	21.7	15.0	18.4	19.0	14.2	16.6
Seed soaking	1	5.8	5.9	5.9	7.5	7.5	7.5
	2	5.8	5.0	5.4	9.2	4.2	6.7
	5	1.7	3.3	2.5	6.7	4.2	5.5
Mean		4.45	4.7		7.8	5.3	
Soil application	1	5.8	10.0	7.9	7.5	5.8	6.7
	2	5.8	5.0	5.4	3.3	4.2	3.8
	5	4.2	5.0	4.6	5.8	1.7	3.8
Mean		5.27	6.7		5.53	3.9	

L.S.D.5% for:

Application (A) = 4.9
Concentration (C) = 3.74
Pre–emergence (P) = 5.22
Post–emergence (Po) = 3.81
A×C = 3.5
A×P = 5.2
A×P×Po = 3.63
A×C×P×Po = 4.97

Effect of S. cerevisiae application on pod-rot of peanut under field conditions, 2014 and 2015 seasons:

Data in Table (5) indicate that all concentrations of *S. cerevisiae* decreased pod rot disease incidence compared with controls in both seasons (2014 and 2015). Seed soaking in *S. cerevisiae* at concentration 5 ml / L gave the maximum reductions of all fungi causing pod – rot (5.4% and 4.0%) in both growing seasons, followed by treated soil at concentration 5ml/L (5.6% and 6.2%) in the two growing seasons 2014 and 2015, respectively. On the other hand, at concentration of 1 ml/L *S.*

cerevisia either in seed soaking or soil treatment gave the least effective treatments towards the pod –rot incidence. In general, increasing concentration of *S. cerevisiae* in both treatments led to increase reduction in pod rot.

Table 5. Effect of *S. cerevisiae* application on pod-rot disease incidence (%) of peanut under field conditions in seasons 2014 and 2015

Treatments	Conc. Ml/L	% Pod-rot	
		Mean	
		2014	2015
Seed soaking	1	10.4	9.6
	2	7.0	7.0
	5	5.4	4.0
Mean		7.6	6.9
Soil application	1	9.0	8.4
	2	7.8	7.2
	5	5.6	6.2
Mean		7.5	7.3
Control (untreated)	0.0	14.2	15.0
L.S.D.5% for application (A) =		1.3	

Effect of S. cerevisae application on chlorophyll content in peanut plant leaves:

Data in Table (6) show that yeast application resulted in higher leaf chlorophyll content if compared to the control. Irrespective the application method, increasing in chlorophyll content was obtained via increasing concentration during the tested seasons. The high means of chlorophyll content i.e. 10.8 and 10.41 mg/g fresh weight were due to concentration 5 ml/L in soaking seed treatment and soil application, respectively. On contrast, the low means of contents, being 8.68 and 8.63 mg/g were obtained due to using concentration 1 ml/L as seed soaking or soil application, respectively.

Table 6. Effect of *S. cerevisiae* application on chlorophyll content in peanut leaves during 2015 and 2016

Treatments	Conc. ml / L	Total chlorophyll mg/g fresh leaf weight (a+b)		Mean
		2014	2015	
Control	0.0	8.19	7.98	8.09
Seed soaking	1	9.12	8.23	8.68
	2	9.92	8.94	9.43
	5	11.13	10.47	10.80
Soil application	1	9.07	8.31	8.63
	2	9.60	8.90	9.25
	5	11.57	9.25	10.41
L.S.D.0.05 %	-	0.50	0.47	-

Effect of S. cerevisiae on peanut yield (100 pods) under field conditions, 2014 and 2015.

Data in Table (7) indicate that treating either the seeds or the soil with *S. cerevisiae* at concentration of 5 ml/L gave the highest weight of 100 pods which reached 0.340 and 0.345 kg and 0.338 and 0.340 kg in case of seed soaking or soil treatment for the two successive seasons 2014 and 2015 without significant

differences, respectively. Differences between this treatment and the others were significant, except in case of soil application at the rate of 2 ml/L. The lowest 100 pods weight, however, was recorded in case of treating with *S. cerevisiae* at concentration of 1 ml/L since it yielded only 0.300 and 0.290 kg. While, soil application gave 0.310 to 0.338 kg and 0.315 to 0.340 for 100 pods weight in both seasons compared with the controls (0.280 and 0.290 kg/100 pods) in two trial seasons.

Table 7. Effect of *S. cerevisiae* on peanut yield under field conditions in 2014 and 2015

Treatments	Conc. ml/L	Weight of 100 pods (kg)		Mean
		2014	2015	
Control	0.0	0.280	0.290*	0.285
Seed soaking	1	0.300	0.290*	0.295
	2	0.320	0.315	0.318
	5	0.340	0.345	0.343
Soil application	1	0.310	0.315	0.313
	2	0.335	0.330	0.333
	5	0.338	0.340	0.339
L.S.D 0.05%		0.008	0.009	-

*Either the seeds or the soil

D i s c u s s i o n

It is well known that damping-off and root and pod rot diseases of peanut are serious and destructive diseases. Fungi belonging to seventeen fungal species were consistently isolated from rotted roots and stems as well as infected peanut pods. They were *Rhizoctonia solani, Aspergillus niger, A. flavus, Fusarium oxysporum, Alternaria alternata, Macrophomina phaseolina, Aspergillus parasiticus, Aspergillus terreus, Chaetomium* sp., *Fusarium acuminatum, F. moniliforme, F. solani, F. semitectum, Mucor* sp., *Penicillium* sp., *Rhizopus* sp. and *Sclerotium rolfsii*. The first six fungi, however, recorded the highest frequency (%) in isolation trials. These results are in agreement with those of Abdel-Rahman and El-Shimy (1999), Morsy (1999 and 2013), Atta–Alla *et al*. (2004), Hanafi, (2004) and Ismail and Abd El-Moemen (2007).

Saccharomyces cerevisiae effectively inhibited the mycelia growth of *F. oxyoporum*, *M. phaseolina* and *R. solani* the causal pathogens of peanut damping-off and pod – rot diseases. This may be due to production of antifungal diffusible and volatile metabolites (Walker *et al*., 1995, Masih *et al*., 2001 and Höfte *et al*., 2004), also several reports on yeasts on fruits and leaf surfaces suggested the occurrence and the activity of antibiotics in the interaction with fungal pathogens. However, very few reports present details of the nature of the antibiotics produced and exception being the heptadencenoic and methyl-hepatadecenoic acids produced by the yeast like fungus *Sparolhrix flocculosa* (Choudhury *et al*., 1994 and Benyagoub *et al*., 1996).

Moreover, it reduced percentages of infection when peanut plants were grown from seeds treated with different concentrations of *S. cerevisiae*. In this respect,

Madi *et al*. (1997), Sallam (1998), Hassan and Abd El-Rehim (2002), and El-Tarabily (2004) reported that *R. solani* and *S. rolfsii* were effectively suppressed by some plant growth promoting yeast. Also, Shalaby and El-Nady (2008) stated that several plant pathogenic fungi (especially soilborne fungi) were sensitive to *S. cerevisiae in vitro* and *in vivo* application.

Mechanisms of the yeasts in soil to decrease roots and pods infection have been reported to play a significant role in the biocontrol activity of these antagonistic yeasts against fungal phathogens of leaves and fruits include competition for nutrients and space (Fokkema 1984; Droby *et al*., 1989, Filonow 1998, Janisiewicz *et al*., 2000); production of cell wall – degrading enzymes such as B-1, 3 gluconase and clhitinase (Castoria *et al*., 2001 and Masih and Paul, 2002).

The yeast *S. cerevisiae* is considered a new promising plant growth promoting yeast for different crops. It became, in the last few decades, a positive alternative to chemical fertilizers and safely used for human, animal and environment (Omran, 2000). Due to cytokinin content, yeast treatments were suggested to play a beneficial role in cell division and cell enlargement (Natio *et al*., 1981). Yeast as a natural stimulator for plant growth is also characterized by its richness in protein (47%), carbohydrates (33%), nucleic acid (8%), lipids (4%), and different minerals (8%), pyridoxine hormones and other growth regulating substances, biotin B12 and folic acid (Nagoclawithana, 1991). On the other hand, *S. cerevisiae* has been reported to enhance plant growth of peanut plants. This may be due to its direct effect on plant growth or indirect by its inhibitory effect on growth and development of fungi affecting peanut plants due to its richness in tryptophan which considered precursor of indole acetic acid (IAA) and on flower initiation due to its effect on carbohydrate accumulation (Warning and Philips, 1973).

Results showed that the application of *S. cerevisiae* to seeds and soil increased pigments formation of chlorophyll a, b and their total contents. This action was obtained via increasing yeast concentration. This increase in photosynthetic pigments formation might be attributed to the role of yeast cytokinins in delaying the aging of leaves by reducing degradation of chlorophyll and enhancing the protein and RNA synthesis (Castelfranco and Beale, 1983 and Shalaby and El-Nady, 2008).

The results of our study indicate that *S. cerevisiae* has strong potential as plant growth promoters and as biocontrol agent of the soil-borne fungal plant pathogens *F. oxyoporum*, *M. phaseotina* and *R. solani* which causing damping-off and pot-rot diseases in peanut plants.

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المقاومة الحيوية لمرضي موت البادرات وعفن قرون الفول السوداني باستخدام الخميرة *Saccharomyces cerevisiae*

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تم عزل سبعة عشر نوعا من الفطريات المختلفة من جذور وسوق وثمار الفول السوداني من الأسطح الخارجية للقرون وكانت أكثر الفطريات تكراراً فى العزل هى أنواع من الفطريات: ريزوكتونيا سولانى، أسبرجلس نيجر، أسبرجلس فلافس، فيوزاريوم أوكسى أسبوريم، الترناريا الترناتا، وماكروفومينا فاصولينا، حيث تراوحت نسبة تكرار عزلها (7,7 % إلى 14,3%) و (6و0% إلى 11,7%) من الجذور والسوق وايضا الثمار على التوالى.

أدى استخدام الخميرة *S. cerveisiae* بتركيز 5 مل / لتر ماء إلى خفض قطر النمو إلى 59,67% و 51,89% و 86,67% لكل من الفطريات ماكروفومينا فاصولينا وريزوكتونيا سولانى وفيوزاريوم اكسيسبورم على التوالى .ويعتبر استخدام الخميرة بتركيز 5 مل / لتر ماء أفضل التركيزات فى خفض نسبة حدوث مرض موت البادرات المتسبب عن الفطريات ماكروفومينا فاصولينا وريزوكتونيا سولانى وفيوزاريوم اكسيسبورم الى 25% و15% و 20% على التوالى تحت ظروف العدوى الصناعية مقارنة ب 50 % و65% و45% لمعاملات الكنترول بينما وصل الخفض فى متوسطى نسب حدوث مرض موت البادرات عند استخدام التركيز (5مل/ لتر ماء) الى 5.45% ، 3.75% تحت ظروف الحقل عند معاملة البذرة أو التربة على التوالى مقارنة بمتوسط الكنترول 16.6% . أثبتت النتائج أن هناك ارتباط بين زيادة التركيز ونقص أمراض موت البادرات وعفن الثمار و أيضاً زيادة وزن محصول الثمارالناتج والمحتوى الكلى للكلوروفيل (أ ، ب) لأوراق الفول السودانى.