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STIMULATORY EFFECT OF SOME YEAST APPLICATIONS ON RESPONSE OF TOMATO PLANTS TO INOCULATION WITH BIOFERTILIZERS

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ABSTRACT

Impact of using of *Saccharomyces cerevisiae* either as foliar spraying with extract of activated cells or as seedlings inoculation on growth characters and yield of tomato plants (*Lycopersicon esculentum*, Mill, c.v. Super Strain B) was evaluated in two field experiments in the presence of inoculation with nitrogen fixer (*Azospirillum lipoferum* Mn3) and phosphate-solubilizing bacteria (*Bacillus megaterium* var. *phosphaticum*). Generally, the results revealed that inoculation with any biofertilizer enhanced activities of dehydrogenase and nitrogenase. Also, several plant parameters were stimulated significantly as a result of inoculation with *Azospirillum* alone or with phosphate dissolver referring to control. Moreover, application of yeast either as foliar spraying or seedling inoculum enhanced the tested strains of N_2-fixer and P-solubilizer, which led to increases in growth parameters, mineral content as well as carbohydrate concentration of tomato plant, fruit yield, T.S.S. and vitamin C in the fruits. The data also show that application of yeast as foliar spraying either without or with biofertilizer inoculation caused further increments in all estimated parameters except dehydrogenase and nitrogenase activities that recorded the maximum values by application of *Saccharomyces cerevisiae* as seedling inoculum with *Azospirillum* and *B. megaterium*. Therefore, seedlings inoculation with *Saccharomyces cerevisiae* or it's application as foliar spraying in combined with dual inoculation by nitrogen fixer and phosphate solubilizer can be recommended to improve the plant growth and to increase the fruit quality and yield of tomato plants.

Key words: *Saccharomyces cerevisiae*, Yeast, Foliar spraying, Tomato, Growth and yield, *Azospirillum*, *Bacillus megaterium*

INTRODUCTION

In the last few decades, biofertilization has become a positive alternative to chemical fertilizer (Wange, 1996). *Azospirillum* represents the best-characterized genus of plant growth-promoting rhizobacteria. Azospirilla increase yields of many crops by improving development of properly colonized roots, increasing water and mineral uptake from soil and by biological nitrogen fixation and biosynthesis of plant growth hormones (Steenhoudt and Vanderleyden,

2000). A promising trend for increasing the efficiency of biofertilizers is the use of different mixtures of biopreparations as N_2-fixers and phosphate-solubilizers (Okon and Labandera-Gonzales, 1994). Moreover, the effect of combined inoculation with both nitrogen fixers and phosphate-solubilizers on yield and nutrient accumulation in plants was more significant than the effect of separate treatments (Abou-Aly and Gomaa, 2002).

Spraying tomato plants by yeast increased plant growth, uptake of NPK by tomato plants and increased number of clusters and fruit set percentage as well as total yield (Abdel-Aziz, 1997). Moreover, plant inoculated with yeast had a beneficial effect on tomato plant growth; also, presence of yeasts favours the proliferation of N_2-fixing bacteria and other beneficial microorganisms in soil (Armanios *et al*, 1991).

The purpose of this work is to study the possibility of using yeast either as foliar spraying or as inoculant in soil in stimulation of N_2-fixer and phosphate-solubilizing bacteria to improve growth, yield and quality of tomato plants.

MATERIALS AND METHODS

The experiment was planted in the Agricultural Research Experimental Center, Fac. of Agric. Moshtohor, Zagazig Univ., during 2002 and 2003 seasons to study the effect of application of yeast (*Saccharomyces cerevisiae*) as an amendment for tomato plants either as soil inoculum or as foliar spraying and evaluate its stimulative effect on nitrogen fixer (*Azospirillum*) and phosphate dissolver (*B. megaterium*). Mechanical and chemical analyses of the experimental soil are presented in Table (1). Mechanical analysis was estimated according to Jackson (1973), whereas, chemical analysis was estimated according to Black *et al* (1982).

Azospirillum lipoferum Mn3 was provided from the Unit of Biofertilizers, Fac of Agric., Ain Shams Univ., Cairo, Egypt. While *Bacillus megaterium* var. *phosphaticum* (pure local strain) was obtained from Biofertilizers Production Unit, Soil, Water and Environment Res. Inst., ARC, Giza, Egypt. Also, *Saccharomyces cerevisiae* was obtained from Agric. Microbiol. Dept. Soil, Water and Environment Res. Inst., ARC, Giza, Egypt.

A heavy cell suspension of each culture was prepared. *Azospirillum lipoferum* was grown on semi-solid N-free malate medium (Dobereiner, 1978) and *B. megaterium* on Bunt and Rovira medium (1955) modified by Abdel-Hafez (1966). While *Saccharomyces cerevisiae* was grown on yeast extract malt extract glucose medium YEMEG (**Atlas, 1995**). After 5 days of incubation at 30°C, microbial cells were separately suspended into sterile water to reach 10^8 cfu/ml. The mixed inoculum was prepared by mixing equal volumes of the desired cell suspensions.

Table (1): Mechanical and chemical analyses of the experimental soil.

Mechanical analysis

Soil particles	Unit	Seasons	
		2002	2003
Coarse sand	%	18.16	18.40
Fine sand	%	13.38	14.19
Silt	%	12.45	14.65
Clay	%	56.01	52.76
Textural class		Clay	Clay

Chemical analysis

Parameters	Unit	Seasons	
		2002	2003
Organic matter	%	1.85	1.98
Total nitrogen	%	0.30	0.32
Total phosphorus	%	0.15	0.17
Total potassium	%	0.50	0.56
Iron	ppm	28.8	23.0
Zinc	ppm	2.90	3.60
Manganese	ppm	17.30	18.80
Copper	ppm	2.07	2.53
$CaCO_3$	%	0.52	0.45
pH		8.19	8.13

Yeast as foliar spraying

A technique allowed yeast cells (*Saccharomyces cerevisiae*) to be grown and multiplied efficiently on YEMEG medium was used for 5 days on a shaker at 30°C to produce beneficial bioconstituents, hence allowed such constituents to release out of yeast cells (Spencer *et al*, 1983). Two cycles of freezing and thawing for disruption of yeast cells and releasing their content were done. Yeast extract was used as a foliar spraying due to the well established its enhancement effect upon growth and development of many plants (Fathy *et al*, 2000). Foliar spray was applied in three times by 20 days intervals (20, 40 and 60 days after transplanting) using 200ml/L of yeast extract per each plot. The untreated plants were sprayed with tap water.

Inoculation process

Seeds of tomato were sown, and the seedlings were transplanted after 30 days from sowing Tomato seedlings were successively washed with water and were soaked in heavy cell suspension of *Azospirillum lipoferum*, *B megaterium* and *Saccharomyces cerevisiae* individually or mixed cultures for 30 min. Arabic gum (10%) was added as an adhesive agent prior to inoculation. In uninoculated treatments, seedlings were treated with uninoculated media. In addition, over-head soil technique was carried out using freshly prepared suspensions of either individual or mixed culture, which spread on soil surface adjacent to the seedlings at a rate of 1L of the inoculum (containing 10^8 cfu/ml) per each plot. This application was added three times during the growth period up to the flowering stage (15, 30 and 45 days after transplanting)

The seedlings were transplanted on 19th and 23rd of March in 2002 and 2003 seasons, respectively in rows 2.5m long and 1m wide. There were three rows as replicates in each plot, the total area of the plot was 7.5m^2 (2.5m×3m). The treatments were arranged in a complete randomized block design.

Calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) were added at the rates of 300 and 200 kg/fed respectively before transplanting for all treatments. While ammonium sulphate (20.5% N) as N-fertilizer was added at a rate of 400 kg/fed in three equal doses at 30, 45 and 60 days after transplanting for all treatments except *Azospirillum* treatments that received half dose of nitrogen fertilizer. The other normal agricultural treatments of growing tomato were practiced according to their standard recommendations.

Sampling and determinations

After 30, 60 and 90 days of transplanting, representative soil samples from rhizosphere of tomato plants were taken. The samples were analyzed for dehydrogenase activity according to the method described by Casida *et al* (1964) while nitrogenase activity was estimated according to Hardy *et al* (1973).

After 70 days of transplanting, plant height, number of branches and dry matter were estimated. Total carbohydrates were determined by using phenol-sulphuric acid method described by Dubois *et al* (1956). Total nitrogen, phosphorus and potassium were estimated in the plants according to microkjeldahl method (A.O.A.C., 1990), APHA (1992) and Dewis and Freitas (1970), respectively.

Yield and quality

At harvest, number of fruits/plant, yield/plant (g) and total yield (ton/fed.) were recorded. Also, total soluble solids (T.S.S.) was measured in the juice of tomato fruits by using a hand refractometer, while vitamin C (mg/100 ml juice) was determined according to the method described by A.O.A.C. (1990).

RESULTS AND DISCUSSION

Enzymatic activities

-Dehydrogenase activity

Changes in dehydrogenase activity were determined as indication of microbial activities in the tested soil samples. Data presented in Table (2) show that dehydrogenase activity differed between plant growth stages and varied significantly between inoculation treatments. The combined inoculation with *Azospirillum* and *B. megaterium* increased the activity of enzyme more than individual inoculation at all growth stages. Also, application of *Saccharomyces cerevisiae* extract as foliar spraying recorded a slight increases in dehydrogenase activity than the treatments without yeast. Moreover, the highest values of the dehydrogenase activity was observed in the plants that inoculated with *Saccharomyces cerevisiae* in the presence of *Azospirillum* and *B. megaterium*, this may be due to the stimulating effect of the yeast on the rhizosphere microorganisms. Meanwhile, dehydrogenase activity is positive correlated with

the number of soil microorganisms that release carbon dioxide in the rhizosphere which decrease soil pH, this process increase nutrient uptake and availability of the nutrients in the rhizosphere. This could be attributed to the supply of NPK that release with inoculation by yeast and biofertilizers (Armanios *et al*, 1991 and Solaiman *et al*, 2003).

-Nitrogenase activity

The values presented in Table (3) indicated that nitrogenase activity was affected significantly with all microbial inoculation. Nitrogenase activity was high at the second stage (after 60 days from transplanting) then decreased gradually with plant age. A combination of *Azospirillum* and PSB resulted in significant increase in acetylene-reducing activity with all yeast applications than individual inoculation. Inoculation with a mixed culture of *Azospirillum, B. megaterium* and *Saccharomyces cerevisiae* resulted in a maximum increase in nitrogenase activity compared to foliar spraying and uninoculated with yeast treatments. Seedling inoculation with *Saccharomyces cerevisiae* cells may be has the potential for enhancing the native and the effective strains of nitrogen fixers by exudation of carbon compounds that have special importance to the growth of nitrogen fixing microorganisms (Tuladhar and Subba Rao, 1985 and Omar and Ismail, 2002).

Plant growth

Plant height, number of branches and dry matter of tomato plants were proportional to the plant growth after two months from transplanting. Results in Table (4) show that increases in growth characters were observed with the different inoculation treatments. Significant increases were observed in growth characters of tomato plants that inoculated with *Azospirillum* and P-solubilizer in the presence of *Saccharomyces cerevisiae* inoculum. The enhancing effect of the yeast inoculation on enzymatic activities in the rhizosphere with the same treatments (Tables 2 and 3) may explain the increase in plant growth. Also, enhancement of plant growth by inoculation with *Saccharomyces cerevisiae* may be attributed to its capability to produce ethylene in the rhizosphere region of plant that enhances plant root distribution (Arshad and Frankenberger, 1989). Moreover, maximum values of plant height, number of branches and dry matter of plant were recorded in the treatment that received foliar spraying by yeast extract in the presence of dual inoculation with *Azospirillum* and *B. megaterium*. Obtained results could be expected since used biofertilizers enhanced the plant growth. The effect of inoculation with *Azospirillum* on root morphology and development, uptake of nitrogen and other minerals and hormone supply to plants have been suggested as factors contributing to growth responses (Krol, 1999). Also, yeast extract as a natural source of cytokinins might enhance cell division and enlargement so far increasing leaf surface area as well as enhancing the accumulation of soluble metabolites (Fathy *et al*, 2000). In the same trend, yeast is considered as a natural source of Bs vitamins and most of the essential elements (Nagodawithana, 1991).

T able 2. Effect of inoculation with *Azospirillum* and phosphate solubilizing bacteria (PSB) under different applications of yeast on dehydrogenase activity (µl DHA/g soil/day) in rhizosphere of tomato plants.

Treatments	30 days		60 days		90 days	
	2002	2003	2002	2003	2002	2003
Without yeast applications						
Fertilized control	11.55	16.51	24.67	32.79	15.43	25.39
Azospirillum lipoferum	13.80	18.44	30.33	33.48	20.65	26.61
***Azospirillum* + PSB**	13.90	24.53	40.89	56.75	34.26	41.57
Foliar spraying with yeast						
Fertilized control	12.06	18.03	27.87	33.91	16.72	25.39
Azospirillum lipoferum	15.94	28.42	33.41	47.90	23.57	37.42
***Azospirillum* + PSB**	18.15	29.35	40.82	61.67	27.79	42.41
Seedlings inoculation with yeast						
Fertilized control	23.25	26.95	31.95	39.19	29.68	36.28
Azospirillum lipoferum	30.71	35.23	39.71	57.45	32.33	41.67
***Azospirillum* + PSB**	25.40	38.48	52.41	72.54	42.32	47.63
L.S.D at 5%	1.81	2.74	3.82	2.55	3.30	2.29

Table 3. Effect of inoculation with *Azospirillum* and phosphate solubilizing bacteria (PSB) under different applications of yeast on nitrogenase activity (n mol C_2H_4/g plant/h) in rhizosphere of tomato plants.

Treatments	30 days		60 days		90 days	
	2002	2003	2002	2003	2002	2003
Without yeast applications						
Fertilized control	15.38	16.79	32.15	37.45	10.73	21.84
Azospirillum lipoferum	51.62	67.92	83.76	95.37	56.52	67.18
***Azospirillum* + PSB**	72.96	106.75	110.40	157.09	68.67	91.77
Foliar spraying with yeast						
Fertilized control	19.02	23.16	28.56	31.76	12.39	15.34
Azospirillum lipoferum	93.28	82.18	97.04	119.22	60.32	65.87
***Azospirillum* + PSB**	85.12	112.46	121.63	168.49	81.86	97.96
Seedlings inoculation with yeast						
Fertilized control	27.43	24.25	52.87	43.92	20.07	26.47
Azospirillum lipoferum	132.85	164.91	197.61	172.12	87.70	94.47
***Azospirillum* + PSB**	138.61	163.65	206.29	213.07	107.33	123.15
L.S.D at 5%	3.27	6.25	11.52	10.44	3.53	3.93

Table 4. Growth characters of tomato plants as affected by inoculation with *Azospirillum* and phosphate solubilizing bacteria (PSB) under different applications of yeast after 60 days from sowing

Treatments	Plant height (cm)		No. of branches		Dry matter (%)	
	2002	2003	2002	2003	2002	2003
Without yeast applications						
Fertilized control	39.60	40.10	8.89	10.37	19.06	23.95
Azospirillum lipoferum	40.59	41.28	9.24	12.06	22.37	26.71
Azospirillum + PSB	47.42	43.63	10.26	13.96	25.37	31.41
Foliar spraying with yeast						
Fertilized control	49.60	44.47	12.64	13.00	21.94	31.90
Azospirillum lipoferum	52.40	55.39	12.97	12.64	25.61	37.40
Azospirillum + PSB	56.61	53.29	14.58	16.34	35.21	42.28
Seedlings inoculation with yeast						
Fertilized control	42.52	43.26	11.46	11.35	22.43	29.85
Azospirillum lipoferum	45.65	48.33	11.72	13.00	23.08	35.72
Azospirillum + PSB	51.14	50.94	12.45	15.64	32.74	40.18
L.S.D at 5%	2.42	3.00	0.93	1.53	1.69	2.11

Chemical constituents of tomato plant

Total carbohydrates and mineral contents (N, P and K) in tomato plants showed similar trend to those recorded in growth characters. Data in Table (5) revealed that treating tomato seedlings with the tested strains either singly or in combination caused significant increases of total carbohydrates as well as mineral content except for the concentration of potassium in both seasons. Remarked increases were obtained when plants were inoculated with yeast especially in the presence of *Azospirillum* and *B. megaterium*. This may be due to the interaction between the three tested microorganisms that may be increased the amount of growth promoting substances which is mainly responsible of increased dry weight and the consequent increase in chemical constituents. These data are in harmony with Armanios (1991). It is worth noticed that, the highest scores of chemical constituents were observed as a result of foliar spraying with yeast extract in the presence of dual inoculation with *Azospirillum* and *B. megaterium*. The beneficial effect of these microorganisms on nutrient uptake may be attributed to the promoting effect of PSB and N_2-fixer and the synergistic effect of the yeast extract. Moreover, a stimulative effect for foliar spraying with yeast was also reported by Abdel-Aziz (1997) who mentioned that spraying tomato plants with yeast increased the content of N, P and K as well as their uptake per plant.

Yield and its components

Data presented in Table (6) show that there were significant increases in the fruits number and yield components in both seasons when the plants were inoculated with *Azospirillum* and *B. megaterium*. This treatment gave increases in total yield by 27.84% and 12.05% over the control in the two seasons, respectively. Also, addition of *Saccharomyces cerevisiae* inoculum in the presence of N_2-fixer and P-solubilizer increased total yield by 36.84% and 39.36% over the control in the two seasons, respectively. These increases may be attributed to the beneficial effects of N_2-fixer. Also, PSB can be decompose organic and insoluble phosphates by utilizing organic compounds as carbon and energy source and produce organic acids that solubilize insoluble phosphate, which improved crop yield. Furthermore, yeast has beneficial effect on dehydrogenase and nitrogenase activities, growth characters and mineral content that recorded in the same treatment in this work (Tables 2, 3, 4 and 5). On the other hand, interaction between biofertilizers and foliar spraying with yeast extract gave maximum relative increase of total yield (39.09% and 42.01%) over the control in the two seasons. These results are in good line with those of plant growth and fruits number. Furthermore, yeast via its cytokinins content and the high content of vitamin Bs and minerals might play a role in orientation and translocation of metabolites from leaves into the reproductive organs, also, it might play a role in the synthesis of protein and nucleic acids and minimized their degradation (Natio *et al.* 1981). All of these attributes might lead to the improvement of tomato yield.

Table 5. Effect of inoculation with *Azospirillum* and phosphate solubilizing bacteria (PSB) under different applications of yeast on total carbohydrates and minerals concentrations of tomato plants.

Treatments	Total carbohydrates (%)		Nitrogen content (%)		Phosphorous content (%)		Potassium content (%)	
	2002	2003	2002	2003	2002	2003	2002	2003
Without yeast applications								
Fertilized control	55.45	58.07	2.17	2.68	0.391	0.331	2.11	2.53
Azospirillum lipoferum	58.39	63.84	2.75	3.21	0.412	0.451	2.54	2.85
***Azospirillum* + PSB**	64.35	67.81	2.88	3.36	0.488	0.489	2.32	2.67
Foliar spraying with yeast								
Fertilized control	64.97	65.94	3.06	3.45	0.411	0.430	3.02	2.63
Azospirillum lipoferum	67.05	68.72	3.24	3.60	0.428	0.461	2.98	2.94
***Azospirillum* + PSB**	71.52	70.73	3.65	3.95	0.527	0.563	3.14	3.08
Seedlings inoculation with yeast								
Fertilized control	60.57	62.52	3.11	3.18	0.473	0.496	2.18	2.64
Azospirillum lipoferum	64.28	67.88	3.42	3.53	0.505	0.540	2.67	2.58
***Azospirillum* + PSB**	69.76	72.59	3.81	3.68	0.514	0.526	2.81	2.87
L.S.D at 5%	1.65	1.74	0.21	0.18	0.062	0.055	N.S	N.S

Table 6. Effect of inoculation with *Azospirillum* and phosphate solubilizing bacteria (PSB) under different applications of yeast on yield and its components of tomato plants.

Treatments	Number of fruits/ plant		Yield / plant (g)		Total yield (ton/fed.)		% Relative to the control	
	2002	2003	2002	2003	2002	2003	2002	2003
Without yeast applications								
Fertilized control	12.69	15.71	1015.6	1257.5	11.172	13.832	0.00	0.00
Azospirillum lipoferum	15.75	17.09	1260.0	1367.6	13.860	15.043	24.06	8.75
Azospirillum + PSB	16.02	18.06	1298.1	1409.0	14.280	15.499	27.81	12.05
Foliar spraying with yeast								
Fertilized control	14.61	17.24	1183.6	1396.9	13.020	15.362	16.54	11.06
Azospirillum lipoferum	15.89	20.71	1296.2	1537.8	14.274	17.298	27.76	25.52
Azospirillum + PSB	17.01	21.50	1412.7	1785.8	15.540	19.643	39.09	42.01
Seedlings inoculation with yeast								
Fertilized control	14.98	17.12	1198.9	1333.2	13.188	14.665	18.04	6.02
Azospirillum lipoferum	15.59	18.78	1279.0	1458.5	14.070	16.043	25.93	15.98
Azospirillum + PSB	17.59	20.36	1389.8	1752.5	15.288	19.277	36.84	39.36
L.S.D at 5%	1.28	1.08	42.32	36.22	0.684	0.845	--	--

Fruit chemical constituents

According to the results in Table (7), total soluble solids (T.S.S.) and vitamin C were significantly increased with the different inoculation treatments. Inoculation with *Saccharomyces cerevisiae* in combination with *Azospirillum* and *B. megaterium* improved the fruit quality than individual inoculants or uninoculated treatments. In addition, total soluble solid and vitamin C in fruit juice recorded maximum values in the treatment that received foliar spraying with yeast extract in the presence of dual inoculation with N_2-fixer and P-solubilizer. The stimulative effect of foliar spray with yeast on fruit quality was also reported by Abdel-Aziz (1997).

Table (7): Effect of inoculation with *Azospirillum* and phosphate solubilizing bacteria (PSB) under different applications of yeast on chemical constituents of tomato fruits.

Treatments	Total soluble solids (T.S.S %)		Vitamin C (mg/100 ml juice)	
	2002	2003	2002	2003
	Without yeast applications			
Fertilized control	3.0	3.6	23.76	24.48
Azospirillum lipoferum	3.5	4.7	25.92	25.20
***Azospirillum* + PSB**	4.3	4.9	26.12	28.08
	Foliar spraying with yeast			
Fertilized control	4.0	4.8	25.20	26.64
Azospirillum lipoferum	4.5	5.5	29.16	30.96
***Azospirillum* + PSB**	5.1	6.0	30.24	33.12
	Seedling inoculation with yeast			
Fertilized control	4.0	4.5	25.20	25.92
Azospirillum lipoferum	4.0	4.5	26.28	27.36
***Azospirillum* + PSB**	5.0	5.0	28.80	31.68
L.S.D at 5%	0.37	0.43	1.85	1.14

It can be concluded from the obtained results in this work that tomato plants responsible to inoculation with N_2-fixer and P-solubilizer that was compatible with half dose of recommended N-fertilizer. Of interest in the present study was using *Saccharomyces cerevisiae* as a natural source of phytohormones, Bs vitamins and most of the essential elements in the foliar spraying application and comparison of its effect as seedlings inoculation on the growth and yield of tomato plants. There was a marked useful effect of both system especially in the presence of N_2-fixer and P-solubilizing bacteria than using biofertilizers without yeast.

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التأثير المحفز لبعض تطبيقات الخميرة على استجابة نباتات الطماطم للتلقيح بالأسمدة الحيوية

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تم دراسة تأثير استخدام الخميرة كرش ورقى لمستخلص الخلايا الحية أو كلقاح لشتلات الطماطم فى التربة على النمو والإنتاج ولزيادة فاعلية التسميد الحيوى بكل من الأزوسبيريلام والبكتريا المذيبة للفوسفات *B. megaterium* وذلك خلال موسمى ٢٠٠٢و ٢٠٠٣.

وقد أشارت النتائج إلى أن هناك نشاط ملحوظ لكل من انزيمى الديهيدروجينيز والنيتروجينيز وكذلك النمو الخضرى والإنتاج وجودة الثمار حيث تم الحصول على زيادة معنوية كنتيجة للتلقيح بالأزوسبيريلام وحده أو كلقاح مزدوج مع البكتريا المذيبة للفوسفات عن المعاملات الغير ملقحة.

علاوة على ذلك فقد أدى استخدام الخميرة سواء رشا على النباتات أو لقاح فى التربة إلى تحفيز وتنشيط الأزوسبيريلام والبكتريا المذيبة للفوسفات مما أدى إلى زيادة معنوية فى النمو الخضرى ومحتوى النبات من العناصر والكربوهيدرات وكذلك أعداد الثمار والناتج الكلى، وأيضا زيادة فى جودة الثمار من ناحية المواد الصلبة الكلية وفيتامين ج عن المعاملات الغير معاملة بالخميرة. وعند مقارنة كلا التطبيقين للخميرة ، أظهرت النتائج أن استخدام الخميرة فى الرش أعطى زيادة ملموسة فى كل القياسات السابقة عن استخدامها كلقاح ماعدا نشاط انزيمى الديهيدروجينيز والنيتروجينيز اللذان أعطا قيما أعلا فى حالة استخدام لقاح الخميرة سواء مع أو بدون استخدام الأسمدة الحيوية وأن كان استخدامها مع الأزوسبيريلام والبكتريا المذيبة للفوسفات أدى إلى ارتفاع قيم نشاط كلا الإنزيمين.

ولذلك فإن استخدام الخميرة سواء للرش أو كلقاح مدعم بوجود الأسمدة الحيوية مثل الأزوسبيريلام والبكتريا المذيبة للفوسفات يمكن أن تؤدى إلى تحفيز وتنشيط الأسمدة الحيوية مما يؤدى إلى تحسين نمو نباتات الطماطم وزيادة جودتها وإنتاجيتها