STUDIES ON FERTILIZATION REQUIREMENTS OF TURMERIC (*Curcuma domestica* Val.) PLANT

A- Effect of chemical fertilizer, yeast and biofertilization on vegetative growth of turmeric

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ABSTRACT

This study was carried out in the Experimental Farm of Faculty of Agriculture, Cairo University, Egypt during two successive seasons 2004, 2005 to investigate the effect of chemicals, yeast and biofertilization on vegetative growth of turmeric (*Curcuma domestica* Val.) plant.

One level of the following bacterial strains mixture was used: *Azotobacter chroococcum*, *Azospirillum lipoferum*, *Bacillus polymixa*, *Bacillus megatherium* and *Pseudomonas fluorescence*. Also one level (6g/litre) of active dry yeast (*Saccharomyces cerevisiae*), in addition to three levels from the recommended dose (zero, 50% and 75%) of nitrogen and phosphorus (120 N kg/hectar and 60 P_2O_5 kg/hectar) were applied.

The results of these experiments can be summarized as follows: The treatment of biofertilizer + 75% of the recommended dose of both nitrogen and phosphorus fertilizer led to the highest values of vegetative parameters such as (plant height, stem diameter and leaf area) compared to control plants. Also, it increased rhizome fresh and dry weight per plant and per feddan) compared to using active dry yeast + the same treatment of chemical fertilizers or using chemical fertilizers alone.

Key words: Yeast, Biofertilization, Nitrogen, Phosphorus, Turmeric, Plant growth.

INTRODUCTION

Curcuma belongs to the family Zingiberaceae; it is a genus of about 70 species of rhizomatous herbs, about 30 species occurs in India, of which a few are of economic importance **(Keys, 1976; Chang and But, 1986 and Wren, 1988.** *C. longa* L. syn. *C. domestica* Val. (turmeric) an herbaceous perennial plant is one of the most valuable and important spices all over the world. Medicinal uses of turmeric rhizomes are: treatment of acid, flatulent, or atonic dyspepsia. **(Intanonta, 1986 and Thamlikitkul, 1989),** treatment of ulcers and inflammation **(Prucksunand, 1986 ; Iwu, 1993 and Masuda, 1993,** diarrhea, epilepsy and skin diseases **(Chang and But, 1986),** treatment of asthma, coughs, dizziness, hemorrhages, jaundice, ringworm **Chang and But, 1986; Kapoor, 1990; Cambie and Ash, 1994 and Ghazanfar, 1994)**

Patra (1998) showed that rhizome yield and plant growth increased consistently as the application rates of N, P and K increased. The highest yields were recorded with NPK at 90:60:90. **Venkatesha *et al*. (1998)** showed that, plants provided with N: P: K at 150:125:250 kg/ha or 200:175:300 kg/ha gave better growth and yield. **Yamgar *et al*. (2001)** reported that, N: P: K at 200:100:100 kg/ha resulted in the maximum plant height, number of leaves, leaf length and green rhizome yield. **Thomas *et al*. (2002)** pointed out that, the growth and yield of turmeric increased by applying NPK at 75:60:150 kg/ha. **Gaskins *et al* (1985)**

suggested that nitrogen-fixing bacteria increases the production of plant growth regulators, which stimulate plant growth.

Ali *et al.*, (2001) on guar plants found that, phosphorene caused an increase in plant height, number of branches per plant, dry weight per plant . **Al-Qadasi (2004)** found an increase in plant height, number of branches and herbage fresh and dry weights/plant as a result of using biofertilizer (*Azotobacter + Azospirillum + Bacillus*) on *Ocimum basilicum* plants. **Barakat *et al.*, (2004)** on *Allium cepa* found a significant increase in plant height, leaves fresh and dry weights / plant as a result of using Rhizobacterin (a mixture of *Azotobacter* and *Azospirillum*) and Microbein (a mixture of *Azotobacter, Azospirillum, Pseudomonas, Rhizobium* and *Bacillus*). **Abou-zaid (1984)** mentioned that, the protein of yeast (*Saccharomyces cerevisiae*) comprises 18 common amino acids.

Ahmed *et al*. (1997) mentioned that, the dry yeast contains 34.87% protein, 7.55% ash, 6.54 glycogen, 2.09% fats and 4.92% cellulose. In pot experiment **Ali (2001)** studied the effect of spraying marigold (*Calendula officinalis* L.) plants with active dry yeast at 0.0, 1.5, 3.0 and 4.5 g/L, he found that, the treatments significantly increased plant height as compared to control plants except the low concentration in both seasons. Also, he added that all concentrations significantly increased branch number/plant and herb dry weight in comparison with the unsprayed plants. The best results in all cases were observed when plants sprayed with high concentration of active dry yeast at 4.5 g/l. **Ahmed (2002)** used active dry yeast at 0, 2, 4 and 6 g/l on (*Leucaena leucopenia*) plants. He found that all active dry yeast treatments enhanced the growth; the best results were obtained with the high concentration. **Ahmed (2004)** studied the response of Chamomile (*Matricaria recutita* cv. Goral) plants to soil drench and foliage spray of yeast suspension at concentrations; 0, 1, 2 and 4g/L, he found that applying active dry yeast as soil drench at 4g/L increased plant height, number of inflorescences, root length as well as herb fresh and dry weights compared to control. **Al-Qadasi (2004)** on (*Ocimum basilicum* L.) plants, showed that inoculation of active dry yeast (150ml/plant at1%yeast) increased number of branches, fresh weight/ plant and per fed., leaf area and herb dry weight /plant compared to the control. The heaviest herb, fresh and dry yield /plant and per feddan was obtained by treating the plants with biofertilizer at 150ml/ plant plus full dose of NPK. On the other hand, the applied active dry yeast alone led to decrease herb dry yield/ fed as compared to untreated plants in both seasons.

MATERIALS AND METHODS

Two field experiments were conducted during the two successive seasons of 2004 and 2005 at the Experimental Farm of Faculty of Agriculture, Cairo University to study the effect of chemical fertilizer, yeast and biofertilization on the growth of turmeric (*Curcuma domestica*) plants. The soil was sandy loam. Table (1) shows the physical and chemical characteristics of the experimental soil. **(Klute, 1982)**

The experiment was laid out in randomized complete block design with three replications. The soil was prepared and divided into plots with size of 2m x 1.5m. Each plot included 2 ridges. Seeds of weight 15g with two eyes per piece of seed were planted in May, a spacing of 40cm among plants in the ridge. The plot contained 10 plants. Twenty m^3 of cattle manure were added precultivation per fed. The rhizomes cultivated on 1st May in both two seasons. All agricultural practices were followed as recommended.

Treatments:

1. Chemical fertilizers:

a- Nitrogen fertilizer:

Ammonium nitrate (33.5%) was added at zero, 50% or 75% of the recommended dose (120 N kg/hectare according to **Patra (1998).** Nitrogen was added at 2 equal doses, the first addition of chemical fertilization was on 1st July, the second addition was on 1st September.

b- Phosphorus fertilizer:

Calcium super phosphate (15.5%) was added at rate of zero , 50% or 75% of the recommended dose (60 P_2o_5 kg per hectare, was added at soil preparation according to **Patra (1998)**.

c- Potassium fertilizer:

Potassium sulphate (48%) was added at rates of 100% of the recommended dose (90 K_2O unit per hectare according **Patra (1998)**, was added with nitrogen fertilizer.

2. Biofertilization:

a- Yeast:

The suspension was prepared as following: 6g of the powder of commercially used active dry yeast (*Saccharomyces cerevisiae*) were added to 30g of sugar dissolved in tap water, to reach one liter, and then the suspension was equibated at room temperature until fermentation. Yeast was added 1 week after each mineral fertilization, in both two seasons.

b- bacterial strains:

The strains of (*Azotobacter chroococcum, Azospirillum lipoferum, Bacillus polymixa, Bacillus megatherium and Pseudomonas fluorescence*) were mixed and added to experimental soil, 1 week after each mineral fertilization, in both seasons (2.5L mixture of 5 strains + 22.5L tap water).

Preparation of the biofertilizer:

Distilled water was put in the flask, then peptone (5gm/L) and beef extract (3gm/L) were added and all sterilized in autoclave at 121° C for 20 minutes. The flask is left at room temperature for 2 hour until it cool. After that, inoculated the strain in sterile room condition. The flask, which inoculated, was incubated at 28° C for 7-10 days to obtain the highest growth. Finally, the five strains were mixed and added to experimental soil. The biofertilizer (2.5L mixture of 5 strains + 22.5L tap water) was added to the soil. The strains were preserved on specific media under (2-8° C) to use it in the second addition. Table(2) shows the microbial components CFU/g in dry soil.

Table (1): Some physical and chemical properties of the experimental soil

Mechanical analysis			
Sand %	**Silt %**	**Clay %**	**Texture class**
55.30	29.75	14.93	sandyloam
pH	8.23	Total N	480 ppm
E.C.	2.81 mmohs	Total P	37.8 ppm
Organicmatter%	0.23	Total K	35.1 ppm
Cations meq/L:		**Anions meq/L:**	
Na^+	9.50	$HCO_3^=$	4.40
K^+	0.7	$SO_4^=$	25.00
Ca^{++}	14.00	Cl^-	13.00
Mg^{++}	8.20	-	-

Table (2): Microbial components CFU/g dry soil

Strains	Before adding	After adding
1-*Azotobacter chroococcum*	3.2×10^5	2×10^7
2-*Azespirillium lipoferum*	5.3×10^5	9.8×10^5
3-*Bacillus polymixa*	1.6×10^2	3.2×10^5
4-*Bacillus megatherium*	4.1×10^4	1.2×10^6
5-*Pseudomonas fluorescence*	3.5×10^3	0.8×10^4

Treatments:

The experiment consisted of 27 treatments as follows:

Chemical fertilization:

1. Zero% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses.
2. Zero% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses.
3. Zero% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses.
4. 50% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses.
5. 50% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses.
6. 50% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses.
7. 75% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses.
8. 75% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses.
9. 75% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses.

Chemical fertilizer + active dry yeast:

10. Zero% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses + active dry yeast.
11. Zero% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses + active dry yeast.
12. Zero% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses + active dry yeast.
13. 50% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses + active dry yeast.
14. 50% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses + active dry yeast.
15. 50% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses + active dry yeast.
16. 75% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses + active dry yeast.
17. 75% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses + active dry yeast.
18. 75% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses + active dry yeast

Chemical fertilizer + strains of biofertilizer:

19. Zero% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses + biofertilizer
20. Zero% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses + biofertilizer.
21. zero% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses + biofertilizer
22. 50% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses + biofertilizer
23. 50% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses + biofertilizer
24. 50% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses + biofertilizer
25. 75% of ammonium nitrate + zero% of calcium superphosphate of the recommended doses + biofertilizer
26. 75% of ammonium nitrate + 50% of calcium superphosphate of the recommended doses + biofertilizer
27. 75% of ammonium nitrate + 75% of calcium superphosphate of the recommended doses.

The following parameters were measured:

a. Plant height (cm).
b. Stem diameter (mm).
c. Leaf area (cm^2).
d. Rhizome fresh weight / plant (g).
e. Rhizome fresh weight / fed. (Kg).
f. Dry matter percentage (%).
g. Rhizome dry weight / plant (g).
h. Rhizome dry weight / fed. (kg)

Statistical analysis:

Data subjected to statistical analysis according to (Snedecor and Cochran 1980).

RESULTS AND DISCUSSION

Effect of chemical fertilizer and biofertilization on the vegetative growth parameters

a. Plant height (cm):

Data in Table (3) show the effect of chemical fertilization, active dry yeast and biofertilization on turmeric plant height. The application of biofertilizer resulted in having the tallest plants (46.82 and 40.63 cm), followed by (43.04 and 36.92cm) obtained from the application of active dry yeast, while the lowest values (37.79 and 30.58 cm) were obtained from the without bio-or yest application in the first and the second seasons , respectively. The interaction between biofertilizer or yeast, nitrogen and phosphorus fertilizers has a significant effect on plant height. The highest values (52.56 and 47.25 cm) were obtained from the plants that received biofertilizers + 75% of the recommended dose of both nitrogen and phosphorus fertilizers in the first and the second season, respectively. While the lowest values were obtained from uninoculated plants without nitrogen or phosphorus fertilization (26.28 and 20.99cm) in both seasons respectively. Thus, it can be concluded that, treating turmeric plants

with biofertilizers + 75% of the recommended dose of both nitrogen and phosphorus fertilizers increased plant height more than adding active dry yeast + 75% of the recommended dose of both nitrogen and phosphorus fertilizers in the first and the second seasons respectively. Also , this may be due to the increase of N in the root zone and the synergistic effect of these microorganisms on the physiological and metabolic activities of the plant. This enhancing effect may induce exudates of some hormonal substances like cytokinins and auxins, which encourage plant height. This may be attributed due to presence of more atmospheric nitrogen fixed in the soil, which was probably due to activation of bacteria, providing favorable conditions **(Rajput and Singh, 1996)**. Meanwhile, **(Subb-Rao, 1984)** stated that, the favorable effect of bio-fertilizers on growth parameters might be ascribed to its important role in fixing atmospheric N as well as increasing the secretion of natural hormones namely IAA, GA_3 and cytokinins, antibiotics and possibly increasing the availability of various nutrients. Similar results were obtained by **Al-Qadasi (2004)** who found an increase in plant height as a result of using biofertilizer (*Azotobacter + Azospirillum + Bacillus*) on *Ocimum basilicum* plants and **Barakat *et al.*, (2004)** on *Allium cepa*.

Table (3): Effect of chemical fertilizer, yeast and biofertilization on turmeric plant height (cm) during seasons 2004 and 2005

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	26.28	20.99	34.28	28.49	38.74	31.95	33.10	27.14
	N_{50}%	38.95	30.74	43.70	38.04	47.12	41.00	43.26	36.59
	N_{75}%	40.20	32.16	44.35	37.97	47.63	41.94	44.06	37.36
P_{50}%	N_0%	30.77	24.26	39.16	32.92	43.58	37.17	37.84	31.45
	N_{50}%	40.84	32.66	44.82	38.90	47.93	42.36	44.53	37.97
	N_{75}%	42.88	35.90	46.36	40.72	49.93	45.14	46.39	40.59
P_{75}%	N_0%	33.08	25.79	41.12	33.87	44.63	38.69	39.61	32.78
	N_{50}%	42.31	33.96	45.71	39.50	49.24	40.17	45.76	37.87
	N_{75}%	44.82	38.81	47.89	41.90	52.56	47.25	48.43	42.65

Table (3-a): Interaction between nitrogen fertilizer and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	30.04	23.68	38.19	31.76	42.32	35.94	36.85	30.46
	N_{50}%	40.70	32.45	44.74	38.81	48.10	41.18	44.52	37.48
	N_{75}%	42.64	35.62	46.20	40.20	50.04	44.78	46.29	40.20
mean		37.79	30.58	43.04	36.92	46.82	40.63	42.55	36.05

Table (3-b): Interaction between phosphorus fertilizer and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	35.14	27.96	40.78	34.83	44.50	38.30	40.14	33.70
	P_{50}%	38.17	30.94	43.45	37.51	47.15	41.56	42.92	36.67
	P_{75}%	40.07	32.85	44.91	38.42	48.81	42.04	44.60	37.77
mean		37.79	30.58	43.05	36.92	46.82	40.63	42.55	36.04

LSD 5%			
1st	2nd	1st	2nd
B =1.53	B =0.99	PB =0.58	PB =1.13
P =0.33	P =0.65	BN =0.45	BN =1.14
N =0.26	N =0.66	PN =0.45	PN =1.14
BPN=0.78	BPN =1.98		

b. Stem diameter (mm):

Data shown in Table (4) show the impact of chemical, biofertilizers and active dry yeast on stem diameter of turmeric plants. There are significant differences among all treatments. The obtained data revealed that, turmeric plants fertilized by biofertilizer gave the biggest stem diameter (13.53 and 11.58 mm), followed by adding active dry yeast (13.33 and 11.36), while the control gave the lowest values (12.05 and 9.82 mm) in the first and the second seasons, respectively. Data also indicated that, the interaction effects of biofertilizer or active dry yeast, nitrogen and phosphorus fertilizers were significant. The combination of biofertilizer + 75% of the recommended dose of both nitrogen and phosphorus recorded the highest estimates (16.08 and 14.52 mm) in both seasons. While the lowest values were obtained from the plants without chemicals, yeast and biofertilization (8.31 and 6.23) in both seasons. These results are in accordance with those of **Besada (1981)** who reported that, seed inoculation with effective N_2-fixing strain of *Azospirillum brasilense* improved the growth of certain xerophytes plants.

Table (4): Effect of chemical fertiler, yeast and biofertilization on turmeric stem diameter (mm) during seasons 2004 and 2005

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	8.31	6.23	10.50	8.59	10.56	9.01	9.79	7.94
	N_{50}%	11.82	9.42	12.90	11.01	13.11	11.08	12.61	10.50
	N_{75}%	12.82	10.83	13.85	11.86	14.12	12.27	13.60	11.65
P_{50}%	N_0%	11.35	8.94	12.53	10.58	12.95	10.79	12.16	10.10
	N_{50}%	12.43	10.10	13.58	11.66	13.70	11.72	13.24	11.16
	N_{75}%	13.48	11.50	14.39	12.27	14.81	12.69	14.23	12.15
P_{75}%	N_0%	11.63	9.18	12.76	10.81	12.87	10.94	12.42	10.31
	N_{50}%	12.67	10.35	13.73	11.76	13.92	11.96	13.44	11.36
	N_{75}%	13.92	11.83	15.74	13.69	16.08	14.52	15.25	13.26

Table (4-a): Interaction between nitrogen and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	10.43	8.12	11.93	9.99	12.01	10.11	11.45	9.41
	N_{50}%	12.31	9.96	13.40	11.48	13.58	11.55	13.10	11.00
	N_{75}%	13.41	11.39	14.66	12.60	15.00	13.07	14.36	12.35
		12.05	9.82	13.33	11.36	13.53	11.58	12.97	10.92

Table (4-b): Interaction between phosphorus and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	10.98	8.83	12.41	10.49	12.60	10.79	12.00	10.03
	P_{50}%	12.42	10.18	13.50	11.50	13.70	11.73	13.21	11.14
	P_{75}%	12.74	10.45	14.08	12.09	14.29	12.38	13.70	11.64
mean		12.05	9.82	13.33	11.36	13.53	11.58	12.97	10.92

LSD 5%			
1st	2nd	1st	2nd
B = 0.17	B =0.27	PB =0.14	PB =0.22
P =0.25	P =0.13	BN =0.16	BN =0.16
N =0.30	N =0.09	PN =0.16	PN =0.16
BPN =0.28	BPN =0.28		

c. Leaf area (cm^2):

The effects of chemical and biofertilizers on leaf area of turmeric plants are shown in Table (5). Generally, the obtained data indicated that, the leaf area of plants received biofertilizer (140.49 and 128.68 cm^2) significantly increased compared to those treated with active dry yeast (134.12 and 121.26 cm^2) or those grown in control (117.90 and 106.85 cm^2) in both seasons respectively. The interaction between biofertilizers or yeast, nitrogen and phosphorus levels was significant. The highest leaf area records (148.53 and 138.56 cm^2) were produced by applying of biofertilizer + 75% of recommended doses of both nitrogen and phosphorus fertilizers followed by applying of active dry yeast + 75% of recommended doses of both nitrogen and phosphorus fertilizers (145.90 and 136.56 cm^2) in the first and second seasons respectively, while the lowest values were obtained from control (59.32 and 44.39 mm) in seasons 2004 and 2005 respectively. Thus, it can be concluded that, treating turmeric plants with biofertilizer significantly increases the leaf area and stem diameter, this may be due to the increase in nitrogen content in the soil as a result of N-fixation and phosphorus from phosphate dissolving bacteria (PDB) as well as growth promoting substances such as indole acetic acid and gibberellins produced by all organisms used. These results are similar to those mentioned by **Besada (1981)** on certain xerophytes plants, **Misra (1997)** on gladiolus plants, **Shashidhar *et al.* (1997**), **Meenakshi *et al.* (2001)** and **Yamgar *et al.* (2001)** on turmeric plants

d. Rhizome fresh weight/ plant (g):

Data about how rhizome fresh weight is affected by chemical and biofertilizers application in 2004 and 2005 seasons is presented in Table (6). Data revealed that, there are significant differences among all treatments. The highest rhizome fresh weight/ plant (55.70 and 46.58 g) was obtained by using the biofertilizer, followed by using active dry yeast (50.76 and 42.58 g) in the first and second seasons, respectively. Meanwhile the lowest estimates (42.62 and 37.78 g) were obtained by the control in the first and the second seasons, respectively. In addition, results revealed that, substantial effects were produced by the combination of biofertilizer + nitrogen levels + phosphorus levels. Fertilization with biofertilizer + 75% of the recommended dose of nitrogen + 75% of the recommended dose of phosphorus produced the heaviest yield of rhizome fresh weight/ plant (66.80 and 56.00 g), followed by the application of biofertilizer + 75% of nitrogen fertilizer + 50% of phosphorus fertilizer, while the application of active dry yeast + 75% of the recommended dose of nitrogen and phosphorus fertilizers gave (61.01 and 51.22 g) in the first and second seasons, respectively. But the control led to lowest values (25.97 and 23.63 g) in both successive seasons respectively. The increment of rhizome fresh weight may be attributed to the increase in plant height, leaf area and stem diameter and may be attributed to the activity of the free-living bacteria as nitrogen fixing bacteria found in the rhizosphere of roots, as well as phosphate dissolving bacteria, which results in the available phosphate, in addition to decreasing the pH of soil, leading to increasing the absorption of trace elements. These bacteria proved to be able to produce auxins and other plant growth substances in the plant rhizosphere (**Tien *et al*, 1979**). These results resemble the results of **Kshiragar *et al*. (1994)** on seedlings of onion, **Misra (1997)** on gladiolus plants, **Rashed , Nahed (2002)** on some aromatic plants

Table (5): Effect of chemical, yeast and biofertilization on turmeric leaf area (cm^2) during seasons 2004 and 2005

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	59.32	44.39	115.72	98.49	125.46	115.99	100.16	86.29
	N_{50}%	120.26	109.75	130.43	117.97	138.83	125.75	129.84	117.82
	N_{75}%	132.51	122.56	141.53	130.57	146.28	134.20	140.11	129.11
P_{50}%	N_0%	107.93	93.37	124.00	108.92	132.53	122.72	121.78	108.34
	N_{50}%	121.36	112.71	137.77	125.09	143.49	128.22	134.21	122.01
	N_{75}%	135.56	124.67	143.70	133.13	146.53	136.58	141.93	131.46
P_{75}%	N_0%	115.86	104.66	127.19	111.60	136.93	124.04	126.66	113.43
	N_{50}%	126.82	118.36	139.96	129.03	145.80	132.50	137.52	126.63
	N_{75}%	141.50	131.18	145.90	136.56	148.53	138.12	145.31	135.29

Table (5-a): Interaction between nitrogen and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	94.37	80.81	122.60	106.34	131.64	120.91	116.20	102.69
	N_{50}%	122.81	113.61	136.05	124.03	142.71	128.82	133.86	122.15
	N_{75}%	136.52	126.13	143.71	133.42	147.11	136.30	142.45	131.95
		117.90	106.85	134.12	121.26	140.49	128.68	130.84	118.93

Table (5-b): Interaction between phosphorus and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	104.03	92.23	129.23	115.68	136.85	125.31	123.37	111.07
	P_{50}%	121.61	110.25	135.46	122.38	140.85	129.17	132.64	120.60
	P_{75}%	128.06	118.07	137.68	125.73	143.75	131.55	136.50	125.12
mean		117.90	106.85	134.12	121.26	140.49	128.68	130.84	118.93

LSD 5%			
1st	2nd	1st	2nd
B =3.69	B =2.15	PB =1.47	PB =1.47
P =0.85	P =0.85	BN =1.44	BN =1.34
N =0.83	N =0.77	PN =1.44	PN =1.34
BPN =0.88	BPN =2.32		

Table (6): Effect of chemical, yeast and biofertilization on turmeric rhizome fresh weight/plant (g) during seasons 2004 and 2005

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	25.97	23.63	39.80	33.07	42.31	36.45	36.03	31.05
	N_{50}%	39.32	36.12	48.74	40.59	54.47	44.32	47.51	40.34
	N_{75}%	44.43	37.70	50.38	41.86	58.00	45.55	51.09	41.71
P_{50}%	N_0%	34.92	33.52	46.93	38.32	47.29	41.27	43.05	37.70
	N_{50}%	44.99	39.25	52.27	43.74	58.12	47.77	51.79	43.59
	N_{75}%	50.83	44.45	55.35	47.71	61.95	53.43	56.04	48.53
P_{75}%	N_0%	39.19	35.33	47.79	40.24	52.82	44.04	46.60	39.87
	N_{50}%	50.20	43.21	54.13	46.49	59.55	50.38	54.63	46.69
	N_{75}%	53.73	46.80	61.01	51.22	66.80	56.00	60.51	51.34

Table (6-a): Interaction between nitrogen and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	33.36	30.83	44.84	37.21	47.47	40.59	41.89	36.21
	N_{50}%	44.84	39.53	51.72	43.61	57.38	47.49	51.31	43.54
	N_{75}%	49.66	42.98	55.73	46.93	62.25	51.66	55.88	47.19
		42.62	37.78	50.76	42.58	55.70	46.58	49.69	42.31

Table (6-b): Interaction between phosphorus and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	36.57	32.48	46.46	38.51	51.59	42.11	44.88	37.70
	P_{50}%	43.58	39.07	51.52	43.26	55.79	47.49	50.30	43.27
	P_{75}%	47.71	41.78	54.31	45.98	59.73	50.14	53.92	45.97
mean		42.62	37.78	50.76	42.58	55.70	46.58	49.69	42.31

LSD 5%			
1st	**2nd**	**1st**	**2nd**
B =2.25	B =0.32	PB =1.11	PB =1.66
P=0.64	P =0.96	BN =1.11	BN =0.56
N =0.64	N =0.32	PN =1.11	PN =0.56
BPN=1.9	BPN =0.70		

e. Rhizome fresh weight/ feddan (Kg):

The effects of chemical and biofertilizers application on rhizome fresh weight/ feddan in 2004, 2005 seasons are listed in Table (7). Data revealed that, there are significant differences among biofertilizer, yeast and control in the first season. Using of biofertilizer yielded the greatest rhizome fresh weight/ feddan (779.83 kg), followed by the application of active dry yeast (710.68 kg), meanwhile the lowest value (596.70 kg) was recorded from control. On the other hand, there are no significant differences among biofertilizer, yeast and control in the second season and the values were (598.29, 594.31 and 588.28 kg) respectively. The interaction effects among biofertilizer, nitrogen and phosphorus fertilizers varied from significant to insignificant. The combination of biofertilizer + 75% of the nitrogen recommended dose + 75% of the phosphorus recommended dose yielded the greatest rhizome fresh weight/ feddan (935.25 and 783.95 kg), followed by the application of biofertilizer + 75% of nitrogen recommended dose + 50% of phosphate recommended dose (867.25 and 748.02 kg), while the application of active dry yeast + 75% of the recommended dose of nitrogen and phosphorus fertilizer gave (854.14 and 717.08 kg), the control yielded the lowest rhizome fresh weight/ feddan (363.58 and 330.82 kg) in the first and second seasons respectively. Thus, the increment in rhizome fresh weight/ feddan may be attributed to the increase in rhizome fresh weight/ plant caused by the increase of rhizome size leading to increasing root length and increasing absorption of N, P, K. as well as trace elements, which reflects on the plant growth. These results concur with the results on turmeric plants.

Table (7): Effect of chemical, yeast and biofertilization on turmeric rhizome fresh weight/feddan (kg) during seasons 2004 and 2005

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	363.58	330.82	557.25	463.03	592.39	510.30	504.40	434.72
	N_{50}%	550.48	505.73	682.41	568.31	762.58	620.433	665.16	564.82
	N_{75}%	622.07	527.80	711.67	619.42	812.00	637.76	715.24	594.99
P_{50}%	N_0%	488.93	469.23	657.07	536.43	662.06	577.73	602.68	527.80
	N_{50}%	629.86	549.55	731.78	612.42	813.73	668.83	725.12	610.27
	N_{75}%	711.62	622.32	774.85	667.91	867.25	748.02	784.58	679.42
P_{75}%	N_0%	548.71	494.67	669.11	563.36	739.48	616.56	652.43	558.20
	N_{50}%	702.80	604.99	757.87	650.86	833.75	705.27	764.80	653.71
	N_{75}%	752.22	655.15	854.14	717.08	935.25	783.95	847.20	718.73

Table (7-a): Interaction between nitrogen and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	467.07	431.57	627.81	520.94	664.64	568.20	586.51	506.90
	N_{50}%	627.71	553.42	724.02	610.53	803.35	664.84	718.36	609.60
	N_{75}%	695.30	601.76	780.22	668.14	871.50	723.25	782.34	664.38
		596.70	588.28	710.68	594.31	779.83	598.29	695.74	593.63

Table (7-b): Interaction between phosphorus and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	512.04	454.78	650.44	550.25	722.32	589.50	628.27	531.51
	P_{50}%	610.14	547.03	721.23	605.59	781.01	664.86	704.13	605.83
	P_{75}%	667.91	584.94	760.37	643.77	836.16	701.93	754.81	643.54
mean		596.70	588.28	710.68	594.31	779.83	598.29	695.74	593.63

LSD 5%			
1st	2nd	1st	2nd
B =31.54	B =13.79	PB =15.50	PB =10.60
P =8.95	P =6.12	BN =15.72	BN =15.46
N =9.08	N =8.92	PN =15.72	PN =15.46
BPN=27.23	BPN =26.77		

f. Dry matter percentage :

Data in Table (8) show the effect of chemical and biofertilization on dry matter percentage of turmeric plants, there are significant differences among all treatments. The application of biofertilizer gave the highest dry matter percentage (30.48 and 30.32 %), followed by application of active dry yeast (29.89 and 29.38 %), while the lowest values (29.96 and 29.01 %) was obtained from the control in the first and the second seasons respectively. The interaction among biofertilizer, yeast, nitrogen and phosphorus fertilizers has a significant effect on dry matter %. The highest values (31.06 and 31.47 %) were obtained from plants received biofertilizer + 75% of the recommended dose of both nitrogen and phosphorus fertilizers, while the lowest values obtained from control (28.60 and 27.98%) in the first and the second seasons respectively. These results are in accordance with the results of **Venkatesha *et al*. (1998)** and **Meenakshi *et al*. (2001)** on turmeric plants

Table (8): Effect of chemical, yeast and biofertilization on turmeric dry matter percentage during seasons 2004 and 2005.

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	28.60	27.98	28.71	28.37	30.05	29.02	29.12	28.46
	N_{50}%	29.87	28.90	30.00	29.15	30.28	30.05	30.05	29.37
	$N_{75\%}$	30.43	29.35	30.48	29.48	30.91	30.95	30.61	29.93
P_{50}%	N_0%	29.33	28.55	29.93	28.80	30.11	29.35	29.79	28.90
	N_{50}%	29.97	29.02	30.09	29.25	30.32	30.23	30.13	29.50
	N_{75}%	30.48	29.47	30.85	30.43	30.97	31.23	30.77	30.38
P_{75}%	N_0%	29.73	28.80	30.00	29.00	30.13	29.67	29.95	29.16
	N_{50}%	30.00	29.32	30.31	29.40	30.45	30.95	30.25	29.89
	N_{75}%	30.88	29.68	31.08	30.55	31.06	31.47	31.19	30.57

Table (8-a): Interaction between nitrogen and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	29.22	28.44	29.97	28.72	30.10	29.34	29.76	28.84
	N_{50}%	30.06	29.08	30.35	29.27	30.89	30.41	30.43	29.59
	N_{75}%	30.60	29.50	30.80	30.16	31.00	31.22	30.80	30.29
		29.96	29.01	30.37	29.38	30.66	30.32	30.33	29.57

Table (8-b): Interaction between phosphorus and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	29.63	28.74	29.73	29.00	30.41	30.01	29.93	29.25
	P_{50}%	29.93	29.01	30.29	29.49	30.47	30.27	30.23	29.59
	P_{75}%	30.20	29.27	30.46	29.65	30.73	30.96	30.46	29.87
mean		29.96	29.01	30.37	29.38	30.66	30.32	30.33	29.57

LSD 5%			
1st	2nd	1st	2nd
B =0.05	B =0.17	PB =0.07	PB =0.09
P =0.04	P =0.05	BN =0.07	BN =0.11
N =0.04	N =0.063	PN =0.07	PN =0.11
BPN=0.13	BPN =0.19		

g. Rhizome dry weight/ plant (g):

Table (9) show the effect of chemical and biofertilizers on rhizome dry weight/ plant. It can be observed from data that, the greatest rhizome dry weight/ plant (17.00 and 14.18 g) was obtained from plants received biofertilizer, followed by the application of active dry yeast (15.21 and 12.54g) On the other hand , the lightest rhizome dry weight/ plant (7.43 and 6.16 g) was produced from the control in seasons 2004 and 2005 respectively. The interaction between chemical and biofertilizer led to significant increase compared to control. While , using biofertilizer + 75% of nitrogen recommended dose + 75% of phosphorus recommended dose gave the highest estimates (20.77 and 17.62 g), followed by the application of biofertilizer + 75% of nitrogen recommended dose + 50% of phosphorus recommended dose (19.19 and 16.69 g), the application of active dry yeast + 75% of the recommended dose of nitrogen and phosphorus gave (18.96 and 15.64 g), the control gave the lowest estimates (7.43 and 6.16 g) in both seasons. The increment in rhizome dry weight/ plant may be attributed to the increase in rhizome fresh weight/ plant. The same results were obtained by **Misra (1997)** on gladiolus plants**, Ahmed *et al.* (2001)** on *Ambrosia maritima*, **Ali *et al.*, (2001)** on guar plants, **Al-Qadasi (2004)** on *Ocimum basilicum* plants and **Youssef *et al.*, (2004)** on *Salvia officinalis* plants.

Table (9): Effect of chemical, yeast and biofertilization on turmeric rhizome dry weight/plant (g) during seasons 2004 and 2005

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	7.43	6.16	11.43	9.38	12.74	10.57	10.53	8.70
	N_{50}%	11.74	10.44	14.27	11.83	16.49	13.32	14.17	11.86
	N_{75}%	13.54	11.06	15.49	12.34	17.93	14.17	15.65	12.52
P_{50}%	N_0%	10.32	9.57	13.51	11.03	14.20	12.17	12.68	10.92
	N_{50}%	13.46	11.39	15.73	12.79	17.62	14.46	15.61	12.88
	N_{75}%	15.47	13.08	17.08	14.51	19.19	16.69	17.25	14.76
P_{75}%	N_0%	11.65	10.17	13.99	11.67	15.91	13.06	13.85	11.64
	N_{50}%	15.23	12.67	16.41	13.67	18.14	15.60	16.59	13.98
	N_{75}%	16.59	13.48	18.96	15.64	20.77	17.62	18.77	15.58

Table (9-a): Interaction between nitrogen and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	9.80	8.79	12.98	10.69	14.29	11.94	12.36	10.47
	N_{50}%	13.48	11.50	15.47	12.76	17.42	14.46	15.46	12.91
	N_{75}%	15.20	12.54	17.18	14.16	19.29	16.16	17.22	14.29
		12.83	10.94	15.21	12.54	17.00	14.18	15.01	12.55

Table (9-b): Interaction between phosphorus and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	10.90	9.22	13.73	11.18	15.72	12.69	13.45	11.03
	P_{50}%	13.09	11.35	15.44	12.78	17.00	14.44	15.18	12.86
	P_{75}%	14.49	12.11	16.57	13.66	18.27	15.43	16.41	13.73
mean		12.83	10.94	15.21	12.54	17.00	14.18	15.01	12.55

LSD 5%			
1st	2nd	1st	2nd
B =0.66	B =0.003	PB =0.34	PB =1.16
P =0.19	P =0.12	BN=0.33	BN =0.16
N =0.19	N =0.92	PN =0.33	PN =0.28
BPN =0.59	BPN =1.98		

h. Rhizome dry weight/ feddan (Kg):

Data obtained about rhizome dry weight/ feddan as affected by the application of chemical and biofertilizers in 2004 and 2005 seasons are presented in Table (10), there are significant differences among all treatments. In general, data showed that turmeric plants grown in soil fertilized with biofertilizer gives the greatest rhizome dry weight/ feddan (237.92 and 197.88 kg) compared to the application of yeast (212.92 and 175.57 kg) or the control (179.57 and 153.19 kg) in the first and the second seasons respectively. Regarding the interaction between the chemical and biofertilizers, it can be observed that, there was significant increment in rhizome dry weight/ feddan (290.78 and 246.68 kg) resulted from using the biofertilizer + 75% of the

recommended dose of both nitrogen and phosphorus fertilizers, followed by the application of 75% of nitrogen recommended dose + 50% of phosphorus recommended dose (268.61 and 233.61 kg), while the application of active dry yeast + 75% of both nitrogen and phosphorus recommended doses gave (265.44 and 219.01 kg) compared to control which gave the lowest values (103.97 and 92.59 kg) in seasons 2004 and 2005 , respectively. Thus, the increment in rhizome dry weight/ feddan may be due to the increase in rhizome fresh weight/ feddan. These results agree with the results of **Venkatesha et al (1997)** on turmeric plants and **Mahfouz (2003)** on *Majorana hortensis* plants.

Table (10): Effect of chemical, yeast and biofertilization on turmeric rhizome dry weight/feddan (kg) during seasons 2004 and 2005

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
P_0%	N_0%	103.97	92.59	159.97	131.27	178.41	148.03	147.45	123.96
	N_{50}%	164.41	146.16	199.83	165.67	230.86	186.43	198.37	166.09
	N_{75}%	189.51	154.89	216.86	172.76	250.97	198.38	219.12	175.34
P_{50}%	N_0%	144.48	133.98	189.19	154.47	198.85	170.38	177.50	152.94
	N_{50}%	188.49	159.48	220.27	179.11	246.73	202.16	218.49	180.25
	N_{75}%	216.63	183.17	239.07	203.14	268.61	233.61	241.44	206.64
P_{75}%	N_0%	163.15	142.43	195.91	163.38	222.79	176.88	193.95	160.90
	N_{50}%	213.17	177.38	229.79	191.33	253.91	218.35	232.29	195.69
	N_{75}%	232.31	188.67	265.44	219.01	290.78	246.68	262.84	218.12

Table (10-a): Interaction between nitrogen and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of N	N_0%	137.20	123.00	181.69	149.71	200.01	165.10	172.97	145.93
	N_{50}%	188.69	161.00	216.63	178.70	243.83	202.32	216.38	180.67
	N_{75}%	212.82	175.58	240.46	198.30	270.12	226.22	241.13	200.03
		179.57	153.19	212.92	175.57	237.99	197.88	210.16	175.55

Table (10-b): Interaction between phosphorus and biofertilizers

		WITHOUT		YEAST		BIO		MEAN	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Mean of P	P_0%	152.63	131.21	192.22	156.57	220.08	177.61	188.31	155.13
	P_{50}%	183.20	158.89	216.18	178.90	238.06	202.05	212.48	179.95
	P_{75}%	202.88	169.49	230.38	191.24	255.83	213.97	229.69	191.57
Mean		179.57	153.19	212.92	175.57	237.99	197.88	210.16	175.55

LSD 5%			
2nd	1st	2nd	1st
PB =3.49	PB =4.75	B =0.003	B =9.22
BN =2.80	BN =4.73	P =2.01	P =2.75
PN =2.80	PN =4.73	N =1.62	N =2.73
		BPN =4.85	BPN=8.19

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دراسات عن الاحتياجات السمادية لنبات الكركم

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أجريت تجربة حقلية خلال موسمي ٢٠٠٤ ، ٢٠٠٥ بمزرعة كلية الزراعة- جامعة القاهرة- مصر. لدراسة تأثير استخدام السماد الكيماوي والخميرة والسماد الحيوي على النمو الخضري في نبات الكركم.

تم استخدام مستوى واحد من خليط من السلالات البكتيرية التالية:

Azotobacter chroococcum, Azospirillum lipoferum, Bacillus megatherium and *Pseudomonas fluorescence*.

كما تم استخدام مستوى واحد من الخميرة *Saccharomyces cervisia* بمعدل ٦جم/لتر بالإضافة إلى ثلاث مستويات (صفر، ٥٠%، ٧٥%) من الجرعة الموصى بها من كل من السماد النيتروجيني والفوسفاتي (١٢٠ كجم نيتروجين/هكتار، ٦٠ كجم فوسفور/ هكتار).

وكانت أهم النتائج المتحصل عليها:

- أدت المعاملة بالسماد الحيوي+ ٧٥% من الجرعة الموصى بها من السماد الفوسفاتي والنيتروجيني إلى الحصول على أعلى القيم لجميع الصفات الخضرية مثل (ارتفاع النبات- قطر الساق- مساحة الورقة)، مقارنة بالخميرة + نفس الجرعة من الأسمدة الكيماوية وكذلك مقارنة باستعمال الأسمدة الكيماوية فقط دون إضافة السماد الحيوي أو الخميرة. كما أدت هذه المعاملة أيضا للحصول على أعلى محصول للريزومات الطازجة والجافة للنبات وكذلك للفدان في كلا الموسمين مقارنة باستخدام الخميرة+ نفس الجرعة من الأسمدة الكيماوية أو استعمال الأسمدة الكيماوية فقط دون إضافة السماد الحيوي أو الخميرة.