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EFFECT OF ORGANIC AND BIOFERTILIZERS APPLICATION AS COMPARED TO CHEMICAL FERTILIZERS ON: I- VEGETATIVE GROWTH AND FLOWERING OF TOMATO PLANTS

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ABSTRACT

A field experiment was performed at Kaha Vegetable Research Station, Horticultural Research Institute during the two successive summer seasons of 1997 and 1998 to compare the effect of organic, mineral and biofertilizers on soil chemical composition, growth as well as flowering of tomato plants.

Biofertilizers were used as phosphorein, microbien and rhizobacterin compounds at rates of 1kg, 2 kg, and 3 kg / fed for each. Organic manure fertilizer in the form of chicken manure was used at two rates, i.e., 10m^3 and 15 m^3 / fed as single application or combined with the same biofertilizers rates.

NPK mineral fertilizer was used at four levels, i.e., the recommended level for tomato crop (120 kg N + 45 kg P_2O_5 + 96 kg K_2O / fed) as control, 25 %, 50 %, 75 % from NPK recommended fertilizers. The separate organic and biofertilizers plots did not receive any doses from the mineral fertilizer.

The obtained results indicated that chicken manure at 15 m^3 / fed in the presence of mixture of phosphorein, microbien and rhizobacterin at rate of 3 kg / fed of each was the most favourable treatment in reducing soil pH, increasing N, P soil content with significant increment on the different parameters of vegetative growth and flowering of tomato plants. The second superior treatment was 10 m^3 chicken manure plus the mixture of biofertilizers followed by 50 % or 25 % NPK recommended mineral fertilizer in the prersence of biofertilizer mixture.

INTRODUCTION

Tomato (*Lycopersicon esculentum,* Mill.) is one of the most important vegetable crops grown in Egypt for fresh consumption and processing. The total cultivated area of tomato in Egypt was about 401329 fed during 1998 season which represents 44.66 % of the total vegetable area in Egypt “according to the statistics of Ministry of Agriculture”. To obtain the best yield from a tomato crop, suitable cultural practices must be adopted. Among the methods followed for improving the quantity and quality of tomato fruits are the application of major fertilizers to satisfy the needs of plants from such elements since good growth is mostly associated with good yield and best quality. Organic and biofertilization is also very important methods of providing the plants with their nutritional requirements without having an undesirable impact on the environment.

Regarding the effect of applying chemical fertilizers plus biofertilizers on soil chemical composition, Radwan (1983) found that available phosphorus content increased as a result of P-fertilization and inoculated

tomato plants with phosphatic dissolving bacteria. Subbiah (1990) observed that at 50 % of the recommended N rate (60 kg/ha) and treating tomato seedling with Azospirillum resulted in the highest soil N content.

Numerous investigators explained the important role of biofertilizers in reducing soil pH and increasing N - P soil contents by secreting organic acids such as acetic, propionic, fumaric and succinic. Such acids lowered the pH and bring about the dissolution of bands forms of phosphate and render them available for growing plants (Ibrahim and Abdel-Aziz, 1977) or by mineralization (Singh *et al*., 1992).

The effect of biofertilizers in single application or in the presence of different levels from NPK on tomato growth was reviewed by numerous investigators. Biofertilization with the different strains of bacteria induced significant increases in plant growth expressed as fresh and dry weight of different plant organs as well as number of leaves and branches (Radwan, 1983).

Gomaa (1989) and Monib *et al*. (1990) obtained the highest significant increases in total dry weight, number of leaves, root biomass as a result of combined effect of biofertilizers and mineral fertilization at a rate of 1/3 NPK from the tomato recommended mineral fertilizer comparing with the root inoculation treatment alone. Recently, Awad (1998) using 50 % and Hewedy (1999 b) using 75 % from tomato NPK recommended fertilizer obtained better significant results on plant growth including plant height, number of leaves and branches per plant as well as dry matter comparing with the chemical or biofertilizer fertilization in single application.

Concerning application of manure fertilizer plus biofertilizers and its effects on soil chemical composition and plant growth, it was found that application of manure fertilizer increased the total N content (Abdel-Moez *et al*., 1995), avaliable phosphurs content (Giusquiani *et al.,* 1988) and content of exchangeable potassium (Kajj *et al*., 1990). It also played an important role in reducing pH values of the soil (El-Masry, 1995).

Regarding the combined effect of bacterial fertilizers, i.e. *Azotobacter*, *Chroococcum* and *Azospirillum* and organic manure, Fallik and Okon (1996) and Awad (1998) reported that bacterial strains were highly effecient on promotion of nitrogen fixation, CO_2 evaluation and ammonification resulting in adjustement of pH media than using each of them in single application.

The addition of organic manure to the soil also increased the growth of the plants, Montasser (1987) stated that the dry matter content of tomato plant as well as plant growth parameters were increased by using FYM.

Concerning organic manuring and interaction between nitrogen fixing bacteria and phosphobacteria, Kostov *et al.* (1991) and Awad (1998) on tomato stated that the plants which fertilized with compost or chicken manure and biofertilized with *Azospirillum sp*., *Pseudomonas sp*. and phosphate dissolving bacteria showed significant increases in plant growth and fresh and dry weights comparing with the plants which biofertilized only or received NPK mineral fertilizer.

The objective of this research was to study the application of various bacterial fertilizers in individual application or combined with mineral or organic fertilizer on plant growth and flowering of tomato.

MATERIALS AND METHODS

Two field experiments were carried out at Kaha Vegetable Research Station, Horticultural Research Institute, during summer seasons of 1997 and 1998 to study the effect of some different sources of fertilizers, i.e. mineral, organic and biological in single or combined application on tomato growth and flowering.

Tomato seeds cv. Castle Rock were sown in the nursery on 8th and 10th of January and transplanting took place on 2nd and 4th of March in both 1997 and 1998 seasons, respectively. The treatments of the experiment were arranged in a complete randomized block design with four replications. The plot area was 12 m^2 and contained 3 rows (each row was 4 m in length and 1 m in width),.

The experiment included 21 treatments as the following:

1- 25 % NPK recommended + biofertilizer (1)*
2- 50 % NPK recommended + biofertilizer (1)
3- 75 % NPK recommended + biofertilizer (1)
4- 25 % NPK recommended + biofertilizer (2)*
5- 50 % NPK recommended + biofertilizer (2)
6- 75 % NPK recommended + biofertilizer (2)
7- 25 % NPK recommended + biofertilizer (3)*
8- 50 % NPK recommended + biofertilizer (3)
9- 75 % NPK recommended + biofertilizer (3)
10- 10m^3 Organic manure + biofertilizer (1)
11- 15m^3 Organic manure + biofertilizer (1)
12- 10m^3 Organic manure + biofertilizer (2)
13- 15m^3 Organic manure + biofertilizer (2)
14- 10m^3 Organic manure + biofertilizer (3)
15- 15m^3 Organic manure + biofertilizer (3)
16- 10m^3 Organic manure only
17- 15m^3 Organic manure only
18- Biofertilizer (1) only
19- Biofertilizer (2) only
20- Biofertilizer (3) only
21- 100 % NPK recommender chemical fertilizer (control)

The amount of mineral fertilizers and the time of applications are shown in Table (1).

Concerning the biological fertilizer a mixture of *Bacillus megaterium* phosphate dissolving bacteria under the commercial name of “phosphoren”, *Azotobacter inoculum* nitrogen fixing bacteria under the commercial name of “rhizobacterin” and a mixture of P dissolving and nitrogen fixing bacteria under the commercial name of “microbien” at the three rates, i.e. each at 1 kg

*** Biofertilizer(1): mixture of 1kg phosphoren+1kg microbien+1kg rhizobacterin**
Biofertilizer(2): mixture of 2kg phosphoren+2kg microbien+2kg rhizobacterin
Biofertilizer(3): mixture of 3kg phosphoren+3kg microbien+3kg rhizobacterin

2 kg and 3 kg / fed were mixed with moist sand and added in site transplanting holes, then the transplants were planted and directly irrigated after covering the holes. Other cultural practices were carried out according to the recomendations of Ministry of Agriculture.

Table (1): Amount of mineral fertilizers (kg/fed.) during one season at rates of 25%, 50%, 75% and 100% of the recommended mineral fertilizers for tomato.

Fertilizers type	Fertilizer rate	Amount of fertilizers (kg/fed)			Total amount (kg/fed)
		After 20 days from transplanting	After 45 days from transplanting	After 65 days from transplanting	
Ammonium sulphate 20.5% N	25 %	48.78	48.78		97.56
	50 %	97.56	97.56		195.12
	75 %	146.39	146.34		292.68
	100 %	195.12	195.12		390.24
Ammonium nitrate 33 % N	25 %			30.30	30.30
	50 %			60.61	60.61
	75 %			90.91	90.91
	100 %			121.21	121.21
* Calcium super-phosphate 15.5% P_2O_5	25 %				75.58
	50 %				145.16
	75 %				217.74
	100 %				290.32
Potassium sulphate 48% K_2O	25 %	25	25		50
	50 %	50	50		100
	75 %	75	75		150
	100 %	100	100		200

*** Calcium superphosphate was added during soil preparation.**

The organic manure was applied per plot during soil preperation. The chemical analysis of the chiken manure are shown in Table (2).

Table (2): The chemical properties of the chicken manure during 1997 and 1998 seasons.

Analysis fraction	1997	1998
pH	5.35	5.41
Available nitrogen ppm	8033	7833
Available K_2O ppm	792	754
Available P_2O_5 ppm	1794	1677

Soil chemical composition

To determine N, P, K and pH, random samples from soil experimental plots at the depth of 0 - 30 cm were taken before applying the manure or mineral fertilizer and after the last picking.

Plant growth

Random samples of 4 plants from each plot were chosen after 75 days from transplanting to determine plant height, number of leaves and branches per plant, leaf area of the fourth leaf from the plant top as well as dry weight of tomato plants after drying the plant samples at 70 °C until constant weight.

Flowering characteristics

Four plants from each plot were randomly chosen and labelled to calculate number of flowering clusters per plant, average number of flowers per cluster and fruit set percentage of the first four clusters.

Data were statistically analyzed according to Snedecor and Cochran (1980). The differences between treatment means were tested using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Soil chemical composition

Tables (3 a &b) show the effect of treatments on soil pH and Nand P content which were determined before adding the fertilizers and after the last picking. The obtained results emphasize that the pH value under organic manure plus biofertilizer mixture, 50 % and 25 % NPK plus biofertilizer, 75 % NPK plus biofertilizers at the medium and high rates, i.e. 2 and 3 kg/fed was significantly decreased comparing with the recommended 100 % NPK chemical fertilizers (control). The superior treatment in reducing soil pH value was 15 m^3 organic manure plus inoculation before transplanting with the mixure phosphorein, microbien and rhyizobactorin.

The obtained results are in harmony with those reported by Awad (1991), Abdel-Moez *et al*. (1995) and El-Masry (1995). They reported that addition of organic manures play an important role in soil pH values and the reduction effect depending on manure type, soil depth and application rate. Several investigators came to the similar results as the combined effect of organic manure and biofertilizers was more effective in reducing soil pH than individual application (Awad, 1998). Hewedy (1999 a) with biofertilizers plus different levels of NPK fertilizers on soil pH came to similar results.

The obtained slight reduction in soil pH value might be due to the determination that was carried out at the end of the experiment, it was reported shown that the maximum reduction in pH value, by using biofertilizers, was recorded 50 days from treatment then it started to decrease slowly again (Hewedy, 1999 b). Concerning N, P and K soil contents as affected by different fertilizers types, data in Table (3 a&b) indicate that in general all treatments significantly incerased the available nitrogen soil content except 75 % NPK fertilization

Table (3a): Effect of mineral, organic and biofertilizers on chemical properties of the experimental soil before applying the fertilizers and after the last picking at summer season of 1997.

Characters / Treatments	Before applying the fertilizers				After the last picking			
	pH	N ppm	P ppm	K ppm	PH	N ppm	P ppm	K ppm
5% NPK recommended + biofertilizer (1)*	8.46	74.70	11.80	49.50	8.210 c-f	109.6 fg	21.50 de	62.00 b
0% NPK recommended + biofertilizer (1)	8.59	74.10	10.60	48.30	8.140 c-f	125.3 ef	23.70 cd	66.00 b
5% NPK recommended + biofertilizer (1)	8.30	75.00	11.20	46.60	8.330 a-c	93.30 gh	20.70 e	54.00 c
5% NPK recommended + biofertilizer (2)*	8.48	73.40	11.90	48.80	8.210 c-f	109.6 fg	21.60 de	66.00 b
0% NPK recommended + biofertilizer (2)	8.56	74.20	10.70	49.20	8.150 e-g	140.9 de	24.40 c	66.00 b
5% NPK recommended + biofertilizer (2)	8.35	73.90	10.90	48.50	8.240 b-e	93.90 gh	21.10 e	55.00 c
5% NPK recommended + biofertilizer (3)*	8.50	73.70	11.60	47.90	8.210 c-f	125.3 ef	22.00 de	66.00 b
0% NPK recommended + biofertilizer (3)	8.52	74.10	11.40	46.60	8.180 d-f	140.9 de	25.00bc	89.00 a
5% NPK recommended + biofertilizer (3)	8.45	73.80	11.10	49.40	8.260 b-e	93.90 gh	21.20 e	55.00 c
0m3 organic manure + biofertilizer (1)	8.58	74.50	11.70	48.50	8.140 e-g	140.9 de	25.40 bc	55.00 c
5m3 organic manure + biofertilizer (1)	8.53	74.70	10.40	47.90	8.00 h	186.9 b	28.30a	55.00 c
0m3 organic manure + biofertilizer (2)	8.51	74.90	10.90	49.20	8.140 e-g	156.6 cd	25.70 bc	55.00 c
5m3 organic manure + biofertilizer (2)	8.55	75.60	11.20	49.50	8.00 h	209.3 a	28.90 a	55.00 c
0m3 organic manure + biofertilizer (3)	8.60	74.80	11.50	50.00	8.09 f-h	172.3 bc	27.20 ab	55.00 c
5m3 organic manure + biofertilizer (3)	8.57	75.00	10.90	47.60	8.03 gh	220.9 a	29.40 a	62.00 b
0m3 organic manure only	8.33	73.90	11.30	49.20	8.230 b-f	93.90 gh	21.80 de	47.00 d
5m3 organic manure only	8.42	74.40	10.80	48.40	8.230 b-f	125.3 ef	22.00 de	47.00 d
iofertilizer (1) only	8.34	74.10	11.90	47.90	8.360 ab	84.60 h	18.40 f	35.00 e
iofertilizer (2) only	8.36	73.90	10.80	48.50	8.300a-d	93.90 gh	19.70 ef	47.00 d
iofertilizer (3) only	8.40	73.30	11.30	49.30	8.28 a-e	93.90 gh	20.80 e	47.00 d
00% of recommended chemical fertilizer (control)	8.47	73.90	12.00	48.70	8.400 a	78.30 h	18.40 f	54.00 c
test	N.S	N.S	N.S	N.S	* *	* *	* *	* *

*** Biofertilizer (1): mixture of 1kg phosphoren + 1kg microbien + 1kg rhizobacterin / fed.**
*** Biofertilizer (2): mixture of 2kg phosphoren + 2kg microbien + 2kg rhizobacterin / fed.**
*** Biofertilizer (3): mixture of 3kg phosphoren + 3kg microbien + 3kg rhizobacterin / fed.**

Table (3b): Effect of mineral, organic and biofertilizers on chemical properties of the experimental soil before applying the fertilizers and after the last picking at summer season of 1998.

Characters / Treatments	Before applying the fertilizers				After the last picking			
	pH	N ppm	P ppm	K ppm	PH	N ppm	P ppm	K Ppm
25% NPK recommended + biofertilizer (1)*	8.52	78.30	14.10	79.00	8.25	133.0 d-g	45.20 f	139.0 b
50% NPK recommended + biofertilizer (1)	8.59	77.70	13.80	78.40	8.22	140.9 b-g	56.20 d	144.5 b
75% NPK recommended + biofertilizer (1)	8.52	78.50	13.50	77.80	8.42	117.3 gh	31.77 gh	87.0 e-g
25% NPK recommended + biofertilizer (2)*	8.56	77.90	14.20	79.10	8.25	133.7 d-g	48.10 ef	141.3 b
50% NPK recommended + biofertilizer (2)	8.59	78.40	13.90	78.60	8.20	146.2 b-f	57.03 d	149.3 ab
75% NPK recommended + biofertilizer (2)	8.63	78.50	14.20	79.30	8.38	125.3 f-g	32.20 gh	87.0 efg
25% NPK recommended + biofertilizer (3)*	8.53	78.70	13.70	78.20	8.23	138.9 c-g	50.07 e	144.0 b
50% NPK recommended + biofertilizer (3)	8.60	79.20	14.10	78.40	8.19	154.7 a-e	64.37 c	167.3 a
75% NPK recommended + biofertilizer (3)	8.61	77.90	13.90	77.70	8.28	130.0 e-g	33.40 g	89.67d-g
$10m^3$ organic manure + biofertilizer (1)	8.64	79.20	14.20	79.10	8.19	155.4 a-d	70.93 b	108.3d-f
$15m^3$ organic manure + biofertilizer (1)	8.67	77.50	13.70	77.50	8.16	164.3 ab	72.60 b	111.7 cd
$10m^3$ organic manure + biofertilizer (2)	8.66	78.60	14.50	79.20	8.17	156.6 a-d	71.77 b	108.7d-f
$15m^3$ organic manure + biofertilizer (2)	8.69	80.00	13.90	80.00	8.10	171.7 a	80.37 a	132.3 bc
$10m^3$ organic manure + biofertilizer (3)	8.68	79.10	14.80	79.30	8.16	161.8 a-c	71.93 b	110.0 de
$15m^3$ organic manure + biofertilizer (3)	8.70	78.90	15.00	79.10	8.10	172.3 a	81.40 a	134.7 b
$10m^3$ organic manure only	8.63	78.60	13.80	76.80	8.27	131.9 d-g	34.10 g	80.0 g
$15m^3$ organic manure only	8.65	79.30	13.90	78.70	8.27	139.2 c-g	54.50 d	82.33 g
Biofertilizer (1) only	8.51	78.40	14.10	79.30	8.38	88.70 i	29.07 hi	74.00 g
Biofertilizer (2) only	8.55	77.60	13.70	78.50	8.36	99.13 hi	26.40 ij	75.00 g
Biofertilizer (3) only	8.53	77.80	14.60	76.90	8.34	99.13 hi	31.23 gh	76.33 g
100% of recommended chemical fertilizer (control)	8.50	78.10	14.60	76.50	8.53	83.50 i	24.73 j	85.67 fg
F test	N.S	N.S	N.S	N.S	N.S	* *	* *	* *

*** Biofertilizer (1): mixture of 1kg phosphoren + 1kg microbien + 1kg rhizobacterin / fed.**
*** Biofertilizer (2): mixture of 2kg phosphoren + 2kg microbien + 2kg rhizobacterin / fed.**
*** Biofertilizer (3): mixture of 3kg phosphoren + 3kg microbien + 3kg rhizobacterin / fed.**

plus inoculation. The highest increase was found in case of 15 m^3 chicken manure plus biofertilizers mixure at the highest two rates (i.e. 2, 3 kg/fed). While the lowest values were obtained from 100 % NPK treatment (control).

Regarding avaliable phosphorus soil content after the last picking, data revealed that all fertilizer treatments that contained biofertilizers induced obivious increment in soil available phosphorus during the two seasons. Some of these increments were highly significant, due to 15 m^3 organic manure plus biofertilizers which increased the phosphorus amount more than 50 % in the first season and more than thrice in the second season.

Concerning the potassium content in experimental soil after the last picking data in Table (3 a & b) showed that the superior treatments in this regard were 50 % & 25 % NPK plus biofertilizers at the three rates used. The next significant treatments that induced higher potassium content than the control were 10 m^3 and 15 m^3 manure fertilizer plus biofertilizers.

The most important parameters in relation to the chemical changes that took place and induce the most effective influence were the changes in pH value and available N, P and K. The changes reflected the chemical and biotrasformations that took place in growth media and the avaliablity of some nutrients may be due to microbial decomposition of organic matter causing production of organic acids and CO_2, which combined with water to form carbonic acid, which in turn reduced soil pH values and increased the availabilty of some nutrients.

The obtained results are in agreement with those reported by Abdel-Moez *et al*. (1995) on soil N content; Giusquiani *et al*. (1988) on available phosphorus content and Kajj *et al*. (1990) on patassium soil content with using different types of manure fertilizer. While several investigators reported that the efficiency of biofertilizers in the presence of organic manures were highest in this regard (Fallik and Okon, 1996; Awad, 1998). With using different percentages from NPK mineral fertilizer, several investigators came to similar results on N, P and K soil contents as well as soil pH (Radwan, 1983 on P; Gomaa, 1989 on P and N soil contents, Subbiah, 1990 on N soil content) and by Hewedy, (1999 b) on soil pH.

Vegetative growth

Concerning the growth behavior after 75 days from transplanting, data in Table (4 a & b) reveal that, the plant height in the first season was not affected by any treatments, nevertheless the mixture of 75 % recommended NPK and biofertilizers at the three rates produced the lowest significant values, while during the second season, applying manure fertilizer alone or with biofertilizer had a significant effect in this respect. Number of leaves and branches were significantly affted by the mixure of manure and biofertilizers at the two rates, i.e. 10 and 15 m^3/fed during the two seasons comparing with the control treatment.

In regard to leaf area, data in Table (4 a & b) show that the most effective treatments in producing the highest values of leaf area was the mixure of organic manure and biofertilizers followed by organic manure only as well as 50 % and 25 %, recommended NPK plus biofertilizer. The lowest values of leaf area were obtained by using biofertilizers only and 75 % NPK with biofertilizers.

The enhancing effect of organic manure combined with biofertilizer on plant growth might be attributed to the increment in bacterial population and its activity (Kundu and Gour, 1980) and increase the availability and uptake of N-P which reflect on plant growth (Kostov *et al.,* 1991; Awad, 1998) and also to their ability to release plant promoting substances, mainly IAA, gibberellin and cytokinin like substances which could stimulate plant growth, absorption of nutrients and efficiency of nutrient and the metabolism of photosynthesis rates (Reynders and Vlassak, 1982; Frankenberger and Arshad, 1995).

The obtained results are in harmony with those reported by Kostov *et al*. (1991) and Awad (1998) on tomato with using mixture of organic manures and biofertilizer. Several investigators indicated that combined application of N fertilizer or NPK at low levels with biofertilizers increased plant growth than using the high levels in single application or combined with biofertilizers, (Bashan *et al*., 1989a on pepper; Bashan *et al*., 1989b on eggplant; Gomaa, 1989; Monib *et al.,* 1990; Awad, 1998; Hewedy, 1999b on tomato).

Table (4a): Effect of mineral, organic and biofertilizers on tomato plant growth after 75 days from transplanting during summer season of 1997.

Characters / Treatments	Plant height (cm)	No. of leaves / plant	No. of branches/ plant	Leaf area (cm^2)
25% NPK recommended + biofertilizer (1)*	39.67 a-c	79.67 d-g	16.00 f-j	15.21 ij
50% NPK recommended + biofertilizer (1)	39.67 a-c	78.67 e-g	13.67 ij	18.36 f-i
75% NPK recommended + biofertilizer (1)	37.00 c	66.33 gh	12.67 j	14.58 ij
25% NPK recommended + biofertilizer (2)*	39.67 a-c	96.67 a-d	21.00 a-e	17.50 f-j
50% NPK recommended + biofertilizer (2)	47.67 a	97.67 a-c	22.67 ab	20.26 e-h
75% NPK recommended + biofertilizer (2)	36.67 c	74.67 f-h	17.00 e-i	15.09 ij
25% NPK recommended + biofertilizer (3)*	46.33 ab	87.00 a-f	19.00 b-g	15.82 ij
50% NPK recommended + biofertilizer (3)	41.67 a-c	79.00 e-g	17.33 d-i	20.87 e-h
75% NPK recommended + biofertilizer (3)	37.00 c	60.00 h	14.00 ij	14.91 ij
$10m^3$ organic manure + biofertilizer (1)	39.00 a-c	87.00 a-f	17.00 e-I	21.13 d-g
$15m^3$ organic manure + biofertilizer (1)	46.00 ab	103.3 a	24.00 a	26.49 bc
$10m^3$ organic manure + biofertilizer (2)	42.00 a-c	81.00 c-g	20.00 b-f	21.29 d-f
$15m^3$ organic manure + biofertilizer (2)	46.67 ab	84.00 b-g	18.33 c-h	30.22 a
$10m^3$ organic manure + biofertilizer (3)	38.67 bc	100.7 ab	22.00 a-c	23.08 c-e
$15m^3$ organic manure + biofertilizer (3)	41.00 a-c	98.00 a-c	21.00 a-e	28.34 ab
$10m^3$ organic manure only	42.00 a-c	67.67 e-h	19.00 b-g	20.95 e-g
$15m^3$ organic manure only	40.00 a-c	93.00 a-e	21.33 a-d	24.83 b-d
biofertilizer (1) only	42.00 a-c	70.00 f-h	16.67 f-j	18.52 f-i
biofertilizer (2) only	44.33 a-c	75.00 f-h	14.67 h-j	17.17 g-j
biofertilizer (3) only	42.00 a-c	73.67 f-h	15.00 g-j	16.86 h-j
100% of recommended chemical fertilizer (control)	46.00 ab	76.00 e-h	14.67 h-j	17.97 f-i
F test	* *	* *	* *	* *

*** Biofertilizer (1): mixture of 1kg phosphoren + 1kg microbien + 1kg rhizobacterin / fed.**
*** Biofertilizer (2): mixture of 2kg phosphoren + 2kg microbien + 2kg rhizobacterin / fed.**
*** Biofertilizer (3): mixture of 3kg phosphoren + 3kg microbien + 3kg rhizobacterin / fed.**

Table (4b): Effect of mineral, organic and biofertilizers on tomato plant growth after 75 days from transplanting during summer season of 1998.

Characters / Treatments	Plant height (cm.)	No. of leaves / plant	No. of branches/ plant	Leaf area (cm^2)
25% NPK recommended + biofertilizer (1)*	36.33 f-h	77.00 f-h	18.00 c-f	14.57 hi
50% NPK recommended + biofertilizer (1)	38.33 d-h	69.67 g-j	15.67 e-h	20.51 c-e
75% NPK recommended + biofertilizer (1)	36.00 gh	57.00 k	13.00 h	13.94 i
25% NPK recommended + biofertilizer (2)*	35.67 gh	92.00 de	20.67 b-d	17.06 gh
50% NPK recommended + biofertilizer (2)	38.00 e-h	80.00 fg	18.67 b-f	24.38 a
75% NPK recommended + biofertilizer (2)	36.00 gh	65.67 i-k	13.67 gh	13.64 i
25% NPK recommended + biofertilizer (3)*	40.33 d-f	73.00 g-j	18.00 c-f	17.13 gh
50% NPK recommended + biofertilizer (3)	38.00 e-h	87.00 ef	18.00 c-f	18.46 e-g
75% NPK recommended + biofertilizer (3)	35.00 h	70.67 g-j	17.00 d-h	13.87 i
$10m^3$ organic manure + biofertilizer (1)	36.33 f-h	96.00 c-e	18.67 b-f	19.27 d-g
$15m^3$ organic manure + biofertilizer (1)	42.33 cd	101.00 cd	20.00 b-d	24.31 a
$10m^3$ organic manure + biofertilizer (2)	44.33 bc	92.33 de	17.67 c-g	20.44 c-f
$15m^3$ organic manure + biofertilizer (2)	53.00 a	133.0 a	29.00 a	23.46 ab
$10m^3$ organic manure + biofertilizer (3)	40.67 c-e	75.33 g-i	19.00 b-e	19.33 d-g
$15m^3$ organic manure + biofertilizer (3)	47.00 b	112.7 b	21.67 bc	21.49 b-d
$10m^3$ organic manure only	39.67 d-g	76.00 g-i	19.67 b-e	19.28 d-g
$15m^3$ organic manure only	41. 00 c-e	106.0 bc	22.67 b	22.14 a-c
biofertilizer (1) only	37.33 e-h	66.00 h-k	16.67 d-h	14.79 hi
biofertilizer (2) only	40.33 d-f	63.00 jk	14.67 f-h	14.81 hi
biofertilizer (3) only	39.33 d-g	66.67 h-k	18.33 c-f	13.23 i
100% of recommended chemical fertilizer (control)	38.67 d-h	74.67 g-i	14.67 f-h	17.64 fg
F test	* *	* *	* *	* *

*** Biofertilizer (1): mixture of 1kg phosphoren + 1kg microbien + 1kg rhizobacterin / fed.**
*** Biofertilizer (2): mixture of 2kg phosphoren + 2kg microbien + 2kg rhizobacterin / fed.**
*** Biofertilizer (3): mixture of 3kg phosphoren + 3kg microbien + 3kg rhizobacterin / fed.**

Dry matter content

Data in Table (5) show that the favourable treatment for producing high dry matter per tomato plant organs was 15 m^3 chicken manure per feddan with biofertilizers followed by organic at 15 m^3 or 25 % and 50 % NPK with biofertilizers, while the biofertilizers alone and 75 % NPK plus biofertilizers inoculation were the lowest effective treatments. This increment might be attributed to the enhancing effect of the mentioned treatments on vegitative growth, i.e., number of leaves and branches as well as leaf area, which positively reflected on dry matter contents. The positive effect of organic manure is attributed to their effect on physical, chemical and biological properities of soil (Montasser, 1987). The efficiency of organic manure on plant dry weight increased as a result of combined effect with biofertilizers than using each of both in individual application. Several investigators came to similar results (Kostov *et al*., 1991; Awad, 1998).

Regarding the effect of different rates from NPK plus biofertilizer on plant dry matter, several investigators came to similar results Gomaa (1989), Monib *et al*. (1990) and Awad (1998). They reported that using 33.3 % or 50 % from the recommended dose of NPK fertilizer in the presence of biofertilizers led to significant effect on plant dry matter comparing with the normal mineral fertilizer or biofertilizer in single application.

Flowering characters

Data in Table (6 a & b) indicate clearly that application of 15 m^3 chicken manure plus biofertilizers mixture at the three rates produced the highest values of flowering parameters of tomato plants as number of flowering clusters per plant, number of flowers per cluster, number of setting fruits per cluster and fruit set percentage. The next favourable treatments were 10 m^3 chicken manure plus biofertilizers followed by 50 and 25 % NPK mineral fertilizers plus biofertilizers. The lowest records of flowering parameters were attained from using biofertilizers alone, 75 % NPK plus

Table (5): Effect of mineral, organic and biofertilizers on tomato plant dry weight after 75 days from transplanting during summer seasons of 1997 and 1998.

Characters / Treatments	Season 1997			Season 1998		
	Dry weight of leaves/ plant (gm.)	Dry weight of branches/ plant (gm.)	Total dry weight of plant (gm.)	Dry weight of leaves/ plant (gm.)	Dry weight of branches/ plant (gm.)	Total dry weight of plant (gm.)
25% NPK recommended + biofertilizer (1)*	36.92 h-j	10.64 g-j	47.56 hi	47.95 c-f	14.63 b-f	62.58 c-e
50% NPK recommended + biofertilizer (1)	43.00 e-g	13.75 c-e	56.75 fg	45.89 c-g	15.86 bc	61.75 c-e
75% NPK recommended + biofertilizer (1)	31.55 j	9.430 j	40.98 j	40.98 f-h	10.85 h	51.83 f-h
25% NPK recommended + biofertilizer (2)*	47.12 c-f	12.38 e-h	59.50 d-f	50.97 b-d	14.91 b-e	65.88 cd
50% NPK recommended + biofertilizer (2)	48.13 c-e	13.64 c-e	61.77 d-f	46.40 c-g	14.47 c-f	60.87 de
75% NPK recommended + biofertilizer (2)	41.13 gh	10.59 g-j	51.72 gh	37.71 h	12.14 f-h	49.85 h
25% NPK recommended + biofertilizer (3)*	48.64 c-e	10.78 g-j	59.42 d-f	42.53 e-h	12.18 f-h	54.71 e-h
50% NPK recommended + biofertilizer (3)	39.09 g-i	12.73 d-g	51.82 gh	45.20 d-g	13.89 c-g	59.09 d-g
75% NPK recommended + biofertilizer (3)	34.33 ij	9.66 ij	43.99 ij	42.90 e-h	11.66 gh	54.56 e-h
10m^3 organic manure + biofertilizer (1)	48.43 c-e	16.11 b	64.54 b-d	49.63 c-e	13.29 d-h	62.92 c-e
15m^3 organic manure + biofertilizer (1)	52.56 a-c	16.38 b	68.94 bc	53.51 bc	17.01 ab	70.52 bc
10m^3 organic manure + biofertilizer (2)	44.47 d-g	13.27 c-f	57.74 e-g	51.80 b-d	14.58 b-f	66.38 cd
15m^3 organic manure + biofertilizer (2)	55.12 ab	15.45 bc	70.57 ab	57.47 b	18.47 a	75.94 ab
10m^3 organic manure + biofertilizer (3)	47.06 c-f	16.04 b	63.10 c-f	46.34 c-g	14.23 c-f	60.57 d-f
15m^3 organic manure + biofertilizer (3)	56.85 a	18.60 a	75.45 a	64.61 a	16.00 bc	80.61 a
10m^3 organic manure only	48.56 c-e	15.02 bc	63.58 c-e	49.13 c-e	14.34 c-f	63.47 c-e
15m^3 organic manure only	50.12 b-d	14.85 b-d	64.97 b-d	51.81 b-d	15.29 b-d	67.10 cd
biofertilizer (1) only	33.15 j	11.13 f-j	44.28 ij	39.08 gh	12.47 e-h	51.55 gh
biofertilizer (2) only	34.09 ij	11.90 e-I	45.99 h-j	41.41 f-h	13.00 d-h	54.40 e-h
biofertilizer (3) only	41.59 f-h	10.31 h-j	51.90 gh	35.81 h	14.44 c-f	50.25 h
100% of recommended chemical fertilizer (control)	50.45 b-d	12.17 e-h	62.62 c-f	45.77 d-g	14.35 c-f	60.12 d-g
F test	* *	* *	* *	* *	* *	* *

*** Biofertilizer (1): mixture of 1kg phosphoren + 1kg microbien + 1kg rhizobacterin / fed.**
*** Biofertilizer (2): mixture of 2kg phosphoren + 2kg microbien + 2kg rhizobacterin / fed.**
*** Biofertilizer (3): mixture of 3kg phosphoren + 3kg microbien + 3kg rhizobacterin / fed.**

Table (6a): Effect of mineral, organic and biofertilizers on flowering characteristics at summer season of 1997.

Characters / Treatments	No. of clusters per plant	No. of Flowers per cluster	No. of fruits per cluster	Fruit set %
25% NPK recommended + biofertilizer (1)*	18.0 d-g	2.667 c-e	2.113 b-e	59.48 c-g
50% NPK recommended + biofertilizer (1)	18.00 d-g	3.222 a-d	2.890 ab	61.85 c-f
75% NPK recommended + biofertilizer (1)	14.67 h	2.222 ef	1.667 e	54.86 e-g
25% NPK recommended + biofertilizer (2)*	19.33 c-e	2.833 b-e	2.223 b-e	61.02 c-g
50% NPK recommended + biofertilizer (2)	19.0 c-f	3.33 a-d	2.780 ab	67.36 b-d
75% NPK recommended + biofertilizer (2)	16.67 f-h	2.333 ef	1.777 de	52.17 g
25% NPK recommended + biofertilizer (3)*	19.33 c-e	3.00 a-e	2.113 b-e	61.12 c-g
50% NPK recommended + biofertilizer (3)	19.67 cd	3.333a-d	2.890 ab	67.76 b-d
75% NPK recommended + biofertilizer (3)	16.00 gh	2.444 d-f	2.113 b-e	54.17 e-g
$10m^3$ organic manure + biofertilizer (1)	19.67 cd	3.333 a-d	2.33 a-e	67.73 b-d
$15m^3$ organic manure + biofertilizer (1)	26.67 b	3.667 ab	2.89 ab	76.75 ab
$10m^3$ organic manure + biofertilizer (2)	20.0 cd	3.444 a-c	2.557 a-d	75.00 ab
$15m^3$ organic manure + biofertilizer (2)	26.67 b	3.667 ab	3.053 a	77.78 ab
$10m^3$ organic manure + biofertilizer (3)	21.0 c	3.555 a-c	2.667 a-c	76.39 ab
$15m^3$ organic manure + biofertilizer (3)	31.67 a	3.778 a	3.110 a	79.59 a
$10m^3$ organic manure only	19.33 c-e	2.778 b-e	2.447 a-e	63.90 c-e
$15m^3$ organic manure only	26.67 b	3.333 a-d	2.78 ab	68.06 bc
biofertilizer (1) only	12.0 i	1.778 f	1.667 e	50.44 g
biofertilizer (2) only	14.67 h	2.222 ef	1.890 c-e	52.78 f-g
biofertilizer (3) only	16.0 gh	2.222 ef	1.777 de	56.95 d-g
100% of recommended chemical fertilizer (control)	17.0 e-h	2.444 d-f	2.113 b-e	61.73 c-f
F test	* *	* *	* *	* *

*** Biofertilizer (1): mixture of 1kg phosphoren + 1kg microbien + 1kg rhizobacterin / fed.**
*** Biofertilizer (2): mixture of 2kg phosphoren + 2kg microbien + 2kg rhizobacterin / fed.**
*** Biofertilizer (3): mixture of 3kg phosphoren + 3kg microbien + 3kg rhizobacterin / fed.**

Table (6b): Effect of mineral, organic and biofertilizers on flowering characteristies at summer season of 1998.

Characters / Treatments	No. of clusters per plant	No. of flowers per cluster	No. of fruits per cluster	Fruit set %
25% NPK recommended + biofertilizer (1)*	17.00 b-f	2.778 b-d	2.22 b-f	63.33 a-c
50% NPK recommended + biofertilizer (1)	18.67 b-f	3.00 a-d	2.44 a-e	67.93 a-c
75% NPK recommended + biofertilizer (1)	13.67 d-f	2.556 cd	1.78e-f	66.67 a-c
25% NPK recommended + biofertilizer (2)*	17.67 b-f	2.889 b-d	2.33 a-e	61.81 a-d
50% NPK recommended + biofertilizer (2)	18.67 b-f	3.222 a-d	2.22 b-f	65.28 a-c
75% NPK recommended + biofertilizer (2)	15.67 c-f	2.556 cd	2.00 c-f	60.00 a-d
25% NPK recommended + biofertilizer (3)*	18.00 b-f	2.889 b-d	2.44 a-e	64.66 a-c
50% NPK recommended + biofertilizer (3)	19.00 b-f	3.222 a-d	2.67 a-c	63.89 a-c
75% NPK recommended + biofertilizer (3)	16.00 c-f	2.778 b-d	1.78 ef	46.03. d
$10m^3$ organic manure + biofertilizer (1)	19.67 b-e	3.333 a-d	2.44 a-e	66.07 a-c
$15m^3$ organic manure + biofertilizer (1)	22.67 bc	3.667 ab	3.05 a	75.69 a
$10m^3$ organic manure + biofertilizer (2)	20.00 b-d	3.444 a-c	2.56 a-d	65.28 a-c
$15m^3$ organic manure + biofertilizer (2)	23.67 b	3.722 ab	3.00 a	77.77 a
$10m^3$ organic manure + biofertilizer (3)	21.20 b-d	3.444 a-c	2.78 ab	73.33 ab
$15m^3$ organic manure + biofertilizer (3)	31.00 a	4.056 a	3.00 a	77.69 a
$10m^3$ organic manure only	18.67 b-f	2.889 b-d	2.56 a-d	67.26 a-c
$15m^3$ organic manure only	19.00 b-e	3.33 a-d	2.78 ab	70.83 a-c
biofertilizer (1) only	11.33 f	2.222 d	1.78 ef	59.72 a-d
biofertilizer (2) only	12.33 ef	2.222 d	1.56 f	53.98 cd
Biofertilizer (3) only	13.67 d-f	2.333 cd	1.89 d-f	55.55 b-d
100% of recommended chemical fertilizer (control)	17.00 b-f	3.00 a-d	2.56 a-d	67.26 a-c
F test	* *	* *	* *	* *

*** Biofertilizer (1): mixture of 1kg phosphoren + 1kg microbien + 1kg rhizobacterin / fed.**
*** Biofertilizer (2): mixture of 2kg phosphoren + 2kg microbien + 2kg rhizobacterin / fed.**
*** Biofertilizer (3): mixture of 3kg phosphoren + 3kg microbien + 3kg rhizobacterin / fed.**

biofertilizers and the control treatment which received 100 % of NPK recommendation.

The superiority of chicken manure fertilizer with biofertilizers as well as 50 % or 25 % NPK recommended mineral fertilizers plus biofertilizers on flowering of tomato plants might be attributed to the favourable effect of the mentioned treatment on increasing the availability of soil N, P and K as shown in Table (3 a & b) which facilitate the nutrients uptake and consequently photosynthetic capacity may increase. Number of leaves per plant, leaf area as well as dry matter content could be reliable index as shown in Tables (4 a, b and 5) that explained the relation between dry matter content per plant and fruit set percentage.

The stimulative effect of the highest rate of chiken manure plus biofertilizers as well as 50 % or 25 5 NPK from the recommended mineral fertilizer in the presence of biofertilizers on flowering characters are in harmony with those reported by Ocampa and Barea (1978) who reported that the flowering characters of tomato plants were promoted in the presence of both bacterial fertilizer groups associated with NPK fertilizers; Bashan *et al.* (1989a). On pepper; Gomaa (1989) on tomato and squash using multi biofertilizers in the presence of 1/3 NPK recommended fertilizer and Hewedy (1999a) on tomato using multi and dual bacterial fertilizer application plus 75 % NPK recommended fertilizer.

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دراسة تأثير الأسمدة العضوية والحيوية على النمووالإزهار فى الطماطم مقارنة بالأسمدة الكيميائية

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*** قسم بحوث الخضر ـ معهد بحوث البساتين ـ مركز البحوث الزراعية**

أجريت تجربتان حقليتان بالموسم الصيفى لعام ١٩٩٨/١٩٩٧ بمحطة بحوث الخضر بقها ـ معهد بحوث البساتين لدراسة تأثير كل من السماد العضوى والحيوى والمعدنى على التركيب الكيميائى للتربة ونمو وإزهار نباتات الطماطم وتضمن التسميد الحيوى مخلوط من مركبات الفوسفورين والميكروبين والريزوباكترين بمعدلات ١ كجم ، ٢ كجم ، ٣ كجم / فدان لكل منهم وتم إضافتها اما منفردة أو مقرونة مع السماد العضوى والمعدنى. والسماد العضوى المستخدم هو سماد الدواجن بمعدلين هما ١٠ م^{٣} ، ١٥ م^{٣} / فدان ، أما السماد المعدنى الأزوتى والفوسفور والبوتاسيوم فقد استخدم بأربع مستويات ١٠٠ % وهو المستوى الموصى به (١٢٠ وحدة أزوت + ٤٥ وحدة فوسفور + ٩٦ وحدة بوتاسيوم) كمعاملة للمقارنة ، أما المستويات الأخرى فكانت ٢٥ % ، ٥٠ % ، ٧٥ % من المستوى الموصى به.

وقد أوضحت النتائج المتحصل عليها أن معاملة السماد العضوى بمعدل ١٥ م^{٣} / فدان فى وجود مخلوط المركبات الحيوية بمعدل ٣ كجم / فدان لكل منها هى أفضل المعاملات فى خفض درجة حموضة التربة وزيادة محتواها من الأزوت والفوسفور وأدت إلى زيادة معنوية فى صفات النمو الخضرى والزهرى ، تلى ذلك معاملة ١٠م^{٣} سماد عضوى فى وجود مخلوط المركبات الحيوية ثم معاملة ٥٠ % ، ٢٥ % من من توصية السماد المعدنى فى وجود مخلوط المركبات الحيوية.