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Productivity of Tomato Plants Treated with some Biological, Organic and Inorganic Fertilizers

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A TWO successive years field experiment was performed on a clayey soil at Faqus, Sharkia Governorate, Egypt during the summer growing seasons of 2005 and 2006 to investigate the possibility of partial or entirely substituting bio and organic fertilizers instead of inorganic ones. Therefore, a mixture of three biofertilizers (phosphorien, nitrobien and microbien) (BFM) and chicken manure (CM) were applied either solely or in combinations with a BFM plus 25%, 50% or 75% of recommended NPK rate (RR). Nitrogen, P and K contents in plants and fruits and fruit yield and quality as well chemical composition of soil were studied. The basal control treatment of the experiment was the NPK recommended rate (100%). The experiment was established with four replicates in a randomized complete block design including 7 treatments. The results could be summarized as follows :

1. Soil content of available N and P was markedly increased but soil pH was slightly decreased with (CM) + BFM, while 25% and 50% of recommended NPK combined with the BFM showed the highest K content in the soil comparing with the other treatments.
2. Chicken manure + BFM followed by (CM) alone resulted in the highest dry weights of plant organs and whole plant as compared with the control treatment (100% of RR) which did not differ significantly in this respect with the 25% or 50% of recommended NPK combined with (BFM).
3. Tomato plants fertilized with (CM) and inoculated with (BFM) followed by (CM) solely treatment contained the highest N and P values as compared with the control treatment which did not differ from that of 25%, 50% and 75% of NPK RR combined with boifertilizers. Whereas, the plants fertilized by 25%, 50% and 75% of NPK RR + BFM gave the highest K conc.
4. The highest increments in the four forms of tomato yield, *i.e.;* early, mid-season, late and total were obtained by (CM + BFM) followed by the treatments of 25% and 50% of NPK RR + BFM, which oftenly did not differ significantly from the control.
5. Tomato fruits produced from plants received (CM + BFM) contained the highest concentrations of N, P and K followed by those received 25%, 50% and 75% of NPK RR + BFM or (CM) only.
6. The highest values of fruit dry matter as well as reducing and total sugars were achieved from treatments of control, 25% and 50% of

NPK RR + BFM and (CM) only which did not differ significantly from the other treatments. Vitamin C, total acidity, T.S.S. and non reducing sugar were not significantly affected by any of the applied treatments.

Generally, it could be concluded that (CM) application before transplanting at the rate of 20m^3 fed^{-1} + BFM at the rate of 3kg fed^{-1} from each was the recommended treatment which produced the quality fruits of total at NPK RR. Application of NPK 25% and 50% of (NPK RR + FBM) at the same rate showed similar effect as fertilization with the NPK RR. Thus, these treatments can replace completely or partially instead of N, P and K mineral fertilizers, which protect the environment chemical pollution and its harmful effect on human and animal health besides reducing the production costs.

Keywords: Chicken manure (CM), Biofertilizer mixture (BFM), NPK Recommended rate (RR), Tomato plants.

As the universe is going now on the way of clean agriculture and minimizing pollution effects, organic and biofertilizers became of the best management products to improve soil characteristics and productivity. They are considered as the most important factor in reducing the application of the inorganic fertilizers, consequently, reduce the adverse environmental impact of chemicals (Marschner, 1995 and Khafagy, 1999).

Tomato (*Lycopersicon esculantum* Mill) is one of the most popular and widely grown vegetable crops in Egypt. It contains some important nutritional compounds for human feedings such as proteins, fats, carbohydrates in addition to some minerals and vitamins especially C and A.

Biofertilizers play an important role in enhancing crop productivity through nitrogen fixation, phosphate solubilization, plant hormones production, ammonia excretion, siderophores formation and to control various plant diseases (El-Banna & Tolba, 2000; Ghallab & Salem, 2001; Dakhly *et al.*,2004 and Shalaan, 2005). Usually, biofertilizers contain one or more of the following; symbiotic or non symbiotic N_2-fixing bacteria which both are able to fix atmospheric nitrogen as well as phosphate dissolving bacteria which solubilize phosphates and micronutrients through the production of organic acids and subsequent reduction in soil pH (Saber, 1993 and Ashour, 1998). Besides, micro-organisms such as *Pseudomonas, Azotobacter, Azospirillium* and *Mycorrhyzae* can secrete growth promoting substances, *e.g.,* indole acetic acid, gibberellins, cytokinins like substances and auxins (Subba Roa, 1993; Frankenberger & Arshard, 1995 and Bashan & Holguin, 1997). A promising trend for increasing the efficiency of biofertilizers in the use of different mixtures of biopreperations. Several researchers indicated that dual or multi application of bacteria prepared as biofertlizers such as nitrogen fixing and phosphate dissolving bacteria showed a significant efficiency in stimulating plant growth and nutrients uptake as well as tomato fruit yield than in case of single application (Terry *et al.,* 1995; Heweedy, 1999; Awad, 1998 and EL-Banna *et al.,* 2001).

Organic manures are well established to be involved in fertilization in almost worldwide due to their beneficial effects on the physio-chemical and biological characteristics of soil which in turn influence the growth and increase plants production (Youssef *et al.,* 2001). In other words, organic manures improve moisture retention in the soil and are a good source of essential nutrients as well they beneficially affect micro flora activities, improve soil structure and decrease soil pH after cultivation (Amara & Dahdoh, 1995; Saha *et al.,* 1995 and El-Ghamry & El-Naggar, 2001).

Recently, intensive efforts are being focused to minimize the applied amounts of chemical fertilizers to decrease the production costs and environmental pollution with good fruit yield. There is now a very fast growing demand for organically grown food products (for both local and export markets), which help in the fast spreading of organic and bio-agriculture. So, the present research was undertaken to investigate the possibility of partial or complete substituting chemical fertilizers by biofertilizer mixture combined either with different portions from the NPK recommended rate (100%) or with chicken manure.

Material and Methods

A two successive years field experiment was performed to fullfil the objectives of the present work as the following:

Soil

A soil at Faquos, Sharkia Governorate, Egypt which was clayey in texture (*Typic torrerts*). The main analytical values were: clay = 56.80%, silt =19.30%, sand = 23.90%, pH (1:2.5 water suspension) =7.8, EC_e (soil paste extract) =1.26 dSm^{-1}, OM=1.74%, available N= 74.30 mg kg $soil^{-1}$, available P = 11.28 mg kg $soil^{-1}$ and available K = 420 mg kg $soil^{-1}$.

Studied crop

Tomato (*Lycopersicon esculantum* Mill) variety Castle Rock.

Date of sowing and transplanting

Seeds were sown in the nursery in beds of 2x2m area under plastic low tunnel protection on June 10^{th} 2005 and 2006 and transplanted on August 20^{th}.

Experimental treatments

1. 100% of NPK recommended rate as control (NPK RR). The recommended NPK according to Ministry of Agriculture are 120 kg N, 45kg P_2O_5 and 96 kg K_2O fed^{-1}.

2.Bio-fertilizer mixture (BFM) is a mixture consisted of *Basillus megatherium* (phosphate dissolving bacteria) under the commercial name of phosphorien, *Azospirillum sp.* and *Azotobacter sp.* (nitrogen fixing bacteria) under the commercial name of nitrobien and a mixture of P-dissolving bacteria (*B. megatherium*) and N_2-fixing bacteria *Azospirillum sp.* and *Azotobacter sp.*) under the commercial name of microbien. The efficient strains of bacteria in peat growth media were obtained from General Organization for Agriculture Equalization Fund (GDAEF), Ministry of Agriculture, Egypt.

3. Chicken manure at the rate of $20m^3$ fed^{-1}(CM). The important chemical analysis is shown in Table 1 according to page *et al.* (1982).
4. 25% of the NPK RR + BFM.
5. 50% of the NPK RR + BFM.
6. 75% of the NPK RR + BFM and 7- (CM) + BFM.

TABLE 1. Chemical analysis of chicken manure (CM) used in the experiment.

Available Nutrients (mg kg-1)			Total N%	O. C %	O. M %	C/N ratio	pH
N	P	K					
8078	884	1836	2.4	26.4	49.8	11:1	6.2

Each treatment was replicated 4 times. During soil preparation, CM and calcium super phosphate (15.5% P_2O_5) were added. Taking into consideration that plot area was $12m^2$ which contained 3 ridges (4m length and 1m apart), BFM inoculation was performed by mixing the three biofertilizers at the rate of 3 kg fed^{-1} from each with moist sand and added inside seedling holes, then the seedlings were transplanted at 30 cm apart. Potassium sulphate (48% K_2O) was divided into two equal doses and applied after 20 days from transplanting and at the beginning of flowering, *i.e.,* 45 days after transplanting. Ammonium sulphate (20.5% N) was added at three equal doses; the first two doses were in combination with the potassium fertilizer. The third one was applied after fruit setting stage (65 days after transplanting).

Plant sampling

Random samples of 4 plants from each plot were chosen and dry weights of plant organs (leaves and branches) at two growth stages (30 and 75 days from transplanting) were determined. Nitrogen, P and K concentrations were estimated as mentioned in Cottenie *et al.* (1982).

Yield

Fruit yield was calculated (ton fed^{-1}) for early yield (yield of the 1^{st} two pickings), mid-season yield (yield of the 3^{rd} and 4^{th} pickings) and late yield (yield of the two last pickings, *i.e,* the 5^{th} and the 6^{th} pickings) and total yield of the 6^{th} pickings).

Quality

At the red ripe stage, 10 fruits from the 2^{nd} and 4^{th} pickings were randomly chosen from each plot and the following data were recorded; dry matter %, N, P and K contents determined according to Cottenie *et al.* (1982), Total soluble solids (TSS%) using hand refractometer, reducing, non-reducing and total sugars as described by Dubios *et al.* (1956) and ascorbic acid and titratable acidity as mentioned by (A.O.A.C., 1990).

Soil sampling

Random soil samples were collected from 0-30 cm depth after the last picking to determine pH and available N, P and K nutrients (mg kg $soil^{-1}$) as mentioned by Hesse (1971).

Statistical analysis

All data were statistically analyzed according to Gomez & Gomez (1984).

Results and Discusion

As the obtained data of both successive years were not significantly different, their averages were taken in consideration.

Soil chemical analysis

The main parameters related to the chemical changes that may take place and affect plant growth such as the changes in soil pH and soil contents of N, P and K. The changes reflected, of course, chemical and biotransformation that took place in plant growth media and also the availability of nutrients in soil and because of their uptake by plants. As shown in Table 3 soil pH and available N, P and K in soil were significantly affected under all the experimental treatments as denoted bellow.

Soil pH

It is obvious that the different fertilizeration treatments used in this study slightly decreased soil pH values determined after the last picking than that determined before transplanting. The most effective treatment on soil pH was CM + BFM followed by 50% RR of NPK then 25% RR of NPK, each plus biofertilizers mixtures (BFM). El-Masry (1995); Abdel-Moez *et al.* (1997) and Salib *et al.* (2003) reported that addition of manure play an important role in soil pH values and the net reduction effect is dependent on manure type, and its application rate as well as a on soil depth. Furthermore, El-Leboudi *et al.* (1988); Awad (1998) and Ouda (2000) attributed the decrease in soil pH values as a result of soil manuring increasing the partial pressure of CO_2 of the soil atmosphere due to increase in the microbial activity and decomposition of added organic manures such processes tends to increase the concentration of protons in soil and the decrease in soil pH may be explained by the production of organic acids, CO_2 and hydrogen ion (H^+), Almost similar to those obtained by Ouda (2000).

Available N, P and K in soil

Results presented in Table 2 indicate that all the experimental treatments increased soil available N content (mg kg $soil^{-1}$) determined after the last picking compared to that before adding the fertilizers. The highest increase was found in case of (CM) combined with BFM, while the lowest increase was obtained with the RR of NPK (control). Shawky (1990) reported that the efficiency of nitrogen fixation was affected by the initial presence of NH_4-N in the growth media which had a significant stimulating effect on multiplication of nitrogen fixing bacteria .

TABLE 2. Some chemical analysis of the experimental soil after the last picking as affected with the used biological, organic and inorganic fertilizers.

Parameters / Treatments	pH	Available Nutrients (mg Kg soil^{-1})		
		N	P	K
100% of RR NPK (Control)	8.38	78.6	17.30	254.0
Biofertilizers (BFM)	8.32	91.3	18.45	243.0
Chicken manure (CM)	8.24	109.3	20.20	247.0
25% of the NPK RR + BFM	8.17	115.3	21.80	265.0
50% of the NPK RR + BFM	8.12	135.9	24.22	274.0
75% of the NPK RR + BFM	8.26	93.6	21.50	256.0
CM + BFM	8.02	204.3	28.07	260.0
LSD at 0.05	0.03	1.97	0.140	5.6

Regarding available P content (mg kg soil^{-1}) in soil, data show that all the fertilization treatments especially those containing biofertilizers induced the available P. Where, the (CM + BFM) treatment was the most effective as it increased the phosphorus amount in the soil more than that before adding the fertilizer. As well as, in the both alkaline and acidic soils, in general, it is well known that immobilization of phosphorus is a serous problem of phosphate fertilization in Egypt, fewer conversion of soluble P to the soil into insoluble forms (El-Dahtory *et al.,* 1989). It was found that numerous microorganisms are able to solublize unavailable forms of calcium-bound phosphate by excreting organic acids such as formic, acetic, lactic, propionic, fumaric and succinic, these acids lower the soil ph which directly bring insoluble phosphates in soil into soluble forms (Abdel-Ati *et al.,* 1996) or indirectly chelated calcium with release of soil; solid P into solution (El-Dahtory *et al.,* 1989).

Concerning the soil available K (mg kg soil^{-1}), results reveal that the plots that received at 50% of NPK RR followed by those received 25% of that rate in combination with BFM led to tomato yield seedlings containing the highest potassium concentration. The next treatment that induced K content than before transplanting was that of (CM + BFM).

Such results are in a good harmony with those obtained by Saleh *et al.* (1999); Ouda (2000); Reda (2001); Ashour *et al.* (2004) and Abdel-Hady *et al.* (2005). Other investigators reported that the efficiency of organic manures in the presence of biofertilizers were highest in this regard (Fallik & Okon, 1996; Awad, 1998 and Reda, 2001). With using different percentage of NPK RR plus BFM, the obtained results are almost similar to those of Ouda (2000).

Generally, it can be said that the experimental plots that received CM + BFM contained the highest values of available N and P and a slightly reduced soil pH, while that received (50% and 25% of NPK RR + FBM) showed the highest content of soil avail-K.

Plant Growth

Plant growth expressed as dry weight of leaves/plant, branches/plant and whole plant at the two growth stages (30 and 75 days after transplanting) are shown in Table 3. Comparing with control treatment (the recommended NPK), adding (CM + BFM) followed by single application of (CM) gave the highest values in this respect. On the other hand, the control treatment did not reflect any significant differences comparing with 25% and 50% from recommended NPK mixing with BFM in dry weights of leaves and branches and consequently the whole plant at the two growth stages. The lowest effective treatments were application of the BFM alone and (75% of recommended NPK + BFM).

TABLE 3. Dry weight of tomato plant (g plant^{-1}) at different 30 and 75 days after transplanting as affected with the used biological, organic and inorganic fertilizers.

Parameters / Treatments	After 30 days from transplanting			After 75 days from transplanting		
	D. W. of Leaves / plant	D. W. of Branches / plant	Total D. W. / plant	D. W. of Leaves / plant	D. W. of Branches / plant	Total D. W. / plant
100% of RR NPK (Control)	4.92	1.63	6.55	48.56	13.27	61.83
Biofertilizers (BFM)	4.43	1.32	5.75	37.88	12.21	50.09
Chicken manure (CM)	7.36	1.94	9.30	50.38	14.90	65.28
25% of the NPK RR + BFM	5.02	1.61	6.63	48.61	13.19	61.80
50% of the NPK RR + BFM	4.93	1.64	6.57	48.44	13.34	61.78
75% of the NPK RR + BFM	3.51	0.99	4.50	38.46	10.72	49.18
CM + BFM.	8.57	2.64	11.21	57.17	16.99	74.16
LSD 0.05	0.15	0.14	0.20	0.17	0.15	0.29

The increases in the dry weight of plant noticed with application of (CM) alone are supposed to be due to beneficial effects of it on physical, chemical and biological properties of the soil which in turn increase plants growth and production. The inducing effects of organic manures on plant growth with those reported by Ouda (2000); Youssef *et al.* (2001); Radwan & Awad (2002); Dakhly *et al.* (2004) and Shaban (2005).

The efficiency of (CM) on plant dry weight increased as a result of the combined effect of BFM than using any individual source of fertilizers. This finding might be attributed to the increment in bacterial population and its activity (Fallik & Okon, 1996; Awad, 1998 and Reda, 2001) and increasing the availability and uptake of N and P which positively reflected on plant growth, as well as ability of some microorganisms to release plant promoting substances, mainly indole acetic acid, gibberellins, cytokinin-like substances and auxins which could be stimulate plant growth, absorption of nutrient and efficiency of nutrients and the metabolism processes (Frankenberger & Arshard, 1995 and

Bashan & Holguin, 1997). These results matched well with these of Awad (1998); Ouda (2000); Radwan & Awad (2002); Dakhly *et al.* (2004); Shaban (2005) and Shalaan (2005).

Regarding the effect of different of portions of (NPK RR + BFM) on plant dry weight, the results are mostly similar to those reported by Awad (1998); Ouda (2000); Ghallab & Salem (2001); Abo El-Soud *et al.* (2003) and El-Assiouty & Abuo-Sedera (2005). They found that using 25% or 50% of the NPK RR in the presence of BFM led to significant effect on plant dry weight comparing with the normal chemical fertilizers or biofertilizers in single application. It can be said that, the favorable treatments for producing high dry weights of tomato plant comparing with the control were (CM + BFM) followed by (CM) alone then 25% and 50% (RR) of NPK + (BFM) in both cases.

N, P and K concentrations in plant

Data in Table 4 show that the concentrations of N, P and K in tomato plant tissues were significantly affected by the different treatments of fertilization. Results of N and P concentration in general, showed the same previous trend for dry matter content, where, tomato plants received (CM + BFM) followed by that fertilized with (CM) solely showed the highest N and P concentrations compared with the other treatments. In addition, the differences between control treatment and 25%, 50% and 75% of NPK (RR) + BFM did not reach the significant level. Whereas, the lowest values of n and p concentrations were attained by using the (BFM).

TABLE 4. N, P and K concentrations (%) in tomato plants at 75 days after transplanting as affected with the used biological, organic and inorganic fertilizers.

Parameters / Treatments	N%	P%	K%
100% of RR NPK (Control)	3.30	0.250	1.32
Biofertilizers (BFM)	3.14	0.223	1.13
Chicken manure (CM)	3.48	0.276	1.02
25% of the NPK RR + BFM	3.30	0.246	1.38
50% of the NPK RR + BFM	3.30	0.250	1.40
75% of the NPK RR + BFM	3.29	0.253	1.34
CM + BFM.	3.57	0.310	1.13
LSD 0.05	0.01	0.008	0.01

As for K conc., it is obvious that comparing with control treatment. The plants fertilized by different percentages from NPK (RR) *i.e.,* 25% 50% and 75% + (BFM) showed the highest K conc., while the lowest values were found in the plants fertilized by (CM + BFM) applied either separately or in combination. It is obvious that, (CM + BFM) followed by (CM) only yielded the highest conc. for N, P, while the highest K was attained with 50% NPK RR+ BFM. However, the 100% NPK RR treatment was ranked at the fourth situation for all the nutrients.

The increment of N, P and K concentrations in tomato plants is due to the increases in the available N, P and K in soil which facilitates plant uptake of these nutrients. The obtained results are in agreement with those reported by Ouda (2000); Ghallab & Salem (2001); Abo El-Soud *et al.* (2003) and El-Assiouty & Abuo-Sedera (2005) using different rates of NPK fertilizers in single or in combined application with biofertilizers.

Fruit yield

Results in Table 5 reveal significant variations in tomato yield achieved through the successive pickings (early, mid-season, late and total yields) due to the experimental treatments. Comparing with the control treatment, the highest increase in tomato yield was obtained with applying (CM + BFM) which increased total yield of tomato by about 16.84%. This treatment was followed by the treatments of 25% RR or 50% RR + BFM and 100 RR for early yield, both mid, late and total yield, respectively. Meanwhile, the lowest significant yields of the four stages were recorded under the treatments of (BFM) alone as well as (75% RR NPK + BFM). In this regard, several investigators reported that applying biofertilizers alone without simulative rates from chemical or organic fertilizers was less effective than using recommended rates from NPK (Awad, 1998; Ouda , 2000 and Radwan & Awad, 2002).

TABLE 5. Early, mid-season, late and total fruit yield (ton fed^{-1}) of tomato plants as affected with the used biological, organic and inorganic fertilizers.

Treatments \ Parameters	harvesting stages			Total yield (ton fed^{-1})
	Early	Mid season	Late	
100% of RR NPK (Control)	3.25	9.70	4.15	17.10
Biofertilizers (BFM)	1.47	7.13	3.25	11.85
Chicken manure (CM)	2.93	9.29	3.81	16.03
25% of the NPK RR + BFM	2.88	9.84	4.25	16.97
50% of the NPK RR + BFM	2.77	9.85	4.30	16.92
75% of the NPK RR + BFM	1.67	7.79	3.23	12.69
CM + BFM.	4.06	10.79	5.13	19.98
LSD 0.05	0.11	0.19	0.15	0.26

The favorable effect of (CM + BFM) as well as 25% and 50% RR NPK in the presence of biofertilizers might be attributed to the simulative effect of these treatments on increasing N, P and K conc. in tomato plant tissues as shown in Table 4 and dry matter content Table 3 since the increments in these parameters were positively reflected on tomato yield.

The obtained results are in accordance with those reported by Ouda (2000); Ghallab & Salem (2001); Abo El-Soud *et al.* (2003) and El-Assiouty & Abuo-Sedera (2005) using mixture of biofertilizers in the presence of different percentages of recommended NPK.

It may be concluded that tomato fruit yield was maximized under the (CM + BFM) treatments followed by the 100% rr of NPK treatment which did not differ significantly from the 25% RR + BFM and 50%RR + BFM treatments, respectively.

N, P and K concentrations in tomato fruits

It can be seen from Table 6 that the studied treatments showed significant differences in N, P and K concentrations in tomato fruits. At the 2[nd] picking the highest values of N conc. in tomato fruits compared to the control treatment were obtained by adding (CM + BFM).Meanwhile, at the 4[th] picking, the highest N conc. was obtained by applying (CM) and 50% of NPK RR each combined with (BFM), where the differences between them were non-significant. The next significant treatment at this stage was (CM) application solely. Then, the treatment (25% of NPK RR + BFM) which did not differ significantly from the control. The lowest effective treatment in this determination, at the two pickings when (BFM) was solely applied.

Regarding P conc. in tomato fruits, data show that at the two pickings, fruits produced from plants received (CM + BFM) followed by the 50% of (NPK RR + BFM) showed the highest P concentration. On the other hand, it was generally noticed that P conc. from the treatment of (25% NPK RR + BFM) as well as (CM) applied singly did not differ significantly from the control treatment. The lowest P conc., whoever, was observed in the fruits of plants inoculated by (BFM).

TABLE 6. N, P and K concentrations in tomato fruits at 2[nd] and 4[th] pickings as affected with the used biological, organic and inorganic fertilizers.

Parameters / Treatments	2[nd] picking			4[th] picking		
	N	P	K	N	P	K
100% of RR NPK (Control)	3.45	0.524	4.32	3.04	0.456	3.92
Biofertilizers (BFM)	2.90	0.503	4.11	2.78	0.430	3.03
Chicken manure (CM)	2.99	0.520	4.33	3.16	0.451	3.43
25% of the NPK RR + BFM	3.14	0.528	4.32	3.05	0.456	3.30
50% of the NPK RR + BFM	3.24	0.546	4.33	3.35	0.490	3.60
75% of the NPK RR + BFM	2.84	0.516	4.03	3.76	0.443	3.03
CM + BFM.	3.66	0.632	4.55	3.35	0.528	4.09
LSD 0.05	0.014	0.012	0.011	0.013	0.010	0.013

Concerning K conc. in tomato fruits, data indicate that at the two pickings, the (CM + BFM) treatment was the most effective comparing with other treatments at the 2[nd] picking only. It is obvious that there were non-significant differences in K conc. between control treatment and treatments of adding (CM) only and (25% & 50% of NPK RR plus BFM). At the two pickings, application of (BFM) only and (75% of NPK RR plus BFM) produced lowest values of potassium conc.

It may be concluded that the highest values of N, P and K conc. in tomato fruits were maximized at both 2^{nd} and 4^{th} pickings under (CM + BFM), except N% at the 4^{th} picking. The N% was (3.35%) ranked at the 2^{nd} position while N% was maximized (3.76%) under the treatment of 75% NPK RR + BFM and 50% or 25% of NPK RR. This might be attributed to the simulative effect of these treatments on soil NPK (Table 3) and hence, on plant (Table 4). These treatments may suggest a positive relationship between NPK conc. in plant and their conc. in tomato fruits. The obtained results are similar to those reported by El-Saadany & Abdel-Rasoul (1999); Radwan & Awad (2002) and Khalil *et al.* (2004) using organic manures separately or combined with biofertilizers and by El-Karamany *et al.* (2000); Ouda (2000) and Ghallab & Salem (2001) using different rates of NPK with different biofertilizers.

Fruit quality

Data Table 7 illustrate the effects of fertilization treatments used in the experiment on tomato fruit quality, *i.e.,* dry matter content, vit. C content, total acidity and sugar content as reducing, non-reducing and total sugars at the 2^{nd} and 4^{th} pickings, respectively. As shown in the Table, all treatments exerted significant effects on dry matter (%) as well as both reducing and total sugars, while no significant difference were detected among the values of vit. C content, total acidity, T.S.S (%) and non-reducing sugars of the two pickings.

TABLE 7. Fruit quality of tomato plants as affected with the used biological, organic and inorganic fertilizers.

Treatments \ Parameters	D M %	Vit C. mg / 100m	Total acidity %	TSS %	Sugar % of dry weight		
					Red.	Non-Red.	Total sugars
	2^{nd} Picking of fruit yield						
100% of RR NPK (Control)	6.45	16.14	0.45	5.50	38.6	1.00	39.60
Biofertilizers (BFM)	5.06	16.17	0.44	5.47	31.93	0.93	32.86
Chicken manure (CM)	6.45	16.11	0.45	5.50	38.58	0.97	39.55
25% of the NPK RR + BFM	6.48	16.19	0.45	5.50	38.70	1.00	39.70
50% of the NPK RR + BFM	6.53	16.08	0.45	5.53	38.60	0.97	39.57
75% of the NPK RR + BFM	5.50	16.12	0.44	5.47	31.10	0.93	32.03
CM + BFM	6.53	16.09	0.45	5.47	38.70	1.00	39.70
LSD 0.05	0.10	--	--	--	0.12	--	0.18
	4^{th} Picking of fruit yield						
100% of RR NPK (Control)	6.82	17.18	0.45	5.37	30.67	1.20	31.87
Biofertilizers (BFM)	5.73	17.12	0.44	5.33	27.30	1.17	28.47
Chicken manure (CM)	6.86	17.06	0.45	5.37	30.60	1.20	31.80
25% of the NPK RR + BFM	6.83	17.06	0.44	5.40	30.67	1.20	31.87
50% of the NPK RR + BFM	6.93	17.17	0.44	5.37	30.63	1.23	31.86
75% of the NPK RR + BFM	6.14	17.15	0.44	5.33	28.50	1.17	29.67
CM + BFM	6.90	17.14	0.45	5.40	30.70	1.23	31.93
LSD 0.05	0.12	--	--	--	0.11	--	0.17

The results indicate that the highest values of fruit dry matter (%) and reducing and total sugars were achieved at the two pickings under the treatments of (CM + BFM), as well as (25% RR & 50% of NPK) for DM% only. However, the differences between them were insignificant. Whereas, the treatment of (75% NPK RR + BFM), as well as (BFM) alone produced less T.S.S. (%).

It was noticed also, that fruit sugar content differed in the 4^{th} picking than in the 2^{nd} one. Both reducing and total sugars in tomato fruits were decreased in the 4^{th} picking, but the non-reducing sugar increased in the 4^{th} picking compared with the 2^{nd} one. The favorable effects of the treatments (25% and 50% of NPK RR) each combined with (BFM) as well as (CM)) either in single application or combined with (BFM) on fruit quality were in agreement with those reported by Fatah-Allah *et al.* (1997); Awad (1998); Heweedy (1999) and Ouda (2000).

Generally, it could be concluded that, CM application at the rate of $20m^3$ fed^{-1} + BFM mixture (phsphorien, microbien and nitrobien) at a rate of 3 kg fed^{-1} before tomato transplanting is the recommended treatment, as it produced the highest total tomato yield with the best quality comparing with application of 100% of NPK without bacteria inoculation. Application of 25% and 50% of recommended NPK + bifertilizer mixture at the same rate showed almost similar effects as fertilizeration with the recommended N, P and K fertilizers. Thus, these treatments can replace entirely or partially N, P and K mineral fertilizers, which reduce production costs and conserve the environment from chemical pollution hazards on human and animal health.

References

A. O. A. C. (Association of Official Analytical Chemists) (1990) *"Official Methods of Analysis"*, 15^{th} ed., Washington, D.C., USA.

Abdel-Ati, Y. Y.; Hammad, A. M. M. and Ali, M. Z. H. (1996) Nitrogen fixing and phosphate solublizing bacteria as biofertilizers for potato plants under Minia conditions. *1^{st} Egypt. Hung. Hort. Conf., Kafr EL-Sheikh, Egypt,* 15-17 Sept.

Abdel-Hady, B.; Camilia, A.; El-Deewiny, Y. and Abdel-Mooez, M. R. (2005) Effect of inorganic fertilizer and organic residues on growth and NPK uptake by rocket plants. *Egypt. J. Appl. Sci.* **20** (6A): 347-357.

Abdel-Moez, M. R.; Shaheen, A. A. and Abd El-Fattah, A. A. (1997) Effect of town refuses compost and sulfur on nutrients uptake, vegetative growth characteristics and yield of onion. *Egypt. J. Appl. Sci.* **12**:197-207.

Abo El-Soud, A. A.; Ragab, A. A.; Mekhemer, G. A. A. and Mikhacel, F. T. (2003) Response of faba bean to inoculation with N2-fixer and phosphate-dissolving baceria as influenced by different sources of phosphorus. *Egypt. J. Appl. Sci.* **18** (1): 73-90.

Amara, Mervat A. T. and Dahdoh, M. S. A. (1995) Effect of inoculation with plant growth promoting rhizbacteria (pgpr) on yield and uptake of nutrients by wheat grown on sandy soil. *5^{th} National Congress on Bio-Agric. Relation to Environ.*, No. 20-21, Cairo, Egypt.

Ashour, I. A.; Ali, M. and Hashem, F. A. (2004) Efficiency of using amendments and biofertilizers for controlling salinity and alkalinity of soil. *Egypt. J. Appl. Sci.* **19**(7b):772-783.

Ashour, S. A. (1998) Influence of biofertilizers and phosphorus application on growth and yield of potato. *J. Agric. Mansoura Univ.* **23**(7): 3351-3358.

Awad, N. M. (1998) The use of microorganisms in ecological farming systems. *Ph. D. Thesis*, Fac. Sci., Cairo Univ., Egypt, 215 p.

Bashan, Y. and Holguin, G. (1997) *Azospirillum*-plant relationship: Environmental and physiological advances (1990-1996). *Canadian J. Microbiol.* **43**: 103-121.

Cottenie, A.; Verloo, M.; Kikens, L.; Velghe, G. and Camerlynck, R. (1982) Chemical analysis of plant and soils Lab. Anal. Agroch., Fac. Agric., State University Gent., Belgium.

Dakhly, O. F.; Abdel Mageed, Y. T. and Hassan, E. A. (2004) Effect of nitrogen, organic fertilizers and new azotopacter transformants on aquash. *Minia J. of Agric. Res. & Develop.* **24**(1):1-30.

Dubios, M.; Gilles, K.A.; Hamitton, J. K.; Robbers , P. A. and Smith, F. (1956) Colorimetric method for determination of sugars and related substances. *Anal. Chem.* **28**(3):350-356.

El-Assiouty, F. M. M. and Abou-Sedera, S.A. (2005) Effect of chemical and bio-fertilizers on spinash (spinacia oleracea l.) seed production and quality. *Egypt, J. Appl. Sci.* **20**(5B):789-806.

El-Banna, E. N. and Tolba, A. F. (2000) Effect of microbein (biofertilizer) and different levels of nitrogen and phosphorus on growth and yield of potato plant (*Solanum tuberosum* L. *J. Agric. Sci. Mansoura Univ.* **25** (8) : 5413-5423.

EL-Banna, E. N.; Awad, E. N.; Ramadan, H. M. and Mohamed, M. R. (2001) Effect of bio-organic fertilization indifferent seasons on growth, yield and tubers quality of potato (*Selenium Tuberosum*) *J. Agric. Sci. Mansoura Univ.* **26** (3): 1873-1882.

El-Dahtory, Th.; Abdel-Nasser, M.; AbdAllah, A. R. and El-Mohandes, M. A. (1989) Studies on phosphate solubilizing bacteria under different soil amendments. *Minia J. Agric. Res. & Dev.* **11** (2): 935-950.

EL-Ghamry, A. M. and EL-Naggar, E. M. (2001) Evaluation of some organic residues as soil conditioners on different Egyption soils. *J. Agric. Sci. Mansoura Univ.* **26**(12): 8207 - 8214.

EL-Karamany, M. F.; Ahmed, M. K. A.; Bahr, A. A. and Kabesh, M. O. (2000) Utilization of biofertilizers in field crop production. 13. Effect of organic manuring, chemical and biofertilizers on yield and nutrient content of some grown on newly reclaimed soil. *Egypt. J. Appl. Sci.* **15**(11):137-155.

EL-Leboudi, A. E.; Ismail, A. S.; Negm, M. A. and Montaser, S. Y. (1988) Organic acids and nutrient availability in calcareous soils. *Inter. Symp. Soil Conditioners,* Egypt.

El-Masry, A. A. (1995) Effect of some soil ammendments on the avialability of nutrients to plant. *M. Sc. Thesise,* Fac. of Agri., Al-azahar Univ., Egypt.

El-Saadany, S. M. M. and Abd El-Rasoul, Sh. M. (1999) Effect of gypsum, fym and pfhosphorien applications on peanut crop grown on newly reclaimed sandy soil. *Egypt. J. Appl. Sci.* **14**(7):611-625.

Fallik, E. and Okon, Y. (1996) Ino coolants of Azospirillum basilense: Biomass production, survival and growth promotion of setaeia italica and Zeamays. *Soil Bid. Biochem.* **28**(1): 123 - 126.

Fatah-Alah, M. A.; Khalil, R. M.; Malash, N. M. and Midan, S. A. (1997) Response of some promising pepper cultivars to farmyard manures and nitrogen fertilization. *Menofia J. Agric. Res.* **22** (2):459-491.

Frankenberger, J. W. T. and Arshad, M. (1995) *"Phytohormones In Soils".* 503 p. Microbial production and function. Marcel Dekker, Inc., New York.

Ghallab, A.M. and Salem, S.M. (2001) Effect of some biofertilizer treatments on growth, chemical composition and productivity of wheat plants grown under different levels of npk fertilization. *Annals. Agric. Sci., Ain Shams Univ., Cairo* **46** (2): 485-509.

Gomez, K.A. and Gomez, A.A. (1984) *"Statistical Procedures for Agricultural Research",* 2nd ed., p. 680, John Wiely and Sons New York.

Heweedy, A. M. (1999) Influence of single and multi bacterial fertilizer on the growth and fruit yield of tomato. *Egypt. J. Appl. Sci.* **14**(7): 508-523.

Hesse, P. R. (1971) *"A Text Book of Soil Chemical Analysis",* John Murry, Ltd., 50 Albermarle Street, London.

Khafagy, E. E. (1999) Reducing the potential for adverse environmental impacts of inorganic nitrogen in Agro-ecosystem. *M. Sc. Thesis,* Fac. Agric., Mansoura Univ., Egypt, 96 p.

Khalil, A. A.; Nasef, M. M.; Ghazal, F. M. and El-Emam, M. A. (2004) Effect of integrated organic manuring and biofertilizer on growth and nutrient uptake of wheat plants grown on diverse textured soils. *Egypt. J. Agric. Res.* **82**(2):221-234.

Marschner, H. (1995) *"Mineral Nutrition of Higher Plants",* 2nd ed., 864 p., Academic Press, Harcourt Brace and Company, Publishers. London, San Diego, New York, Boston, Sydney, Tokyo, Toronto.

Ouda, A. M. M. (2000) Biological studies on tomato yield and its components. *Ph. D. Thesis,* Fac. Agric. Mansoura Univ., Egypt, 105 p.

Page, A.l.; miller, R.H. and Keeney, D.R. (1982) *"Methods of soil analysis",* Part 2 Chemical and Microbiologcal Properties, 2nd, Amer. Soc. Agron., Madison, W. I., USA.

Radwan, S. M. A. and Nemat, M. Awad (2002) Effect of soil amendments with various organic wastes with multi-biofertilizers on peanut plants in sandy soil. *J. Agric. Sci. Mansoura Univ.* **27**(5) : 3485 - 3493.

Reda, M. M. A. (2001) Effect of organic. inorganic and biofertilizeration on improving some properties of calcarious soil and its productivity of maize plants. *J. Agric. Sci. Mansoura Univ* **26**(8) : 5082 - 5098.

Saber, M.S.M. and Gomaa, A.M.H. (1993) Associative action of a multi-strain biofertilizer on tomato plants grown in a newly reclaimed soil. *The 6th International Symposium on Biological Nitrogen Fixation with Non-Legumes.* Sep. 6-10, pp. 493-497, Ismailia, Egypt.

Saber, M. S. M. (1993) A multi - strain biofertilizer. *The Sixth International Symposium Nitrogen Fixation with Non-Legumes, Ismailia,* Egypt 6-10 September

Saha, N.; Das, A. C. and Mulkherjee (1995) Effect of decomposition of organic matter on activities of microorganisms and availability of nitrogen, phosphorus and sulphur in soil. *J. Indian Soc. Soil Sci.* **43**:210- 215.

Saleh, A. L.; Abdel-Moze, M. R. and Abdel-Galil, A. (1999) Effect of some organic fertilizers on nutrients uptake and yield of wheat (*Triticum Aestivium*). *Egypt. J. Appl. Sci.* **14**(7):508-523.

Salib, Madlain M.; Awadalla, A. A. and Mikhail, M. I. (2003) Impact of organic and bio-fertilzers on some physical and chemical properties of clay soil and its productiveity of onion bulbs. *Egypt. J. Appl. Sci.* **14**(7):508-523.

Shalaan M. N. (2005) Effect of compost and different sources of biofertilizers on borage plants (*Borago Officienals,* L.) *Egypt. J. Agric. Res.* **83**(1):271-284.

Shaban, M. M. E. (2005) Conserving soil fertility of some soils of Egypt. *M. Sci. Thesis,* Fac. of Agric., Al-Azahr Univ.

Shawky, B. T. (1990) Effect of *Azotobacter* and *Azospirilla* on germination of seeds of some agricultural crops. *Zentralbl. Mikrobiol.* **145**: 209-217.

Subba Roa, N. S. (1993) *"Biofertilizer in Agriculture",* 3rd ed., 219 p., Oxport and IBH New Delhi, India,

Terry, E.; Pino, M.; Delos, A. and Medina, N. (1995) Biofertilizer application in early season tomato cultivation. *Cultivos Tropicales,* **16** (3): 69-71. (*c.f. Hort.. Abstr.* **67** (2): 2220, 1997).

Youssef, A. M.; El-Fouly, A. H. M.; Youssef, M. S. and Mohamdien, S. A. (2001) Effect of using organic and chemical fertilizers in fertigation system on yield and fruit quality of tomato. *Egypt. J. Hort.* **28**:59-77.

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تأثير إضافة بعض الأسمدة الحيوية والعضوية والكيماوية على محصول الطماطم

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أجريت تجربة حقلية لمدة موسمين زراعيين (٢٠٠٥، ٢٠٠٦) على تربة طينية بمنطقة فاقوس- محافظة الشرقية-مصر في الموسم الصيفي بهدف تقليل استخدام الأسمدة الكيماوية النتروجينية والفوسفاتية والبوتاسية أوعدم استخدامها، وذلك عن طريق دراسة تأثيرمخلوط الأسمدة الحيوية (فوسفورين والنتروبين والميكروبين) ، وسماد مخلفات الدواجن ، والتسميد الحيوي مع التسميد العضوى، بالاضافة إلى التسميد الكيماوي بنسب مختلفة عن المعدل الموصى به من السماد النتروجيني والفوسفاتي والبوتاسي (٢٥٪، ٥٠٪، ٧٥٪) مع إضافة مخلوط الأسمدة الحيوية السابق ذكره مع كل نسبة ومقارنة ذلك بالتسميد الكيماوي بالمعدل الموصى به بالكامل (١٠٠٪) من الأسمد الثلاثة على:التركيب الكيماوي للتربة، نمو النبات، تركيزالنتروجين والفوسفوروالبوتاسيوم في النبات والثمار، بالإضافة إلى محصول الطماطم وجودته.

وتضمنت التجربة سبعة معاملات في تصميم قطاعات كاملة العشوائية ذو أربع مكررات، ويمكن تلخيص النتائج المتحصل عليها في الآتي:

١. زاد بوضوح محتوى التربة من النتروجين والفوسفورالميسر، وانخفضت بدرجة بسيطة درجة حموضة التربة بإضافة سماد مخلفات الدواجن مصحوب بالتسميد الحيوي مقارنة ببقية المعاملات، بينما كانت معاملات التسميد بنسب (٢٥٪ ، ٥٠٪) من المعدل الموصى به وفي وجود التسميد الحيوي هى أفضل المعاملات بالنسبة لمحتوى التربة من البوتاسيوم الميسر.

٢. أشارت النتائج إلى أن أعلى وزن جاف لأجزاء النبات المختلفة وللنبات ككل من معاملة التسميد بسماد مخلفات الدواجن مع التسميد الحيوي يليها معاملة التسميد بسماد مخلفات الدواجن فقط ، وذلك مقارنة بالكنترول (المعدل الموصى به) علماً بأن معاملة الكنترول لم تختلف معنوياً في هذا الخصوص عن معاملات التسميد الكيماوي بنسب (٢٥٪ ، ٥٠٪) من المعدل الموصى به في وجود التسميد الحيوي.

٣. أدت معاملة التسميد بسماد مخلفات الدواجن مع التسميد الحيوي يليها معاملة التسميد بسماد مخلفات الدواجن فقط إلى أعلى زيادة في محتوي النبات من النتروجين والفوسفورمقارنة بمعاملة الكنترول علماً بأن معاملة الكنترول لم تختلف معنوياً في ذلك عن معاملات التسميد الكيماوي (٢٥٪ ، ٥٠٪ ، ٧٥٪) من المعدل الموصى به في وجود التسميد الحيوي بينما كانت أكبر زيادة في محتوى النبات من البوتاسيوم نتيجة لمعاملات التسميد الكيماوي بنسب (٢٥٪ ، ٥٠٪ ، ٧٥٪) من المعدل الموصى به في وجود التسميد الحيوي مقارنة بباقى المعاملات.

٤. أعطت معاملة التسميد بسماد مخلفات الدواجن مع التسميد الحيوي أعلى زيادة في محصول الطماطم سواء المبكر أو في منتصف الموسم أوالمتأخرأوالكلي مقارنة بمعاملة الكنترول يليها معاملات التسميد الكيماوي بنسب (٢٥٪ ، ٥٠٪ ، ٧٥٪)

من المعدل الموصى به، وفي وجود مخلوط الأسمدة الحيوية والتي لا تختلف عن معاملة الكنترول.

٥. وجد أن أعلى تركيزمن النتروجين والفوسفوروالبوتاسيوم في الثمارمقارنة بمعاملة الكنترول نتج عن معاملة التسميد بسماد مخلفات الدواجن مع التسميد الحيوي يليها في ذلك التسميد الكيماوي بنسبة (٢٥٪ أو ٥٠٪) من المعدل الموصى به في وجود التسميد الحيوي أو التسميد مخلفات الدواجن فقط.

٦. أوضحت الدراسة أن أعلى زيادة في محتوى الثمارمن المادة الجافة والسكريات المختزلة والكلية نتج عن معاملات الكنترول والتسميد الكيماوي بنسبة(٢٥٪ ، ٥٠٪) من المعدل الموصى به مع التسميد الحيوي يليه معاملة سماد مخلفات الدواجن بمفرده أومع التسميد الحيوي. علما بأن هذه المعاملات لم تختلف معنويا عن بعضها البعض. هذا ولم يتأثر محتوى الثمار من كل من فيتامين C ، والحموضة الكلية، والمواد الصلبة الذائبة الكلية، والسكريات غيرالمختزلة بأي من معاملات التسميد المختلفة تحت الدراسة. ومن الملاحظ أن محتوى الثمار من السكريات المختزلة والكلية إنخفض في الجمعه الرابعة عنه في الجمعة الثانية، في حين زاد محتواها من السكريات غيرالمختزلة في الجمعة الرابعة عنه في الجمعة الثانية.

ويمكن التوصية باستخدام التسميد العضوي بسماد مخلفات الدواجن مع التسميد الحيوي بمخلوط الأسمدة الحيوية (فوسفورين، نتروبين، ميكروبين) لإنتاج أعلى محصول من الطماطم، يلي ذلك استخدام التسميد الكيماوي بنسبة (٢٥٪ أو ٥٠٪) من المعدل الموصى به من الأسمدة الكيماوية مع إضافة نفس مخلوط الأسمدة الحيوية والتي أعطت محصولاً لايختلف معنوياً عن المحصول الناتج من التسميد الكيماوي بالمعدل الموصى به (الكنترول). ومن ثم فإن هذه الدراسة تشير إلى إمكانية إما الاستغناء عن التسميد الكيماوي جزئياً أوحتى كلياً، مما ينتج عنه حماية البيئة من التلوث الكيماوي وأثره الضارعلى صحة الإنسان والحيوان، وهي أهم الأهداف المطلوب تحقيقها في العالم، بالإضافة إلى خفض تكاليف الإنتاج.