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EFFECT OF FYM, MINERAL AND BIOFERTILIZER NP ON DRY WEIGHT AND YIELD OF TOMATO GROWN IN SANDY SOIL

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ABSTRACT: This investigation was conducted during the two summer seasons of 2003and 2004 at El-Khattara Experimental Farm, Fac. Agric., Zagazig University, to study the performance of tomato cv. Castle Rock in relation to FYM levels (20 and 40 m^3/*fed*) and seven different combinations between mineral N (30, 60, 90,120 kg /*fed*), mineral P (12, 20, 28, 80 kg P_2O_5/*fed*) and biofertilizer treatments (nitrobein (Nr) and phosphorein (Pr) as mixed fertilizer at 0.4 and 0.6 kg/*fed*, respectively).

Application of 40 m^3 FYM/*fed* stimulated, generally, the growth of tomato plants expressed as dry weight of different plant organs and enhanced photosynthetic pigments as well as the yield and its components compared to 20 m^3 FYM/feddan. In spite of that, an adverse effect was found on carotenoid content compared to 20 m^3 FYM/feddan.

The application of 75 % N and 35 % P_2O_5 of recommended dose plus inoculation of tomato transplants with biofertilizers (Nr+Pr) and /or 100 % of recommended mineral NP were the most favourable treatments for growth expressed as dry weight of different plant organs and total chlorophyll content in tomato leaves and yield and its components, except average fruit weight.

Generally, inoculation of tomato transplants with Nr+Pr combined with 75 % N and 35 % P_2O_5 of recommended fertilizer or 100 % of recommended mineral NP without Nr+Pr combined with 40 m^3 FYM/*fed* were considered the proper interaction treatments which showed the best dry weight, total chlorophyll and yield and its components of tomato plants under sandy soil conditions compared to other interaction treatments.

Key words: Tomato, FYM, mineral NP, biofertilizers, dry weight, chlorophyll and yield.

INTRODUCTION

Tomato (*Lycopersicon esculentum,* (Mill.) L.) is one of the major important vegetable crops grown in Egypt either for fresh consumption or for processing. Fertilization is a major factor increasing tomato growth and yield as well as fruit quality. Many investigators directed their combination to N and P or organic fertilizers; others went to production of plant growth and yield modifying substances by such biofertilizers. Recently, a great attention has been directed to the using of organic and biofertilizers to minimize mineral fertilizers decrease the pollution of the agricultural environment and produce healthy food for human. Thus, growth of most vegetable crops including tomato was improved by applying different organic fertilizers, such as farmyard manure (Verlodt, 1984; Subbiah *et al.*, 1985; Zhang *et al.*, 1988; Fattahalla 1992a). For improving the soil conditions and fertility for tomato plant growth, photosynthetic pigments and yield, applying of FYM up to about 40 m^3*/fed* was recommended by Fattahalla (1992a and b), Arisha and Bardisi (1999) on potato, Abdalla *et al.* (2001) and El-Mansi *et al.* (2004) on tomato. Inoculation of tomato transplants with biofertilizers like microbein (N-fixing bacteria) increased, number of fruits/plant, yield / plant and yield/ Feddan of tomato (Moustafa and Omar, 1990; Abd El-Ati *et al.*, 1996; El-Gamal, 1996; El-Nagaar, 2004).

However, the combination among FYM, mineral and biofertilizers has been found to increase dry weight and yield (El-Gamal, 1996 on potato; Dawa *et al.*, 2000 on tomato).

Therefore, the objective of this work was to determine the suitable rate of FYM and the best combination between mineral (N+P) and the biofertilizers nitrobein and phosphorein on the growth, chemical composition and yield of tomato (cv. Castle Rock) under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive summer seasons of 2003 and 2004 at El-Khattara Experimental Farm, Fac. Agric., Zagazig University, to study the response of tomato plant growth and productivity to FYM and different combinations among mineral NP and/or biofertilizer under sandy soil conditions using drip irrigation system. The experimental soil was sandy in

texture with 7.90 pH, 1.32 % organic matter, 0.021 % total N, 14.62 ppm available N, 19.46 ppm available P and 75.10 ppm available K. The FYM chemical properties were: 6.82 and 6.58 pH, 0.77 and 0.81 % total N, 0.24 and 0.23 % total P and 1.49 and 1.52 % total K in the first and second seasons, respectively.

This experiment included 14 treatments, which were the combinations between two rates of FYM (20 and 40 m^3/*fed*) and seven different combinations between mineral NP and nitrobein+ phosphoreinas presented in Schedule1.

These treatments were randomly arranged in a split plot design with four replications. Farmyard manure (FYM) was randomly arranged in the main plots and the combination between mineral NP and nitrobein + phosphorein were randomly distributed in the sub plots. Nitrobein (0.4kg/*fed*) and phosphorein (0.6 kg/*fed*) were only dissolved in four liters of water and little of Arabic gum (20%)as adhesive agent and the roots of transplants were dipped for three minutes in this suspension before transplanting.

Schedule1: The tested combinations of N, P_2O_5, nitrobein and phosphorein.

***Percentage of the recommended fertilizers		Kg/*fed*			
		Mineral		Biofertilizers	
N	P_2O_5	N	P_2O_5	Nr*	Pr**
25	15	30	12	00	00
50	25	60	20	00	00
75	35	90	28	00	00
25	15	30	12	0.4	0.6
50	25	60	20	0.4	0.6
75	35	90	28	0.4	0.6
100	100	120	80	00	00

Nr*: Nitrobein, Pr: Phosphorein *** recommended N and P were 120 and 80 kg/*fed* for tomato according Ministry of Agric. Egypt.**

Tomato cv. Castle Rock was used and its source was Atlas Seeds Company (USA). The area of the experimental unit was 12 m^2. It contained two lines each of 5 m length and 1.2 m width. One dripper line was used for each row. Tomato seeds were sown on January 15 and transplanted on March 15 in 2003 and 2004 seasons, respectively. The distance between plants was 50 cm. The other normal agricultural treatments (drip irrigation, pests control and weed control, etc.) of growing tomato plants were practiced.

Data Recorded

Plant growth

A random sample of three plants from each experimental unit was taken at 65 days after transplanting and different plant parts; i.e., roots, branches and leaves, were dried at 70 °C till constant weight, then weighed and recorded.

Photosynthetic pigments

Fresh leaves samples were taken from the fourth upper leaf at 65 days after transplanting and chlorophyll a, b as well as carotenoids were determined according to the method described by Wettestein (1957).

Yield and its components

Fruits of each experimental unit were harvested at full-ripe stage then counted, weighed and the following yield parameters were calculated: number of fruits / plant, average fruit weight, yield / plant, total yield / *fed* and the relative yield.

Statistical Analysis

The obtained data were subjected to the analysis of variance according to Snedecor and Cochran (1980). Means separation was done by Duncan (1958).

RESULTS AND DISCUSSION

Plant Growth

Dry weight

a. Effect of FYM

Data presented in Table 1 indicate that application of FYM at the rate of 40 m^3/feddan exerted a marked effect on dry weight of roots, branches, leaves and total tomato plant compared to application of 20 m^3/FYM /feddan. These results were true in the two growing seasons, except branches dry weight in the first season, which was not significantly affected.

Table 1: Effect of FYM on dry weight of tomato plants (gm/ plant)in summer seasons

FYM (m^3/*fed*)	Root	Branches	Leaves	Total	Relative (%)
			2003 season		
20	8.13 b	12.21 a	21.63 b	42.19 b	100.0
40	9.76 a	12.12 a	23.38 a	45.26 a	107.3
			2004 season		
20	12.46 b	17.87 b	34.12 b	64.42 b	100.0
40	13.83 a	18.37 a	38.28 a	70.61 a	109.6

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

The relative increases in total dry weight due to application of 40 m^3 FYM/feddan were 7.3 and 9.6 % over 20 m^3 FYM/fed. in the first and second seasons, respectively .

Since sandy soil had low organic matter and also low mineral nutrients, organic manure can improve its content of organic matter, and this in turn led to improve soil conditions such as soil water content, and increase the availability of minerals as well as the level of extractable minerals. Also, increase microorganisms in soil which in turn increase phytohormones, which affect plant growth.

The obtained results are in harmony with those reported by Fattahallah (1992a), Dawa *et al.*, (2000), Abdalla *et al.* (2001) on tomato, who reported that application of FYM up to 45 m^3*/fed* significantly increased dry weight of tomato plant organs.

b. Effect of the combination between mineral NP and biofertilizers

The obtained data in Table 2 show that adding 75 % mineral N+35 % mineral P_2O_5 of recommended plus inoculation of tomato transplants with nitrobcin (Nr) and phosphorein (Pr) at different rates enhanced the dry weight of different plant organs with insignificant differences between this treatment and the application of 100 % mineral NP without biofertilizers which increased dry weight of tomato plant organs compared to the other fertilizer treatments. This means that application of 75 % mineral N+35 % P_2O_5 plus Nr+Pr recorded the same results of application of 100 % mineral NP without biofertilizers enough for enhancing total dry weight of tomato plants. These results were true in both seasons of study. From the aforementioned results, it could be suggested that the application of 75 % mineral N + 35 % mineral P_2O_5 of recommended dose with inoculation of tomato transplants by biofertilizers (Nr+Pr) was the most favourable treatments for tomato growth and also for its economical beneficial for minimizing N and P rates.

The same data in Table 2 reveal that application of 50 % mineral N+25 % mineral P_2O_5 or 75 % of recommended mineral N + 35 % mineral P_2O_5 plus inoculation with Nr+Pr at different rates as well as application of 100 % mineral NP alone recorded the same and best results for root dry weight of tomato plans.

The relative increase in total dry weight of tomato organs were about 20.9 and 26.4 % for 75 % mineral N+35 % mineral P_2O_5 and Nr+Pr and 25.5 and 26.8 % for 100

Table 2: Effect of the combination between mineral (NP) and biofertilizer on dry weight of tomato plants(gm/ plant) in summer seasons

Mineral NP and biofertilizer			Root	Branches	Leaves	Total	Relative (%)
					2003 season		
25 % N +	15 % P_2O_5	from (R.D.)	8.06bc	10.73c	21.51c	39.30 c	100.0
50 % N +	25 % P_2O_5	from (R.D.)	8.26bc	11.50ab	21.43c	41.19b	104.8
75 % N +	35 % P_2O_5	from (R.D.)	7.76c	12.63ab	21.75bc	42.89b	109.1
25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	7.63c	12.13b	21.30c	41.06b	104.4
50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	8.90abc	11.93b	21.96bc	42.79b	108.8
75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	9 71ab	13.00a	24.81ab	47.53a	120.9
100 % N +	100 % P_2O_5	from R.D (Check)	10.30a	13.25a	25.81a	49.36a	125.5
					2004 season		
25 % N +	15 % P_2O_5	from (R.D.)	10.59d	16.51b	32.04c	59.14d	100.0
50 % N +	25 % P_2O_5	from (R.D.)	11.85cd	17.10b	32.16c	61.11d	103.3
75 % N +	35 % P_2O_5	from (R.D.)	13.13bc	17.23b	35.86b	66.21c	111.9
25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	12.71c	19.46a	34.79b	66.34c	112.1
50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	14.73a	18.94a	36.40b	70.07b	118.4
75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	14.35ab	19.38a	41.05a	74.78a	126.4
100 % N +	100 % P_2O_5	from R.D (Check)	14.66a	19.26a	41.09a	75.00a	126.8

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

% NP recommended over 25 % mineral N+ 15 % P_2O_5 from recommended in the first and second seasons, respectively.

The necessity of nitrogen and phosphorus for tomato growth has been demonstrated by many investigators, since nitrogen and phosphorus supply was describe for vegetative growth, dry matter accumulation as well as nutrient uptake. Nitrogen plays major roles related with plant growth, in addition to vital contribution in several biochemical processes in plant related in growth (Marschner, 1995). In addition, Mengel and Kirkby (1978) reported that N is an important constituent of protoplasm and other biological agents. Also, Gardener *et al.*(1985) declared that P is an essential component of the energy transfer compounds, genetic information system, cell membranes and phosphoproteins.

Moreover, the superiority of inoculation with biofertilizers might be owe much to the vital role of bacteria that present in the applied biofertilizer and capable of contributing some hormone substances, i.e., gibberellins, auxins and cytokinins, which stimulate the cell elongation and development and hence plant growth (Tien *et.al.*, 1970; Bouton *et.al.*, 1985; Paleg, 1985; Cacciari *et. al.*, 1989).

In addition, the superiority of inoculation with the biofertilizers phosphorus could be explained in the light of the great role played with such phosphate solubilizing bacteria in correcting the solubility problem and releasing the fixed phosphate form to the ready available form for plant nutrient, then supply the plants with their phosphorus needs.

These results were paralled with those reported by Saber and Gomaa (1993), Ali and Selim (1996) and El-Mansi *et al.* (2004) on tomato plants. They concluded that fertilization of tomato plants with the chemical nitrogen fertilizer at 80 kg/feddan without microbein or with 200 or 400 gm /feddan gave the highest dry weight of branches, leaves and total dry weight / plant.

c. Effect of the interaction between FYM and the combination with mineral NP and biofertilizers

The obtained data in Tables 3 and 4 indicate that the application of 100 % mineral recommended NP and 75 % mineral N+35 % mineral P_2O_5 from recommended plus Nr+Pr at different rates combined with 40 m^3 FYM/*fed* were the best interaction

Table 3: Effect of the interaction between farmyard manure and the combination between mineral (NP) and biofertilizer on dry weight of tomato plants (gm/ plant) in summer seasons

Treatments				Root	Branches	Leaves	Total	Relative (%)
FYM (m^3/*fed*)	x	Mineral NP and biofertilizer		2003 season				
20	25 % N +	15 % P_2O_5	from (R.D.)	6.90d	11.40abc	19.02e	37.33e	100.0
	50 % N +	25 % P_2O_5	from (R.D.)	7.80cd	11.55abc	20.20de	39.55e	105.9
	75 % N +	35 % P_2O_5	from (R.D.)	6.82 d	11.73abc	21.73b-e	41.78de	111.9
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	7.45cd	12.23ab	19.20e	38.88e	104.1
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	8.85bcd	12.63ab	22.23b-e	43.70cde	117.0
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	8.00cd	12.70ab	24.40abc	45.10cd	120.8
	100 % N +	100 % P_2O_5	from R.D (Check)	9.10bc	13.25ab	24.70ab	47.05bc	126.0
40	25 % N +	15 % P_2O_5	from (R.D.)	9.22bc	10.05c	22.00b-e	41.28de	110.5
	50 % N +	25 % P_2O_5	from (R.D.)	8.72cd	11.45abc	22.65b-e	42.83cde	114.7
	75 % N +	35 % P_2O_5	from (R.D.)	8.70cd	13.52a	21.77b-e	44.00cd	117.8
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	7.82cd	12.02abc	23.40bcd	43.25cde	115.8
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	8.95bc	11.23bc	21.70b-e	41.88de	112.1
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	11.42a	13.30ab	25.23ab	49.95ab	133.8
	100 % N +	100 % P_2O_5	from R.D (Check)	11.50a	13.25ab	26.92a	51.67a	138.4

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 4: Effect of the interaction between farmyard manure and the combination between mineral (NP) and biofertilizer on dry weight of tomato plants (gm/ plant) in summer seasons

Treatments				Root	Branches	Leaves	Total	Relative (%)
FYM (m^3/*fed*)	x	Mineral NP and biofertilizer		2004 season				
20	25 % N +	15 % P_2O_5	from (R.D.)	8.20f	15.35g	30.38f	53.92g	100.0
	50 % N +	25 % P_2O_5	from (R.D.)	11.27e	17.15ef	30.63f	59.05f	109.5
	75 % N +	35 % P_2O_5	from (R.D.)	12.07de	16.25fg	32.35ef	60.67ef	125.5
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	11.20e	19.50ab	31.88ef	61.33def	113.7
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	15.52a	19.23ab	35.58cd	70.32c	130.4
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	14.27abc	19.88a	38.63b	72.78bc	134.9
	100 % N +	100 % P_2O_5	from R.D (Check)	14.70ab	18.80abc	39.42b	72.93bc	135.2
40	25 % N +	15 % P_2O_5	from (R.D.)	12.98cd	17.67de	33.70de	64.35d	119.3
	50 % N +	25 % P_2O_5	from (R.D.)	12.43de	17.05ef	33.70de	63.17de	117.1
	75 % N +	35 % P_2O_5	from (R.D.)	14.18abc	18.20cd	39.38b	71.75c	133.0
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	14.23abc	19.42ab	37.70bc	71.35c	132.3
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	13.93bc	18.65bcd	37.22bc	69.82c	129.4
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	14.43abc	18.88abc	43.47a	76.78a	142.3
	100 % N +	100 % P_2O_5	from R.D (Check)	14.63ab	19.73a	42.75a	77.07a	142.9

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

treatments and recorded the highest values of tomato. dry weight of different plant organs in comparison with the other interaction treatments in the two growing seasons.

These results suggested that the application of 40 m^3 FYM /feddan, 75 % mineral N+35 % mineral P_2O_5 with biofertilizers (Nr+Pr) being more favourable for growth of tomato plants.

The abovementioned proper two interaction treatments recorded relative increase in total dry weight of tomato plants were about 33.8 and 42.3 for the interaction between 40 m^3 FYM/fed combined with 75 % mineral N+ 35 % mineral P_2O_5, 38.4 and 42.9 for the interaction between 40 m^3 FYM/fed combined with 100% mineral NP from recommended over the other treatments in the first and second seasons, respectively.

These results are in paralled true with those reported by Kumaran *et al.*, (1998) who, reported that plant growth of tomato was the best with organic + inorganic and *Azospirllum* and phosphobacteria.

Photosynthetic Pigments

Effect of FYM

Data in Table 5 indicate that increasing FYM rate from 20 m^3*/fed* to 40 m^3*/fed* significantly increased chlorophyll a, chlorophyll b, and total chlorophyll (a+b) in leaf tissues of tomato plants in the two seasons of study, except chlorophyll a in the second season, which was not significantly affected by increasing FYM rate. In spite of enhancing effect of the application of the high rate of FYM (40 m^3 */fed*) on leaf chlorophyll content in tomato, an adverse effect was found in total carotenoid compared to low rate of FYM (20 m^3 */fed*). In this connection, Arisha and Bardisi (1999) reported that FYM at 45 m^3*/fed* increased chlorophyll (a+b) as well as carotenoids content in potato leaves.

Effect of the combination between mineral NP and biofertilizers

Data presented in Table 6 show that the application of 50 % mineral N+25 % mineral P_2O_5 and 75 % mineral N+35 % mineral P_2O_5 from recommended fertilizers plus Nr+Pr at different rates as well as the application of 100 % mineral NP of recommended dose enhanced chlorophyll a, chlorophyll b, and total chlorophyll contents in tomato leaves compared to the other treatments. In spite of that different minerals plus Nr+Pr combination

Table 5: Effect of FYM on photosynthetic pigments (mg/gm/ dry weight) of tomato leaves in summer seasons

FYM (m^3/*fed*)	Chlorophyll			Total carotenoids
	a	b	Total (a+b)	
		2003 season		
20	3.91b	4.33b	8.26b	3.22a
40	4.20a	5.52a	9.81a	2.82b
		2004 season		
20	3.84a	4.48b	8.32b	2.96a
40	4.13a	5.48a	9.61a	2.94a

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 6: Effect of the combination between mineral (NP) and biofertilizer on photosynthetic pigments (mg/gm/ dry weight)of tomato leaves in summer seasons

Mineral NP and biofertilizer			Chlorophyll a	Chlorophyll b	Chlorophyll Total (a+b)	Total carotenoids
					2003 season	
25 % N +	15 % P_2O_5	from (R.D.)	3.55c	3.71d	7.27c	2.93a
50 % N +	25 % P_2O_5	from (R.D.)	3.88bc	4.38bc	8.15bc	3.04a
75 % N +	35 % P_2O_5	from (R.D.)	3.82bc	4.75bc	8.58bc	3.16a
25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	3.88bc	4.46bc	8.35bc	3.18a
50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.18abc	5.41ab	9.60ab	2.88a
75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.40ab	5.61ab	10.40a	2.73a
100 % N +	100 % P_2O_5	from R.D (Check)	4.66a	6.14a	10.87a	3.22a
					2004 season	
25 % N +	15 % P_2O_5	from (R.D.)	3.60c	4.77bc	8.38c	2.80a
50 % N +	25 % P_2O_5	from (R.D.)	3.83ab	4.54c	8.38c	2.94a
75 % N +	35 % P_2O_5	from (R.D.)	3.78bc	4.62c	8.41c	2.76a
25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	3.91ab	5.03b	8.94b	3.33a
50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.23a	5.10b	9.33ab	2.88a
75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.25a	5.25b	9.50a	2.69a
100 % N +	100 % P_2O_5	from R.D (Check)	4.24a	5.54a	9.79a	3.22a

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

did not reflect significant effect on carotenoid content. These results held true in the two growing seasons.

It could be concluded that the application of medium levels of the recommended NP plus biofertilizers improved chlorophyll content in tomato leaves.

The enhancing effect of biofertilizer application may be due to the effect on mobilizing nutrients by such microorganisms and to accelerate microbial processes, which help in availability of metals and increased levels of extractable minerals (El-Kramany *et al.*, 2000).

Accordingly, the enhancing of nutrient uptake process by such microorganisms to augment the extent of the availability of nutrients in a form which can be easily assimilated and may be reflected on the biosynthesis of chlorophylls in tomato leaves.

These results are in accordance with those found by El-Gamal (1996), under newly reclaimed soils, who found that increasing N application up to 200 kg/feddan alone and/or application of 200 kg N with inoculation of potato seed tuber with Halex 2, resulted in a high leaf chlorophyll content. El-Nagaar (2004) came to similar conclusion working with chicken manure at 38.5m^3/*fed* and/or with mineral N at 120 kg/*fed* that gave the highest concentrations of chlorophyll and carotenoids in tomato leaves.

Effect of the interaction between FYM and the combination with mineral NP and biofertilizers

Data in Tables 7 and 8 indicate that the interaction between FYM rates and different minerals and Nr+Pr at different rates significantly affected chlorophyll a and b in tomato leaves.

Results showed, except few cases, that the addition of 50 % mineral N+25 % mineral P_2O_5 and 75 % mineral N plus 35% mineral P_2O_5 + Nr+Pr as well as 100 % mineral NP alone combined with 40 m^3 FYM /feddan gave the maximum values of chlorophyll a and b and total chlorophyll in both seasons. The interaction showed significant differences and in general the high carotenoid values were recorded with the interaction between 20m^3 FYM combined with 50 % mineral N+ 25 % P_2O_5 plus Nr+Pr as well as with 100 % mineral NP alone. However, data did not reflect significant effect in the second season.

Yield and its Components

Effect of FYM

Presented data in Table 9 indicate that increasing FYM rate from 20 to 40 m^3/*fed* significantly affected yield and its component,

Table 7: Effect of the interaction between farmyard manure and the combination between mineral (NP) and biofertilizer on photosynthetic pigments (mg/gm/ dry weight) of tomato leaves in summer season

Treatments				Chlorophyll a	Chlorophyll b	Chlorophyll Total (a+b)	Total carotenoids
FYM (m^3/*fed*)	x	Mineral NP and biofertilizer		2003 season			
20	25 % N +	15 % P_2O_5	from (R.D.)	3.27e	2.76d	6.03e	2.67ab
	50 % N +	25 % P_2O_5	from (R.D.)	3.52de	4.17cd	7.70de	2.99ab
	75 % N +	35 % P_2O_5	from (R.D.)	3.61cde	5.21bc	8.83cd	3.34ab
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.00b-e	3.84cd	7.84de	3.47ab
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.36a-d	4.29cd	8.66cd	3.50a
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.21a-d	4.66cd	8.89cd	2.99ab
	100 % N +	100 % P_2O_5	from R.D (Check)	4.44abc	5.37bc	9.82bc	3.55a
40	25 % N +	15 % P_2O_5	from (R.D.)	3.83b-e	4.66cd	8.50cd	3.18ab
	50 % N +	25 % P_2O_5	from (R.D.)	4.25a-d	4.60cd	8.60cd	3.10ab
	75 % N +	35 % P_2O_5	from (R.D.)	4.03b-e	4.30cd	8.34cde	2.98ab
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	3.76b-e	5.08bc	8.85cd	2.89ab
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.01b-e	6.53ab	10.55ab	2.27b
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.59ab	6.55ab	11.90a	2.47ab
	100 % N +	100 % P_2O_5	from R.D (Check)	4.89a	6.92a	11.92a	2.89ab

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 8: Effect of the interaction between farmyard manure and the combination between mineral (NP) and biofertilizer on photosynthetic pigments (mg/gm/ dry weight) of tomato leaves in summer season

Treatments				Chlorophyll a	Chlorophyll b	Chlorophyll Total (a+b)	Total carotenoids
FYM (m^3/*fed*)	x	Mineral NP and biofertilizer				2004 season	
20	25 % N +	15 % P_2O_5	from (R.D.)	3.29c	4.45de	7.75ef	2.93a
	50 % N +	25 % P_2O_5	from (R.D.)	3.73bc	3.88f	7.63f	2.76a
	75 % N +	35 % P_2O_5	from (R.D.)	3.76bc	4.01ef	7.79def	2.90a
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	3.80abc	4.72cd	8.52cd	3.30a
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.00abc	4.69d	8.69cd	2.84a
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.27ab	4.81cd	9.09c	2.68a
	100 % N +	100 % P_2O_5	from R.D (Check)	3.97abc	4.78cd	8.76cd	3.31a
40	25 % N +	15 % P_2O_5	from (R.D.)	3.92abc	5.09cd	9.01c	2.68a
	50 % N +	25 % P_2O_5	from (R.D.)	3.93abc	5.20cd	9.14c	3.12a
	75 % N +	35 % P_2O_5	from (R.D.)	3.80abc	5.23bc	9.04c	2.61a
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.02abc	5.35bc	9.39bc	3.37a
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.46ab	5.50bc	9.97b	2.93a
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	4.22ab	5.70ab	9.92b	2.69a
	100 % N +	100 % P_2O_5	from R.D (Check)	4.52a	6.29a	10.82a	3.13a

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

i.e., number of fruit/ plant, yield / plant and total yield/*fed*, in the growing summer seasons and without significant effect on average fruit weight. These results held true in the two growing seasons. The relative increase in yield due to application of 40 m^3 FYM/*fed* were about 14.3 and 13.4 % over 20 m^3 FYM/fed in the first and second seasons, respectively.

The increments in yield of tomato fruits may be due to the increase in the yield of dry weight, total chlorophyll (Tables 1 and 5) and also, due to the increase in fruit number per plant (Table 9).

The beneficial effect of organic manure on yield may be due not only to that the organic manure improves the soil structure conditions which encouraged the plant to have a good root development by improving the aeration of soil, but also due to that mineral N fertilizer helps the living organisms in organic manure to multiply (Cooke, 1972)

These results are in harmony with those reported by Fattahallah (1992b), Abdalla *et al.* (2001), Awad *et al.* (2002) and El-Nagaar (2004) on tomato, who reported that application of FYM up to the highest level gave the highest values of number of fruits/ plant, yield/ plant as well as per feddan.

Effect of the combination between mineral NP and biofertilizers

Data in Table 10 indicate that application of 75 % mineral N plus 35% mineral P_2O_5 + inoculation of tomato transplants with nitrobein and phosphorein at different rates as well as fertilization of tomato plants with 100 % of the recommended NP without Nr+Pr were the best treatments which recorded the highest values of number of fruits/ plant, yield/ plant and yield / feddan.

On the contrary, the combination treatments have no significant effect on fruit weight. These results held good in the two growing seasons.

The increments of total yield per feddan reached 24.2 and 28.2 % for 75 % mineral N+35% mineral P_2O_5 plus Nr+Pr and 27.6 and 32.5 % for 100 % mineral NP alone over application of 25 % mineral N+15% mineral P_2O_5 alone in the first and second seasons, respectively.

These results are in accordance true with those reported by Kumaraswany and Madalageri (1990), Ali and Selim (1996), Barakat and Gabr (1998), Mahmoud and Amara (2000), Abd

Table 9: Effect of FYM on yield and its components of tomato plants in summer seasons

FYM (m^3/*fed*)	No. of fruits/ plant	Average fruit weight (gm)	Yield/ plant (gm)	Total yield (ton/feddan)	Relative yield (%)
			2003 season		
20	18.43b	56.16a	1036.0b	7.975b	100.0
40	20.29a	55.51a	1176.0a	9.120a	114.3
			2004 season		
20	23.36a	62.50a	1448.0b	10.080b	100.0
40	23.46a	68.76a	1521.0a	11.440a	113.4

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 10: Effect of the combination between mineral (NP) and biofertilizer on yield and its components of tomato plants in summer seasons

Mineral NP and biofertilizer			No. of fruits/ plant	Average fruit weight (gm)	Yield/ plant (gm)	Total yield (ton/*fed*)	Relative yield (%)
					2003 season		
25 % N +	15 % P_2O_5	from (R.D.)	16.00d	56.75a	913.0d	7.532c	100.0
50 % N +	25 % P_2O_5	from (R.D.)	19.13bc	56.74a	1085.0bc	8.242b	109.4
75 % N +	35 % P_2O_5	from (R.D.)	20.25b	54.56a	1099.0bc	8.434b	111.9
25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	17.50cd	54.75a	940.0cd	8.358b	110.9
50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	20.25b	54.05a	1092.0bc	8.274b	109.8
75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	22.63a	56.80a	1280.0a	9.378a	124.5
100 % N +	100 % P_2O_5	from R.D (Check)	23.25a	57.20a	1331.0a	9.614a	127.6
					2004 season		
25 % N +	15 % P_2O_5	from (R.D.)	20.13c	66.06a	1331.0d	9.372e	100.0
50 % N +	25 % P_2O_5	from (R.D.)	21.25bc	66.32a	1411.0cd	9.722de	103.7
75 % N +	35 % P_2O_5	from (R.D.)	22.00bc	67.21a	1471.0cd	10.160cd	108.4
25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	21.50bc	65.57a	1406 .0cd	10.530bc	112.3
50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	24.75b	65.68a	1554.0bc	11.110b	118.5
75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	27.25a	63.53a	1726.0ab	12.020a	128.2
100 % N +	100 % P_2O_5	from R.D (Check)	28.00a	65.03a	1747.0a	12.420a	132.5

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

El-Rahman *et al.* (2001) and El-Nagaar (2004) on tomato plants. They indicated that the combination between mineral and biofertilizers significantly increased yield and its components of tomato plants.

Effect of the interaction between FYM and the combination with mineral NP and biofertilizers.

Data in Tables 11 and 12 show that the interaction between FYM rates and different minerals and nitrobein (Nr) and phosphorein (Pr) combination treatments had significant effect on number of fruit / plant, yield/ plant and total yield / feddan, while it did not reflect any significant effect on average fruit weight in both seasons of study.

It is interest to note that application of 40 m^3 FYM/feddan combined with fertilization of tomato plants with 75 % mineral N+35% mineral P_2O_5 plus Nr+Pr or combined with adding 100 % of the recommended mineral fertilizer alone were the best two interaction treatments which gave the highest number of fruits/ plant, yield / plant as well as total yield / feddan.

The increments in total yield were about 41.8 and 50.5% for 40 m^3FYM/feddan combined with 75 % mineral N+35% mineral P_2O_5 plus Nr+Pr and 46.1 and 51.5 % for 100 % recommended alone over 20 m^3 FYM/*fed* combined with 25% N+15% P_2O_5 in the first and second seasons, respectively.

It could be concluded from this study that application of 40 m^3FYM/*fed* combined with 75 % mineral N+35% mineral P_2O_5 plus inoculation of tomato transplants with Nr+Pr or combined with 100 % mineral NP gave the highest values of plant dry weight, leaf chlorophyll content, number of fruits / plant, yield / plant and total yield / feddan and were considered the most favourable interaction between treatments in this respect.

The positive effect of biofertilizer application on tomato fruit yield may be directly correlated with improving plant growth, as dry matter production, and at that time minimizing of NP rates specially in sandy soil. Such response to biofertilizer application was reported by (Abdel-Mouty *et al.* (2001), who stated that biofertilizer application improved growth and dry matter of tomato plants. In addition, El-Kalla, *et al.* (1997), Abdalla *et al.* (2001) and Abdalla (2002) found that biofertilizer application increased total yield production of the studied crops. In the same

Table 11: Effect of the interaction between farmyard manure and the combination between mineral (NP) and biofertilizer on yield and its components of tomato plants in summer season

Treatments				No. of fruits/ plant	Average fruit weight (gm)	Yield/ plant (gm)	Total yield/ (ton/*fed*)	Relative yield (%)
FYM (m^3/*fed*)	x	Mineral NP and biofertilizer		2003 season				
20	25 % N +	15 % P_2O_5	from (R.D.)	14.50e	53.00a	768.1g	7.106d	100
	50 % N +	25 % P_2O_5	from (R.D.)	18.75c	59.38a	1117.0bcd	7.610cd	107.0
	75 % N +	35 % P_2O_5	from (R.D.)	18.50c	57.50a	1064.0cde	7.158d	100.7
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	15.50de	53.85a	823.9fg	7.700cd	108.3
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	19.25bc	55.13a	1059.0cde	7.974c	112.2
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	20.50b	57.88a	1180.0bc	8.679b	122.1
	100 % N +	100 % P_2O_5	from R.D (Check)	22.00ab	56.42a	1242.0b	8.841b	124.4
40	25 % N +	15 % P_2O_5	from (R.D.)	17.50cd	60.50a	1059.3cde	7.959c	112.0
	50 % N +	25 % P_2O_5	from (R.D.)	19.50bc	54.10a	1054.6cde	8.873b	124.8
	75 % N +	35 % P_2O_5	from (R.D.)	22.00b	51.63a	1135.0bcd	8.950b	125.9
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	19.50bc	55.65a	1057.8cde	9.017b	126.8
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	21.25b	52.97a	1125.0bcd	8.574bc	120.6
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	24.75a	55.72a	1379.0ab	10.077ab	141.8
	100 % N +	100 % P_2O_5	from R.D (Check)	24.50a	57.97a	1420.0a	10.387a	146.1

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test.

Table 12: Effect of the interaction between farmyard manure and the combination between mineral (NP) and biofertilizer on yield and its components of tomato plants in summer season

Treatments				No. of fruits/ plant	Average fruit weight (gm)	Yield/ plant (gm)	Total yield/ (ton/*fed*)	Relative yield (%)
FYM (m^3/*fed*)	x	Mineral NP and biofertilizer		2004 season				
20	25 % N +	15 % P_2O_5	from (R.D.)	19.00d	64.72a	1229.0e	8.470e	100.0
	50 % N +	25 % P_2O_5	from (R.D.)	20.00d	64.13a	1280.0de	9.030de	106.6
	75 % N +	35 % P_2O_5	from (R.D.)	21.50cd	64.72a	1374.0cd	9.555d	112.8
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	21.50cd	61.30a	1312.0d	9.590d	113.2
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	24.00bc	62.17a	1484.0cd	10.570bc	124.7
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	28.50a	60.85a	1732.0ab	11.280b	133.1
	100 % N +	100 % P_2O_5	from R.D (Check)	29.00a	59.60a	1732.0ab	12.040ab	142.1
40	25 % N +	15 % P_2O_5	from (R.D.)	21.25cd	67.40a	1432.0cd	10.275c	121.3
	50 % N +	25 % P_2O_5	from (R.D.)	22.50c	68.53a	1542.0bcd	10.415bc	122.9
	75 % N +	35 % P_2O_5	from (R.D.)	22.50c	69.70a	1568.0bcd	10.765bc	127.0
	25 % N +	15 % P_2O_5	from (R.D.)+ Bio Nr+Pr	21.50cd	69.85a	1501.0cd	11.470ab	135.4
	50 % N +	25 % P_2O_5	from (R.D.)+ Bio Nr+Pr	23.50bc	69.18a	1625.0bc	11.640ab	137.4
	75 % N +	35 % P_2O_5	from (R.D.)+ Bio Nr+Pr	26.00ab	66.20a	1721.0ab	12.750a	150.5
	100 % N +	100 % P_2O_5	from R.D (Check)	27.00ab	70.45a	1902.0a	12.800a	151.1

(RD): Recommended dose, Nr : Nitrobein , Pr ; Phosphorein

Values having the same alphabetical letter (s) did not significantly differ at 0.05 level of significance according to Duncan's multiple range test..

direction, Srivastava *et al.* (1998) added that availability of P influence the productivity of vegetable crops by affecting processing of energy storage and transfer, such role might be favourable for N which plays an important role in plants such as synthesis of protein, pigments and enzymes.

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تأثير السماد العضوى و المعدنى و الحيوى النيتروجينى والفوسفاتى على الوزن الجاف والمحصول للطماطم النامية فى الأرض الرملية

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قسم البساتين- كلية الزراعة - جامعة الزقازيق- مصر

أجرى هذا البحث خلال الموسمين الصيفيين لعامى ٢٠٠٣ و ٢٠٠٤ تحت ظروف الأراضي الرملية فى مزرعة التجارب الزراعية بمنطقة الخطارة التابعة لكلية الزراعة - جامعة الزقازيق، بهدف دراسة تأثير معدلات التسميد العضوى (٢٠ أو ٤٠ م^3/فدان) و سبعة توليفات مختلفة بين الأسمدة الآزوتية المعدنية (٣٠، ٦٠، ٩٠، ١٢٠ كجم أزوت صافى للفدان) والفوسفاتية (١٢، ٢٠، ٢٨، ٨٠ كجم فوسفور صافى للفدان) و الأسمدة الحيوية الآزوتية والفوسفاتية (مخلوط النيتروبين والفوسفورين بمعدل ٢٠٠ جم/فدان) على الوزن الجاف لأجزاء النبات ومحتوى الأوراق من الصبغات النباتية ، والمحصول للطماطم المنزرعة صنف كاسل روك.

وقد أوضحت النتائج المتحصل عليها أن إضافة السماد العضوي للطماطم بمعدل ٤٠ م^3 /فدان إلى زيادة نمو نباتات الطماطم معبرا عنه كوزن جاف لمختلف أجزاء النبات وكذا صبغات الكلوروفيل أ، ب فى أنسجة أوراق النبات، وكذلك المحصول ومكوناته عند مقارنته بمعدل ٢٠ م^3 /فدان من السماد العضوى.

ومن ناحية أخرى، فقد أدى تسميد نباتات الطماطم باضافة٧٥ % من السماد المعدنى النيتروجينى (ن) +٣٥ % من السماد المعدنى الفوسفاتى (فو$_2$ اه) + تلقيح

الشتلات بالنيتروبين والفوسفورين، وكذلك التسميد المعدنى ١٠٠ % (من الكميات التى ينصح بتسميد الطماطم بها من كل من النيتروجين والفوسفور) بدون تلقيح بالمخصبات إلى الحصول على أفضل نمو معبرا عنه كوزن جاف لمختلف أجزاء النبات ومحتوى أنسجة الأوراق من الكلوروفيل الكلى ، والمحصول ومكوناته باستثناء متوسط وزن الثمرة.

بصفة عامة وجد أن تلقيح شتلات الطماطم بالأسمدة الحيوية مع إضافة ٧٥ % من السماد المعدنى النيتروجينى +٣٥ % من السماد المعدنى الفوسفاتى وكذلك استخدام ١٠٠ % من السماد المعدنى فقط بدون سماد حيوي تحت ظروف التسميد العضوى باستخدام ٤٠ م^{٣} /فدان هى أفضل معاملات التفاعل للحصول على أعلى القيم للوزن الجاف للنبات والكلوروفيل الكلى بالأوراق، والمحصول ومكوناته لنباتات الطماطم صنف كاسل روك النامية تحت ظروف الأراضي الرملية مقارنة بمعاملات التفاعل الأخرى.