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EFFECT OF FARMYARD MANURE AND MINERAL NITROGEN SOURCES AND RATES ON DRY WEIGHT, PHOTOSYNTHETIC PIGMENTS AND YIELD OF TOMATO GROWN IN SANDY SOIL

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ABSTRACT: The present study was carried out at El-Khattara Experimental Farm, Fac. Agric., Zagazig University during the two summer seasons of 2004 and 2005, to study the effect of fertilization of tomato plants grown in sandy soil with farmyard manure (FYM); 0.0 and 40 m^3/*fed* and two mineral nitrogen forms; NH_4-N and urea-N which were applied on three basic rates (60, 90 and 120 kg N/*fed.*) either solely or in combination; urea-N +NH_4-N(30+30, 45+45, 60+60) besides zero level of the both (check).

Application of FYM at 40 m^3/*fed* significantly enhanced dry weight of different tomato plant organs, photosynthetic pigments, N content in both roots and leaves and P and K content in stem as well as yield and its components expressed as average fruit weight, yield/plant and total yield/ *fed.*, N at the highest level (120 kg), in general, was the most superior level for enhancing all the studied characters, specially, when applied in the form of 60 kg urea-N+60 kg NH_4-N.

Application of 40 m^3 FYM/*fed* combined with urea-N at the rate of 120 kg/*fed* or with 60 kg urea-N+60 kg NH_4-N/*fed* were the superior and optimum interaction treatments.

Key words: Tomato, organic fertilization, mineral nitrogen fertilization, dry weight, yield and photosynthetic pigments.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is considered as one of the main and most important vegetable crops in Egypt for fresh consumption and processing. Some problems could be a rise due to application of nitrogenous chemical fertilizers; e.g., some nitrogen could be lost via nitrate reduction, denitrification and/or ammonia volatilization. In addition, some amounts of nitrogen can be evaporate from soil surface and leached through under ground water, causing environmental pollution.

Organic fertilization is very important method for providing the plants with their nutritional requirements without having an undesirable impact on the environment. It is necessary to add organic fertilizers alongside nitrogenous chemical fertilizers to improve the physical and chemical properties of the soil particularly sandy soil. Many investigators studied the response of tomato plant to application of mineral nitrogen and farmyard manure each alone or in combination. Growth characters were improved by application of mineral nitrogen as reported by Abd El-Aziz (1997), Barakat and Gabr (1998), El-Shobaky (2002), Abd El-Rahman (2003), El-Robae (2003) and El-Naggar (2004) all are working on tomato, and FYM as reported by Arisha and Bardisi (1999) and Awad *et al.* (2002) on potato and El-Mansi *et al.* (2004) and Mohsen (2006) on tomato. El-Beheidi *et al.* (2006) found that application of 40 m^3 FYM/*fed* significantly increased dry weight of roots, branches, leaves and total/tomato plant. For improving photosynthetic pigments and yield and its components, it has been reported that application of 40 m^3 FYM/*fed* was the superior in this connection (Fattahallah, 1992a and b; Shuoyb, 2004; El-Beheidi *et al.*, 2006). Similarly, it has been reported by many investigators that mineral nitrogen fertilization enhanced photosynthetic pigments and yield and its components of tomato (El-Beheidi *et al.*, 1991; El-Gizawy *et al.*, 1993; Abd El-Aziz, 1997; Barakat and Gabr, 1998; El-Shobaky, 2002; Abd El-Rahman, 2003; El-Robae, 2003; El-Naggar, 2004).

The combination among FYM and mineral nitrogen fertilizers had been found to enhance dry weight and yield of tomato (Shuoyb, 2004; El-Beheidi *et al.*, 2006).

Therefore, this study aimed to elucidate the effects of mineral

nitrogen fertilization and FYM as well as their interaction on the growth, photosynthetic pigments, yield and fruit quality of tomato, and also to determine the optimum combination between FYM and mineral nitrogen fertilizer for improving the growth and yield and its components of tomato.

MATERIALS AND METHODS

This experiment was carried out during the two summer seasons of 2004 and 2005 at El-Khattara Experimental Farm, Fac. Agric., Zagazig Univ., to study the effect of organic manure and mineral nitrogen on growth, mineral contents and yield and its components of tomato plants under newly reclaimed sandy soil conditions.

The analyses of both experimental farm and organic manure are presented in Table 1 (a and b).

Table l(a). Some physical and chemical properties of the experimental farm before sowing

Characters	2004 season	2005 season
Physical properties		
Sand (%)	94.76	93.66
Silt (%)	2.86	3.97
Clay (%)	2.38	2.37
OM (%)	0.132	0.129
Texture	Sandy	Sandy
Chemical properties		
pH	7.96	8.09
Ec (mmohs /cm)	2.25	2.30
Total N (%)	0.12	0.13
Available N (ppm)	14.23	13.85
Available P (ppm)	13.44	19.46
Available K (ppm)	75.10	70.92

Soil samples were taken from 25cm soil depth

Table 1(b). Total N % in farmyard manure (FYM)

Organic source (FYM)	2004 season	2005 season
Total N (%)	0.75	0.70
Total N (Kg/m^3)*	2.50	2.40

*One m^3 from FYM equal to 336 kg

This experiment included 20 treatments, which were the combinations between two FYM levels and 10 sources and rates of mineral nitrogen as follows:

Farmyard Manure

Check (untreated), and 40 m^3/feddan.

Nitrogenous Sources Used

were (AS) ammonium sulphate (20.5 % N) and (U) urea (46 % N) applied on three basic rates (60, 90 and 120 kg N/*fed*) either solely or in combination. The sources and amounts of used fertilizers are shown in Schedule 1

These treatments were arranged in a split - plot design with four replicates. FYM treatments were randomly arranged in the main plots, whereas sources and rates of mineral nitrogen were randomly distributed in the sub- plots.

Nitrogen fertilizers were divided into five equal portions and weekly applied to plants as soil application beginning 20 days

Schedule 1. The sources, the basic rates and the amounts of used fertilizers

The source	Basic rate (kg N/*fed*)	The amounts of used fertilizers (kg/*fed*)		
		(U)	+	(AS)
	0.0 (Check)	0.0		0.0
Urea (U)	60	130.4		
	90	195.6		
	120	260.8		
Ammonium sulphate (AS)	60			300
	90			450
	120			600
U+AS	30+30	65.2		150
	45+45	97.8		225
	60+60	130.4		300

from transplanting, whereas phosphorus and potassium fertilizers were added at the rates of 400 and 200 kg/*fed* in the form of calcium superphosphate and potassium sulphate, respectively, whereas FYM fertilizer was added at the time of soil preparation.

Plot area was 21 m^2, which contained two dripper lines with 10.5 m long and 1.0 m wide between each two dripper lines. The distance between drippers was 50 cm, plants were transplanted at 50cm apart. Each sub-plot contained 42 plants. One line was used for taking samples to determine the dry weight of different plant parts and other chemical analysis and the other line was used for yield determination.

One row was left between each two experimental plots as a guard row to avoid the overlapping of fertilizer treatments.

Tomato seeds cv. Castle Rock were sown on January 1st and were transplanted on March 1st, in both seasons.

The other common agricultural practices of growing tomato plants under sandy soil conditions in the district; i.e., drip irrigation, micro- elements spraying, pests control and weed control were carried out.

Data Recorded

Dry weight

A random sample of five plants from every experimental unit was taken at 90 days after transplanting and different plant parts; i.e., roots, stems and leaves were dried at 70 °C till constant weight, then weighed and recorded.

Photosynthetic pigments

Fresh leaf samples were taken from the upper and outer fourth leaf of the plant at 90 days after transplanting and chlorophyll a, b and carotenoids were determined according to the method described by Wettestein (1957).

Minerals content

The dry weight of different plant parts, in 2005 season only, were finely ground and wet digested with sulfuric acid and perchloric acid (3:1*V/V*). Contents of nitrogen, phosphorus and potassium were determined according to the methods described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively.

Yield and its components

Fruits of each plot were harvested at the red ripe stage, then counted, weighed and the following data were calculated: average fruit weight (gm), average number of fruits / plant, yield / plant (gm), early yield (yield of the first two pickings as ton/*fed*), mid-season yield (yield of the third and fourth pickings as ton/*fed*), late yield (yield of the last two pickings as ton/*fed*), total yield (the total yield of all pickings as ton/*fed*) and relative yield (%).

Statistical Analysis

The obtained data were subjected to the analysis of variance according to Snedecor and Cochran (1980). Mean separation was done using LSD at 0.05 level of probability.

RESULTS AND DISCUSSION

Dry Weight

Effect of farmyard manure

The obtained data in Table 2 show that the application of FYM at 40 m^3/*fed* exerted a marked significant effect on dry weight of different organs of tomato plant in both seasons of study except, the dry weight of stem in the first season only. The relative increases in total dry weight due to application of 40 m^3/*fed* were about 11.19 and 11.65 % over control (without application of FYM) in the first and second seasons, respectively.

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

These results are in harmony with those reported by Arisha and Bardisi (1999) and Awad *et al.* (2002) on potato and El-Beheidi *et al.* (2006) on tomato. They found that application of FYM at the rate of 40 m^3/*fed* exerted a marked effect on dry weight of roots, branches, leaves and total of tomato plant.

Effect of nitrogen sources and rates

Data in Table 2 reveal that the dry weights of different organs of tomato plant as well as the whole plant dry weight were significantly affected by application of mineral nitrogen sources and rates

Table 2 . Effect of farmyard manure rates and nitrogen sources and rates on dry weight of tomato plants at 90 days after transplanting in the two seasons

Treatments	2004 season					2005 season				
	Dry weight (gm/plant)					Dry weight (gm/plant)				
	Roots	Stem	Leaves	Total	Relative D.W. (%)	Roots	Stem	Leaves	Total	Relative D.W.(%)
Effect of FYM (m3/fed)										
0	8.60	11.19	36.11	55.90	100.00	9.02	11.01	35.93	55.95	100.00
40	10.77	12.70	38.70	62.17	111.19	10.93	13.13	38.41	62.47	111.65
LSD at 0.05 level	1.72	NS	1.15	2.23	--	0.31	1.82	0.53	1.57	---
Effect of nitrogen sources and rates (kg/*fed*)										
0.0 (control)	8.17	8.70	31.95	48.82	100.00	8.57	9.08	31.41	49.06	100.00
60 Urea-N	9.57	11.60	35.28	56.44	115.62	10.31	11.66	34.92	56.89	115.36
90 Urea-N	10.64	13.32	39.40	63.36	129.80	9.75	13.46	37.78	60.99	124.31
120 Urea-N	11.24	13.81	42.20	67.25	137.75	11.70	14.60	42.98	69.28	141.20
60 NH4-N	8.92	10.60	33.55	53.07	108.72	9.01	9.76	33.99	52.77	107.54
90 NH_4-N	9.51	11.81	37.02	58.34	119.52	9.35	11.45	36.04	56.84	115.85
120 NH4-N	9.86	12.63	39.22	61.71	126.42	10.59	13.20	40.01	63.80	130.03
30 Urea-N +30 NH4-N	8.85	11.74	34.52	55.11	112.90	9.19	11.61	34.76	55.56	113.24
45 Urea-N +45 NH4-N	9.73	11.95	39.16	60.84	124.64	10.55	12.48	37.46	60.49	123.29
60 Urea-N +60 NH4-N	10.33	13.29	41.76	65.38	133.94	10.73	13.70	42.34	66.77	136.09
LSD at 0.05 level	1.28	1.43	2.60	3.30	--	1.48	1.97	3.20	4.42	--

It is obvious from such data that urea -N at 120 kg N/*fed* followed by 60 kg urea-N+60 kg NH_4-N were the superior treatments regarding the dry weight of different plant organs and whole plant without significant differences between them. It is also clear that these observations could confirm the favourable effect due to application of such superior treatments. In addition, application of NH_4-N at the rate of 120 kg/*fed* enhanced the dry weight of different plant organs and whole plant in the second season.

The relative increases in the total dry weight/plant due to application of 120 kg of urea -N/*fed* and 60 kg urea N+60 kg NH_4-N/*fed* were 37.75, 33.94 and 41.20, 36.09 % over control in the first and second seasons, respectively. These findings showed the necessity of nitrogen for tomato growth as it has been demonstrated by many investigators, of them El-Beheidi *et al.* (1991), Barakat and Gabr (1998) and El-Robae (2003) found that dry weights of different parts of tomato plant were increased with increasing nitrogen fertilizer level.

Effect of interaction

The results of the interaction between farmyard manure and both sources and rates of mineral nitrogen on dry weight of different tomato plant organs and total as well as the relative increase of the total dry weight/plant are illustrated in Table 3.

Such data reveal that application of different nitrogen sources and levels alone were, in general, less effective on dry weight of different tomato plant organs and whole plant than the combination of these treatments with FYM at $40m^3$/ feddan. In addition, the interaction between FYM at 40 m^3/*fed* and 120 kg urea-N/*fed* was the most effective treatment in this regard and that was followed by the combination between FYM at 40 m^3/*fed* and 60 kg urea-N+60kg NH_4/*fed* compared with all other interaction treatments without significant differences between those two superior interaction treatments.

The relative increases in the total dry weigh/plant were 54.98 and 46.36 %, in the first season and 58.04 and 51.06 %, in the second season, due to the application of 40 m^3/FYM+120 kg urea-N/*fed* and 40 m^3/ FYM+60 kg urea-N+60 kg NH_4-N /*fed*, respectively. Similar findings were obtained by Midan (1995) on pepper, Shuoyb (2004) and El-Beheidi *et al.* (2006) on tomato.

Photosynthetic Pigments

Effect of farmyard manure

Data in Table 4 clear that application of 40 m^3 FYM/*fed* enhanced significantly the photosynthetic pigments; i.e., chlorophyll (a) and total chlorophyll (a+b) in leaf tissues of tomato plants in the two seasons. However, the enhancing effect on chlorophyll (b) did not reach the level of significance. Moreover, application of FYM had insignificant effect on total carotenoids. These results agree with those reported by Arisha and Bardisi (1999), on potato and Shuoyb (2004) and El-Beheidi *et al.* (2006) on tomato. They found that increasing FYM rate significantly increased chlorophyll a, b, and total chlorophyll (a+b) in leaf tissues of tomato plants.

Effect of nitrogen sources and rates

As for the effect of both nitrogen sources and rates on photosynthetic pigments, it is seen from the data in Table 4 that the combination between the two sources of nitrogen at different levels reflected, in general, favourable effect on chlorophyll a, b and total chlorophyll (a+b) content in tomato leaf tissues more than the application of the two sources at different levels solely. It is also clear that NH_4-N, in general, gave more intensive leaves compared with the corresponding level of urea-N regarding chlorophyll (a) and total chlorophyll in both seasons.

The conclusion that can be drown here is 45 kg urea-N+45 kg NH_4-N or 60 kg urea-N+60 kg NH_4-N/*fed* recorded maximum values of chlorophyll (a) total chlorophyll (a+b) in both seasons, as well as total carotenoids in first season only without significant differences between them. On the other hand, efficiency of urea-N source on the synthesis of chlorophylls and carotenoids Table 4 showed that this source of nitrogen seem to be the least effective one in this concern. This may be due to that urea-N was easly leached down from the root zoon.

Obtained results were similar to those reported by El-Beheidi *et al.* (1991), El- Gizawy *et al l.* (1993), Abd El-Aziz (1997), Barakat and Gabr (1998) El-Shobaky (2002), Abd El-Rahman (2003) and El- Robae (2003). Moreover, El-Naggar (2004), on tomato concluded, under sandy soil conditions, that chlorophyll a, b, total (a+b) and carotenoids were significantly affected by sources of nitrogen.

Table 3 . Effect of interaction between farmyard manure rates and nitrogen sources and rates on dry weight of tomato plants at 90 days after transplanting in the two seasons

Treatments			2004 season					2005 season				
			Dry weight (gm/plant)					Dry weight (gm/plant)				
FYM	X	Nitrogen sources and rates	Roots	Stem	Leaves	Total	Relative D.W.(%)	Roots	Stem	Leaves	Total	Relative D.W.(%)
m^3/*fed*		(kg/*fed*)										
0		0.0 (control)	7.42	7.75	30.87	46.04	100.00	7.33	8.08	30.71	46.12	100.00
		60 Urea-N	8.83	10.67	34.17	53.67	116.54	9.47	10.49	33.11	53.07	115.06
		90 Urea-N	9.82	12.22	37.91	59.95	130.18	9.25	11.87	36.43	57.55	124.78
		120 Urea-N	10.23	12.44	40.45	63.12	137.06	10.60	13.23	41.83	65.66	142.36
		60 NH4-N	7.85	9.99	32.40	50.24	109.09	8.09	9.09	32.46	49.64	107.63
		90 NH4-N	7.80	11.35	35.58	54.73	118.84	8.27	10.74	34.60	53.61	116.24
		120 NH4-N	9.07	12.08	38.61	59.76	129.77	9.91	11.98	39.78	61.67	133.71
		30 Urea-N +30 NH4-N	7.70	11.26	33.26	52.22	113.39	8.08	11.22	33.02	52.32	113.44
		45 Urea-N +45 NH4-N	8.10	11.44	36.38	55.92	121.43	9.25	10.36	36.44	56.05	121.53
		60 Urea-N +60 NH4-N	9.17	12.70	41.50	63.37	137.61	9.96	13.10	40.90	63.96	138.68
40		0.0 (control)	8.92	9.64	33.03	51.59	112.03	9.81	10.08	32.11	52.00	112.74
		60 Urea-N	10.30	12.52	36.38	59.20	128.55	11.16	12.23	36.74	60.13	130.37
		90 Urea-N	11.47	14.42	40.88	66.77	144.99	10.26	15.05	39.13	64.44	139.72
		120 Urea-N	12.25	15.17	43.95	71.37	154.98	12.79	15.97	44.13	72.89	158.04
		60 NH4-N	9.99	11.22	34.71	55.92	121.43	9.92	10.43	35.52	55.87	121.14
		90 NH4-N	11.23	12.26	38.47	61.96	134.54	10.43	12.16	37.48	60.07	130.24
		120 NH4-N	10.65	13.18	39.84	63.67	138.26	11.27	14.42	40.24	65.93	142.95
		30 Urea-N +30 NH4-N	10.00	12.20	35.78	57.98	125.90	1.30	12.01	36.50	49.81	108.00
		45 Urea-N +45 NH4-N	11.36	12.46	41.95	65.77	142.82	11.86	14.60	38.47	64.93	140.78
		60 Urea-N +60 NH4-N	11.49	13.88	42.03	67.40	146.36	11.50	14.39	43.78	69.67	151.06
LSD at 5 % level			1.81	2.03	3.68	4.67	---	2.09	2.79	4.53	6.25	---

Table 4 . Effect of farmyard manure rates and nitrogen sources and rates on photosynthetic pigments (mg/gm dry weight) of tomato leaves at 90 days after transplanting in the two seasons

Treatments	2004 season				2005 season			
	Chlorophyll			Total carotenoides	Chlorophyll			Total carotenoides
	a	b	Total (a+b)		a	b	Total (a+b)	
Effect of FYM (m^3/*fed*)								
0	3.57	2.67	6.25	2.68	3.75	2.91	6.67	2.52
40	3.92	2.70	6.62	2.69	4.28	3.20	7.48	2.67
LSD at 0.05 level	0.17	NS	0.20	NS	0.12	0.29	0.20	NS
Effect of nitrogen sources and rates (kg/*fed*)								
0.0 (control)	3.05	2.88	5.33	2.26	3.44	2.30	5.74	2.04
60 Urea-N	3.44	2.80	5.74	2.69	3.55	2.46	6.01	2.56
90 Urea-N	3.48	2.46	5.94	2.67	3.62	2.69	6.31	2.75
120 Urea-N	3.46	2.40	5.86	2.76	3.79	2.71	6.50	2.84
60 NH4-N	3.64	2.47	6.11	2.21	3.85	2.96	6.81	2.74
90 NH4-N	3.64	2.77	6.41	2.43	4.09	3.03	7.12	2.11
120 NH4-N	4.00	2.79	6.79	2.78	4.23	3.28	7.51	2.82
30 Urea-N +30 NH4-N	4.07	3.18	7.25	2.48	4.40	3.60	8.00	2.99
45 Urea-N +45 NH4-N	4.13	3.12	7.25	3.21	4.58	3.72	8.30	2.45
60 Urea-N +60 NH4-N	4.53	3.08	7.61	3.37	4.67	3.81	8.48	2.68
LSD at 0.05 level	0.44	0.64	0.82	0.67	0.20	0.25	0.20	NS

Effect of interaction

Table 5 demonstrates the efficiency of the combination between FYM and both sources and rates of nitrogen on photosynthetic pigments of tomato leaves. Such combination treatments reflected insignificant effect in both seasons. On the other hand, increasing chlorophyll (a), total chlorophyll as well as total carotenoids in leaf tissues was found due to application of FYM at 40 kg N/*fed* in combination with 60 kg urea-N+60 kg NH_4-N/feddan. However, insignificant.

Similar findings were obtained by Shuoyb (2004) and El-Beheidi *et al.* (2006) on tomato, who indicated that addition of 100 % mineral NP alone or combined with 40 m^3 FYM /*fed* gave the maximum values of chlorophyll a and b and total chlorophyll (a+b) in tomato leaves.

NPK Contents

Effect of farmyard manure

As for the minerals content in different organs of tomato plant as affected by application of FYM, data in Table 6 obviously show that FYM at 40 m^3/*fed* significantly increased total N content (%) in both roots and leaves and the percentages of P and K in stem, whereas FYM had insignificant effect on the percentages of N in stem and P as well as K in both roots and leaves.

These results could be explained due to application of FYM that contains microorganisms have ability to supply plants with fixed N, P and release phyotohormones, which could increases the growth and dry weight, and this in turn increase NPK content in tissues of tomato plants. In addition, organic manure may play a favourable role in increasing nutrients availability through the processes of chelating, biochemical processes and production of several organic acids during decomposition of organic manure as reported by Hammad *et al.* (1990) and El-Mansi *et al.* (2004).

These results are in harmony with those reported by Fattahallah (1992a) and El-Beheidi *et al.* (2006) on tomato and Arisha and Bardisi (1999) on potato. They found that increasing FYM increased N, P and K contents in different plant organs.

Effect of nitrogen sources and rates

Data presented in Table 6 show the effect of both nitrogen sources and rates on NPK contents (%) in different organs of tomato plant.

Table 5 . Effect of interaction between farmyard manure rates and nitrogen sources and rates on photosynthetic pigments (mg/gm dry weight) of tomato leaves at 90 days after transplanting in the two seasons in the two seasons

Treatments		2004 season				2005 season			
		Chlorophyll				Chlorophyll			
FYM (m^3/*fed*)	X Nitrogen sources and rates (Kg/*fed*)	a	b	Total (a+b)	Total carotenoides	a	b	Total (a+b)	Total carotenoides
0	0.0 (control)	2.86	2.24	5.10	2.28	3.21	2.25	5.46	2.08
	60 Urea-N	3.35	2.00	5.35	2.66	3.33	2.38	5.71	2.66
	90 Urea-N	3.29	2.10	5.39	2.36	3.39	2.55	5.94	2.75
	120 Urea-N	3.43	2.37	5.80	3.12	3.59	2.51	6.10	2.67
	60 NH4-N	3.33	2.53	5.86	2.21	3.68	2.59	6.27	3.22
	90 NH4-N	3.54	3.07	6.61	2.61	3.85	2.83	6.68	2.00
	120 NH4-N	3.95	2.62	6.57	3.18	3.99	3.06	7.05	2.60
	30 Urea-N +30 NH4-N	3.94	3.31	7.25	2.19	4.05	3.47	7.52	2.73
	45 Urea-N +45 NH4-N	3.80	3.40	7.20	3.10	4.19	3.76	7.95	2.39
	60 Urea-N +60 NH4-N	4.25	3.05	7.30	3.06	4.27	3.70	7.97	2.16
40	0.0 (control)	3.25	2.33	5.58	2.25	3.66	2.35	6.01	2.00
	60 Urea-N	3.52	2.55	6.07	2.71	3.76	2.53	6.29	2.47
	90Urea-N	3.67	2.81	6.48	2.99	3.85	2.83	6.68	2.75
	120 Urea-N	3.48	2.43	5.91	2.41	3.99	2.92	6.91	3.02
	60 NH4-N	3.95	2.41	6.36	2.20	4.02	3.33	7.35	2.27
	90 NH4-N	3.75	2.47	6.22	2.25	4.33	3.24	7.57	2.21
	120 NH4-N	4.05	2.97	7.02	2.37	4.47	3.49	7.96	3.04
	30 Urea-N +30 NH4-N	4.20	3.06	7.26	2.76	4.63	3.74	8.37	3.25
	45 Urea-N +45 NH4-N	4.46	2.83	7.29	3.32	4.97	3.68	8.65	2.50
	60 Urea-N +60 NH4-N	4.82	3.11	7.93	3.68	5.08	3.92	9.00	3.20
LSD at 5 % level		NS	NS	NS	NS	NS	NS	NS	NS

Table 6 . Effect of farmyard manure rates and nitrogen sources and rates on the minerals content of tomato plants at 90 days after transplanting in 2005 season

Treatments	Minerals content (%)								
	Roots			Stem			L ves		
	N	P	K	N	P	K	N	P	K
				Effect of FYM (m^3/*fed*					
0	1.59	0.183	0.91	1.98	0.204	2.15	2.80	0.282	2.85
40	1.79	0.196	0.98	2.56	0.235	2.51	3.52	0.335	3.20
LSD at 0.05 level	0.12	NS	NS	NS	0.021	0.12	0.65	NS	NS
(Kg /fed)	Effect of nitrogen sources and rates (kg/*fed*)								
0.0 (control)	1.39	0.135	0.67	1.91	0.145	1.44	2.48	0.249	2.24
60 Urea-N	1.44	0.203	1.00	2.14	0.165	1.85	2.93	0.277	2.78
90 Urea-N	1.75	0.182	0.90	2.22	0.184	2.06	2.97	0.312	2.96
120 Urea-N	2.02	0.207	1.03	2.72	0.221	2.42	4.06	0.334	3.44
60 NH4-N	1.55	0.165	0.82	2.46	0.218	2.50	3.08	0.281	2.77
90 NH4-N	1.64	0.208	1.03	2.13	0.237	2.58	2.79	0.299	3.03
120 NH4-N	1.49	0.193	0.96	2.03	0.258	2.60	3.03	0.336	3.22
30 Urea-N +30 NH4-N	1.62	0.193	0.96	1.92	0.235	2.49	2.69	0.298	2.76
45 Urea-N +45 NH4-N	1.83	0.213	1.06	2.29	0.266	2.58	3.47	0.328	3.44
60 Urea-N +60 NH4-N	2.20	0.196	0.98	2.88	0.268	2.81	4.08	0.372	3.56
LSD at 0.05 level	0.47	NS	NS	0.31	0.048	0.48	0.55	0.058	0.61

Data presented in Table 6 show tsignificant differences among the used sources of nitrogen as well as their rates regarding minerals content except P and K content in roots, which were not affected by nitrogen sources and rates when they were added singly or together.

Results clearly show that application of 60 kg urea-N+60 kg NH_4-N/ *fed* was the superior treatment for giving the uppermost values of N, P and K when compared with other treatments. In addition, application of 45 kg urea-N+45kg NH_4-N/*fed* revealed significant enhancing effect on the contents of P and K in both stem and leaves. Moreover, urea-N at 120 kg/ *fed* was found to has a favourable significant effect on minerals content (%) in both stem and leaves without significant differences between this treatment and the superior one that previously mentioned.

These results are in harmony with those reported by El-Robae (2003) and Mohsen (2006) on tomato plant. They indicated that N, P and K contents in roots, branches and leaves of tomato plants recorded their maximum values with application of 100 % from the recommended NP.

Effect of interaction

Data in Table 7 clearly demonstrate that the interaction treatments between FYM and nitrogen sources and rates had significant effect on N content in both stem and leaves, but they did reflect any significant effect on NPK contents in roots and both P and K in stem and leaves. However, N content was at maximum value due to application of 60 kg urea-N +60 kg NH_4-N/*fed* or application of 120 kg urea-N/*fed*, without significant differences between the two treatments when they were added along with 0.0 or 40 m^3/feddan.

In this respect, Mohsen (2006), under sandy soil conditions, reported that application of 40m^3 FYM/*fed* combined with application of 75 % N from the recommended dose was the most favourable interaction treatment for NPK content in tomato plant parts.

Yield and its Components

Effect of farmyard manure

Data in Table 8 demonstrate the effect of FYM on yield and its components of tomato plant, such data reveal that application of FYM at the rate of 40 m^3/*fed* significantly affected yield and its components, except number of

Table 7 . Effect of interaction between farmyard manure rates and nitrogen sources and rates on the mineral content of tomato plants at 90 days after transplanting in 2005 season

Treatments		Minerals content (%)								
FYM	N sources and rates	Roots			Stem			Leaves		
(m^3 */fed*)	(Kg */fed*)	N	P	K	N	P	K	N	P	
0	0.0 (control)	1.20	0.113	0.56	1.58	0.136	1.31	2.30	0.229	1.85
	60 Urea-N	1.44	0.191	0.95	1.83	0.144	1.77	2.68	0.260	2.56
	90 Urea-N	1.65	0.192	0.95	1.85	0.176	1.98	2.56	0.277	2.67
	120 Urea-N	2.06	0.198	0.98	2.65	0.187	2.07	3.24	0.274	3.14
	60 NH4-N	1.27	0.142	0.70	1.78	0.195	2.39	3.00	0.268	2.77
	90 NH4-N	1.53	0.229	1.14	2.02	0.218	2.32	2.68	0.280	3.17
	120 NH4-N	1.52	0.192	0.95	1.68	0.248	2.39	2.74	0.318	3.21
	30 Urea-N +30 NH4-N	1.54	0.185	0.92	1.82	0.231	2.26	2.28	0.287	2.74
	45 Urea-N +45 NH4-N	1.79	0.204	1.01	2.01	0.254	2.33	3.07	0.300	3.11
	60 Urea-N +60 NH4-N	1.95	0.182	0.91	2.58	0.252	2.71	3.44	0.323	3.24
40	0.0 (control)	1.58	0.157	0.78	2.24	0.154	1.57	2.66	0.268	2.64
	60 Urea-N	1.45	0.214	1.06	2.46	0.187	1.94	3.19	0.295	3.00
	90 Urea-N	1.85	0.173	0.86	2.60	0.193	2.14	3.37	0.346	3.26
	120 Urea-N	1.98	0.217	1.08	2.80	0.255	2.77	4.88	0.393	3.74
	60 NH4-N	1.82	0.188	0.94	3.14	0.241	2.62	3.16	0.295	2.77
	90 NH4-N	1.75	0.187	0.93	2.23	0.256	2.83	2.91	0.317	2.90
	120 NH4-N	1.45	0.195	0.97	2.37	0.269	2.81	3.32	0.354	3.23
	30 Urea-N +30 NH4-N	1.71	0.201	1.00	2.03	0.238	2.71	3.09	0.308	2.78
	45 Urea-N +45 NH4-N	1.87	0.222	1.10	2.58	0.278	2.84	3.88	0.355	3.77
	60 Urea-N +60 NH4-N	2.44	0.210	1.05	3.17	0.284	2.91	4.72	0.422	3.88
LSD at 0.05 level		NS	NS	NS	0.45	NS	NS	0.78	NS	NS

fruits/plant and early yield/*fed* in the two growing seasons. This treatment gave the uppermost values of average fruit weight, yield/plant, medium and late as well as total yield/feddan. The relative increase in total yield due to application of 40 m^3 FYM/*fed* was about 22.22 and 23.05 % over untreated control in the first and second seasons, respectively.

The increment in yield of tomato may be due to the increase in dry weights Table 2, total chlorophyll Table 4 and also due to average fruit weight Table 8.

The favourable effect of FYM on yield and its components may be attributed not only to that the organic manure improves the soil structure conditions which encouraged the plants 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).

In this connection, El-Beheidi *et al.* (2006) concluded that increasing FYM rate from 20 to 40 m^3/*fed* significantly affected yield and its components; i.e., number of fruits/ plant, yield / plant and total yield/*fed* of tomato plants.

Similar findings were obtained on many vegetable crops by many researchers such as Casanova *et al.* (1991), Fattahallah (1992b), Shuoyb (2004) on tomato; Midan (1995) and Omran *et al.* (1995) on pepper; Awad *et al.* (2002) on potato.

Effect of nitrogen sources and rates

Table 9 indicates that increasing nitrogen rates of both urea and ammonium sources up to the highest level; i.e., 120 kg N/*fed* enhanced the yield and its components in both seasons, compared to the lower rates of both sources and untreated control. Also, application of urea-N+NH_4-N at the highest level (60 kg urea-N+60 kg NH_4-N/*fed*) was superior in this concern. All yield and its components; i.e., number of fruits /plant, average fruit weight, yield/plant, early, medium as well as late yield and total yield/*fed* were at maximum values due to application of 120 kg urea/*fed* followed by 60 kg urea -N+60 kg NH_4-N/feddan.

The same data reveal also that relative yield was increased by 184.19, 139.82 and 154.39 % and by 205.58, 147.03 and 170.54 % due to application of 120 kg urea-N, 120 kg NH_4-N and 60 kg urea-N+60 kg NH_4-N/*fed* over the untreated control in the first and second seasons, respectively.

Table 8. Effect of farmyard manure rates on yield and its components of tomato plants in the two seasons

Treatments	No. of fruits/ plant	Average fruit weight (gm)	Yield/ plant (kg)	Early yield (ton/*fed*)	Medium yield (ton/*fed*)	Late yield (ton/*fed*)	Total yield (ton/*fed*)	Relative yield (%)
(m^3/*fed*)				2004 season				
0	12.06	75.59	0.911	1.390	5.254	1.440	8.084	100.00
40	12.70	91.67	1.164	1.400	6.372	2.109	9.881	122.22
LSD at 0.05 level	NS	4.85	0.039	NS	0.271	0.442	0.331	---
				2005 season				
0	12.00	74.06	0.888	1.370	5.194	1.398	7.962	100.00
40	12.36	93.61	1.157	1.393	6.327	2.078	9.798	123.05
LSD at 0.05 level	NS	15.09	0.074	NS	0.708	0.164	0.624	---

Table 9 : Effect of nitrogen sources and rates on the yield and its components of tomato plants in the two seasons

Treatments (kg/*fed*)	No. of fruits/ plant	Average fruit weight (gm)	Yield/ plant (kg)	Early yield (ton/*fed*)	Medium yield (ton/*fed*)	Late yield (ton/*fed*)	Total yield (ton/*fed*)	Relative yield (%)
(Kg/fed)				2004 season				
0.0 (control)	10.33	48.15	0.497	0.621	2.862	0.808	4.291	100.00
60 Urea-N	12.50	83.21	1.040	1.255	6.074	1.569	8.898	207.36
90 Urea-N	12.66	94.60	1.197	1.556	6.521	1.943	10.020	233.51
120 Urea-N	14.00	99.16	1.388	1.823	7.869	2.503	12.195	284.19
60 NH4-N	11.50	70.95	0.815	1.076	4.664	1.428	7.168	167.04
90 NH4-N	12.16	79.05	0.961	1.346	5.467	1.559	8.372	195.10
120 NH4-N	12.83	95.60	1.226	1.600	6.674	2.017	10.291	239.82
30 Urea-N +30 NH4-N	11.83	81.58	0.965	1.348	5.290	1.732	8.370	195.05
45 Urea-N +45 NH4-N	12.66	87.57	1.108	1.551	5.816	1.937	9.304	216.82
60 Urea-N +60 NH4-N	13.33	96.44	1.285	1.775	6.890	2.251	10.916	254.39
LSD at 0.05 level	1.36	8.96	0.061	0.118	0.288	0.361	0.522	----
				2005 season				
0.0 (control)	9.83	44.15	0.433	0.573	2.666	0.771	4.010	100.00
60 Urea-N	12.16	86.66	1.053	1.259	6.091	1.571	8.921	222.46
90 Urea-N	13.00	93.75	1.218	1.577	6.618	1.975	10.170	253.61
120 Urea-N	14.00	102.80	1.439	1.834	7.913	2.507	12.254	305.58
60 NH4-N	10.66	77.15	0.822	1.095	4.741	1.281	7.117	177.48
90 NH4-N	12.00	79.93	0.959	1.398	5.524	1.532	8.454	210.82
120 NH4-N	12.00	94.71	1.136	1.540	6.425	1.941	9.906	247.03
30 Urea-N +30 NH4-N	12.16	79.61	0.968	1.306	5.158	1.668	8.132	202.79
45 Urea-N +45 NH4-N	13.00	79.86	1.038	1.512	5.594	1.874	8.980	223.94
60 Urea-N +60 NH4-N	13.00	99.71	1.296	1.719	6.874	2.256	10.849	270.54
LSD at 0.05 level	1.23	6.74	0.083	0.166	0.473	0.313	0.700	---

Thus, the efficiency of urea N in increasing the total yield and improving the yield components was greater than NH_4-N. Urea-N exceeded NH_4-N by 44.37 and 58.55 % regarding total yield/*fed* when the both N forms were applied at the rate of 120 kg/*fed* in the first and second seasons, respectively. The increments in total yield may be due to the increments of both number of fruits/plant and average fruit weight.

From the above mentioned results, it could be concluded that application of urea-N at the rate of 120 kg/*fed* was the best and optimum fertilization treatment for increasing the total yield of tomato per plant or per feddan compared with all other treatments. These results indicate the beneficial effects of urea -N specially under sandy soil conditions. The general trend of the effects of N fertilizers was similar to that one observed with dry weight (Table 2).

Obtained results matched well with those of El-Beheidi *et al.* (1991), Barakat and Gabr (1998), El-Shobaky (2002), Abd El-Rahman (2003), and El-Robae (2003) all on tomato. They found that nitrogen fertilizers at the highest rates significantly increased fruit weight, both number and weight of fruits/plant and early and total yield of tomato.

Effect of interaction

Data in Table 10 show that the interaction between FYM and different nitrogen fertilizer sources and rates had significant effect on number of fruits/plant, average fruit weight, yield /plant and yield/*fed* represented as early, medium, late and total in both seasons.

It is interest to note that application of FYM at the rate o 40 m^3/*fed* combined with the highest rate of urea-N (120 kg/*fed*) was the best interaction treatment followed by 40 m^3 FYM x 60 kg urea-N+60 kg NH_4-N/*fed.* These two interaction treatments gained the uppermost values of yield and all studied yield components in both seasons compared with all other treatments. Application of urea-N at the highest rate (120 kg) was superior source and rate in this concern even if applied alone without application FYM.

The increments in total yield due to application of 40 m^3 FYM+120 kg urea- N/*fed* were about 271.55 and 336.52 % over the untreated control, while they were about 230.30 and 281.83 % due to the application of 40 m^3FYM+60 kg urea-N+60 kg

Table 10 : Cont.

Treatments: FYM (m^3/*fed*)	X Nitrogen sources and rates (Kg/*fed*)	No. of fruits/ plant	Average fruit weight (gm)	Yield/ plant (kg)	Early yield (ton/*fed*)	Medium yield (ton/*fed*)	Late yield (ton/*fed*)	Total yield (ton/*fed*)	Relative yield (%)
					2005 season				
0	0.0 (control)	9.33	31.86	0.297	0.489	2.140	0.492	3.121	100.00
	60 Urea-N	12.33	68.63	0.846	1.151	5.092	1.056	7.299	233.86
	90 Urea-N	13.30	79.96	1.063	1.524	5.915	1.521	8.960	287.08
	120 Urea-N	14.33	86.53	1.239	1.853	7.153	1.878	10.884	348.73
	60 NH4-N	10.00	70.63	0.706	1.026	4.193	1.075	6.294	201.66
	90 NH4-N	12.00	70.66	0.847	1.453	5.145	1.323	7.921	253.79
	120 NH4-N	11.66	88.16	1.027	1.619	6.007	1.711	9.337	299.16
	30 Urea-N +30 NH4-N	11.66	74.83	0.872	1.246	4.687	1.390	7.323	234.63
	45 Urea-N +45 NH4-N	12.66	76.80	0.972	1.610	5.413	1.672	8.695	278.59
	60 Urea-N +60 NH4-N	12.66	92.50	1.171	1.726	6.197	1.860	9.783	313.45
40	0.0 (control)	10.33	56.43	0.582	0.658	3.192	1.050	4.900	157.00
	60 Urea-N	12.00	104.70	1.256	1.368	7.091	2.086	10.545	337.87
	90 Urea-N	12.66	107.53	1.361	1.631	7.321	2.429	11.381	364.65
	120 Urea-N	13.66	119.06	1.626	1.816	8.673	3.135	13.624	436.52
	60 NH4-N	11.33	83.66	0.947	1.163	5.290	1.488	7.941	254.43
	90 NH4-N	12.00	89.20	1.070	1.343	5.902	1.742	8.987	287.95
	120 NH4-N	12.33	101.26	1.243	1.461	6.843	2.171	10.475	335.62
	30 Urea-N +30 NH4-N	12.66	84.40	1.068	1.366	5.628	1.946	8.940	286.44
	45 Urea-N +45 NH4-N	13.33	82.93	1.105	1.414	5.775	2.076	9.265	296.86
	60 Urea-N +60 NH4-N	13.33	106.93	1.425	1.713	7.551	2.653	11.917	381.83
	LSD at 0.05 level	1.74	9.53	0.117	0.235	0.670	0.442	0.990	---

NH_4-N/*fed* in the first and second seasons, respectively.

It is also clear from the same data in Table 10 that all the interaction treatments enhanced yield and its components compared with untreated control. It could be concluded that the superior and optimum interaction treatment, under the conditions of this experiment, for improving yield and its components of tomato plant was 40 m^3 FYM+120 kg urea-N/feddan. Such interaction treatment gained also the uppermost values of dry weight Table 3.

It is also interest to note that application of all used nitrogen forms and rates gained higher total yield when combined with 40 m^3 FYM/*fed* than those added without addition of FYM. This confirm the essentiality of FYM under sandy soil conditions. In this connection, El- Beheidi *et al.*(2006) indicated that application of 40 m^3 FYM/ *fed* combined with fertilization of tomato plants with 75 or 100 % of the recommended mineral N were the best two interaction treatments which gave the highest number of fruits/ plant and yield / plant as well as total yield / feddan.

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تأثير السماد العضوى ومستويات وصور السماد النيتروجينى المعدنى على الوزن الجاف ، وصبغات التمثيل الضوئى ، ومحصول الطماطم النامية فى الاراضى الرملية

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قسم البساتين – كلية الزراعة – جامعة الزقازيق - مصر

أجريت هذه الدراسة فى مزرعة التجارب الزراعية بمنطقة الخطارة التابعة لكلية الزراعة- جامعة الزقازيق خلال الموسمين الصيفيين لعامى ٢٠٠٤ و ٢٠٠٥، بهدف دراسة تأثير التسميد بالسماد العضوى (السماد البلدى) بمعدلين هما صفر، ٤٠ م ^{3} /للفدان ، والسماد النيتروجيني المعدنى (أمونيا –ن ، يوريا – ن) بثلاث معدلات من كل منهما (٦٠ ، ٩٠ ، ١٢٠ كجم ن /للفدان) كل على حده ، أو إضافتهما معا (٣٠+ ٣٠ أو ٤٥ +٤٥ أو ٦٠ +٦٠ كجم ن/ للفدان أمونيا –ن + يوريا – ن على الترتيب) هذا الى جانب معدل صفر من كلا الصورتين .

وأظهرت النتائج أن التسميد العضوى بمعدل ٤٠ م^{3} / للفدان أحدث زيادة معنوية فى كل من المادة الجافة للأجزاء النباتية المختلفة لنبات الطماطم ، والكلوروفيلات ، ومحتوى كل من الجذور والأوراق من النيتروجين ، ومحتوى الساق من كل من الفوسفور والبوتاسيوم ، وكذا المحصول ومكوناته معبرا عنه على صورة متوسط وزن الثمرة ، ومحصول النبات ، والمحصول الكلى للفدان.

كما أن المعدل العالى من السماد النيتروجينى (١٢٠ كجم/ للفدان) كان أفضل مستوى بالنسبة لجميع الصفات المدروسة وخصوصا عندما أضيف على صورة ٦٠ كجم أمونيا – ن + ٦٠ كجم يوريا – ن.

وأن أفضل معاملات التفاعل هى أن يضاف السماد العضوى بمعدل ٤٠ كجم م٣/ للفدان مع اليوريا بمعدل ١٢٠ كجم يوريا – ن أو مع ٦٠ كجم يوريا – ن + ٦٠ كجم أمونيا – ن .