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EFFECT OF TRANSPLANTING DATE, LEVEL AND SOURCE OF NITROGEN FERTILIZER ON GROWTH AND YIELD OF TOMATO

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ABSTRACT: This study was carried out durring summer season, 2007 at Tall El-kabeer, Ismailia Governorate, Egypt to assess the impact of three transplanting dates (March 10th , April 1st and 20th), three nitrogen fertilizer levels (150, 180 and 210 Kg N/fed) and also ratio between N sources (ammonium sulfate, 20.6 % and ammonium nitrate, 33.5 %) applied at ratios of 2:1, 1:1 and 1:2 from two fertilizer sources on growth and yield of tomato (supper strein-B cultivar).

The results indicated that there was no siginificant difference between transplanting date on plant hieght, number of leaves and leaf area, while it was significant on vegetative fresh and dry wieght and yield per plant. The second date recorded the highest values in vegetative fresh and dry wieght followed by first and third date, while the first date was recorded the highest value in yeild per plant followed by second and third date. Data also indicat that there was significant differnce between N levels. Application of N at 210 Kg/fed recorded the highest values followed by 180 and 150 Kg N/fed in all of tested parametres. As for N source (ammonium sulfate and nitrante), there was siginficant differnece on vegetative fresh and dry wieght only where, application of N fertilizers at ratio of 2:1 (ammonium sulfate: ammonium nitrante) recorded highest value followed by 1:1 and 1:2 ratios.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetable crops grown under outdoor and indoor conditions. It has become an important commercial crop so far as the cultivation area, production, industrial values and its contribution to human nutrition.

Tomato can grow under a wide range of temperature however; fruit set is limited in a narrow range. Relatively low or high temperature lead to poor fruit set. The critical factor in tomato fruit setting is the night

temperature, the optimal range being 15- 20°C (Went, 1945). Fruit set is also low when the average maximal night/day temperature is above 32°C and the average minimal night temperature is above 21°C (Moore and Thomas, 1952).

Plant production in developed and certain developing countries has increased due to the use of high yielding cultivars and enhanced consumption of inorganic fertilizers, especially the nitrogenous ones. Fruit yields of tomato ranged from 83 t/ha with no fertilizer to 169 t/ha with 600 kg N + 150 kg P_2O_5 + 400 kg K_2O /ha, and fruit quality was increased as P and K rate increased but it was decreased as N rate increased (Doran, *et al.*, 1999). Also, Ramadan *et al.* (2007) found that using 100 % mineral fertilizer or 75 % poultry manure plus 25 % mineral fertilizer significantly increased all vegetative growth characteristics of tomato.

The excessive use of nitrogen fertilizers represents the major cost in plant production and creates pollution of agro-ecosystem, as well as deterioration of soil fertility (Fisher and Richter, 1984).

The present investigation was imposed to study the effect of transplanting date, nitrogen fertilizer levels and ratio between two nitrogen sources on growth and yield of tomato.

MATERIALS AND METHODS

Field experiment was carried out during summer season of 2007 at Tall El-kabeer, Ismailia Governorate, Egypt to study the effect of three transplanting dates (March 10^{th} , April 1^{st} and 20^{th}), three nitrogen fertilizer levels (150, 180 and 210 Kg N/fed) and also ratio between N sources (ammonium sulfate, 20.6 % and ammonium nitrate, 33.5 %) applied at ratios of 2:1, 1:1 and 1:2 from two fertilizer sources on growth and yield of tomato (supper strein-B cultivar). Plots were arranged in a split-split plot design with three replications. The transplanting dates consisted of main plots, N fertilizer levels 150, 180 and 210 Kg N/fed were assigned randomly to sub-plots, while N source; ammonium sulfate (20.6%) and ammonium nitrate (33.5%) applied at ratios of 2:1, 1:1 and 1:2 were assigned randomly to sub-sub-plots. Each sub-sub-plot contained 3 rows with 3.0 m long and 0.7 m width. The whole required amount of each N fertilizer rate was added to plants with water irrigation (fertigation) during all period of growth starting after one week from

transplanting date.

Seeds of the tomato (super strein-B cultivar) were grown in the greenhouses of Vegetable Research Station, Dokki, Giza. Tomato seedlings of 35 days old were transplanted into the field on rows with interspace of 35 cm between plants in three transplanting dates, (March 10^{th}, April 1^{st} and 20^{th}). All the recommended cultural practices for growing tomato were performed whenever it was necessary according to recommendatios of Ministry of Agriculture.

In each experimental unit, plants from the outer two rows were assigned to measure the morphological characteristics, whereas plants of the middle row were allocated to determine fruits yield.

Soil samples (0-60 cm depth) were taken just before transplanting date and applying fertilizer treatments to analysis of some physical and chemical proporties.

Chemical and mechanical analysis of soil

Soil samples were air dried, crushed and passed through a 2-mm sieve then thoroughly mixed to be homogenous before laboratory analysis.

Soil reaction (pH): Soil reaction was determinated in 1: 2.5 (soil : water) suspension using Beckman pH meter as outlined by (Jackson 1967).

EC: Electrical conductivity was measured in soil paste extract according to the methods outlined by (Jackson 1967).

Total Nitrogen (T. N.): Total nitrogen was determined by micro-kjeldahle method according to the procedure described by FAO (1980).

Organic Mater (O. M.): Organic mater was determined according to FAO (1980).

Mechanical analysis: Particle size distribution was determinated using pipette method and sodium haxametaphosphate as a dispersing agent. (Klute, 1986).

Table (1) chemical and mechanical analysis of soil

pH at 1: 2.5	EC_e (ppm)	T . N (ppm)	O .M (%)	(%)			Texture
				clay	sand	silt	
8.1	563.2	840.0	1.6	11.2	85.6	3.2	Loamy sand

Water analysis

Water irrigation samples were taken also during growing season to analyze some chemical properties.

Water reaction (pH): Water reaction was determinated using Beckman pH meter as outlined by (**Jackson, 1967**).

Cations and anions: Electrical conductivity (EC) cations and anions were determinated in samples according to the methods outlined by (**Jackson, 1967**).

Table (2) analysis of water samples

pH	EC_w (ppm)	Milliequivalent / liter						
		Cations				Anions		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO^{-}_3	HCO^{-}_3	Cl^{-}
7.6	288.0	5.0	2.0	1.2	0.2	Nil	3.4	5.0

Climatic data:

The radiation and temperature (minimum and maximum) were measured daily and averaged for 10 days by Central Laboratory for Agricultural Climate (CLAC), A.R.C., Egypt as indicated in Table (3).

Morphological characteristics

Three random plants from each sub-sub-plot were chosen after 60 days from transplantig, cut off at ground level and sub-divided into leaves, stems and fruits. The following morphological measurments were undertaken.

Table (3) Radiation and minimum and maximum air temperature during the period from 10/3 to 10/7 /2007

Period Day (from –to) /month/year	Radiation (w/m^2)	Temperature °C	
		Maxi.	Mini.
1-10 March, 2007	110.8	25.6	13.2
11-20 March, 2007	120.6	24.8	14.2
21-31 March, 2007	139.7	25.0	14.7
1-10 April, 2007	150.8	26.0	13.8
11-20 April, 2007	173.4	25.0	14.7
21-30 April, 2007	176.7	29.0	19.5
1-10 May, 2007	192.3	24.3	15.3
11-20 May, 2007	205.6	28.9	18.6
21-31 May, 2007	185.3	29.7	18.7
1-10 June, 2007	190.5	32.8	22.1
11-20 June, 2007	195.3	32.2	21.2
21-30 June, 2007	210.4	38.6	24.3
1-10 July, 2007	197.6	34.9	22.7

a. Plant height (cm): average hight of three plants from ground level up to top of plant.

b. Number of leaves per plant: average number of leaves of three plants.

c. Total vegetative fresh wieght: average of vegetative fresh wieght of three plants was calculated from adding the fresh wieghts of leaves + stems + fruits.

d. Total leaf area: average of leaf area of three plants was recorded by using adigital leaf area meter (LI- 300 portable Area Meter) produced by LI-COR, Lincoln, USA.

e. Total vegtative dry wieght: average of vegtative dry wieght of three plants was calculated from adding the dry wieghts of leaves + stems + fruits after dried at 70 °C in a forced air- oven for at least 48 hours.

Yield per plant: Average fruits wieght of of three plants was estimated as yield per plant.

Statistical analysis:

Analysis of variance was performed on results from each experiment. F test and least significant differences (LSD) were computed at 5% level **(Snedecor and Cohran 1980).**

RESULTS AND DISCUSSION

The data in Table (4) indicate that there were significant differences between transplanting date on vegetative fresh and dry weight and yield per plant. In this respect, second date of transplanting recorded the highest value for vegetative fresh and dry weight followed by first and third date, while the first date recorded the highest value for yield per plant followed by second and third date. These obtained results could be attributed to difference of climatic factors between three transplanting date, especially day and night temperatures, which affect on growth and fruit set in tomato (table 3). These results are in harmony with Went, (1945) who found that tomato can grow under a wide range of temperature, however; fruit set is limited in a narrow range. Relatively low or high temperature lead to poor fruit set. The critical factor in tomato fruit setting is the night temperature, the optimal range being 15- 20° C. Fruit set is also low when the average maximal night/day temperature is above 32° C and the average minimal night temperature is above 21° C **(Moore and Thomas, 1952).** Also late planting date (June, 2nd) led to fewer flower trusses than early planting date (May, 7th) and late planting date reduced the number of ripe and rotted fruit and yields but increased weight per fruit compared to earlier planting (May, 7th or 19th) as tested by Drost and Price (1991).

Data in Table (4) also indicate that there were significant differences between N levels on vegetative growth and yield per plant. Application of nitrogen at 210 kg N/fed recorded the highest value in all vegetative growth parameters as well as yield per plant, while application of nitrogen at 150 kg N /fed recorded the lowest value in all vegetative growth parameters. These results are in harmony with those obtained by Doran, *et al.*, (1999) who found that fruit yields of tomato ranged from 83 t/ha with no fertilizer to 169 t/ha with 600 kg N + 150 kg P_2O_5 + 400 kg K_2O /ha. Also, Ramadan *et al.* (2007) found that application of 100 % mineral fertilizer or 75 % poultry manure plus 25 % mineral fertilizer significantly increased all vegetative growth characteristics of tomato (plant height, number of leaves/plant/ number of shoot/plant and fresh weight).

The ratio between nitrogen sources (table 5) show also significant differences on number of leaves and vegetative fresh and dry weight only. The ratio 2:1(ammonium sulfate: ammonium nitrate) recorded the highest value followed by 1:1 and 1:2 ratios. There was no significant difference between ratios on other parameters. These results are in harmony with Khalil, *et al.*, (2001) who found that ammonium sulfate fertilizer was the most efficient source of nitrogen for tomato production, followed by urea and ammonium nitrate. The ammonium sulfate + P + K treatment was the best among all treatments on weight of individual fruit and yield per plant.

The interaction between transplanting date and nitrogen levels (table 4) indicate that there were significant differences in all vegetative growth traits but there was insignificant effect on yield per plant. The application of nitrogen at 210 kg N/fed in second date recorded the highest values for all tested parameters, while application of nitrogen at 150 kg N/fed in first and third date of planting recorded the lowest value for all tested parameters.

Also the interaction between transplanting date and ratio between nitrogen sources (table 5) show that there were no significant differences on vegetative growth and dry weight as well as produced yield per plant in three transplanting date.

Finally, results in Table (6) show that there were significant differences in the interaction between nitrogen levels and ratio between nitrogen sources on number of leaves and leaf area only. Application of nitrogen at 150 kg N /fed with ration 1:1 recorded the lowest values in number of leaves and leaf area, while application of nitrogen at 120 kg N /fed with ratio 1: 2 and 1:1 (ammonium sulfate : ammonium nitrate) recorded the highest values in number of leaves and leaf area, respectively.

Table (4) effect of transplanting date and nitrogen levels on vegetative growth and yield of tomato

Dates (D)	N levels (N)	Plant height (cm)	No. of leaves	Vegetative fresh weight (g)	Leaf area (m^2)	Vegetative dry weight (g)	Yield / plant (g)
D_1	150 U	44.0	65.4	539.2	1.8	66.7	921.8
	180 U	44.2	68.4	756.9	2.2	89.9	1016.2
	210 U	47.7	80.2	957.7	2.5	110.0	1092.2
D_2	150 U	46.7	63.0	569.1	1.7	76.1	445.4
	180 U	45.0	68.2	853.3	1.9	89.3	519.9
	210 U	48.8	94.6	1338.4	2.4	129.7	604.5
D_3	150 U	47.3	69.8	361.4	1.6	48.7	344.2
	180 U	49.1	76.7	509.1	2.0	53.6	428.1
	210 U	44.0	84.8	771.5	1.9	74.1	488.5
LSD at 5% (D)		**N. S.**	**N. S.**	**29.5**	**N. S.**	**7.2**	**9.8**
(N)		**1.7**	**5.8**	**26.4**	**0.2**	**6.5**	**8.8**
D × N)		**2.9**	**10.0**	**45.7**	**0.3**	**11.2**	**N. S.**

Table (5) effect of transplanting date and ratio between nitrogen source on vegetative growth and yield of tomato

Dates (D)	Ratio (R)	Plant heigh t (cm)	No. of leaves	Vegetative fresh weight (g)	Leaf area (m^2)	Vegetative dry weight (g)	Yield / plant (g)
D_1	2 : 1	46.0	75.2	834.4	2.1	95.3	1053.6
	1 : 1	45.9	69.8	757.1	2.2	92.0	1004.3
	1 : 2	44.0	69.1	662.4	2.0	79.4	972.3
D_2	2 : 1	48.9	79.2	1085.0	2.2	113.0	543.4
	1 : 1	45.7	69.6	905.6	2.1	99.3	529.4
	1 : 2	45.9	77.0	770.2	1.7	82.9	496.9
D_3	2 : 1	46.2	80.7	620.6	1.9	65.8	450.9
	1 : 1	46.9	76.7	558.7	1.7	61.8	420.4
	1 : 2	47.3	73.9	462.6	1.9	48.8	389.5
LSD at 5 % (R)		N. S.	5.6	25.4	N. S.	6.2	N. S.
(D × R)		N. S.	N. S.	N. S.	N. S.	N. S.	N. S.

Table (6) effect of N levels and ratio between nitrogen source on vegetative growth and yield of tomato

N levels (N)	Ratio (R)	Plant height (cm)	No. of leaves	Vegetative fresh weight (g)	Leaf area (m^2)	Vegetative dry weight (g)	Yield / plant (g)
150 U	2 : 1	46.5	70.1	555.2	1.7	70.3	608.7
	1 : 1	45.0	63.1	500.6	1.5	66.4	569.6
	1 : 2	46.6	65.0	413.9	1.8	55.0	533.0
180 U	2 : 1	45.5	75.0	787.0	2.1	83.6	677.1
	1 : 1	48.9	75.1	720.7	2.2	81.2	661.4
	1 : 2	44.0	63.2	611.7	1.8	86.0	625.6
210 U	2 : 1	49.2	80.0	1197.8	2.3	120.1	762.0
	1 : 1	44.6	77.8	1000.1	2.4	105.6	723.0
	1 : 2	46.7	91.8	869.6	2.0	88.1	700.1
LSD at 5 % (N × R)		N. S.	9.7	N. S.	0.3	N. S.	N. S.

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الملخص العربي

تأثير ميعاد الزراعة ومستوى ومصدر السماد النيتروجيني على النمو والمحصول في الطماطم

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أجريت هذه الدراسة في العروة الصيفي لعام ٢٠٠٧م في التل الكبير بمحافظة الإسماعيلية وذلك بهدف دراسة تأثير ثلاثة مواعيد زراعية مختلفة هي (١٠ مارس، ١، ٢٠ إبريل) و ثلاثة معدلات تسميد نيتروجيني وهي (١٥٠ – ١٨٠ – ٢١٠ كجم نيتروجين/ فدان) بالإضافة إلى دراسة تأثير مصدر السماد النيتروجيني المستخدم (سماد سلفات الأمونيوم (٢٠,٦%) ونترات الأمونيوم (٣٣,٥%)) بنسب ٢ : ١ ، ١:١ ، ١ : ٢ على الترتيب وذلك على النمو والمحصول في صنف الطماطم سوبر استرين بي.

أوضحت النتائج أن مواعيد الزراعة أعطت فرقا معنويا في كل من الوزن الطازج والجاف ومساحة سطح الأوراق وكذا في كمية المحصول بينما لا يوجد فرقا معنويا في ارتفاع النبات وعدد الأوراق، هذا وقد سجل الميعاد الثاني أعلى القيم بالنسبة للوزن الطازج والجاف ومساحة سطح الأوراق تلاه الميعاد الأول ثم الثالث، بينما سجل الميعاد الأول أعلى القيم في كمية المحصول فقط تلاه الثاني ثم الثالث.

أما بالنسبة لمستويات التسميد النتروجيني فقد كان هناك فرقا معنويا وأعطى استخدام المعدل ٢١٠ كجم نيتروجين/فدان أعلى القيم ثم ١٨٠، ١٥٠ على الترتيب وذلك في كل الصفات المدروسة.

وبالنسبة لمصدر السماد المستخدم (سلفات الأمونيوم ، نترات الأمونيوم) فأوضحت النتائج أنه لا يوجد فرقا معنويا في ارتفاع النبات، وعدد الأوراق، مساحة سطح الأوراق وكذا كمية المحصول بين النسب الثلاث (٢ : ١، ١ : ١، ١ : ٢) المستخدمة، بينما كان هناك فرقا معنويا في كل من الوزن الطازج والجاف حيث أعطت النسبة ٢ : ١(سلفات الأمونيوم : نترات الأمونيوم) أعلى القيم تلاه النسب ١ : ١ ثم ١ : ٢ في كلا الوزنين.