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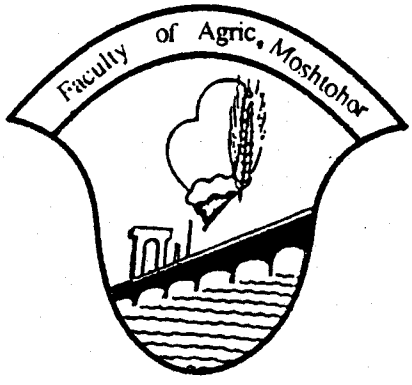

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TOMATO FRUIT YIELD AND QUALITY AS WELL AS NITRATE ACCUMULATION AS AFFECTED BY PLANT DENSITY AND NPK FERTILIZATION LEVEL

BY

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ABSTRACT

Two field experiments were carried out on tomato cv. Peto-86 at the Experimental Farm of Fac. of Agric. Moshtohor, Zagazig Univ. in 1990 and 1991 summer seasons to investigate the effect of plant density and NPK fertilization level on yield and quality of tomato fruits as well as nitrate accumulation. Obtained results show that increasing plant density by increasing number of plants per hill increased the early and total yields per faddan. The highest early and total yields were obtained by the highest used plant density (3 plants/hill). On the other hand, the highest values of average fruit weight, length and diameter as well as number and yield of fruits per plant were noticed with one plant per hill. Furthermore, vitamin C, and titratable acidity were increased while, nitrogen content and nitrate nitrogen accumulation were significantly decreased with boasting the number of plants up to 3 plants per hill. Data also showed that, all total fruit yield and its components as well as the determined fruit constituents, in addition to the nitrate accumulation, were increased with increasing NPK fertilization level. The maximum early and total yields per faddan were obtained in case of planting three plants per hill and applying the highest used level of fertilizers (225 kg N + 96 kg P_2O_5 + 96 kg K_2O/fad.). Meanwhile, no significant differences in TSS%, NO_3-N and total nitrogen were detected in this respect.

INTRODUCTION

Tomato (Lycopersicon esculentum, Mill) occupied the first rank among the vegetable crops grown in Egypt. it is produced for both Local consumption and export. Therefore, in order to achieve maximum output of tomato fruits per unit area with good quality, one should reach to the proper level of NPK fertilization as well as suitable number of plants per each hill as a mean for increasing fruit yield and improving its quality

Increasing plant density either by decreasing planting distances or increasing number of plants per hill increased the produced yield per unit area (Hassan, 1978; Mohmedin, 1983 working on tomato). Moreover, Midan et al . (1985) reported that the highest total yield of tomato was obtained when plant were planted at 30 cm apart and two plants clumps/hill, while three plant clumps increased early yield. However, yield per plant was found to be the highest at the widest spacings (Gupta and Shukla, 1977; Abed and Eid, 1987 working on tomato). High plant population, either by increasing number of plants per hill or by narrowing spacing, generally increased ascorbic acid and acidity in tomato fruits (Midan et al., 1985; Abed and Eid, 1987) and reduced the total soluble solids (El-Aidy et al., 1982; Midan et al., 1985). Moreover, it decreased the nitrogen content (Abed and Eid, 1987 working on tomato). The promotive effect of NPK- fertilization on fruit yield per plant as well as faddan and its components, i.e. average fruit weight and number of fruits per plant has been pointed out by Jaramillo et al. (1978), Abed and Eid (1987) and Abdalla et al. (1990) on tomato.

As regards the effect of increasing the NPK fertilizers level on the chemical constituents of fruits, it was indicated that vitamin C and total acidity were increased (Dimitrov and Rankov, 1979; Abed and Eid, 1987; Abdalla et al., 1990; Eid, 1991 on tomato). The fruit TSS content was also increased as a result of P and K fertilizers addition (Dimitrov and Rankov, 1979; Abdalla et al., 1990 on tomato) and as a result of NPK-application (Eid, 1991).

Although, nitrogen is effective on tomato fruit yield and quality, its higher rates may cause an increase of nitrate accumulation in plant tissues which may induce toxicity to humans. A very little information is available about nitrate accumulation in paprika or tomatoes. Thomas and Heilman (1967) indicated that NO_3-N concentration in paprika leaves was greatly associated with levels of N-application. They recommended that NO_3-N in leaves may be used as indicates for nitrogen status in the crop and the critical concentration was approximately 500 ppm of NO-N. Moreove, Hoff Wilcox (1970) indicated that the maximum nitrate accumulation in tomato fruits was 46-50 ppm (based on fresh wt.) resulted under conditions of high day-temperature (80°F), high N-application (800 ppm of NH_4 NO_3-N) and low light intensity Meanwhile, the approximate critical levels of nitrate-N for leaf lettuce, spinach and

radish roots were 2000, 4000 and 5000 ppm, on dry weight basis, respectively (Maynard and Barker, 1971). Many investigators reported the increments in NO_3-N contents under the conditions of high nitrogen fertilization. Among them, Maynard et al (1976); Szwonek (1986) and Shafshak and Abo-Sedera (1990), all working on lettuce.

So, the aim of this investigation is to verify maximum fruit yield with good quality and less nitrate accumulation through suitable plant density within fertilization level of NPK fertilizers.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture, Moshtohor, Zagazig University, during 1990 and 1991 summer seasons. Seeds of tomato (Lycopersicon esculentum, Mill) cv. Peto-86 were broadcasted in the nursery on January 18th and 14th of 1990 and 1991 under low plastic tunnel. Transplanting took place on 19th and 16th of March 1990 and 1991, respectively. Transplants were planted in the presence of water at 30 cm apart on one side of ridges; 100 cm wide and 3.6 m long. The transplants were not planted in hills in clumps, i.e., not in groups but planted separately from each other with 2 cm apart within the hill. The experiment included 9 treatments resulted from combination of three planting densities, i.e., planting one, two or three plants per hill at 30 cm apart, combined with three fertilization levels of N, P and k fertilizers (75 kg N + 32 kg P_2O_5 + 48 kg K_2O/fad.), (150 kg N + 64 kg P_2O_5 + 72 kg K_2O/fad.) and (225 kg N + 96 kg P_2O_5 + 96 kg K_2O/fad.). Fertilizers were applied in the form of ammonium nitrate (33.5% N), calcium superphosphate (16% P_2O_5) and potassium sulphate (48% K_2O). Fertilizers were divided into three equal portions and then added at 3, 7 and 11 weeks after transplanting. A split plot design with four replicates was adopted. The number of plants in each hill served as main plots while the fertilizers level served as sub-plots. The sub-plot area was about 1/389 fad. Other cultural practices were carried out as commonly followed in the district.

Data recorded:

I-Fruit yield and its components:

All harvested fruits from each experimental plot were used for determining:

1- Number of fruits per plant
2- Average fruit weight (g)
3- Fruit yield per plant.
4- Early yield, calculated from the first three pickings as Ton/fad.
5- Total yield (Ton/fad.).

II- Fruit physical and chemical characteristics:

At each picking time, a representative sample of 15 fruits from each experimental plot was taken for determining the following characters:

1- Fruit length and diameter (cm).
2- Fruit shape index (L/D).
3- Fruit chemical constituents:
   a) Both of vitamin C and titratable acidity content were determined as described in A.O.A.C. (1970).
   b) Total soluble solids (TSS) in fruits were assayed using hand refactometer.
   c) Total N and nitrate-N contents of fruits were determined as described by Pregl (1945) and Kamal (1951), respectively.

All obtained data were subjected to statistical analysis according to Gamez and Gomez (1983).

RESULTS AND DISCUSSION

Effect of plant density and fertilization level on:

I- Fruit yield and its components:

Data presented in Table (1) show that both early and total fruit yield per faddan significantly increased by increasing number of plants per hill. In this regard, the highest early and total yields were obtained in case of planting three plants per hill at 30 cm apart between each hill. However, each of average fruit weight, number and yield per plant were found to be of highest values at the presence of one plant per hill. Similar results were obtained by Hassan (1978), Mohamedien (1983) and Midan et al(1985) working on tomato. moreover, such results were also supported by Gupta and Shukla (1977). and Abed and Eid (1987) working on tomato, who indicated that yield per plant was found to be the highest at the widest spacings (30 cm).

The same results in Table (1) also show that all studied yield aspects, i.e., average fruit weight and number and weight of fruits per plant as well as early and total yield per faddan were increased by increasing fertilizers level.

Table (1): Effect of plant density and fertilization level on tomato fruit yield and its components.

Season		1990					1991				
Number of plants/ hill	Fertilizers level *	Fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)	Early yield/ (Ton/ fad.)	Total yield (Ton/ fad.)	Fruit weight (g)	No. of fruits/ plant	Yield/ plant (g)	Early yield/ (Ton/ fad.)	Total yield (Ton/ fad.)
One plant/ hill	1	83.8	12.05	1009.5	10.42	14.14	81.7	10.71	875.0	9.50	12.25
	2	90.2	12.94	1167.6	11.55	16.35	84.3	12.47	1050.9	11.28	14.71
	3	93.9	13.62	1279.0	11.61	17.91	86.1	12.95	1115.4	11.51	15.62
Two plants/ hill	1	81.5	8.15	664.0	10.54	18.59	79.6	7.37	586.5	10.41	16.42
	2	85.3	8.25	703.3	12.19	19.70	80.1	7.72	618.5	11.73	17.32
	3	86.8	8.35	724.7	12.22	20.29	83.0	7.97	661.3	12.03	18.52
Three plants/ hill	1	79.8	6.25	498.9	10.92	20.96	78.0	5.74	447.9	10.58	18.81
	2	83.9	6.35	532.9	12.66	22.38	77.3	6.36	491.3	12.36	20.63
	3	88.0	6.45	567.3	12.84	23.83	78.2	6.49	507.6	12.36	21.32
L.S.D. at 0.05		1.5	0.53	62.2	0.12	0.21	1.4	0.66	51.4	0.28	0.38
Plant	1	89.3	12.90	1152.0	11.19	16.13	84.0	12.04	1013.8	10.76	15.83
	2	84.5	8.25	697.3	11.65	19.53	80.9	7.69	622.1	11.39	17.55
	3	83.9	6.35	533.0	12.14	22.39	77.8	6.20	482.3	11.77	18.48
L.S.D. at 0.05		0.5	0.27	38.0	0.06	0.13	0.4	0.42	36.2	0.12	0.19
Level	1	81.7	8.86	724.1	10.63	17.90	79.8	7.94	636.5	10.16	14.19
	2	86.5	9.26	801.3	12.13	19.48	80.6	8.85	720.2	11.79	17.42
	3	89.6	9.56	857.0	12.22	20.68	82.4	9.14	761.4	11.97	20.26
L.S.D. at 0.05		0.4	0.17	28.1	0.01	0.07	0.3	0.36	28.6	0.15	0.10

* Level 1 = (75 kg N + 32 kg P_2O_5 + 48 kg K_2O_5).
Level 2 = (150 kg N + 64 Kg P_2O_5 + 72 Kg K_2O fad.)
Level 1 = (225 kg N + 96 kg P_2O_5 + 96 kg K_2O/fad.)

Generally, it could be concluded that the highest increments in the forementioned yield components were connected with the highest used level of NPK fertilizers (225 kg N + 96 kg P_2O_5 + 96 kg K_2O/fad.) this was true during both seasons of growth. These results had a similar trend to those obtained by Jaramillo et al (1978), Abed and Eid (1987) and Abdalla et al (1991) on tomato.

As regards the interactive effect, data at the same table show that the average fruit weight as well as number and weight of fruits per plant were increased with boasting the fertilizers level within one plant per hill. However, the maximum early and total fruit yield per faddan were produced in case of planting three transplants per hill within the highest used level of NPK fertilizers. This was true during both seasons of growth.

II- Fruit quality:

a) Physical characters:

Data presented in Table (2) show that both fruit length and diameter were significantly decreased with increasing number of plants per hill, while, shape index was significantly increased. This was true during both seasons of growth.

With regard to the effect of fertilization level, it is clear from the same data presented in Table (2) that average fruit length and diameter were significantly increased with increasing the fertilizers level. Meanwhile, no significant effect could be noticed with respect to the fruit shape index.

As for the interactive effect among the number of plants per hill and NPK fertilizers level, data at the same table indicate that with the exception of fruit length, no significant differences could be noticed with respect to fruit diameter and shape index. The maximum values for fruit length and diameter were obtained in case of planting one transplant per hill within the highest used level of NPK fertilizers (225 kg N + 96 kg P_2O_5 + 96 kg K_2O/fad.). This result was true during both seasons of growth.

b) Chemical composition:

Data in Table (3) indicated that increasing plant number per hill increased fruit chemical content from vitamin C and titratable acidity but did not affect the percentage of total soluble solids (TSS). On the other hand, the content

Table (2): Effect of plant density and fertilization level on physical characteristics of tomato fruits.

Season		1990			1991		
Number of plants/ hill	Fertilization level	Fruit length (L) (cm)	Fruit diameter (D) (cm)	Fruit idex (L/D)	Fruit length (cm)	Fruit diameter (cm)	Fruit index (L/D)
One plant/ hill	1	6.2	5.4	1.15	6.4	5.3	1.21
	2	6.5	5.5	1.18	6.4	5.4	1.19
	3	6.6	5.5	1.20	6.4	5.4	1.19
Two plants/ hill	1	6.0	5.1	1.18	6.0	4.9	1.22
	2	6.3	5.3	1.19	6.3	5.2	1.21
	3	6.4	5.3	1.21	6.3	5.2	1.21
Three plants/ hill	1	5.9	4.9	1.20	5.8	4.6	1.26
	2	6.1	5.1	1.20	5.9	4.9	1.20
	3	6.1	5.1	1.20	5.9	4.9	1.20
L.S.D. at 0.05		0.13	N.S.	N.S.	0.1	N.S.	N.S.
Plant	1	6.4	5.5	1.16	6.4	5.4	1.19
	2	6.2	5.2	1.19	6.2	5.1	1.22
	3	6.0	5.0	1.20	5.9	4.8	1.23
L.S.D. at 0.05		0.02	0.03	0.03	0.10	0.07	0.01
Level	1	6.1	5.1	1.20	6.1	4.9	1.24
	2	6.3	5.3	1.19	6.2	5.2	1.19
	3	6.4	5.3	1.21	6.2	5.2	1.19
L.S.D. at 0.05		0.02	0.02	N.S.	0.10	0.07	N.S.

Table (3): Effect of plant density and fertilization level on fruit chemical constituents.

Season		1990					1991				
Number of plants/ hill	Ferili-ers level	Vitamin C	Titratable acidity	TSS	Nitrate -N	Total N	Vitamin C	Titratable acidity	TSS	Nitrate -N	Total N
		(mg/100 cm³)		%	(mg/100 g D.W.)		(mg/100 cm³)		%	(mg/100 g D.W.)	
One plants/ hill	1	38.0	540	5.4	1390	2490	40.1	543	5.5	1392	2597
	2	39.4	573	5.3	1420	2520	41.9	578	5.4	1430	2629
	3	40.8	584	5.1	1670	2770	41.8	579	5.4	1679	2878
Two plants/ hill	1	40.8	556	5.5	921	2021	42.0	555	5.6	975	2129
	2	42.9	575	5.4	1200	2300	43.7	580	5.5	1240	2411
	3	43.9	581	5.3	1375	2475	44.9	583	5.3	1380	2582
Three plants/ hill	1	42.5	565	5.7	595	1695	43.5	575	5.8	600	1793
	2	43.6	578	5.5	880	1980	45.7	583	5.6	885	1981
	3	44.8	589	5.4	930	2030	45.8	592	5.6	945	2060
L.S.D. at 0.05		1.2	6.9	N.S.	N.S.	N.S.	2.0	9.5	N.S.	N.S.	N.S.
Plant	1	40.4	554	5.5	1493	2593	41.9	558	5.6	1500	2701
	2	41.9	575	5.4	1165	2265	43.8	580	5.5	1198	2374
	3	43.2	585	5.3	802	1902	44.2	585	5.4	810	1945
L.S.D. at 0.05		0.6	3.8	N.S.	18	22	1.0	4.0	N.S.	16	24
Level	1	39.4	566	5.3	969	2069	41.3	567	5.4	989	2173
	2	42.5	571	5.4	1167	2267	43.5	573	5.5	1185	2340
	3	43.6	577	5.5	1325	2425	45.0	583	5.7	1335	2507
L.S.D. at o.05		0.4	2.8	N.S.	15	19	0.6	2	N.S.	12	18

of total nitrogen and nitrate accumulation in fruits were decreased.

These results are in concidance with those reported by Midan et al. (1985), and Abed and Eid (1987) working on tomato, as regards vitamin C and titratable acidity; with El-Aidy et al (1982), Midan et al (1985) and Abed and Eid (1987) working on tomato with respect to TSS%. Also, these results showed similar trend with those obtained by Abed and Eid (1987) working on tomato as regards total nitrogen content. Moreover, the nitrate accumulation was also increased as the fertilizers level increased. The accumulation of NO_3-N in fruits may be attributed to the unquillibrium status between the absorption and assimilation. Also, when nitrate reductase enzyme not active in NO_3-N reduction to NH_3, accumulation occurs in plant foliage and, in turn, in fruits by translocation. This held true during both season of growth. These results are in accordance with those of Thomas and Heilman (1967) on pepper and Hoff and Wilcox (1970) on tomato. Moreover, Maynard et al (1976), Szwonek (1986) and Shafshak & Abo-Sedera (1990), all working on lettuce reported the same results.

As for the interactional effect, data in Table (3) revealed that the highest content of both vitamin C and total acidity resulted from planting three plants per hill within the highest fertilization level. Meanwhile, no significant effect on TSS%, total nitrogen content and nitrate accumulation was detected. This was true during both seasons of growth. The least nitrate accumulation was detected in plants fertilized with the lowest level of NPK fertilizers with three plants per hill.

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تأثير الكثافة النباتية ومستوى التسميد
على المحصول والجودة وتراكم النترات بثمار الطماطم

سعيد معوض عيد توفيق عبدالحميد عابد فتحي أبوالنصر أبوسديرة
قسم البساتين - كلية الزراعة بمشتهر - جامعة الزقازيق / فرع بنها - مصر

اجريت تجربتان حقليتان بمزرعة التجارب بكلية الزراعة بمشتهر خلال الموسم الصيفي لعامي ١٩٩٠ ، ١٩٩١ على صنف الطماطم بيتو - ٨٦ لدراسة تأثير الكثافة النباتية والتسميد الازوتي والفوسفاتي والبوتاسي على المحصول والجودة وتراكم النترات للثمار .

وكانت كثافة النباتات بالجورة هي نبات واحد ونباتين وثلاثة نباتات أما كميات التسميد المستخدمة فكانت المستوى الاول (٧٥كجم ن + ٣٢كجم فو٢ أ٥ + ٤٨كجم بو٢ أ/فدان) والمستوى الثاني (١٥٠كجم ن + ٦٤ كجم فو٢ أ٥ + ٧٢كجم بو٢ أ/فدان) والمستوى الثالث (٢٢٥كجم ن + ٩٦كجم فو٢ أ٥ + ٩٦كجم بو٢ أ /فدان) وكانت اهم النتائج المتحصل عليها :

أدت زيادة الكثافة النباتية عن طريق زيادة عدد النباتات في الجورة الى زيادة المحصول المبكر والكلي للفدان وقد أعطت زراعة ثلاث نباتات بالجورة أعلى محصول كلي ومبكر كما ازداد عدد ومحصول الثمار بالنسبة للنبات الواحد وكذلك طول وقطر ومتوسط وزن الثمرة بزراعة نبات واحد بالجورة . كما ازداد محتوى الثمار من فيتامين (ج) وكذلك الحموضة الكلية بينما نقص كل من النيتروجين وتراكم النترات بزيادة الكثافة النباتية.. ازداد كل من المحصول الكلي ومكوناته وكذلك المحتوى الكيماوي للثمار بزيادة مستوى التسميد وكان لزيادة مستوى التسميد للمستوى الثالث وزيادة عدد النباتات بالجورة الفضل في زيادة المحصول المبكر والكلي . - بينما لم يكن لهما تأثير معنوي في التأثير على المواد الصلبة الذائبة والنيتروجين وكذلك تراكم النترات بالثمار.