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Effect of Nitrogen Level on Two Tomato Cultivars Under Plastic House Conditions

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Abstract. Two tomato cultivars *Lycopersicon esculentum* Mill. Marmande and Pearson, were tested under three nitrogen levels (10, 20, and 30 gm N/m^2) in plastic house at Dirab Experimental Station, King Saud University. Data of growth showed that Pearson plants gave the highest values for plant height, leaf area, fresh weight, and dry matter content. Nitrogen applications increased dry matter up to the highest level (30 gm N/m^2), but plant height, leaf area, and fresh weight were not affected. A significant response of each cultivar to N applications was observed for fresh weight and dry matter content.

Regarding yield and yield components, Marmande cultivar produced the highest number of fruits/plant and more total yield. Nitrogen treatments did not affect total yield or any of its components. Marmande reflected no response of total yield to N, suggesting that 10 gm N/m^2 was sufficient for the cultivar. The number of fruits and total yield of pearson plants increased with N application up to 20 gm N/m^2, but the fruit weight decreased, suggesting that 20 gm N/m^2 favored Pearson production.

Introduction

Production of vegetables in regions characterized by adverse environmental conditions, such as in sandy soil or under severe climatic conditions (high or low temperature), is quite limited. Developing protected environments, as in plastic or glass-houses, are recently practiced for producing vegetables on a large scale. Improving productivity of these crops to compensate high financial cost is a strategic objective. This could be achieved by improving all cultural practices, in addition to selecting good varieties through evaluation trials.

Variations among tomato cultivars in plant growth and productivity have been reported by Arora *et al.* [1], El Beheidi *et al.* [2] and El-Mansi *et al.* [3]. Reports on the effect of nitrogen on tomato growth were presented by Sharma and Mann [4], O'Sullivan *et al.* [5], and El-Beheidi *et al.* [2]. Data on the yield response to fertilizer treatments were reported by Vittum and Tapley [6, 7] and Cook and Sanders [8].

The use of an optimum N level that results in enhancing yield quantity is a major goal for growers. The present work was conducted to investigate the growth and productivity of two tomato cultivars using three levels of nitrogen under plastic-house conditions.

Materials and Methods

Plastic house experiment was conducted during the growing season of 1989-1990 at Dirab Experimental Station, King Saud University, to study the effect of nitrogen fertilizer on the two tomato cultivars, Marmande and Pearson. Three nitrogen levels; 10, 20, and 30 gm N/m^2, were tested in the study. The cultivars and nitrogen levels were tested in split-plot in a randomized complete block design with four replications. Main-plots were devoted for cultivars and the sub-plot units, of 6 m^2 area, were used for N- levels.

Tomato seeds were sown on 9th November, 1989 and seedlings were transplanted on 24th December, 1989. Every experimental unit (sub-plot) was accommodated with twelve plants. Each nitrogen level was splitted into three equal amounts, and applied as side dressing at 30 day intervals beginning on 10th January, 1990. Nitrogen source was ammonium sulphate (20% N).

Other cultural practices were conducted as recommended. Drip irrigatin was used for water supply.

Experimental data

A. Plant growth:

Three samples of one plant each were randomly taken, beginning at 15 days from the last N application, with 30 day intervals for recording the following measurements:

1. Plant height (cm).
2. Plant leaf area (m^2), using Portable Area Meter Model LI-3000 A.
3. Plant fresh weight (Kg).
4. Dry weight of plant parts, i.e., leaves and stems, (gm).

B. Yield and its components:

1. Total fruit weight (Kg/plot), then converted to Kg/m^2.
2. Number of fruits per plant.
3. Average fruit weight (gm).

Obtained data were subjected to the analysis of variance proposed for split-plot design as presented by Steel and Torrie [9, p. 377-387].

Results and Discussion

Results of growth and yield characters of tomato cultivars as affected by nitrogen applications, will be discussed under the following topics:

1. Morphological traits

Data in Table 1 reflected significant differences between the two cultivars (Marmande and Pearson) in plant height, at the three sampling stages (90, 120, and 150 days from transplanting), favoring Pearson plants. Plant leaf area and fresh weight of the two cultivars appeared statistically similar, although Pearson cv. had relatively high values. Moreover, Pearson cv significantly produced more fresh weight/plant in the first sample only. Similar trends were presented by Arora *et al.* [1] and El-Beheidi *et al.* [2].

Nitrogen levels (10, 20, and 30 gm N/m^2), gradually, increased plant height and leaf area/plant with increasing N level (Table 1). Significant difference in plant height was only scored with the highest N level (30 gm N/m^2) in the first sample, whereas the differences in leaf area were significant in the second sample. The increase in size of tomato transplants, due to N application, was also reported by Weston and Zandstra [10]. Significant increase in plant fresh weight was observed with increasing N level and being maximum with the highest N dose, at first two sampling dates. This might be attributed to the role of N in increasing weight of plant organs, through its role in increasing the capacity of food assimilation. The third sampling took place during fruiting stage at which assimilated food was withdrawn from plant vegetative organs. Therefore, N levels did not cause significant effect on fresh weight.

Cultivar x N interaction did not reflect any significant effect on morphological traits. However, when N was tested with two degrees of freedom for each cultivar (Table 2), fresh weight of both cultivars was significantly increased by increasing N level, but only, at first and second samples. Similar response was observed for Marmande plant leaf area at second sampling date. Differences among cultivars and effect of nitrogen on vegetative growth of tomato plants were reported by O'Sullivan *et al.* [5] and El-Beheidi *et al.* [2].

2. Dry matter

Data in Table 3 revealed that both cultivars were not significantly different in leaf dry weight. However, significant differences in stem and total dry weight were

Table 1. Effect of cultivars and nitrogen fertilizer on plant height, leaf area, and fresh weight of tomato plants at three sampling stages (90, 120, and 150 days after transplanting)

Treatment	Plant height (cm)			Plant leaf area (m^2)			Plant fresh weight (Kg)		
	90	120	150	90	120	150	90	120	150
Cultivars:									
Marmande	116.9b	130.0b	138.6b	0.823a	1.003a	1.041a	0.867b	1.087a	1.029a
Pearson.	136.7a	156.0a	165.6a	0.970a	0.932a	1.742a	0.072a	1.207a	1.436a
LSD 0.05	12.5	25.7	23.6	0.207	0.367	0.544	0.170	0.246	0.467
N. levels (gm/m):									
10	119.7b	131.9a	137.8a	0.811a	0.733b	1.189a	0.530b	0.852b	1.270a
20	125.3ab	142.4a	153.9a	0.837a	0.962b	1.266a	1.233a	1.072b	1.215a
30	135.5a	155.5a	164.6a	1.042a	1.208a	1.316a	1.148a	1.517a	1.216a
LSD 0.05	15.3	31.5	28.9	0.253	0.450	0.666	0.208	0.324	0.571

Values having an alphabetical letter in common, within a comparable group of means do not differ significantly using LSD at 0.05.

Table 2. Effect of nitrogen fertilizer on plant height, leaf area, and fresh weight of two tomato cultivars at three sampling stages (90,120, and 150 days after transplanting)

Treatment	Plant height (cm)			Plant leaf area (m^2)			Plant fresh weight (Kg)		
	90	120	150	90	120	150	90	120	150
Marmande cv.									
N. levels (gm/m^2):									
10	110.6a	113.3a	124.0a	0.656a	0.588b	1.031a	0.701b	0.713b	0.936a
20	117.8a	133.8a	147.3a	0.839a	1.083ab	1.100a	0.906a	1.147ab	1.137a
30	122.3a	143.0a	144.5a	0.975a	1.339a	0.993a	0.995a	1.402a	1.016a
LSD 0.05	21.6	44.6	40.9	0.358	0.636	0.942	0.294	0.459	0.809
Pearson cv.									
N. levels (gm/m^2):									
10	128.9a	150.5a	151.6a	0.966a	0.878a	1.601a	1.019ab	0.992b	1.603a
20	132.7a	151.0a	160.5a	0.834a	0.842a	1.277a	0.916b	0.996b	1.292a
30	148.6a	118.0a	184.8a	1.109a	1.078a	1.538a	1.281a	1.631a	1.413a
LSD 0.05	21.6	44.6	40.9	0.358	0.636	0.942	0.294	0.459	0.809

Values having an alphabetical letter in common, within a comparable group of means, do not differ significantly using LSD at 0.05.

observed for the first two samplings. Generally, Pearson plants produced more dry weight than Marmande plants.

Gradual increase in dry matter content of tomato plant organs was observed with increasing N-level (Table 3). Such a response was significant for all features, except for leaves and total dry weight at second sampling.

Cultivar x N interaction showed insignificant effect on dry matter content. Nevertheless, both cultivars separately and significantly responded to N application at first and third sampling dates (Table 4). Highest values of dry matter of all plant parts of the two cultivars were obtained with highest N application (30 gm N/m^2). Such a result followed the same trend observed with plant fresh weight (Table 2).

Present results on the effect of nitrogen on dry matter content of tomato cultivars were in agreement with that obtained by Sharma and Mann [4], El-Beheidi *et al.* [2], and Weston and Zandstra [10].

3. Yield and its components

Yield per unit area at a fixed plant density is a function of harvested number of fruits per plant and average fruit weight. The results presented in Table 5 reflected significant differences between the two cultivars in number of fruits and total yield. The cultivar Marmande was better in both traits, and was not significantly inferior in average fruit weight. Cultivar differences in productivity were reported by Bhutani *et al.* [11] and El-Mansi *et al.* [3].

The comparison between the means of nitrogen levels listed in Table 5 clearly indicated that increasing N-level beyond 20 gm N/m^2 slightly reduced the number of fruits and total yield. Average fruit weight, on the other hand, was slightly improved with increasing N-level.

Although cultivar x N interaction had no significant effect on yield or its components, the data of the effect of N on each cultivar presented in Table 6 suggested that Pearson cv reflected a significant adverse response to N application for number of fruits and total yield. While, average fruit weight was increased by the increase in N-level up to 30 gm N/m^2. Marmande cultivar did not reflect any significant response to N applications. Cook and Sanders [8] reported that response of tomato yield to N depends on location. Also, El-Mansi *et al.* [3] found that tomato cultivars differ in their response to N applications.

Results presented here were in accordance with that reported by Vittum and Tapley [6, 7] and El-Mansi *et al.* [3]. Generally, the data of Tables 5 and 6 suggested that N applications at 10 or 20 gm N/m^2 seemed to be sufficient to improve fruit number and total yield. It also indicated that increasing N-level did not improve the average fruit weight. It could be concluded that the aforementioned N-levels might

Table 3. Effect of cultivars and nitrogen fertilizer on dry matter contents of tomato plants at three sampling stages (90,120, and 150 days after transplanting)

Treatment	Plant portions dry weight						Total dry weight (gm)/plant		
	Leaf (gm)			Stem (gm)					
	90	120	150	90	120	150	90	120	150
Cultivars:									
Marmande	64.33a	72.50a	89.88a	63.46b	70.73b	91.53a	127.79b	143.23b	181.41a
Pearson	71.60a	73.73a	94.08a	82.96a	110.83a	101.78a	154.56a	184.56a	195.86a
LSD 0.05	10.63	26.60	20.70	11.91	33.91	17.21	21.50	39.91	35.20
N. levels (gm/m^2):									
10	33.81c	63.68a	70.09b	32.20b	84.08b	73.46b	66.01b	147.76a	143.55b
20	78.10b	76.73a	84.59b	90.78a	89.38ab	89.51b	168.88a	166.11a	174.10b
30	91.98a	78.91a	121.28a	96.65a	98.90a	126.99a	188.63a	177.81a	248.27a
LSD 0.05	13.02	32.57	25.36	14.58	41.53	21.07	26.33	41.14	43.11

Values having an alphabetical letter in common, within a comparable group of means, do not differ significantly using LSD at 0.05.

Table 4. Effect of nitrogen fertilizer on dry matter contents of two tomato cultivars at three sampling stages (90,120, and 150 days after transplanting)

Treatment	Plant portions dry weight						Total dry weight (gm)/plant		
	Leaf (gm)			Stem (gm)					
	90	120	150	90	120	150	90	120	150
Marmande									
N. levels (gm/m^2):									
10	51.19b	62.88a	59.65b	51.16b	59.53a	65.70b	102.4b	122.4a	125.4b
20	65.04ab	84.48a	87.23a	62.99a	76.55a	90.40ab	128.1ab	161.1a	177.6b
30	76.77a	70.15a	122.78a	76.23a	76.13a	118.48a	153.0a	146.3a	241.3a
LSD 0.05	18.42	46.08	35.87	20.64	58.76	29.81	37.24	54.46	60.97
Pearson									
N. levels (gm/m^2):									
10	67.68b	64.48a	80.53b	72.90b	108.63a	81.23b	140.6b	203.1a	161.8b
20	60.39b	68.98a	81.95b	79.72ab	121.25a	88.63b	140.1b	190.2a	170.6b
30	86.73a	87.68a	119.78a	96.28a	102.63a	135.50a	183.0a	190.3a	255.3a
LSD 0.05	18.42	46.08	35.87	20.64	58.76	29.81	37.2	57.5	61.0

Values having an alphabetical letter in common, within a comparable group of means, do not differ significantly using LSD at 0.05.

Table 5. Effect of cultivars and nitrogen fertilizer on number of fruits per plant, fruit weight, and yield of tomato cultivars

Treatment	Fruits per plant	Fruit weight (gm)	Yield/m^2 (Kg)
Cultivars:			
Marmande	56.5a	141.6a	8.000a
Pearson	44.0b	151.7a	6.676b
LSD 0.05	9.1	13.2	1.314
N. levels (gm/m^2):			
10	50.9a	143.4a	7.297a
20	52.1a	146.2a	7.615a
30	47.7a	148.9a	7.102a
LSD 0.05	4.5	9.7	0.725

Values having an alphabetical letter in common, within a comparable group of means, do not differ significantly using LSD at 0.05.

Table 6. Effect of nitrogen levels on number of fruits per plant, fruit weight, and yield of tomato cultivars

Treatment		Fruits per	Fruit	Yield/m^2
cultivar	N. gm/m^2	plant	weight (gm)	(Kg)
Marmande	10	57.3a	139.9a	8.017a
	20	56.6a	142.7a	8.074a
	30	56.5a	140.1a	7.916a
LSD 0.05		7.9	14.9	0.978
Pearson	10	44.5a	147.8b	6.578ab
	20	47.7a	150.0ab	7.155a
	30	39.8b	158.2a	6.295b
LSD 0.05		5.4	9.8	0.825

Values having an alphabetical letter in common, within a comparable group of means, do not differ significantly using LSD at 0.05.

be prodding plants to set so many fruits, that the gross drain of minerals and carbohydrates was larger. Consequently, smaller fruits were produced.

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تأثير مستوى التسميد النيتروجيني على صنفين من الطماطم تحت نظام الصوب البلاستيكية

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ملخص البحث. تمت دراسة تأثير ثلاثة مستويات من النيتروجين (١٠، ٢٠، ٣٠جم N/م^{٢}) على صنفي الطماطم: Marmande و Pearson المزروعة في الصوبة البلاستيكية في محطة الأبحاث والتجارب الزراعية لجامعة الملك سعود في ديراب.

وقد أوضحت بيانات النمو أن نباتات الصنف Pearson كانت أطول وأكثر في المساحة الورقية والوزن الرطب ومحتوى المادة الجافة من الصنف الآخر. وقد أدى استخدام التركيز العالي من النيتروجين (٣٠جم N/م^{٢}) إلى زيادة محتوى المادة الجافة لكن لم يتأثر كل من طول النبات والمساحة الورقية والوزن الرطب. وقد وجدت استجابة معنوية لكل صنف لمستويات النيتروجين خاصة فيما يتعلق بالوزن الرطب ومحتوى المادة الجافة.

أما فيما يتعلق بالمحصول ومكوناته، فقد وجد أن نباتات Marmande أعطت عددًا أكبر من الثمار ومحصولاً أكثر، في حين لم يكن لزيادة مستوى النيتروجين أي تأثير على المحصول ومكوناته. وبفحص استجابة كل صنف على حدة للمعاملة بالنيتروجين يتضح أن صنف Marmande لم يعط أي استجابة مما يدل على أن ١٠جم N/م^{٢} تعتبر كمية كافية لذلك الصنف. بينما وجدت زيادة في عدد الثمار والمحصول في صنف Pearson مع زيادة التسميد النيتروجين حتى مستوى ٢٠جم N/م^{٢} لكن وزن الثمار تأثر عكسيًا بزيادة مستوى النيتروجين مما يدل على أن مستوى ٢٠جم N/م^{٢} يعتبر مناسبًا لصنف Pearson.