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EFFECT OF AMMONIUM NITRATE, CALCIUM NITRATE AND PLANTING SPACES ON YIELD AND YIELD COMPONENTS OF TOMATO

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ABSTRACT

This research was conducted at El-Baramoon Horticultural Research Farm, Dakahlia governorate, Egypt during the summer seasons of 2001 and 2002, to evaluate the effect of application of ammonium nitrate (150 kg N/fed), calcium nitrate (150 kg N/fed) and ammonium nitrate (75 kg N/fed) + calcium nitrate (75 kg N/fed) and plant spaces (15, 20 and 25 cm apart) and their combinations on yield and yield components of tomato plants cv. Peto 86. The obtained results revealed that Ca-nitrate 100% application was the most effective treatment for increasing number of branches, fruit length, fruit diameter, total yield / plot as number and weight, fruit weight and total soluble solids (TSS), followed by ammonium nitrate 50% + Ca-nitrate 50% treatment then ammonium nitrate 100% in both seasons. While, the highest record for plant height gave from the application of ammonium nitrate 50% + Ca-nitrate 50%, followed by ammonium nitrate 100%, then Ca-nitrate 100%. The data also indicated that the lowest blossom end rot (BER) as number and weight was in fruits of the treatment Ca-nitrate 100%, followed by ammonium nitrate 50% + Ca-nitrate 50%, then ammonium nitrate 100% treatment.

With respect to the effect of planting spaces, it was cleared that 15 cm space between tomato plants increased marketable yield / plot as number and weight and also gave the highest TSS and plant height compared with wide spaces (20 and 25 cm). While, the 25 cm space gave the highest fruit weight, fruit diameter, fruit length and No. of branches. 15 cm space gave the highest plant height followed by the treatment of 20 cm space then 25 cm space.

The highest marketable yield as weight / plot was obtained from the combination between Ca-nitrate 100% with different plant spaces (15, 20 and 25 cm) followed by ammonium nitrate 50% + Ca-nitrate 50% x 15 cm space then ammonium nitrate 100% x 15 cm space between tomato plants in both seasons. Same data indicated that Ca-nitrate 100% x 25 cm space had the lowest number and weight of BER fruits.

Finally, it could be concluded that the highest marketable yield, best quality and least BER of tomato fruits (cv Peto 86) was obtained from treatment of Ca-Nitrate (150 kg N/fed) with 25 cm space between tomato plants.

INTRODUCTION

Tomato (*Lycopersicon esculentum,* Mill) is one of the most important vegetable crop in Egypt as well as many countries in the world. During the recent years, the demand of tomato fruits for local consumption and exportation purposes was increased.

Nitrate fertilizers are known to produce a rapid response in the plant. Tomato plant is known to be of higher Ca demand (Al-Sahaf, 1984 and Fathy, 1986), since Ca is required for cell division and elongation.

Gomez-lepe and Ulrich (1974) indicated that NO_3-N increased tomato plant height and growth than other used N-forms. Gibson and Pill (1983) showed that NH_4-N compared with NO_3-N reduced number of shoots and growth of tomato.

Fathy (1986) showed that tomato plants, which treated with 100% N in form of NO_3 had the highest plant height, leaf area, dry weight in shoots, roots, fruits and total dry weight as compared with those of plants, which treated with 100% N in form of NH_4.

Lee *et al.* (1991) grew tomato for 4 months in nutrient solution with N as NO_3 and NH_4 in the ratios 93 : 7, 75 : 25 and 50 : 50. It was found that plant height, leaf area and plant fresh and dry weights were greater with the 93 : 7 ratio than with the 50 : 50 ratio, but did not differ significantly from the 75 : 25 ratio.

Lopez and Satti (1996) screened tomato under normal and saline conditions and with applying of $Ca(NO_3)_2$ and KNO_3. They indicated that $Ca(NO_3)_2$ and KNO_3 improved tomato growth traits under normal and adverse conditions.

Ikeda and Osawa (1988) showed that Ca content of tomato plants was higher with NH_4 + NO_3 than NO_3 alone and decreased as the proportion of NH_4-N increased. Lopez and Satti (1996) indicated that $Ca(NO_3)_2$ and KNO_3 improved fruit yield of different 5 tomato cultivars.

Fathy (1986) indicated that different N-forms, NO_3, NH_4 and $Co(NH_2)_2$ had less effect on TSS content of tomato fruit.

Blossom end rot (BER) is the most serious physiological disease in tomato. It was reported that NH_4-N relative to other N-forms enhanced the incidence of BER (Pill *et al.*, 1978; Fathy, 1986 and Hohjo *et al.*, 1995).

In addition, many investigators indicated that BER was a Ca-related disorder (Greenleaf and Adams, 1969; Al-Sahaf, 1984, and Fathy, 1986).

Barker and Ready (1994) indicated that using $Ca(NO_3)_2$ increased Ca content of tomato fruits and restricted BER development.

Al-Said (1997) showed that using NO_3-N from $Ca(NO_3)_2$ as a sole N-source resulted in a significant increase in number and weight of fruits total yield, a decrease in non-marketable yield and the lowest percentage of number and weight of blossom end rotted fruits (BER) of tomato.

Many investigators reported that wide spaces among the plants caused an increase in number of branches and fruit weight, while narrow spaces caused an increase in plant height, number of fruits and total yield in most vegetable crops, which were studied (El-Bakry, 1966; Abd El-Razik, 1974 and Fadle, 1983).

The aim of this research was to study the effect of application of ammonium nitrate, calcium nitrate and planting spaces and their combinations on yield and yield components of tomato plants.

MATERIALS AND METHODS

Two field experiments were conducted at El-Baramoon Horticultural Research Farm, Dakahlia governorate during 2001 and 2002 summer seasons.

Tomato cv. Peto 86 was transplanted on 10th of March in both seasons. The seed sowing date was 40 days earlier.

Experimental treatments were as follows:-

a. Fertilizers (main factor):

1. NH_4NO_3 150 kg N/fed.

2. Ca $(NO_3)_2$ 150 kg N/fed.
3. NH_4NO_3 (75 kg N/fed) + $Ca(NO_3)_2$ (75 kg N/fed).

b. Plant spaces (sub factor):

1. 15 cm apart.
2. 20 cm apart.
3. 25 cm apart.

The aim of this study is to evaluate the effect of application of NH_4NO_3, $Ca(NO_3)_2$ and NH_4NO_3 + $Ca(NO_3)_2$ and planting spaces 15, 20 and 25 cm and their combinations on growth, yield and quality of tomato plants

The equivalent amounts of nitrogen from each fertilizer were divided into three equal doses, the first was applied 20 days after transplanting, the second was applied after 40 days from transplanting and the third was applied after 60 days after transplanting. Other cultural practices were followed as normally practiced. The experimental design was split plots with three replications in both seasons. The nitrogen fertilizers comprised the main plots and were randomly distributed, while the three planting spaces were randomly distributed in the sub-plots. The sub-plot size contained 3 ridges of 4.5 m long and 1.2 m wide making area 16.2 m^2.

Vegetative samples were taken at the rate of three plants randomly from each plot at the middle of harvesting season. Yield and yield components were estimated.

Data recorded were plant height, No. of branches, fruit length, fruit diameter, marketable yield as number and weight, fruit weight, blossom end rotted fruits (Physiological disease) as number and weight and TSS.

Data were analyzed by analysis of variance and Duncan's multiple range test was used for the comparison between treatments (Duncan, 1955).

RESULTS AND DISCUSSION

1. Effect of N-fertilizers:

Data presented in Table (1) clear the effect of ammonium nitrate (NH_4NO_3) and Ca-nitrate [$Ca(NO_3)_2$] on traits of tomato plants. The data showed that Ca-nitrate 100% application was the most effective treatment for increasing number of branches, fruit length, fruit diameter, total yield / plot as number and weight, fruit weight and total soluble solids (TSS), followed by the treatment of ammonium nitrate 50% + Ca-nitrate 50% then the treatment of ammonium nitrate 100% in both seasons. While, the treatment of ammonium nitrate 50% + Ca-nitrate 50% gave the highest record for plant height, followed by ammonium nitrate 100%, then Ca-nitrate 100%. The data also indicated that the lowest blossom end rot (BER) as number and weight was in fruits of the treatment Ca-nitrate 100%, followed by the treatment of ammonium nitrate 50% + Ca-nitrate 50%, then ammonium nitrate 100%.

Its evident from the data of the present work that such superior effect of using NO_3-N from $Ca(NO_3)_2$ 100% as a sole N-source might be due to increasing the nitrogen and calcium contents of plants and for favourite effect to such N-form NO_3-N for feeding tomato relative to NH_4-N (Gomez-Lepe and Ulrich, 1974; Al-Sahaf, 1984; Fathy, 1986; Lee *et al.*, 1991; Lopez and Satti, 1996 and Al-Said, 1997), thereby the synthesis of amino acids, protein, nucleic acids and hormones, hence growth. In addition, Ca is involved in carbohydrate synthesis and translocation, protein, cell division, elongation, enlargement and enzymes activation. The pronounced reduction in BER incidence as a result of $Ca(NO_3)_2$ 100% treatment might be due to that such treatment induce sufficient Ca supply to shoots and fruits, where Ca is known to be involved in supporting blossom end tissues via establishing strong Ca-pectate links, thereby avoid the tissues breakdown. Also, the NO_3-N form relative to NH_4-N form is known to reduce the incidence of BER, this might be due to that NH_4 depressed the uptake and translocate of Ca via the competition effect on the absorption sites on the roots surface (Blair *et al.*, 1970 and Willcox *et al.*, 1973) and via its enhancing effect on the synthesis of amino and organic acids within roots those that retarded the translocation of Ca from roots upward to the shoots and fruits (Evans and Troxler, 1953 and Shear, 1974), NO_3-N is acted in reverse trend.

2. Effect of planting spaces:

Data presented in Table (2) demonstrated that the treatment of 15 cm space between tomato plants increased marketable yield/plot as number and weight and also gave the highest record of TSS and plant height compared with wide spaces (20 and 25 cm between plants). While, the treatment of 25 cm space between tomato plants gave the highest record of fruit weight, fruit diameter, fruit length, and number of branches. The treatment of 15 cm space between tomato plants gave the highest plant height followed by the treatment of 20 cm space, then 25 cm space. These results are in line with those reported by El-Bakry (1966); Abd El-Razik (1974), and Fadle (1983).

The data showed that the increase in marketable yield / plot as number and weight for treatment of 15 cm space between tomato plants could be due to the increase in number of tomato plants / plot compared with 20 and 25 cm spaces.

With respect to the incidence of BER, same data indicated that the treatment of 15 cm space between tomato plants gave the highest record of BER as number and weight, followed by the 20 cm space then 25 cm space treatments.

These results could be due to more competition between plants on available calcium and water for plants from the surrounding media and other nutrients, which affected the calcium uptake (15 cm space treatment) and thereby increased BER incidence.

3. Effect of fertilizers and planting spaces interactions:

The results in Table (3) cleared the effect of such interactions on traits of tomato plants. Such data showed that the highest values of marketable yield per plot was of the combination between Ca-nitrate 100% x 25 cm space, with insignificant differences between marketable yield / plot in all planting spaces with respect to Ca-nitrate 100% treatment, followed by ammonium nitrate 50% + Ca-nitrate 50% x 15 cm space, then ammonium nitrate 100% x 15 cm space in two seasons. These results might be due to the increase in number of fruits in narrow space (15 cm), in addition, the result of the mentioned effect of each factor alone.

Table 1: Effect of fertilizers on traits of tomato plants in 2001 and 2002 seasons.

Fertilizers	Plant height (cm)	No. of Branches	Fruit length (cm)	Fruit diameter	Marketable Yield		Fruit weight (gm)	Blossom end rotted fruits (disease)		TSS %
					No./ plot	Kg/ Plot		No./ plot	Kg/ plot	
2001 season										
Ammonium nitrate 100%	64.26 b	7.11 c	7.38 b	6.91 b	699.89b	48.17 c	69.33 c	297.56a	9.97 a	4.70 c
Ca-nitrate 100%	55.77 c	10.33 a	7.92 a	7.42 a	827.56a	64.56 a	78.67 a	80.67 c	2.91 b	5.61 a
Ammonium nitrate 50% +Ca-nitrate 50%	67.07 a	9.33 b	7.40 b	7.19 ab	718.78b	51.78 b	72.67 b	131.11b	4.50 b	5.36 b
2002 season										
Ammonium nitrate 100%	69.23 b	9.11 c	6.38 b	5.93 a	651.00b	41.53 c	64.33 c	326.44a	9.94 a	4.72 b
Ca-nitrate 100%	60.74 c	12.33 a	6.89 a	6.42 a	777.44a	56.73 a	73.67 a	112.89c	3.71 b	5.56 a
Ammonium nitrate 50% +Ca-nitrate 50%	72.11 a	11.33 b	6.58 b	6.13 a	668.78b	44.80 b	67.67 b	160.00b	4.87 b	5.42 a

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test.

Table 2: Effect of planting spaces on traits of tomato plants in 2001 and 2002 seasons.

Planting spaces (cm)	Plant height (cm)	No. of branches	Fruit length (cm)	Fruit diameter	Marketable yield		Fruit weight (gm)	Blossom end rotted fruits (disease)		TSS %
					No./ plot	Kg/ plot		No./ plot	Kg/ plot	
2001 season										
15	68.06a	7.67 c	6.99 c	6.71 c	846.78a	56.90 a	67.00 c	251.67a	9.35 a	5.81 a
20	60.86b	8.67 b	7.40 b	7.02 b	740.78b	53.57 b	72.11 b	165.00b	5.32 b	5.16 b
25	58.16c	10.44 a	8.31 a	7.79 a	658.67c	54.05 b	81.56 a	92.67 c	2.72 c	4.70 c
2002 season										
15	72.92a	9.67 c	5.95 c	5.71 b	796.67a	49.56 a	62.00 c	280.56a	9.78 a	5.79 a
20	65.83b	10.67 b	6.57 b	5.97 b	691.89b	46.58 b	67.11 b	196.11b	5.75 b	5.16 b
25	63.33c	12.44 a	7.31 a	6.81 a	608.67c	46.92 b	76.56 a	122.67c	2.98 c	4.76 c

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test.

Table 3: Effect of fertilizers and planting spaces interactions on traits of tomato plants in 2001 and 2002 seasons.

Fertilizers	Planting spaces	Plant height (cm)	No. of branches	Fruit length (cm)	Fruit diameter	Marketable Yield No./plot	Marketable Yield Kg/plot	Fruit weight (gm)	Blossom end rotted fruits (disease) No./plot	Blossom end rotted fruits (disease) Kg/plot	TSS %
2001 season											
Ammonium nitrate 100%	15	70.70 b	5.67 f	6.30 f	6.00 d	800.0 c	50.67 c	63.33 f	450.00a	16.48 a	5.23 c
	20	62.33 d	7.00 e	7.43 cd	6.93 c	685.3 e	47.98cd	70.00 d	306.70b	9.00 b	4.60 e
	25	59.73 e	8.67 d	8.40 a	7.80 a	614.3 f	45.88 d	74.67 c	136.00d	3.67 d	4.27 f
Ca-nitrate 100%	15	60.17 e	9.00 c	7.47 cd	7.37 b	907.3 a	64.73 a	71.33 d	108.30de	4.33 d	6.43 a
	20	55.30 f	10.00 bc	7.77 bc	7.10 bc	838.7 b	62.90 a	75.00 c	75.00 f	2.66 f	5.50 c
	25	52.17 g	12.00 a	8.53 a	7.80 a	736.7 d	66.06 a	89.67 a	58.67 f	1.72 g	4.90 d
Ammonium nitrate 50% + Ca-nitrate 50%	15	73.30 a	8.33 d	7.20 de	6.77 c	833.0 b	55.30 b	66.33 e	196.70c	7.23 c	5.77 b
	20	64.93 c	9.00 cd	7.00 e	7.03 bc	698.3 e	49.83 c	71.33 d	113.30de	3.52 de	5.37 c
	25	62.97 d	10.67 b	8.00 b	7.77 a	625.0 f	50.20 c	80.33 b	83.33ef	2.76 ef	4.93 d
2002 season											
Ammonium nitrate 100%	15	75.70 b	7.67 f	5.30 f	5.00 e	750.0 c	43.75 c	58.33 f	473.3 a	16.38 a	5.33 d
	20	67.27 d	9.00 e	6.43 de	5.93 cd	638.7 e	41.52cd	65.00 d	336.7 b	9.0 b	4.60 f
	25	64.73 e	10.67 d	7.40 ab	6.87 a	564.3 f	39.32 d	69.67 c	169.3 d	3.76 e	4.23 g
Ca-nitrate 100%	15	64.77 e	11.00 cd	6.37 de	6.37 bc	857.0 a	56.85 a	66.33 d	141.7 d	5.25 d	6.17 a
	20	60.30 f	12.00 bc	6.77 cd	6.10 cd	788.7 b	55.20 a	70.00 c	108.3 e	3.52 ef	5.50 c
	25	57.17 g	14.00 a	7.53 a	6.80 ab	686.7 d	58.14 a	84.67 a	88.67 e	2.35 g	5.00 e
Ammonium nitrate 50% + Ca-nitrate 50%	15	78.30 a	10.33 d	6.20 e	5.77 d	783.0 b	48.07 b	61.33 e	226.7 c	7.73 c	5.87 b
	20	69.93 c	11.00 cd	6.53 de	5.87 d	684.3 e	43.20 c	66.33 d	143.3 d	4.04 e	5.37 cd
	25	68.10 d	12.67 b	7.00 bc	6.77 ab	575.0 f	43.31 c	75.33 b	110.0 e	2.84 fg	5.03 e

Means having the same letter in the same column do not significantly differ using Duncan's Multiple Range Test.

The data also showed that the highest fruit weight gave from the combination between Ca-nitrate 100% x 25 cm space between tomato plants, followed by ammonium nitrate 50% + Ca-nitrate 50% x 25 cm space, then ammonium nitrate 100% x 25 cm space in both seasons. The superiority of these interaction treatments could be due to a result of the mentioned promotional effect of each factor alone. Also, the above mentioned treatment gave the highest number of branches as same arrangement.

Same data cleared that the highest TSS gave from the combination between Ca-nitrate 100% x 15 cm space, followed by ammonium nitrate 50% + Ca-nitrate 50% x 15 cm space, then ammonium nitrate 100% x 15 cm space treatments in both seasons.

With respect to the incidence of BER, same data indicated that Ca-nitrate 100% treatment x 25 cm space had the lowest number and weight of BER fruits and BER fruits increased by decreasing plant spaces within the same treatment, followed by the combination between ammonium nitrate 50% + Ca-nitrate 50% x 25 cm space, then ammonium nitrate 100% x 25 cm space in both seasons.

Generally, the highest marketable yield as weight per plot was obtained from the combination between Ca-nitrate 100% x different plant spaces (15, 20 and 25 cm), followed by the combination between ammonium nitrate 50% + Ca-nitrate 50% x 15 cm space, then ammonium nitrate 100% x 15 cm space between tomato plants in both seasons of study. These results could be due to the increase in fruits number or weight, in addition the mentioned promotional effect of each factor alone.

Finally, it could be resulted that the highest marketable yield, best quality and least BER of tomato fruits (cv Peto 86) was obtained from treatment of Ca-Nitrate 100% (150 kg N/fed) with 25 cm space between tomato plants.

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تأثير نترات الأمونيوم ونترات الكالسيوم ومسافات الزراعة على المحصول ومكوناته فى الطماطم ·

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قسم بحوث الخضر – مركز البحوث الزراعية – القاهرة – مصر ·

أجرى هذا البحث فى المزرعة البحثية بالبرامون بمحافظة الدقهلية فى الموسم الصيفى ٢٠٠١ ، ٢٠٠٢ وذلك بهدف دراسة تأثير نترات الأمونيوم (١٥٠ كيلو جرام نتروجين / فدان) ونترات الكالسيوم (١٥٠ كيلو جرام نتروجين / فدان) ونترات الأمونيوم (٧٥ كيلو جرام نتروجين / فدان) + نترات الكالسيوم (٧٥ كيلو جرام نتروجين / فدان) ومسافات زراعة مختلفة (١٥ ، ٢٠ ، ٢٥ سم) على النمو والإنتاج والجودة للطماطم صنف بيتو ٨٦ ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:-

١- بالنسبة لتأثير الأسمدة أوضحت النتائج أن نترات الكالسيوم ١٠٠% كانت أفضل معاملة لزيادة عدد الأفرع وطول الثمرة وقطر الثمرة والإنتاج الصالح للتسويق للقطعة التجريبية كعدد ووزن ، ووزن الثمرة والمواد الصلبة الذائبة الكلية يليه نترات الأمونيوم ٥٠% + نترات الكالسيوم ٥٠% ثم نترات الأمونيوم ١٠٠% فى كلا الموسمين·

٢- أوضحت النتائج أيضا أن أقل عفن طرف زهرى كعدد ووزن كان مع معاملة نترات الكالسيوم ١٠٠% يليها نترات الأمونيوم ٥٠% + نترات الكالسيوم ٥٠% وأخيرا نترات الأمونيوم ١٠٠%·

٣- بالنسبة لتأثير مسافات الزراعة ، أوضحت النتائج أن معاملة ١٥ سم مسافة بين النباتات أعطت أعلى إنتاج صالح للتسويق للوحدة التجريبية كعدد ووزن وأيضا أعلى TSS وإرتفاع نبات بالمقارنة بالمسافات الواسعة (٢٠ ، ٢٥ سم) ، بينما أعطت المعاملة ٢٥ سم مسافة زراعة أعلى وزن ثمرة ، وقطر ثمرة ، وطول ثمرة وأعلى عدد أفرع·

٤- كانت أفضل معاملة تفاعل للحصول على أعلى محصول صالح للتسويق كوزن للوحدة التجريبية هو معاملة نترات الكالسيوم ١٠٠% × مختلف مسافات الزراعة (١٥ ، ٢٠ ، ٢٥ سم) يليها نترات الأمونيوم ٥٠% +نترات الكالسيوم ٥٠% × مسافة زراعة ١٥ سم وبعد ذلك نترات الأمونيوم ١٠٠% × مسافة زراعة ١٥ سم فى كلا الموسمين·

٥- كانت أفضل معاملة تفاعل للحصول على أقل عدد ووزن عفن طرف زهرى للثمار هى معاملة نترات الكالسيوم ١٠٠% × مسافة زراعة ٢٥سم بين النباتات·

نتيجة لما سبق فإننا نوصى بزراعة الطماطم صنف بيتو ٨٦ على مسافة زراعة ٢٥ سم مع التسميد بنترات الكالسيوم (١٠٠%) وذلك للحصول على أعلى محصول صالح للتسويق ، وأعلى جودة وأقل إصابة بعفن الطرف الزهرى للثمار·