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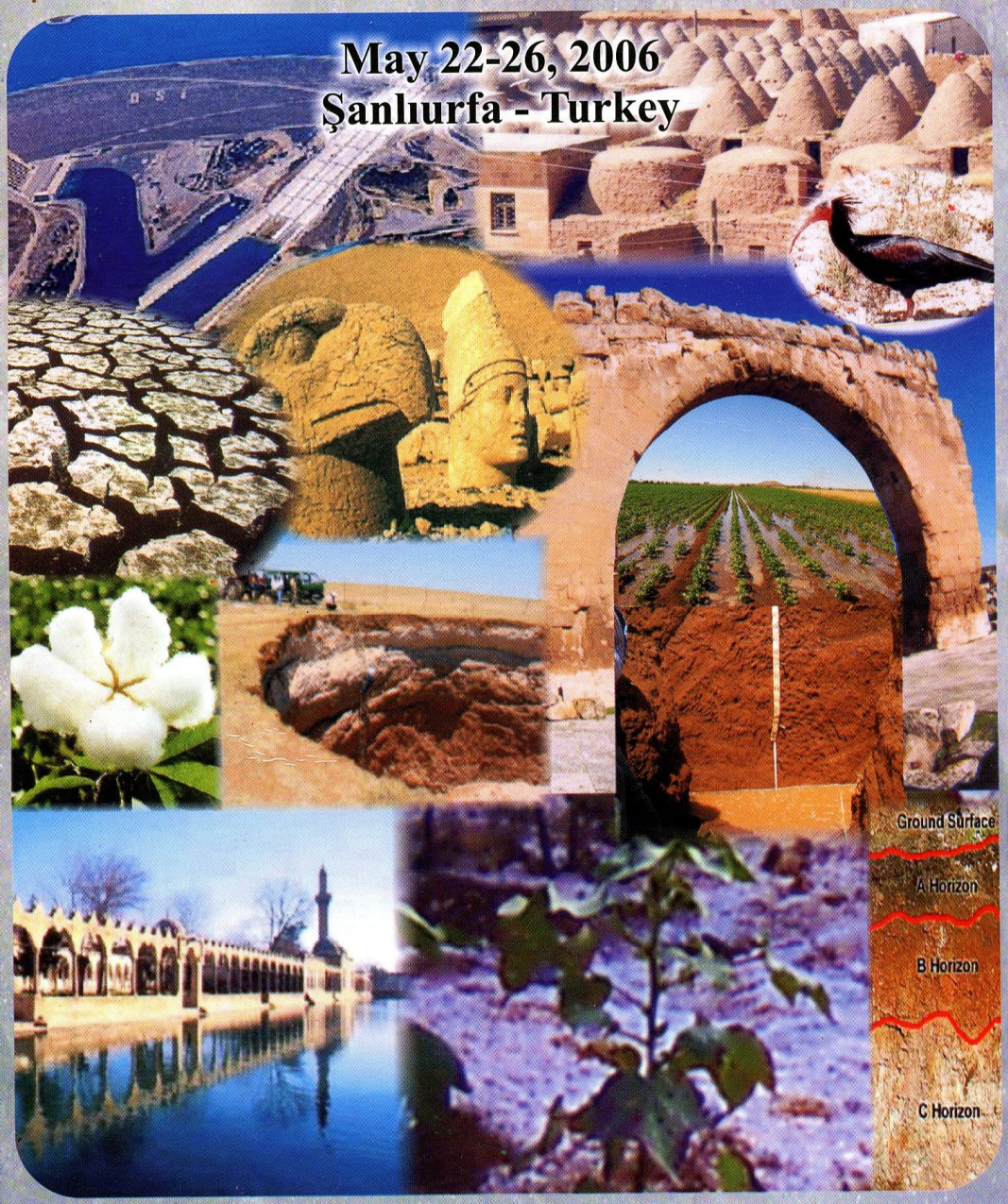

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The Effects of Different Nitrogen Fertilizer Treatments of Tomato Grown by Applying Different Lime Doses on Some Characteristics of Fruit and Blossom-End Rot

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Abstract

In this study in order to decrease blossom-end rot, it was planned to support the plant with calcium by adding lime into the seedbed at the seedling period and besides to give different nitrogen fertilizers after the seedling plant became mature in the transplanting medium to help them take the calcium.

In accordance to this aim, the Rio Grande cultivar of the tomato seedlings were grown in a plastic covered unheated greenhouse between the dates of 02 March 2004 and 29 July 2004 by applying 4 calcium carbonate doses (0, 5, 10, 15 kg ha^{-1} of $CaCO_3$). The seedlings were transplanted into a soil medium where 300 kg ha^{-1} of manure were applied and they were grown by applying 3 different nitrogen sources (calcium nitrate, ammonium nitrate and calcium ammonium nitrate).

The effects of the treatments made on some of the characteristics (yield, length and fruit number with blossom-end rot) of the harvested tomato fruits were examined. In terms of the used lime amount; the highest yield, fruit length and the least blossom-end rot (BER) were found in the plants that were treated with 5 kg ha^{-1} dose of $CaCO_3$. Considering the nitrogen fertilizer treatments; while the highest yield and fruit length were determined with the calcium ammonium nitrate treatment, the least fruit number with blossom-end rot were observed in plants that were fertilized by ammonium nitrate and calcium ammonium nitrate.

Keywords: Tomato, Calcium, Nitrogen and BER

Introduction

Tomato that has an important place in the economy of Turkey is an important income source in their growing regions. The suitable climate conditions of Turkey to grow this vegetable and the existence of an industry to process these vegetables since the 1970's, accelerated the inclination towards tomato. Consequently, Turkey became one of the huge tomato producers such as America and Italy (Vural et al., 2000a). A total of 23 698 667 tons of vegetable are produced in an area of 8 31255 ha in Turkey and the 2.57 % of this, with 609 201 tons in an area of 18057 ha, is provided from Çanakkale. The mostly produced vegetables in Çanakkale are tomato, pepper and watermelon; estimating 540489 tons with 88.7 % of the total vegetable production (DİE, 2002). Tomato is in the first sequence in Turkey with under cover and uncovered vegetable growth (Kabay and Türkmen, 2000). The tomato seedlings form the 70-80 % of the total seedlings carried out in Turkey (Vural et al., 2000b).

Besides cultivar, irrigation, and pest management; mineral fertilization is also important in producing the maximum tomato per unit area in a most economic way. Just as in all culture plants, tomato also needs to be nourished by macro and micro nutrient elements and for the continuity of high yield, the plant nutrient elements removed with the product should be regained to the soil (Yağmur et al., 1993). The roots of the plants with calcium deficiency remain very weak and mostly take a color of brown (Günay, 1992). Calcium in the form of pectate, take the main duty in strengthening the cell walls and plant tissues. Calcium affects the root lengthening and cell division in the plant (Kacar et al., 2002). Blossom-end rot develops in the tomato fruits that cannot be nourished sufficiently by calcium, which is one of the three critic elements (calcium, potassium and phosphor) in tomatoes grown with the soil system (Jones, 1999).

Blossom-end rot in tomato is seen as the rotting of the fruit end connected with the deficiency of calcium in the fruit. The end of the fruit collapse, dry and turn into a paper-like tissue. This disorder is known as "dry rot" among farmers. The blossom-end rot disease may not only be bound to the low calcium levels. If the soil contains from medium to high leveled calcium, blossom-end rot may still develop. Anything about the movement of the calcium with water from the ligneous tissue may cause blossom-end rot as well (Anon., 2004).

Most researchers reasoned the blossom-end rot of tomato to the deficiency of Ca^{2+} in the fruit or in the parts of the plant related with the absorption of the required elements by their roots, the movement of Ca^{2+} to the fruit and the varying Ca^{2+} requirement bound to the growing rate of the fruit. Besides these, a critic value could not be found for Ca^{2+} in the fruit and the effects of suitable and unsuitable conditions for the development of BER have still not be understood very well. Some pressures that lead to water loss and damage of the cell membrane such the declination of the Ca^{2+} amount, which increase the cell membrane permeability, water deficiency in the soil, high salinity or high NH_4^+ effectiveness trigger BER. When the acceptable pressure rate is exceeded, it is observed that BER develops more frequently in the young fruits that are not at the beginning of cell development. In this stage GA (Giberellic Acid) at the highest amount, which is effective physiologically and Ca^{2+} at the lowest amount is found. This hypothesis will develop with the researches towards the physiologically disorders that still keep their obscurity (Suare, 2001).

The aim of this study is to search the effects of different nitrogen sources applied to seedlings obtained from different calcium doses on yield, length and fruit number with blossom-end rot.

Material and Method

Material

This research was conducted at the year 2004, in an unheated plastic application and research greenhouse located at the Bayramiç Vocational College at the University of Çanakkale Onsekiz Mart. The Rio Grande tomato cultivar was used as a plant material in the research and four different calcium carbonate doses were used at the seedling growth stage. As a growing medium seed peat treated with different calcium carbonate doses at 20 multi-pots, were used. The used peat was 70 liters of seed peat and its pH value and organic matter amount was 5.5-6.5 and 45-55%, respectively. At the transplantation stage of the experiment, the calcium nitrate, ammonium nitrate, calcium ammonium nitrate, potassium sulphate and triple super phosphate fertilizers were used. Soil and organic fertilizer was used as a medium in the experiment. The soil was garden soil where tomato growth at production conditions was made previously and the organic fertilizer was goat manure.

Method

In the first stage of the experiment, which is the seedling growth stage, 4 different doses of calcium carbonate was applied, 4 replications were planned and established according to randomized block design in 16 parcels (4 doses calcium carbonate x 4 replications). The calcium carbonate doses (0, 5, 10, 15 kg ha^{-1} $CaCO_3$) applied to 70 liters seed peat used as a growing medium was mixed to the peat according to the estimation of the area. The Rio Grande seed were planted into the peat that was applied with different calcium carbonate doses and filled to multi-pots. They were planted on 02 March 2004 at a total amount of 320, one to each division of the multi-pot. Equal amount of water was given to each multi-pot at the growing period of the seedlings and on 17 April 2004, the applications were transplanted when the seedlings reached to a 4-5 leaved situation. At the transplantation stage, 3 different nitrogen sources were applied to the seedlings grown on mediums where 4 different calcium carbonate doses were applied. They were planned with 4 replications and were established in a randomized block design at 48 parcels (4 seedling development medium x 3 nitrogen source x 4 replications). The soil used in the experiment was sifted and a dry soil was obtained by spreading it. 11 kg of soil was weighed for each pot that forms the parcels in the experiment. Manure was weighed to be 300 kg ha^{-1} and filled into pots by mixing it with the prepared soil. After the filling up of each parcel was completed, all the triple super phosphate as 0.7 kg ha^{-1} P_2O_5, potassium sulphate as 3 kg ha^{-1} K_2O and calcium nitrate, ammonium nitrate and calcium nitrate as 2 kg ha^{-1} N was applied. 3 seedlings were selected from parcels where different calcium carbonate doses were applied in order to apply 3 different nitrogen sources and a total of 48 seedlings, 1 seedling for each parcel, were transplanted to pots on 17 April 2004. The plant selections were made by considering the morphologically best developed seedlings. Equal amount of water was given to each plant throughout the experiment and the soil surface was aired by stirring it. Harvest was made when the tomatoes reddened and the experiment was completed on the 29th of July 2004. The plants and obtained fruits were evaluated by observing the below parameters.

Yield (kg ha^{-1}): The total fruit obtained from each parcel was estimated by weighing them with a 0.01 sensitive scale.

Fruit length (mm): each fruit length was determined by measuring them with a digital compass.

Fruit with blossom-end rot (BER) (number): the number of fruit with blossom-end rot obtained from all plant fruits was counted.

The obtained data were analyzed by using the MINITAB statistical software and analysis of variance was carried out according to randomized block design. In the variance analysis tables, the factors that were important in the 5 % level were shown with * and the differences at the 1 % level were indicated with **. The differences among mediums were found according to LSD. In the comparisons made with LSD, the mediums with no difference among themselves were indicated with the same letter.

Findings and Discussion

The effects of the three different nitrogen sources (calcium nitrate, ammonium nitrate and calcium ammonium nitrate) applied to seedlings obtained from the first calcium carbonate treatment (0 kg ha^{-1}) on yield, fruit length and fruit number with blossom-end rot have been given in Table 1.

When Table 1 is examined, the difference among yields which were obtained by using different nitrogen sources at the tomato plants that came from the medium where calcium carbonate treatment was not made (0 kg ha^{-1}), were found statistically 5% important and the highest yield (14.736 kg ha^{-1}) was obtained with the calcium ammonium nitrate sourced nitrogen treatment.

Table 1. Data of the plants from the medium where its seedling was not treated with calcium carbonate*

Nitrogen sources	Yield (kg ha^{-1})		Fruit length (mm)	Fruit number with BER (number plant^{-1})
CN	10.510	AB	32.73	0.00
AN	2.188	B	27.78	0.00
CAN	14.736	A	28.51	0.50
LSD	%5		ns	ns

CN: Calcium nitrate, AN: Ammonium nitrate, CAN: Calcium ammonium nitrate, ns: Not significant
*The difference among the values indicated with the same letter are not important according to P<0.005

While different nitrogen sources had no statistically important effect on fruit length and fruit number with blossom-end rot, the highest fruit length (32.73 mm) was seen with the calcium nitrate sourced treatment and the fruit number with the least blossom-end rot (0.00) was observed with the calcium nitrate and ammonium nitrate sourced nitrogen treatment.

The effects of the three different nitrogen sources (calcium nitrate, ammonium nitrate and calcium ammonium nitrate) applied to seedlings obtained from the second calcium carbonate treatment (5 kg ha^{-1} $CaCO_3$) on yield, fruit length and fruit number with blossom-end rot have been given in Table 2.

Table 2. Data of the plants from the medium where its seedling was treated with 5 kg ha^{-1} of calcium carbonate*

Nitrogen sources	Yield (kg ha^{-1})	Fruit length (mm)	Fruit number with BER (number plant^{-1})
CN	18.176	33.50	0.50 B
AN	12.656	27.82	0.00 A
CAN	7.885	30.42	0.50 A
LSD	ns	ns	%5

CN: Calcium nitrate, AN: Ammonium nitrate, CAN: Calcium ammonium nitrate, ns: Not significant
*The difference among the values indicated with the same letter are not important according to P<0.005

When Table 2 is examined, the different nitrogen sources applied to tomato plants that came from the 5 kg ha^{-1} calcium carbonate treatment were statistically 5% important on the fruit number with blossom-end rot. While blossom-end rot was seen at the calcium nitrate sourced nitrogen treatment (0.5 per plant), it was not observed at the ammonium nitrate and calcium ammonium nitrate sourced nitrogen treatment. Although there was no important difference statistically, the highest yield (18.176 kg ha^{-1}) and highest fruit length (33.5 mm) was observed with the calcium nitrate sourced nitrogen treatment.

The effects of the three different nitrogen sources (calcium nitrate, ammonium nitrate and calcium ammonium nitrate) applied to seedlings obtained from the third calcium carbonate treatment of 10 kg ha^{-1} $CaCO_3$ on yield, fruit length and fruit number with blossom-end rot have been given in Table 3.

Table 3. Data of the plants from the medium where its seedling was treated with 10 kg ha^{-1} of calcium carbonate*

Nitrogen sources	Yield(kg ha^{-1})	Fruit lenth (mm)	Fruit number with BER(number plant^{-1})
CN	17.335	31.46 A	0.66
AN	9.624	26.24 B	1.00
CAN	14.748	31.44 A	1.00
LSD	ns	%5	ns

CN: Calcium nitrate, AN: Ammonium nitrate, CAN: Calcium ammonium nitrate, ns: Not significant
*The difference among the values indicated with the same letter are not important according to P<0.005

When Table 3 is examined, it is seen that there is a 5% statistical important difference on the fruit length between different nitrogen sources at the tomato plant obtained from the 10 kg ha^{-1} calcium carbonate treatment. Although the calcium nitrate and calcium ammonium nitrate sourced nitrogen treatments were not different statistically, the highest fruit length (31.46 mm) was seen with the calcium nitrate sourced nitrogen treatment.

While there was no statistical difference, the highest yield (17.335 kg ha^{-1}) and the fruit with the least blossom-end rot (0.66 per plant) was observed with the calcium nitrate sourced nitrogen treatment.

The effects of the three different nitrogen sources (calcium nitrate, ammonium nitrate and calcium ammonium nitrate) applied to seedlings obtained from the forth calcium carbonate treatment of 15 kg ha^{-1} $CaCO_3$ on yield, fruit length and fruit number with blossom-end rot have been given in Table 4.

When Table 4 is examined, while there was no statistical impact when the effects of different nitrogen sources at the tomato plants that came from the 15 kg ha^{-1} calcium carbonate treatment on yield, fruit length and

fruit number with blossom-end rot is considered; the highest yield (16.687 kg ha^{-1}) was observed with the calcium nitrate sourced nitrogen treatment.

Table 4. Data of the plants from the medium where its seedling was treated with 15 kg ha^{-1} of calcium carbonate

Nitrogen sources	Yield(kg ha^{-1})	Fruit length (mm)	Fruit number with BER (number $plant^{-1}$)
CN	16.687	25.55	0.67
AN	10.607	28.48	0.25
CAN	13.615	31.10	0.75
LSD	ns	ns	ns

CN: Calcium nitrate, AN: Ammonium nitrate, CAN: Calcium ammonium nitrate, ns: Not significant

The highest fruit length (31.10 mm) was seen with the calcium ammonium nitrate sourced nitrogen treatment. The fruit number with the least blossom-end rot (0.25 per plant) was obtained with the ammonium nitrate sourced treatment.

Results

In this research conducted in an unheated plastic covered greenhouse, the effects of 3 different sourced nitrogen treatments of the Rio Grande cultivar tomato seedlings grown by applying 4 different calcium carbonate doses on some characteristics (yield, length and fruit number with blossom-end rot) of the tomato fruit was examined.

According to the results, of the experiment, in terms of the used lime, the fruit length and least blossom-end rot was obtained from the seedlings where 5 kg ha^{-1} $CaCO_3$ dose was applied.

In terms of the used nitrogen fertilizers, while the highest yield and fruit length was obtained with the calcium nitrate sourced nitrogen treatment, the least blossom-end rot was determined with the ammonium nitrate and calcium ammonium nitrate sourced nitrogen treatment.

After the seedlings grown by applying different calcium carbonate doses were transplanted to pots, 3 different nitrogen sources were applied and the highest yield and fruit length was observed at the calcium nitrate sourced nitrogen treatment where the seedlings were applied a dose of 5 kg ha^{-1} $CaCO_3$. The least blossom-end rot was determined with the calcium ammonium nitrate sourced nitrogen treatment where 15 kg ha^{-1} $CaCO_3$ dose was applied to the seedlings.

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