English Version

Calcium, boron and vegetal regulators in the fruit fixing in tomato

Mayara Wesley da Silva[1], *Cleber Junior Jadoski*[2], *Elizabeth Orika Ono*[3], *Rumy Goto*[4]

Abstract

Tomato crop presents expressive area of cultivation and economical importance for the agribusiness for the state of São Paulo. It was evaluated the influence of boron and calcium nutrients and plant growth regulators to increase fruit set in tomato, in view of the inadequate supply of nutrients, coupled with other external factors may promote the abortion of flowers and fruits. To evaluate the treatments, it was quantified the rate of fruit set in tomato 'Saladinha Plus', and it was ranked the fruit concerning marketing and mass (kg), indicating that due to good conditions in which the experiment was conducted, the treatment application, even in protected cultivation, did not provide greater fruit set, and no increase in the number of marketable fruits.

Key Words: abortion; flowers; commercial production, tomato

Introduction

The protected cultivation represents a great alternative in the production of tomato for consumption *in natura*, however, the use of plastic cover and side curtains promote changes in the soil thermal amplitude, evaporation, period of leaf improvement and, mainly over temperature and humidity (RODRIGUES, 1997). The low relative humidity and the occurrence of high temperatures cause increase in the rate of transpiration, stomata closing, flower abortion (ALVARENGA, 2004), lower fruit fixation and, consequent, fall in the production.

Boron is an essential element in the mineral nutrition of plants. It is absorbed by roots as neutral boron acid ($B[OH]_3$) and as borate ($B[OH]^{4-}$). The absorption occurs by three mechanisms: passive diffusion, easy transport trough protein channels and active transport by specific proteins (LÄUCHLI, 2002). The authors emphasize that the element forms part of the cellular wall and stable complexes in the plasmatic membranes and stimulated the germination of the pollen and elongation of the pollen tube.

For the germination of the pollen grain and growth of the pollen tube, which will guarantee the flower fecundation, the nutrients calcium and boron are essential (MARSCHNER, 1995). However they are immobile in plants, being translocated, mainly, by xylem (ALVARENGA, 2004; FERNANDES, 2006; MALAVOLTA, 2006). Thus, the inappropriate supply of these nutrients may contribute to a reduction of productivity, sue to the lower fruit establishment (LAVIOLA e DIAS, 2008), being necessary its complementation by the application of these nutrients trough leaves or in direction to the flower brunches.

In tomato, the flower abortion is accented by the attack of plagues and diseases and, mainly, by water stress, excess or deficiency of nitrogen (FILGUEIRA, 2000) and/or nutritional unbalance, besides sensibility to temperatures (SMITH, 1935). The ideal temperature for the fruit establishment are between 19 and 24 °C during the day and 12 to 17 °C during the night (SILVA et al., 1994).

Thus, the objective of this experiment was to evaluate the efficacy of calcium and boron nutrients and plant growth regulators for the fruit fixation and

1 Agronomic Engineer, Superviser of quality Agropecuária Vale das Uvas-Petrolina/PE mayarawesley@hotmail.com

2 Agronomic Engineer, Student of the Master's degree with emphasis in Ecophisiology of Big Crops of the Faculty of Agronomic Sciences e-mail: cjadoski@fca.unesp.br

3 Professor, Doctor in Vegetal Physiology of the Faculty of Agronomical Sciences – Unesp e-mail: eoono@ibb.unesp.br

4 Professor, Doctor in Horticulture of the Faculty of Agronomical Sciences – Unesp e-mail: goto@fca.unesp.br

tomato productivity, in protected cultivation.

Material and methods

The experiment was conducted under protected cultivation in the Fazenda de Ensino, Pesquisa e Produção of the FCA - UNESP, in São Manuel, during the months of July 2009 to January 2010. It was used the hybrid Saladinha Plus (Sakata Seed Sudamericana Ltda.), which belong to the group Salada. The seedlings were produced 30 days after the seeding (D.A.S.), when they had 3 to 4 definitive leaves.

The experiment was prepared in scheme of completely randomized block with 6 treatments and 5 blocks. In each replication it was used 3 plants for the evaluation.

The tomato plants were treated with 1.235 g ha^{-1} of calcium; 2.67 g ha^{-1} of boron; 3.145 g ha^{-1} of calcium and 29 g ha^{-1} of boron; 4.145 g ha^{-1} of calcium and 29 g ha^{-1} of boron with 750 mL ha^{-1} of vegetal biostimulating and 5.145 g ha^{-1} of calcium and 29 g ha^{-1} of boron with 200 mg of kinetin L^{-1} of water.

The vegetal biostimulating used contained the mixture of kinetin (90 mgL^{-1}), IBA (50 mgL^{-1}) and GA_3 (50 mgL^{-1}). All the products came from commercial formulas from Stoller from Brazil.

To the treatment solutions, it was added emulsifiable vegetal oil at 1%. The treatments were applied with manual spraying of accuracy at CO_2, with pressure of 4 to 5 kg/cm^2, with jet directed for the flower brunches, in the following phases:

In the moment of the anthesis – when 50% of the flower brunches are already opened.

In the beginning of the fructification – when 50% of the fruits of the flower brunches presented fruit with 2.0 to 3.0 cm of diameter.

In the moment of the first application of the treatments 10 brunches per plant were selected and marked. It was followed by the counting of flowers present in the brunches and, after the fructification, it was counted the number of fruits for the calculation of the index of fixation (IF = (number of fruits/ number of flowers) x 100).

After 130 D.A.S. it was initiated the fruit collection, which were weekly. All the plant fruits were collected and treatments were evaluation regarding to:

The commercial classification of fruits – measure performed with aid of digital caliper (centimeters) and the fruits were classified according to the Cartilha de adesão voluntária para padronização from CEAGESP (1997);

Fruit mass: measure performed in semi-analytic digital weight.

The results obtained were submitted to analysis of variance, with the averages compared by Tukey test at 5%. The data index of fixation was transformed using the equation: arc sin ($\sqrt{x/100}$) for the statistic analysis.

Results and discussion

In Table 1 it is presented the quantity of flowers analyzed and fruits obtained after the application of the treatments. This Table also contains the index of fixation (I. F.), which was not affected significantly with the application of the treatments.

Studies have showed the existence of factors

Table 1. Number of flowers, fruits and Index of fruit fixation (%) in tomato 'Saladinha Plus' treated with calcium, boron and vegetal regulators. São Manuel, UNESP, 2009.

Treatments	Flowers	Fruits	I.F. (%)
Calcium	1033 a	558 a	83 a
Boron	942ab	478ab	79 a
Ca+B	886 b	466 b	82 a
Ca+B+ ck+GA+Ax	989ab	498ab	79 a
Ca+B+kt	889 b	456 b	80 a
Control	945ab	481ab	80 a
C.V. (%)	12.17	17.55	10.4

**averages followed by the same letter in the column do not differ, by Tukey test at 5%.*

which influence directly in the fruit fixation, flower abscission and in the pollen sterility (HOWLETT, 1936), as: conditions of high temperature in the flowering (ALVARENGA, 2004) and deficit or excess of water, which are linked to the unbalance of the relation carbohydrate/nitrogen and other nutrients in the plants (LEOPOLD and SCOTT, 1952).

It was not verified an increase of the I.F. with the application of the treatments, possibly, due to the general conditions of nutrition and climate in which this study was conduced, since it was verified satisfactory gradient between the day and night temperatures, which maintained, on average, in the ideal range for the development and production of tomato, that is between 10 and 35 °C, according to data presented by Dempsey (1970) and Aalvarenga (2004). Nuez (2001) describe that the effect of extreme temperatures out of the recommended range may affect decisively the germination of the pollen grain.

The localized irrigation maintained the water volume constant, which was enough to achieve the crop demand. It was not observed significant incidence of diseases in plants, and the plagues were maintained below the level of economical damage by chemical control.

In the experiment it was used phosphate fertilization in pre planting, and nitrate and potassium trough fertirrigation applied weekly, achieving thus, the nutritional necessities of the plants. The soil of the greenhouse, which was analyzed before the seedling transplanting, presented pH = 6.9, V% = 84 and 8 g dm^{-3} of O. M. Alvarenga (2004) considers that for higher efficiency of nutrient absorption, the ideal range of pH for tomato is 5.5 to 6.5 and with the base saturation between 70 and 80%.

The classification of the fruits per diameter is presented in Table 2, in which fruits with diameter superior than 50 mm are considered marketable. It is verified that fruits which come from plants which received no treatment (control) present higher quantity of fruits with diameter inferior than 40 mm, which are considered of low quality. In this table it can be observed that it occurred a higher number of fruits in the class 50 – 60 mm, with emphasis to the mixture of Ca+B+kt.

Trough Table 3, which presents the average weight of fruits, it is observed that this factor did not change by the application of the treatments. This response is probably due to the moment of application of the treatments, since, according to Gargantini and Blanco (1963), in order to have response in the fruit mass it would be necessary to perform applications during the fruit development. In this sense, the authors verified that the absorption of nutrients is slow until the flowering, in general until 70 days after seeding (DAS), which presented peak between 100 and 120 DAS, moment in which it occurs the maximum development of the tomato fruit.

Facing the results, it can be considered that the application of calcium and boron and of plant growth regulators mixture to these nutrients did not provide better fruit fixation, nor causes increase in the fruit number/size. The results are possibly related to the fact that without passing for some sort of stress and with the nutritional demand achieved; tomato may express all its genetic potential and guarantee good productivity and fruit quality, being harder, in this case, the occurrence of significant effects with supplemental fertilization of boron and calcium and of vegetal growth regulators. These results are in accordance with Mello et al. (2002) who did not

Table 2. Classification of fruits per transversal diameter, according to the CEAGESP, of tomato 'Saladinha Plus' treated with calcium, boron and vegetable growth regulators. São Manuel, UNESP, 2009.

Æ (mm)	Calcium	Boron	Ca+B	Ca+B+ kt+GA+Ax	Ca+B+kt	Control	C.V. (%)
<40	49 CD	70 AB	37 D	51 BC	64 ABC	73 A	14.72
40-50	257 A	283 A	299 A	267 A	327 A	291 A	15.53
50-60	313 B	354 AB	387 AB	367 AB	398 A	306 B	12.01
60-70	102 A	88 A	96 A	87 A	86 A	91 A	21.98
>70	4.00 A	7.00 A	7.00 A	2.00 A	3.00 A	3.00 A	47.57

In the line averages followed by the same letter do not differ, by Tukey test at 5% of probability.

Table 3. Average fruit mass (grams), classified by diameter, according to CEAGESP, of 'Saladinha Plus' tomatoes, treatment with calcium, boron and vegetal growth regulators. São Manuel, UNESP, 2009.

Æ (mm)	Calcium	Boron	Ca+B	Ca+B+ ck+GA+Ax	Ca+B+kt	Control	C.V. (%)
<40	49.22 a	45.49 a	50.24 a	47.66 a	45.11 a	43.06 a	14.73
40-50	80.55 a	80.07 a	77.75 a	82.51 a	78.30 a	77.80 a	6.33
50-60	112.64 a	105.36 a	109.1 a	113.42 a	105.83 a	102.67 a	5.23
60-70	144.21 a	142.11 a	142.75 a	148.76 a	143.70 a	141.01 a	8.1
>70	227.90 a	204.50 ab	201.35 ab	188.74 b	202.49 ab	192.46 ab	9.17

**In the line averages followed by the same letter do not differ, by Tukey test at 5% of probability.*

verify significant effects of the addition of fertilization with boron in the pepper crop.

Conclusion

The application of calcium and boron and vegetal growth regulators with kinetin and biostimulants mixed to these nutrients do not cause significant effects of increase of fixation and higher production in fruit number or size of 'Saladinha Plus' tomato, when planted in crop conditions with soil fertility and climate considered as appropriated.

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