Available online at www.notulaebiologicae.ro

Print ISSN 2067-3205; Electronic 2067-3264

Not Sci Biol, 2012, 4(1):108-111

Notulae Scientia Biologicae

# Effect of Shoot Pruning and Flower Thinning on Quality and Quantity of Semi-Determinate Tomato (*Lycopersicon esculentum* Mill.)

Abdolali HESAMI[1*], Saadat SARIKHANI KHORAMI[2], Seyedeh Samaneh HOSSEINI[2]

[1]*Persian Gulf University, Faculty of Agriculture and Natural Research, Department of Horticultural Science, Bushehr, Iran; aa.hesami@gmail.com (*corresponding author)*

[2]*Tarbiat Modares University, Faculty of Agriculture, Department of Horticultural Science, Tehran, Iran*

**Abstract**

There are many constraints of space, light and availability of fruits to harvest in tomatoes greenhouse. Therefore, two experiments were carried out to determine the effect of shoot pruning and flower thinning on quality and quantity of fruits of semi-determinate tomato in a greenhouse of the Faculty of Agriculture and Natural Resources, Persian Gulf University of Bushehr. Experimental design was randomized complete block designs in which the effect of shoot pruning (single branch pruning, double branch pruning, pyramidal pruning and control) or flower thinning (Cluster with 4 and 5 remained flowers and control) were studied separately. Results showed that, leaf area and plants yield were higher in treatments which were pruned than control. Yields from pyramidal pruning and cluster thinning with 5 remaining flowers were significantly higher than other treatments. On the other hand, qualitative study identified that pyramidal pruning increases vitamin C in fruits, but had no significant effect on total soluble solids.

***Keywords:*** flower thinning, greenhouse, semi-determinate tomato, shoot pruning

## Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetables in terms of economic and nutritional value especially vitamin C content (Kanyomeka and Shivute, 2005). Greenhouse tomato production is very intensive and requires a high amount of input, particularly energy and manpower. For example, labour costs amount to about 30% of production costs. Several manual operations are performed very steadily: removing the axillary shoots and training the main stem keeps the crop in optimal conditions as regards light interception; deleafing consists in removing the oldest leaves, which are no longer photosynthetically active, in order to avoid plant diseases and facilitate harvesting; truss pruning aims at adapting the fruit load to assimilate production, in order to improve fruit grade and quality (Navarrete and Jeannequin, 2000). Although pruning increases costs in tomato production, it improves light penetration inside the plant canopy and increases photosynthesis efficiency and so fruit yield (Ambroszczyk *et al.,* 2008; Mbinga, 1983; Rajewar and Patil, 1979). Since vegetative growth, as a powerful sink, consumes produced assimilates, limitation of vegetative growth enhances assimilate transport to roots or fruits. Thus, proper balance between vegetative and reproductive growth could improve fruit quantity and quality (Arzani *et al.,* 2009). Vegetative growth has direct relation with leaf area, dry matter and stem diameter; however, it has negative correlation with fruit yield (Hall, 1983; Hartmann, 1977; Navarrete *et al.,* 1997).

Many researches done on the effect of pruning on qualitative and quantitative characteristics of tomato show that pruning limits vegetative growth and allows more light penetration and so improves qualitative and quantitative characteristics of tomato fruits (Preece and Read, 2005). Nonetheless, there are some reports stating that pruning causes yield loss and low quality production (Kanyomeka and Shivute, 2005; Resh, 2002). There are some evidences that pruning not only improve fruit quality but also increases plant health against pests and disease (Kanyomeka and Shivute, 2005). In case of indeterminate cultivars despite of high yield, there is low quality due to low light penetration into the canopy. On the other hand consider to high vegetative growth these cultivars must be treated so more costs will be incurred.

The aim of experiment was evaluation of shoot pruning and flower thinning in semi-determinate tomato to gain high yield along with desirable quality and cost.

## Material and methods

The experiment was conducted in a greenhouse at the Faculty of Agriculture and Natural Resources, Persian Gulf University (PGU), Bushehr, Iran (29° 169’ N, 51° 129’ E and 65 m above sea level) from 2007 to 2008. Seeds of a semi-determinate high yielding cultivar (‘ES741 TY F1’, traditional name “Ergon”) and compatible with study region were disinfected by fungicide (Benomyl, 2 g $l^{-1}$) and then germinated in transplant tray containing cocopeat. After four weeks, healthy seedlings were transplanted into

Received 11 November 2011; accepted 26 Januay 2012

the loamy soil. There were 25 m length rows with 0.75 m distance apart each other. A day before transplanting, plants were irrigated to ease transplantation with minimum damage to plants. Transplants were planted with 0.75 m and 0.5 m between and within rows, respectively. The first irrigation was done 24 h after transplanting to get better contact between root and soil. Experimental design was randomized complete block designs in which the effect of shoot pruning (single branch pruning, double branch pruning, pyramidal pruning and control) or flower thinning (Cluster with 4 and 5 remained flowers and control) were studied separately. Regardless of three replications in each block, there were ten plants in each experimental unit. Sampling was done from four plants grown in each plot randomly. Vegetative growth and fruit setting stage are the most sensitive stages to water deficit stress (Arzani *et al.,* 2008). In this study, irrigation intervals were 4-6 days. Weeds were controlled mechanically using hand and sickle twice a week. Shoot pruning and flower thinning was performed by hand while old leaves were clipped by disinfected scissors. There was no pruning or thinning on control plants. Primary pruning was done on all plants except for control. Primary pruning consisted of removing all secondary branches and flower clusters at 30 cm above soil surface. In case of single branch pruning, all secondary branches were removed at early stage of appearance. Regarding pyramidal pruning, main stems were left and pruning was performed on secondary branches. In other words, two secondary branches were left at 30 cm above soil surface till flower appearance and after that apical bud was removed to cut vegetative growth.

In double branch pruning, primary pruning was done at 50 cm above soil surface. In this method main stem and one of the secondary branches were allowed to growth so that these stems were considered as main stems. It is to say that all secondary branches on this stems were removed. In flower thinning treatments all plants were pruned as single branch. There was no thinning in control treatment. Flowers were thinned to 4 and 5 flowers in each cluster at fruitlet stage. Effect of treatments was evaluated on fruit quantity and quality. In this regard, fruit size, total soluble solids, chlorophyll index, leaf area, vitamin C content, damaged fruit percentage, ease of harvest, blossom end rot and catfacing percentage and ripening time were evaluated.

After harvesting, fruits were weighed by digital balance. Total soluble solid was measured using a portable refractometer (model 2WAJ-China). Chlorophyll was extracted in 80 % acetone from the leaf samples according to the method of Dere *at al*. (1999). Extracts were filtrated and content of total chlorophyll was determined by spectrophotometry at 645 and 663 nm, respectively. The content of chlorophyll a, b and total was expressed as mg per 100 $cm^2$ (Arnon, 1949). Leaf area was measured by portable leaf area meter (Model Cl-202.) from three sampled leaves.

Vitamin C content was estimated by titration using iodate solution (Aminuddin *et al*., 2003). It has been considered fruit ripening when the fruit was firm and very red in color. In order to study the ripening time, different treatments were compared to each other based on the first harvesting time. Blossom end rot and catfacing disorders were calculated by weighing of stricken fruits than healthy fruits. Ease of harvesting was calculated according to harvesters scoring from 1 to 20. All date were analyzed using MSTAT-C. Comparison of means was done by Duncan's multiple range tests at 5% probability level.

## Results

### ***First experiment***

Effect of shoot pruning on qualitative and quantitative traits of semi-determinate tomato

*Fruit yield and size*

There was significant difference among different kind of pruning so that pyramidal pruning produced the highest fruit yield (51.87 kg $plot^{-1}$). In addition, there was no significant difference between control treatment and double branch pruning. However, these treatments were significantly different from single branch pruning. It is to say that single branch pruning produced the lowest fruit yield (Tab. 1).

Effect of shoot pruning on fruit size was significant. The highest fruit size was related to single branch pruning and then pyramidal and double branch pruning produced the biggest fruits. The smallest fruits (197.3 $cm^3$) were observed in control treatment (Tab. 1).

*Chlorophyll index and leaf area*

In this study effect of shoot pruning was not significant on chlorophyll index (Tab. 1) while shoot pruning significantly affect leaf area. As can be seen from Tab. 1 although there was no significant difference between pyramidal and double branch pruning, the highest leaf area was related to single branch pruning. Control treatment produced the lowest leaf area (2175.1 $cm^2$).

*Time of ripening and ease of harvest*

Shoot pruning led to early ripening, in other words, increase of pruning intensity accelerated fruit ripening. As single branch the most severe pruning was related to single branch pruning and fruit ripening in this treatment was 23 days earlier than the others treatment (Tab. 1). Furthermore, pruning improved fruit harvesting as more leaves and branches lead to much difficulty in harvesting, so less time was consumed for pruned plants.

*Total soluble solids and vitamin C*

There was no significant difference between control and pruned treatments. However, highest total soluble solids were observed in those plants which were pruned as double branch and pyramidal. In addition, there was no significant difference among treatments in respect of vitamin C content. The result showed that severe branch pruning led to the lower level of Vitamin C. So that the highest and the lowest vitamin C content were obtained from control treatment and single branch pruning, respectively. It is worth mentioning that there was no significant difference between control treatment and pyramidal pruning, because rate of pruning in pyramidal pruning is low. Furthermore single branch pruning and double branch pruning were the same, statistically.

*Fruit destruction rate, blossom end rot and catfacing disorders*

In case of fruit destruction rate, significant difference was observed between pruning treatment and control treatment (Tab. 2). So that the highest damaged fruits were obtained from control treatment while pruning decreased fruit damaging. The highest and the lowest damaged fruits at harvesting time were related to control treatment and single branch pruning, respectively. From Tab. 2, pruning had no significant effect on catfacing disorder. In contrast, pruning significantly decreased blossom end rot. The highest and the lowest blossom end rot were observed in single branch pruning and control treatment, respectively. Moreover, there was no significant difference between double branch pruning and pyramidal pruning in case of blossom end.

***Second experiment***

Effect of flower thinning on qualitative and quantitative traits of semi-determinate tomato

*Fruit yield and size*

The results showed that effect of flower thinning was significant on fruit size and yield. Flower thinning with 5 and 4 flower remaining on plants produced the highest and the lowest yield, respectively. Obtained results revealed that severe pruning increased fruit size (Tab. 3).

*Total soluble solids and vitamin C content*

Effect of flower thinning was significant on total soluble solids so that flower thinning with 4 remained flowers produced the highest soluble solids while 5 remained flowers produced the lowest soluble solids. Vitamin C content was not significantly affected by flower thinning (Tab. 3).

**Discussion**

In tomato, pruning is used to increase weight marketable fruits and fruit yield (Muhammad and Singh, 2007a, 2007b). The present results showed that effect of shoot pruning on qualitative and quantitative traits showed that pruning decreases fruit yield but it does not mean that lack of pruning lead to the highest yield, and in order to the highest yield it is need to minimum pyramidal pruning.

Although, single pruning produced the largest fruits, but size of these fruits were so large (Tab. 1) and these size is not marketable. So double and pyramidal pruning produced more desirable fruits, because they had marketable size. Pyramidal pruning had the highest fruit yield (Tab. 1) but fruit quality of this treatment was low (Tab. 2).

Tab. 1. Effect of shoot pruning on quantity of Semi-determinate tomato in greenhouse

| Kind of shoot pruning | Yield (Kg) | Fruit size ($cm^3$) | Chlorophyll index ($mg/100\ cm^2$) | Leaf area ($cm^2$) | Ease of harvest (-) | Date of ripening (-) |
|---|---|---|---|---|---|---|
| Control | 48.4 b | 197.3 c | 0.06 a | 2175.1 c | 2.7 c | 12-April |
| Pyramidal | 51.9 a | 412.1 bc | 0.05 a | 3000.1 b | 17 b | 26-Feb |
| Double branch | 47.4 b | 456.7 ab | 0.04 a | 3024.2 b | 17 b | 26-Feb |
| Single branch | 35.3 c | 607.7 a | 0.07 a | 3549.4 a | 19.8 a | 20-Feb |

(-) No unit; Means within each column of followed by the same letter are not significantly different

Tab. 2. Effect of shoot pruning on quality of Semi-determinate tomato in greenhouse

| Kind of shoot pruning | TSS (% w/w) | Vitamin C (mg/100 g) | Fruit destruction rate (-) | Cat facing (%) | Blossom end rot (%) |
|---|---|---|---|---|---|
| Control | 4.8 a | 2.20 a | 16.7 a | 4.3 a | 12 b |
| Pyramidal | 4.9 a | 2.05 a | 5.7 b | 5.3 a | 13.7 ab |
| Double branch | 4.96 a | 1.68 b | 3.7 c | 4.7 a | 13.7 ab |
| Single branch | 4.73 a | 1.49 b | 1.3 d | 5.7 a | 17.7 a |

Means within each column of followed by the same letter are not significantly different

Tab. 3. Effect of flower thinning on quality and quantity of semi-determinate tomato in greenhouse

| Kind of Flower thinning | Yield (Kg) | Fruit Size ($cm^3$) | TSS (% w/w) | Vitamin C (mg/100 g) |
|---|---|---|---|---|
| Control | 42.6 b | 492.3 bc | 4.5 b | 1.5 a |
| Cluster with 5 flowers | 53.1 a | 503.5 b | 4.2 c | 1.5 a |
| Cluster with 4 flowers | 39.5 c | 656.9 a | 4.7 a | 1.6 a |

Means within each column of followed by the same letter are not significantly different

Increase of fruit quality on account of weak pruning can be due to more assimilate production by leaves. In single branch pruning, although more lights penetrate into the canopy, low leaf area decreases photosynthesis rate. Therefore in double branch or pyramidal pruning there is an appropriate proportion between leaves and light penetration into the canopy. The present results showed that severe pruning led to ease of harvesting and decreased fruit rotting. Obviously, less leaves and branches ease fruit harvesting. In severe pruning treatments there is high ventilation around the plants and on the other hand more light penetrates into the plant canopy so fungi growth under this condition is reduced (Kanyomeka and Shivute, 2005).

Blossom end rot occur due to calcium deficiency (Taylor and Locascio, 2004). Under water deficit stress or high relative humidity limit calcium uptake and transport in plants and causes blossom end rot. In addition, direct energy into vegetative growth at the expense of fruit development. Heavy pruning will promote vigorous leafy growth and fewer fruit (Dart, 2004). Therefore heavy pruning leads to more calcium allocation to leaf and shoots and decrease calcium transport to fruit and increase blossom end rot in pruned plants. So in control treatment blossom end rot occurred rarely because of more calcium uptake due to more leaf area and shading.

Flower thinning with 5 remained flowers on plant produced the highest fruit yield with desirable size (Tab. 3). This is probably due to high potential of leaves to produce more assimilates. Arzani *et al*. (2000) reported that fruits, as powerful sink for carbohydrates, growth till end of the growing season and increase of volume depend on fruit number. Therefore, flower thinning can improve fruit size. In addition, flower thinning leads to more assimilates allocation to fruits and improves fruit size and quality.

From the findings of this study it could be concluded that pruning of tomato could be practiced to increase the quality of tomato. Double branch pruning and Flower thinning with 5 flower remaining may be recommended for semi-determinate cultivars of tomato ('ES741 TY F1', traditional name "Ergon") in the greenhouse conditions.

## References


Ambroszczyk AM, Cebula S, Sekara A (2008). The effect of plant pruning on the light conditions and vegetative development of eggplant (*Solanum melongena* L.) in greenhouse cultivation. Vege Crops Res Bull 68:57-70.

Aminuddin M, Madani Vaid FH, Mehmood K (2003). Statistical evaluation of the N-bromosuccinimide and iodine as titrimetric methods for estimation of vitamin C in orange juice and pharmaceutical preparations. Pak J Pharm Sci16(2):69-76.

Arnon DI (1949). Copper enzymes in isolated chloroplasts. Polyphenoloxidase in Beta vulgaris. Plant Physiol 24:1-15.

Arzani K, Bahadori F, Piri S (2009). Paclobutrazol reduces vegetative growth and enhances flowering and fruiting of mature 'J.H. Hale' and 'Red Skin' peach trees. Hortic, Environ Biotechnol 50(2):84-93.

Arzani K, Lawes GS, Wood DES (2000). Seasonal vegetative and fruit growth pattern of mature close planted 'Sundrop' apricot trees grown under humid climate. Acta Hortic 516:75-82.

Bailey LH (1911). The Pruning Book. Ed. 12th. The Macmillan Publications. New York, United States, 537 p.

Dart JA (2004). Bitter pit in apples. NSW department of primary industries. Agfact H4.Ac.1. (http://www.dpi.nsw.gov.au).

Dere S, Gunes T, Sivaci R (1999). Spectrophotometric Determination of Chlorophyll-A, B and Total Carotenoid Contents of Some Algae Species Using Different Solvents. Turk J Bot 22:13-17.

Hall D (1983). The influence of nitrogen concentration and salinity of recirculating solutions on the early season vigor and productivity of glasshouse tomatoes. J Hortic Sci 58:411-415.

Hartmann HD (1977). Influence of axillary shoots on growth and yield of tomato varieties. Gartenbauwissenschaft 42(4):178-184.

Kanyomeka L, Shivute B (2005). Influence of pruning on tomato production under controlled environments. Agricult Trop Subtrop 38(2):79-83.

Mbinga W (1983). Pruning and Spacing Effect on Tomato var. Seeda Nam Khem (*Lycopersicon esculentum* Mill.). ARC Training 20-33 p.

Muhammad A, Singh A (2007a). Intra-row spacing and pruning effects on fresh tomato yield in Sudan Savanna of Nigeria. J Plant Sci 2:153-161.

Muhammad A, Singh A (2007b). Yield of tomato as influenced by training and pruning in the Sudan Savanna of Nigeria. J Plant Sci 2:310-317.

Navarrete M, Jeannequin B (2000). Effect of frequency of axillary bud pruning on vegetative growth and fruit yield in greenhouse tomato crops. Sci Hortic 86:197-210.

Navarrete M, Jeannequin B, Sebillotte M (1997). Vigour of greenhouse tomato plants (*Lycopersicon esculentum* Mill.): analysis of the criteria used by growers and search for objective criteria. J Hortic Sci 72:821-829.

Preece JE, Read PE (2005). The Biology of Horticulture. 2th Ed. Copyright by John Wiley and Sons. New York, United States, 528 p.

Rajewar SR, Patil VK (1979). Flowering and fruiting of some important varieties of tomato as affected by spacing, staking and pruning. Ind J Agricult Sci 49(5):358-360.

Resh HM (2002). Hydroponic Tomatoes for the Home Gardener. CRC Press. California, 142 p.

Taylor MD, Locascio SJ (2004). Blossom-end rot: A calcium deficiency. J Plant Nutri 27(1):123-139.