Madras Agric. J., 105 (7-9): 324-328, September 2018

Influence of Pruning Techniques on Yield and Quality Characters of Capsicum Variety Indra Under Shade Net Conditions

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An experiment was conducted to study the influence of pruning techniques to improve the yield and quality characters of capsicum (*Capsicum annum* var. grossum) under shade net condition. The study consisted of three stem pruning systems *viz*., Two main stems, four main stems, Unpruned (control) and three fruit pruning systems one fruit per node, one fruit on alternate nodes, one fruit on every two nodes. Plants pruned to four shoots with one fruit per node recorded the best results for yield hectare^{-1} (64.09 tonnnes). Capsicum plants with two main shoots recorded the highest ascorbic acid (75.61 mg g^{-1}), carotenoid (6.38 mg g^{-1}), TSS content (5.18°brix), except fruit chlorophyll content (0.57 mg g^{-1}), which was found to be highest in unpruned plants. Capsicum plants with one fruit on every two nodes excelled in the qualitative characters *viz*., carotenoid content (5.52 mg g^{-1}), and TSS content (5.11). The capsaicin content and phenol content was not affected by the pruning treatments.

Key words: Capsicum, Quality, Shoot pruning, Fruit pruning

Capsicum (*Capsicum annum* var. *grossum*) known as sweet pepper or bell pepper is one of the most popular vegetable crops grown in India as well as in several other parts of the world. In India, this crop occupies an area of 1.8 thousand hectares with an annual production of about 3.5 million tonnes. Capsicum covers an area of 0.09 thousand ha in Tamil Nadu with an annual production of 0.60 MT (NHB, 2016 - 17). Sweet pepper is an excellent source of bioactive nutrients such as provitamin A (carotenoids), phenolic compounds, Vitamin C, and potassium which accounts for its nutritional quality and antioxidant capacity (Flores *et al*., 2004). It is also rich in Vitamin A (8493 IU), Vitamin C (283 mg) and minerals like Calcium (13.4 mg), Magnesium (14.9 mg), Phosphorus (28.3 mg) Potassium (263.7 mg) per 100 g fresh weight. Capsicum is one of the vegetables grown under protected cultivation. The practice of cultivation in protected environment is a way to avoid the environmental adversities and may favor the production compared to the crop in the open field. Pepper plants have a dichotomous branching habit. Pruning methods usually vary according to the different branching nature of capsicum cultivars and with different plant densities (Dasgan and Abak, 2003). The main reason for pruning capsicum under shade net house is to obtain a proper balance between fruit number and fruit size, train the plants so that they grow upright and thus facilitates better light penetration and aeration all over the plant canopy, thereby increasing the fruit set percentage and early ripening of the fruits coupled with high yield of better sized fruits and reducing the RH and decreasing the disease respectively. When capsicum is allowed to produce many fruits per stem, quality of fruits is affected in terms of size and internal contents. Hence standardization of number of fruits per stem is highly essential to get quality fruits of capsicum. An agronomic practice widely used in fruit growing to increase fruit size, is fruit pruning by hand or using chemicals (Stover *et al*., 2001). Several studies conducted have revealed that manipulating the sink – source affects the quality of both fruits and vegetables. It was also reported that lower sink: source during the fruit developing phase increases the sugar, acid and carotenoid concentrations as expressed on the fruit weight basis in tomato (Bertin *et al*. 2001). Therefore, this study was an attempt to analyze the effects of pruning treatments on the quality traits of capsicum.

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Material and Methods

Field experiments were conducted at the College Orchard, Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during September-February season of 2017-2018 to standardize the pruning techniques to improve the yield and quality characters of capsicum (*Capsicum annum* var. *grossum*) under shade net condition. The experiment was laid out in Factorial Randomized Block Design with three replications, consisting of nine treatments i.e. three stem pruning systems (S_1: Two main stems, S_2: Four main stems, S_3: Unpruned (control) and three fruit pruning systems (T_1: One fruit per node, T_2: One fruit on alternate nodes, T_3: One fruit on every two nodes). The hybrid seeds of capsicum var. Indra was sown in 98 celled plastic pro trays using media coco peat, perlite and vermiculite in the ratio of 3:1:1 in a naturally ventilated green house. The main field was prepared to a fine tilth

and capsicum seedlings were planted on beds in a paired row system under shade net house condition. All cultural practices were followed as per the recommendations given in the Crop Production Techniques of Horticultural Crops 2015. Capsicum plants were pruned according to the treatments to retain the two stems and four stems respectively. The plant tip splits into two at the 5th or the 6th node and are left as such and allowed to grow to get the two stem treatment. In this treatment the two main shoots were maintained as two leaders and the side shoots were pinched after one or two pair of leaves. Whereas in the four stem treatment, the two branches were allowed to split again into two, and thus giving rise to 4 branches. Thereafter, all the side shoots were pinched off after one or two pair of leaves. The plants were left undisturbed without pruning in the unpruned treatment. Usually in capsicum, the tip splits at every node into two and give rise to one strong branch and one week branch. Care is taken to maintain the stronger one and the weaker ones were removed. The pruning was done after 30 days of transplanting at an interval of 8 to 10 days, resulting in bigger fruits with better quality and high productivity. Fruit yield and quality characters were recorded from five plants in each replicated entry selected randomly and were tagged. The quality characters *viz*., fruit ascorbic acid content (Horwitz, 1975), carotenoid content Ranganna (1986), chlorophyll content (Yoshida *et al*., 1971), capsaicin content (Collins *et al*., 1995) and phenolic compounds (Malik and Singh, 1980) and TSS content were studied. TSS content was measured using refractometer. The estimates of mean, variance and standard error were done as per Panse and Sukhatme (1967).

Results and Discussion

Yield per hectare

The yield per hectare differed significantly and influenced by both shoot and fruit pruning treatments (Table 1). The highest fruit yield per hectare was estimated in plants pruned to four stems with 64.09 tonnes and the unpruned ones recorded the lowest yield of 41.27 tonnes.

Table 1a. Effect of shoot and fruit pruning on yield and quality characters of capsicum variety Indra

Stem pruning	Yield per hectare (tonnes)	Ascorbic acid (mg 100 g^{-1})	Carotenoid (mg 100 g^{-1})	Chlorophyll (mg 100 g^{-1})
S_1	51.57	75.61	6.68	0.51
S_2	64.09	73.10	5.19	0.52
S_3	41.27	70.79	4.35	0.57
S. Ed	0.81	0.62	0.04	0.007
CD	1.71*	1.31*	0.78*	0.015*
Fruit pruning				
T_1	59.66	72.42	5.30	0.54
T_2	53.27	73.21	5.39	0.53
T_3	44.01	73.87	5.52	0.53
S. Ed	0.81	0.62	0.04	0.007
CD	1.71*	1.31^{ns}	0.78*	0.015^{ns}
Combined effect				
S_1T_1	58.07	74.87	6.48	13.97
S_1T_2	51.48	75.57	6.65	13.68
S_1T_3	45.16	76.38	6.92	13.23
S_2T_1	75.02	72.09	5.13	15.73
S_2T_2	65.46	73.37	5.17	14.86
S_2T_3	51.80	73.84	5.25	14.32
S_3T_1	45.88	70.29	4.29	16.89
S_3T_2	42.86	70.69	4.35	15.57
S_3T_3	35.07	71.38	4.40	15.32
S. Ed	1.40	1.07	0.04	0.012
CD	2.96*	2.27^{ns}	0.78*	0.027*

Stem pruning S_1- Two main stems S_2- Four main stems S_3- Unpruned (control)

Fruit pruning T_1- One fruit per node T_2- One fruit on alternate nodes T_3- One fruit on every two nodes

The reason might be the actively photosynthesizing plants due to the better availability of sunlight as there is no shading effect. Unlike the unpruned plants, the photosynthetic assimilates do not get diverted to unproductive branches but only to the four productive branches and diversion of these photosynthetic assimilates to the productive four branches only. This result is related to the findings of Ahirwar *et al*. (2015) in capsicum. Among fruit pruning also the treatments differed significantly. The highest fruit yield of 59.66 tonnes was produced in capsicum plants pruned to one fruit per node and the plants with one fruit on every two nodes recorded the lowest yield of 44.01 tonnes. This might be attributed to the excessive removal of fruits in the latter treatment, which might have developed into mature fruits and contributed to high yield per plant. This is in agreement with the findings of Maboko *et al.* (2012), who reported that fruit yield increased in the absence of flower pruning. Fruit pruning had a very pronounced effect on yield.

Ascorbic acid

The capsicum plants in different treatments responded differently (Table 1). Ascorbic acid content was significantly influenced by the pruning treatments. The trend of decrease in ascorbic acid content was observed in capsicum plants with increase in shoot numbers. The highest ascorbic acid of 75.61 mg g^{-1} was recorded in plants pruned to two shoots and the unpruned recorded the lowest with 70.79 mg g^{-1} of ascorbic acid. This may be due to the reduced vegetative load of the plants as a result of pruning that increased the physiological activities and finally improved the ascorbic acid content of the fruits. The results matched with the findings of Ambroszcyk *et al*. (2008) in brinjal and khoshkam *et al*. (2014) in tomato.

Table 1b: Effect of shoot and fruit pruning on yield and quality characters of capsicum variety Indra

Stem pruning	Capsaicin (ppm)	Phenol (mg 100 g^{-1})	TSS content (o brix)
S_1	152.52	0.86	5.18
S_2	138.70	0.84	5.06
S_3	137.79	0.83	4.89
S. Ed	9.48	0.01	0.04
CD	20.10 ns	0.02 ns	0.08*
Fruit pruning			
T_1	133.99	0.82	4.98
T_2	145.51	0.85	5.05
T_3	149.51	0.87	5.11
S. Ed	9.48	0.01	0.04
CD	20.10 ns	0.02 ns	0.08*
Combined effect			
S_1T_1	149.83	0.83	5.09
S_1T_2	157.97	0.87	5.17
S_1T_3	149.77	0.89	5.29
S_2T_1	113.19	0.82	5.01
S_2T_2	141.95	0.85	5.08
S_2T_3	160.95	0.86	5.11
S_3T_1	138.96	0.82	4.83
S_3T_2	136.62	0.83	4.91
S_3T_3	137.80	0.85	4.93
S. Ed	16.43	0.01	0.04
CD	34.83 ns	0.03ns	0.08*

Stem pruning S_1- Two main stems S_2- Four main stems S_3- Unpruned (control)

Fruit pruning T_1- One fruit per node T_2- One fruit on alternate nodes T_3- One fruit on every two nodes

Carotenoid content

The highest carotenoid content was recorded in the plants pruned to two stems with 6.68 mg g^{-1} and the unpruned plants recorded the lowest with 4.35 mg g^{-1}. This might be due to the reduced vegetative load of the plants as a result of pruning that increased the physiological activities and finally improved the carotenoid content of the fruits. Capsicum plants pruned to one fruit on every two nodes recorded the highest carotenoid with 5.52 mg $g^{-1}$and the ones with one fruit per node gave the lowest content of 5.30 mg g^{-1}. The probability that the number of fruits limited in

the capsicum plants with one fruit on every two nodes might have reduced the competition for the available assimilates and hence enhancing the physiological activity and enhancing the carotenoid content. The interaction effect was also found to be significant. Among the interactions, two stemmed plants pruned to one fruit on every two nodes recorded the highest carotenoid with 6.92 mg g^{-1}. The lowest among them was recorded in unpruned plants with one fruit per node.

Chlorophyll content

Capsicum plants with two stems produced fruits with high chlorophyll content. When the plants are exposed to high light concentrations, the chlorophyll may get degraded and lead to less chlorophyll content. The highest fruit chlorophyll content of 0.57 mg $g^{-1}$was produced by the unpruned plants, whereas the two shoot pruned plants recorded the lowest fruit chlorophyll content of 0.51 mg g^{-1}. The reason for higher chlorophyll content can be attributed to the shading effect in the four shoot pruned plants and unpruned plants due to the dense foliage, which reduces the light penetration and there by producing more green dark fruits. The result is in line with Richardson (2012) in tomato fruits. The number of fruits per plant did not have any effect on the fruit chlorophyll content, whereas the interaction effect was significant, unpruned plants with one fruit per node recording the highest and the plants with two main shoots pruned to one fruit on alternate nodes the lowest.

Capsaicin content

Capsaicin is the pungent principle present in capsicum fruits. The various pruning treatments did not produce significant effects on the pungency levels in the capsicum fruits. The capsaicin content remained unaffected and thus did not produce any significant affects due to pruning treatments. The interaction effects also remained non-significant.

Phenol content

Phenols are a group of secondary metabolites present in plants that provide protection against pest and diseases and also induces coloration in vegetables. Phenol content in the fruits did not vary with the various pruning treatments. Ultimately the treatments did not produce significant effects.

TSS content

As the shoot number per plant increased, the TSS content decreased. Hence the fruits on the plants pruned to two stems produced the fruits of better TSS content of 5.18° brix and the lowest TSS of 4.89 ° brix was produced by the unpruned plants. Since fruits act as the sink for the photosynthates produced to be stored, the reduction in sink size increases the sugars being translocated and stored. Hence, the plants have lesser number of shoots and fruits produce more sweet fruits in tomato (Alam *et al.*, 2016; Hesami *et al.*, 2012; Malash *et al.*, 1990). The result is in conformity with Khoshkam *et al.* (2014) and Mbonihankuye *et al.* (2013) in tomato and Ambroszcyk *et al*. (2008) in brinjal. Fruit pruning treatments also had pronounced effect on the TSS content of the fruits. TSS content was found to increase with the number of fruits pruned. The plants with one fruit on every two nodes produced the fruits with highest TSS content of 5.11 ° brix, whereas the plants with one fruit per node produced the fruits with lowest TSS content of 4.98 ° brix. The available carbohydrates synthesized through photosynthesis is stored in the fruits. Since the fruit number is less, more sugars will be translocated to each fruit, finally leading to high TSS content in treatments with plants pruned to one fruit on every two nodes.

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Received : February 20, 2018; Revised : March 10, 2018; Accepted : March 25, 2018