Effect of pruning systems on growth and yield traits of greenhouse grown bell pepper (*Capsicum annuum* L. var. grossum)

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**ABSTRACT**

The present investigation was carried out during 2016-2017 with the objective of observing the effect of the tested systems of pruning on vegetative, fruiting, yield and quality traits of capsicum varieties. The experiment was laid out in a factorial randomized block design with four replications and nine treatments with Indra, Bachata and Inspiration cultivars of capsicum pruned with three intensities i.e. two shoots, four shoots and un-pruned (control). The results showed that the two stem pruning treatment significantly affected the plant growth and flowering characteristics in terms of plant height (194.75 cm), number of days to first flower (20.25 days) in cv. Indra. Same cultivar when left un-pruned recorded more number of fruits per plant (23.64 fruits), but fruit yield per plant (4.14 kg) was observed in four stem pruning treatment in Indra cultivar of capsicum than other cultivars tried.

**Key words:** Bell pepper, Capsicum, Cultivar, Pruning, Quality, Yield.

**INTRODUCTION**

*Capsicum* (*Capsicum annuum* L. var. grossum), member of solanaceae family, is one of the most important vegetable crops grown throughout the world. It is native to tropical South America and was introduced by the Portuguese in the middle of sixteenth century in India. *Capsicum* (*Capsicum annum* L.) is also called as Shimla mirch, bell pepper or sweet pepper. A volatile compound, 2-methoxy-3-isobutyl-pyrazine (C$_9$H$_{14}$N$_2$O), causes the typical taste and fragrance of sweet pepper. The seed contains 12–25% oil (mainly composed of linoleic acid, an unsaturated fatty acid), carbohydrates, proteins and fiber (Lal *et al* 2014). *Capsicum* is rich in vitamin C and provitamin A (Zende 2008). Also, it is one of the valuable medicinal plants in pharmaceutical industries, owing to high amounts of health promoting substances, particularly antioxidants, capsaicin and capsanthin (Aminifard *et al* 2012). It is also used by the security agencies in the preparation of tear gas. It is also used in salad and soup preparations. Pruning the plants to a single stem, two stems or three stems facilitate better management, permit closer planting, early maturity of fruits, higher yield of larger sized fruits as well as uniform light penetration in the plant canopy. Due to the heavy vegetative growth and fruit load on the colored pepper plants shoot pruning proves to be one of the important factor in proper utilization of production area (Maniutiu *et al* 2010). Several studies have reported an increase in fruit yield of sweet pepper with increase in shoot number under soilless media in protected agriculture (Jovicich *et al* 2004 and Maboko *et al* 2012). Keeping in view the above facts the study was conducted with the objective of observing the effect of the tested systems of pruning on vegetative, fruiting, yield and quality traits of capsicum varieties.

**MATERIALS AND METHODS**

The present study was carried out during the year 2016-2017 under net house conditions in the research and experimental farm, Department of Horticulture, Khalsa College Amritsar, Punjab.

**Plant materials:** Three cultivars of capsicum *viz.* Indra (Syngenta), Bachata and Inspiration (Rijkzwaan) of indeterminate growth habit were tested during the studies. The seedling of these varieties were procured from Centre of Excellence for Vegetables, Kartarpur. During the trial, plants were grown in net-house. The seedlings were transplanted on 10$^{th}$ September 2016 inside the naturally ventilated net/poly house of size 27 m x 9 m x 3 m (L x B x H). The healthy and disease free seedlings of the capsicum were transplanted on the raised beds of 1 m width at a plant to plant and row to row spacing of 45 cm x 45 cm.

**Pruning:** *Capsicum* plants were pruned to retain two stem and four stems after 30 days of transplanting at an interval of 8 to 10 days. The tip of the plant splits into two nodes and are left to grow for two stem system. These two branches again split in to two giving rise to four branches. At every node the tip splits into two giving rise to one strong branch and one week branch. The pruning was done after 30 days of transplanting at an interval of 8 to 10 days, which resulted in bigger fruits with better quality and high productivity.

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Experimental design: The experiment was laid out in a factorial randomized block design with four replications, consisting of nine treatments combinations. Three cultivars of capsicum viz. Indra, Bachata, Inspiration and three levels of pruning intensities i.e. two shoots, four shoots and un-pruned (control) were studied in this experiment.

Data recorded: Data was recorded regarding vegetative characters in terms of plant height, leaf area, dry weight of leaves, number of fruits and fruit yield per plant in kg. The data obtained from various characters under study were analyzed by the method of analysis of variance as described by (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION
Plant height (cm): Maximum plant height (183.58 cm) was recorded in cultivar Indra (C1) than cultivars Inspiration (C3) (163.66 cm) and Bachata (C2) (149 cm), respectively (Table 1). It was observed that plants pruned to two shoots (P1) produced taller plants (177.33 cm) than plants pruned to four shoots (P2) (165.66 cm) and un-pruned plants (P3) (153.25 cm). This increase in plant height might be due to trimming of side branches causing flow of nutrients to the axillary branches which might be diverted to the apical tissues leading elongation of shoots. Similar findings were also reported by Onis et al (2001) and Preece and Reed (2005).

Leaf area (cm²): Maximum leaf area (169.22 cm²) was observed in Bachata (C2) followed by Inspiration (C3) (159.62 cm²) and Indra (C1) (145.32 cm²) cultivars presented in (Table 2). Average maximum leaf area (172.67 cm²) was recorded in two stem pruned plants (P1) followed by four stem pruned plants (P2) (153.70cm²) however, Un-pruned plants (P3) was showed having smallest leaf area (147.78 cm²).The effect of interaction of different pruning configuration systems and bell pepper cultivars had been significant on leaf area. In Bachata (C2) cultivars the plants trained to two shoot (180.90 cm²) produced substantially larger leaf area as compared to other treatment combinations. The lowest leaf area was measured in un-pruned plants of Indra (C1) cultivar (135.25 cm²). Similar findings were also reported by Abdullah et al (2013) and Jovicich et al (1999).

Leaf fresh weight: Data presented in (Table 3) revealed that average highest leaf fresh weight (9.03 g) was recorded

| Table 1: Effect of different pruning systems on plant height (cm) of different bell pepper cultivars grown under protected conditions. |
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| Pruning | Cultivars | Indra (C1) | Bachata (C2) | Inspiration (C3) | Mean  |
| Two stem (P1) | 194.75 | 162.0 | 175.25 | 177.33 |
| Four stem (P2) | 182.75 | 149.75 | 164.50 | 165.66 |
| Un-pruned (P3) | 173.25 | 135.25 | 151.25 | 153.25 |
| Mean | 183.58 | 149 | 163.66 |  |
| CD (p=0.05) : | Cultivars : | 2.25 |  |  |
| | Pruning : | 2.25 |  |  |
| | Cultivars x Pruning : | NS |  |  |

| Table 2: Effect of different pruning systems on leaf area (cm²) of different bell pepper cultivars grown under protected conditions. |
| --- |
| Pruning | Cultivars | Indra (C1) | Bachata (C2) | Inspiration (C3) | Mean  |
| Two stem (P1) | 160.10 | 180.90 | 177.00 | 172.67 |
| Four stem (P2) | 140.60 | 163.55 | 156.95 | 153.70 |
| Un-pruned (P3) | 135.25 | 160.20 | 144.90 | 147.78 |
| Mean | 145.32 | 169.22 | 159.62 |  |
| CD (p=0.05) - | Cultivars : | 0.24 |  |  |
| | Pruning : | 0.24 |  |  |
| | Cultivars x Pruning : | 0.41 |  |  |

| Table 3: Effect of different pruning systems on leaf fresh weight (grams) of different bell pepper cultivars grown under protected conditions. |
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| Pruning | Cultivars | Indra (C1) | Bachata (C2) | Inspiration (C3) | Mean  |
| Two stem (P1) | 8.70 | 10.60 | 9.30 | 9.53 |
| Four stem (P2) | 6.55 | 7.75 | 6.28 | 6.85 |
| Un-pruned (P3) | 5.69 | 8.73 | 5.53 | 6.65 |
| Mean | 6.98 | 9.03 | 7.03 |  |
| CD (p=0.05) - | Cultivars : | 0.12 |  |  |
| | Pruning : | 0.12 |  |  |
| | Cultivars x Pruning : | 0.21 |  |  |
in Bachata (C_{2}) which was significantly heavier than Inspiration (C_{3}) (7.03g) and Indra (C_{1}) (6.98g). The plants to two shoots (P_{1}) produced notably more leaf fresh weight (9.53g) than plants pruned to four shoots (P_{2}) (6.85g) and un-pruned plants (P_{3}) (6.65g). Maximum leaf fresh weight (10.60g) was recorded from two stem pruned plants (P_{1}) of Bachata (C_{2}) cultivar which was statistically higher than other treatment combinations. Minimum leaf fresh weight (5.33g) was recorded from un-pruned plants of Inspiration (C_{3}) cultivars. Similar findings were also reported by Abdullah et al (2013) and Jovicich et al (1999).

Leaf dry weight: The highest leaf dry weight (1.90g) was recorded in Bachata (C_{2}) which was significantly higher than Inspiration (C_{3}) (1.40g) and Indra (C_{1}) (1.25g) (Table 4). The variation in leaf dry weight in different cultivars was might be due to the genetic variations or their ability for exploiting the environmental under greenhouse conditions. Plants pruned to two shoots (P_{1}) have significantly more dry weight (1.85g) than in un-pruned plants (P_{3}) (1.38g) and with four stem pruned plants (P_{2}) (1.31g). The highest dry weight (2.21g) of leaves was recorded in Bachata (C_{2}) cultivars pruned to two shoots as compared to all other treatment combinations whereas, un-pruned plants of Indra (C_{3}) produced significantly lowest dry weight (1.03g). These results are in close conformity with Michelik and Wierzbicka (2001) and Elio et al (2005).

Flowering characteristics

Number of days to first flowering: Indra (C_{1}) cultivar of capsicum took considerably lesser number of days (21.0 days) for first flowering to appear than other two cultivars Bachata (C_{2}) and Inspiration (C_{3}). While, Inspiration (C_{3}) took more number of days for first flowering to appear (23.92 days) as compared to Bachata (C_{2}) (22.0 days) as shown in (Table 5). This might be due to an early shift in vegetative to reproductive stage in plants trained to two shoots. The availability of more photosynthates because of only two shoots was maintained per plant. Similar results were also observed by Shukla et al (2011).

Yield traits

Number of fruits per plant: According to the data presented in (Table 6) maximum number of fruits (19.17) was noted in green coloured capsicum cv. Indra and it was followed by

| Pruning | Cultivars | Indra (C_{1}) | Bachata (C_{2}) | Inspiration (C_{3}) | Mean |
|---------|-----------|---------------|-----------------|---------------------|------|
| Two stem (P_{1}) | 12.75 | 7.65 | 7.48 | 9.29 |
| Four stem (P_{2}) | 21.12 | 13.43 | 14.16 | 16.24 |
| Un-pruned (P_{3}) | 23.64 | 15.22 | 16.73 | 18.53 |
| Mean | 19.17 | 12.10 | 12.79 | |

CD (p=0.05) -

| Cultivars | 0.36 |
| Pruning | 0.36 |
| Cultivars x Pruning | 0.63 |
red coloured cv. Inspiration (12.79) and yellow colored capsicum cv. Bachata showed least number of fruits per plant (12.10). The differences observed during the trial might be due to genetic make up of the coloured capsicums. Plants which remained un-pruned (P₃) have significantly more number of fruits per plant (18.53) than four stem pruned plants (P₂) (16.24) and two stem pruned plants (P₁) (9.29). The highest number of fruits per plant (23.64) were recorded in Indra (C₃) cultivars when remain un-pruned as compared to all other pruning combinations whereas, plants of Inspiration (C₃) produced significantly lowest number of fruits per plant (7.48) when pruned to two stems. More number of fruits per plant in un-pruned plants than pruned plant could be attributed due to availability of more number of undistributed fruit producing shoots which resulted into higher number of fruits per plant. Similar results were also reported by Esiyok et al. (1994) in greenhouse pepper (Capsicum annuum L. grossum cv. Kandil and 11B-14).

**Fruit yield per plant (kg):** Indra (C₁) produced significantly higher fruit yield per plant (3.47 kg) than the Bachata (C₂) (2.55 kg) and Inspiration (C₃). Inspiration (C₃) produced minimum fruit yield per plant (2.50 kg) Significantly higher fruit yield per plant was recorded in four stem pruned plants (P₂) (3.50 kg) than two stem pruned (P₁) and un-pruned plants (P₃). The un-pruned plants (P₃) (3.36 kg) produced more fruit yield per plant in comparison with two stemmed pruned plants (P₁) (1.65 kg). Similarly finding was observed by Maboko et al. (2012) and Seifi et al. (2013). The effect of interaction of different pruning configuration treatments and of cultivars of bell pepper was insignificant (Table 7).

**Fruit yield (tones/ha):** It was recorded that variation in the fruit yield (tones/ha) in tested cultivars of bell pepper was recorded to be significant. Indra (C₁) produced significantly higher fruit yield (671.18 tones/ha) than the Bachata (C₂) (493.35 tones/ha) and Inspiration (C₃). Inspiration (C₃) produced minimum fruit yield (484.27 tones/ha) (Table 8). Significantly higher fruit yield per plant was recorded in un-pruned plants (P₃) (678.12 tones/ha) than four stem pruned (P₂) and two stem pruned plants (P₁). The four stem pruned plants (P₂) (650.39 tones/ha) produced more fruit yield per plant in comparison with two stemmed pruned plants (P₁) (320.30 tones/ha). Similarly finding was observed by Esiyok et al. (1994) in greenhouse pepper (Capsicum annuum L. grossum cv. Kandil and 11B-14).

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