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Effect of training level on growth and yield of Capsicum (*Capsicum annuum* L) hybrid buffalo under natural ventilated polyhouse

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Abstract
An experiment was carried out to study the Effect of training level on growth and yield of Capsicum (*Capsicum annuum* L) hybrid buffalo under natural ventilated polyhouse during September, 2016 to February, 2017 at Hi-Tech Horticulture, R.P.C.A.U Pusa, Samastipur, Bihar. There were three levels of training level *viz*. P_1 (two shoots), P_2 (three shoots) and P_3 ((four shoots). The experiment was laid out in factorial randomized block design with three replications. Among the different training level, the maximum plant height (132.23 cm), number of leaf (119.61), leaf area (99.95 dm^2), number of branches (8.93), number of flower per plant (11.41), number of days for fruit set (66.75 days), number of fruit per plant (20.31), yield per plant (3.20 kg), yield (95.01t/ha), and B:C ratio (6.21) was recorded under P_3(four shoots) rest of treatments. maximum fruit weight was recorded under P_1, and least number of days to first harvest, early flower initiation as well as 50 per cent flowering was recorded under training level P_1 (two shoots). maximum fruit weight(175.91 g) was recorded under P_1, and least number of days to first harvest (89.36 days), early flower initiation as well as 50 per cent flowering (52.71 days) was recorded under training level P_1 (two shoots).

Keywords: Capsicum, training level, natural ventilated polyhouse

Introduction
Sweet pepper (*Capsicum annuum* var. grossum L.) belongs to the family solanaceae. Sweet pepper and chilli, the Capsicum, are native to Tropical South America. it is a cool season tropical crop and lacks adaptability to varied environmental conditions (Yoon *et al.* 1989) [7]. Nutritionally, bell pepper are rich in vitamins particularly Vitamin A (180 IU) and vitamin C. 100 gram of edible portion of capsicum provides 24 kCal of energy, 1.3 g protein, 4.3 g carbohydrates and 0.3 g fat (Anon 2007) [1]. It is extensively cultivated in hills of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, Andhra Pradesh and Nilgiri hills during summer months. As an autumn crop, it extends up to winter months in Karnataka, Maharashtra, Tamil Nadu, Bihar, West Bengal, Uttar Pradesh and Madhya Pradesh. Bell pepper/capsicum is one of the highly remunerative vegetables cultivated in most part of the world especially in temperate regions of central and South America and European countries, tropical and subtropical regions of Asian continent. In the world, area and production of bell pepper is merged with that of hot pepper (chilli pepper). Hence, the exact statistics related to bell pepper/chilli as whole is given. China is the major producer of capsicum and contributes 36 per cent of the worlds cultivated area with a production of 15.03 million tones. India contributes average annual production of 1.08 million tonnes from an area of 1.06 million hectare with a productivity of 1.12 tonnes per ha (Anon., 2014) [2]. There is great diversity of climate in India and agro-climatic conditions of the plains are not conducive for seed production of sweet pepper due to various biotic, abiotic and crop factors (flower and fruit drop). Greenhouse the latest word in Indian agriculture is one such means where the plants are grown under controlled or partially controlled environment resulting in higher yields than that is possible under open conditions (Navale *et al.* 2003) [5]. Fruit weight, which is associated with fruit size, is of great importance because it determines prices for colored sweet pepper. In commercial greenhouse pepper crops fruit development is controlled by restricting the branching pattern to 2, 3 or 4 main stems. The reasons for pruning sweet pepper under greenhouse conditions are to train plant growth to facilitate light penetration throughout the leaf canopy for more efficient interception of light.

Material and Methods
The present investigation was carried out at Hi-Tech Horticulture, R.P.C.A.U PUSA,

Samastipur, Bihar during September, 2016 to February, 2017 to study the performance of hybrid capsicum (*Capsicum annuum* L.) *cv*. Buffalo with different levels of spacing under naturally ventilated polyhouse. The seedlings of capsicum hybrid buffalo was planted in two rows on one meter wide bed having 50 cm path between two beds with three training levels P_1 (two shoots/plant), P_2 (three shoots/plant) and P_3 (four shoots/plant). Plants were trained with plastic thread tied to galvanized iron wire stretch over head along the bed. The experiment was laid out in a two factor factorial plot design with three replications. The total numbers of treatments were nine. Irrigation and fertilizer were done as per the recommendation. The misting was carried out by over head mister as per need to bring temperature and relative humidity up to optimum level in polyhouse**.** The polyhouse was heated at night to maintain a minimum temperature of 16 ºC. Maximum temperatures (day time) inside the polyhouse depended on the outside air temperatures and varied from 20 ºC to 34 ºC during the cultivation period. A drip irrigation system was used for irrigation and fertilization. During the experiment Vermicompost 3 kg/m^2, N: P: K 150:150:150 Kg/ha in the form of 19:19:19 water soluble fertilizer was applied alternate day with the help of fertigation unit. Micronutrient solutions were applied through foliar spray @ 2.0 ml per liter of water at monthly interval during crop period. Five plants were tagged at random in each treatment for recording the plant height at an interval of 30 days starting from the date of transplanting. The plant height was measured from the ground level to the growing tip of the main stem and number of leaves from each of five labelled plants was counted and recorded at 30 days interval at 30, 60, 90 and 120 days after transplanting (DAP). The average height was calculated and expressed in centimeters. Five mature photosynthetically active leaves were separated from selected plants of all the treatments. The leaf area was measured using portable leaf area meter (Licor-3000) and expressed in deci sq. m. According to treatments, branches were kept fixed in number per plant. Number of flowers that bloomed was recorded at regular intervals from commencement of flowering to final harvest and total number of flowers per plant was recorded. The number of days taken after planting for 50 per cent of the plants for first flowering was recorded as days to 50 per cent flowering. Number of days taken from the date of transplanting for the first fruit set and first harvest appearance were counted and recorded. The fresh weight of capsicum fruits harvested from the labeled plants from each treatment were weighed and recorded in grams. The number of set fruits from tagged plants were recorded from 60, 90, 120, 150 and 180 DAP. The weight of matured fruits harvested from each picking was recorded till final harvest and total yield of fruits per plant was computed in kilograms and Total weight of matured fruits harvested from each picking in the tagged plants in each replication was recorded till final harvest and the total yield of fruits per hectares under different treatments computed in tones per hectare. Economics of capsicum production under polyhouse was worked out by considering the present price of inputs and produce.

Result and Discussion

The highest plant height (43.36 cm), (84.35 cm), (116.16 cm), (132.23 cm) was recorded under P_3 (four shoots) training level which was P_2 (three shoots) and P_1 (two shoots) at 30, 60, 90, 120 DAP respectively. which might be due to the competition for sunlight among the shoots, but the shoot diameter was found thinner in four shoot level than two shoot level.

The highest number of leaves (50.01), (85.37), (111.60) and (119.61) was recorded under P_3 (four shoots) training level at 30, 60, 90, and 120 DAP respectively, which was significantly superior over P_2 (three shoots) and P_1 (two shoots). This might be due to more number of shoots under the training level P_3 than other training levels. These results corroborate with the findings of Cebula (1995) [3]. The leaf area per plant at different training levels at 90 DAP, the highest number of leaf area (99.95 dm^2) was recorded under P_3 (four shoots) training level which was statistically at par with P_2 (three shoots) and significantly superior over P_1(two shoots). This might be due to accumulation of more photosynthates. Similar results were obtained by Vann *et al*. (1986) [6], Cebula (1995) [3] and Dasgan and Abak (2002) [4] in bell pepper.

The number of branches per plant at different training levels at 120 DAP, the highest number of branches per plant (8.93) was recorded under P_3 (four shoots) training level which was significantly superior over P_2 (three shoots) and P_1 (two shoots). This might be due to more number of shoots under the training level P_3 than other training levels. The highest number of flower per plant (10.19), (11.41), (9.44), (7.54), (3.62) was recorded under P_3 (four shoots) training level which was significantly superior over the rest of the training level at 60, 90, 120, 150, and 180 DAP respectively. This may be due to four number of shoots were maintained.

Number of days to 50 per cent flowering was also significantly influenced by training level, the training level P_1 produced early (52.71 days) 50 per cent flowering followed by P_2 (54.44 days). The late (56.41 days) 50 per cent flowering was observed in training level P_3 (56.41 days), which was at par with spacing P_2 (54.44 days). This might be due to early shift in vegetative to reproductive stage in training level P_1. The availability of more photosynthates because of only two shoots was maintained per plant. Among different training levels of number of days for fruit set, the highest number of days for fruit set (66.75) was observed under P_3 (four shoots) training level which was statistically at par with P_2 (three shoots) and significantly superior over P_1 (two shoots). This might due to least number of branches was available as compared to other training levels. The early (89.36 days) harvesting was observed under P_1 (two shoots) followed by P_2 (93.86 days) and late (96.88 days) harvesting was noticed in spacing P_3. It could be due to the early fruit set, coupled with exposure of fruits to sunlight and better aeration in these treatments. Comparatively late harvesting was observed under training level P_3 due to the dense canopy of plants. Under the different training levels, the highest number of fruit weight (175.91 g) was recorded under P_1 (two shoots) spacing which was statistically at par with P_2 (three shoots) and significantly superior over P_1 (two shoots). which might be due to the adequate supply of metabolites to the limited number of fruits.The similar findings were reported by Cebula (1995) [3] in capsicum. The maximum number of fruits per plant (20.31) was recorded under P_3 (four shoots) training level which was significantly superior over rest of the treatments. This may due to more number of shoots under training level P_3. Among different training levels of yield per plant, the highest number of yield per plant (3.20 kg) was observed in P_3 (four shoots) training level which was significantly superior over rest of the training level which might be due to the more number of shoots per plant than the training level P_1 and P_2. Under different training levels, the

highest yield (95.01 t/ha) was recorded under P_3 (four shoots) training level which was significantly superior over rest of the training level. which might be due to the more number of shoots per plant than the training level P_1 and P_2. Among different training levels, the highest B: C ratio (6.21) was recorded under P_3 (four shoots) training levels which was significantly superior over P_2 (4.91) training levels. It may due to better quality and higher yield obtained than other treatments.

Table 1: Effect of training level on plant height (cm) of capsicum hybrid buffalo at different stage of crop growth

Treatment	Plant height (cm) at 30 DAP	Plant height (cm) at 60 DAP	Plant height (cm) at 90 DAP	Plant height (cm) at 120 DAP
P_1 (Two shoots)	36.01	71.99	102.63	116.71
P_2 (Three shoots)	39.73	77.51	107.05	121.53
P_3 (Four shoots)	43.36	84.35	116.16	132.23
S.Em(±)	1.53	1.89	3.10	3.44
LSD(0.05)	4.59	5.67	9.30	10.32
CV%	11.57	7.28	8.56	8.37

Table 2: Effect of training level on number of leaves of capsicum hybrid buffalo at different stage of crop growth

Treatment	No. of leaves at 30 DAP	No. of leaves at 60 DAP	No. of leaves at 90 DAP	No. of leaves at 120 DAP
P_1 (Two shoots)	36.66	71.20	92.49	99.61
P_2 (Three shoots)	41.89	77.48	98.61	111.29
P_3 (Four shoots)	50.01	85.37	111.60	119.61
S.Em(±)	1.38	2.31	2.85	3.43
LSD(0.05)	4.13	6.93	8.53	10.29
CV%	9.63	8.89	8.46	9.35

Table 3: Effect of training level on number of flower per plant of capsicum hybrid buffalo at different stage of crop growth

Treatment	Number of flower per plant at 60 DAP	Number of flower per plant at 90 DAP	Number of flower per plant at 120 DAP	Number of flower per plant at 150 DAP	Number of flower per plant at 180 DAP
P_1 (Two shoots)	7.52	8.27	7.28	6.01	2.24
P_2 (Three shoots)	9.30	9.31	8.26	6.63	2.89
P_3 (Four shoots)	10.19	11.41	9.44	7.54	3.62
S.Em(±)	0.33	0.32	0.26	0.22	0.11
LSD(0.05)	0.98	0.97	0.76	0.66	0.33
CV%	10.87	9.96	9.18	9.84	11.43

Table 4: Effect of training level on Leaf area(dm^2), Number of branches per plant at 120 DAP, Days to 50% flowering, Number of days for fruit set, Days to first harvest of capsicum hybrid buffalo at different stage of crop growth

Treatment	Leaf area(dm^2)	Number of branches per plant at 120 DAP	Days to 50% flowering	Number of days for fruit set	Days to first harvest
P_1 (Two shoots)	82.48	6.78	52.71	60.99	89.36
P_2 (Three shoots)	93.86	7.56	54.44	63.91	93.86
P_3 (Four shoots)	99.95	8.93	56.41	66.75	96.88
S.Em(±)	2.68	0.33	1.66	1.22	1.66
LSD(0.05)	8.03	1.00	4.98	3.66	4.98
CV%	8.73	12.44	9.14	5.73	5.31

Table 5: Effect of training level on Fruit weight (g), Number of Fruit per plant, Fruit yield / plant(Kg), Yield (t / ha), and B: C ratio of capsicum hybrid buffalo at different stage of crop growth

Treatment	Fruit weight (g)	Number of Fruit per plant	Fruit yield / plant(Kg)	Yield (t / ha)	B : C ratio
P_1 (Two shoots)	175.91	12.35	2.22	65.58	4.02
P_2 (Three shoots)	162.01	15.85	2.60	77.39	4.91
P_3 (Four shoots)	154.08	20.31	3.20	95.01	6.21
S.Em(±)	6.52	0.84	0.08	2.65	0.15
LSD(0.05)	19.55	2.52	0.24	7.96	0.46
CV%	11.93	15.58	8.85	10.03	10.09

Conclusion

In the case of different types of characters like maximum fruit weight was recorded under P_1, and least number of days to first harvest, early flower initiation as well as 50 per cent flowering was recorded under training level P_1 (two shoots). Maximum plant height, number of leaf, leaf area, number of branches, number of flower per plant, number of days for fruit set, fruit weight, number of fruit per plant, yield per plant, yield (t/ha), and B:C ratio was recorded under P_3(four shoots) rest of treatments.

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