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Response of Different Varieties of Carnation (*Dianthus caryophyllus* L.) To Pinching and Boron

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Abstract
An investigation was carried out to study the response of different varieties of carnation (*Dianthus caryophyllus* L.) to pinching and boron under natural ventilated polyhouse during 2014-2015. Experimental results revealed that all the recorded parameters were significantly influenced by variety, pinching and boron.

Variety Baltico recorded significantly highest plant height, number of shoots and internodal length, while flowering parameters like days to first flower bud initiation and days to 50 per cent flowering were significantly minimum in Penelope. Variety Penelope also recorded maximum internodes per stem, duration of flowering and flowers per plant. The maximum diameter of flower bud, flower diameter, stalk girth, stalk length, in situ longevity, vase life of flowers; minimum calyx split flowers per plot was recorded in variety Domingo. Bud length was found maximum in Baltico. Unpinched plants showed significantly maximum plant height, number of internodes and internodal length, while significantly highest number of shoots was observed in double pinched plants. Days to first flower bud initiation and days to 50 per cent flowering were significantly minimum in no pinching. Diameter of bud and flower; bud length, stalk girth, stalk length of flower, in situ longevity and vase life were significantly highest in no pinching whereas double pinching recorded minimum calyx splitting, maximum shoots and flowers per plant. Spray of 0.1 per cent boron recorded better growth, flowering and yield parameters comparatively.

Keywords: Carnation, Varieties, Pinching, Boron, Quality, Yield

Introduction
Owing to the impeccable bond between flowers and humans, floriculture has emerged as a lucrative trade across the globe with more than 190 countries involved in trade. Carnation (*Dianthus caryophyllus* L.), native of the Mediterranean region belongs to the family Caryophyllaceae. It is genetically a quantitative long day plant (Blake, 1955) [3]. Today, carnation occupies the top slot in the global flower trade. In exports, carnation stands next only to rose and chrysanthemum in European markets (Sangita Ladha, 2008) [18].

The performance of carnation varieties varies with region, season, genotypes and growing environment. Testing of the available varieties for suitability and adaptability with respect to flowering, flower quality and yield parameters are of prime importance. Apical dominance is one of the serious problems for commercial carnation growers, as it does not permit the lateral buds to develop, resulting in limited number of lateral branches and flowers (Pathania *et al*., 2000) [13]. Pinching refers to the removal of apical portion of the plant.Quality is one of the most important characters in the cut flower industry and this is influenced by the application of nutrients (Belgaonkar *et al*., 1997) [2]. Calyx splitting is a complex disorder in carnation. Boron deficiency can aggravate the disorder. On the other hand, excess boron has been found toxic to the plants which expresses as leaf tip burn symptoms. Therefore, there is a need to standardize the dose of boron so that it controls calyx splitting without causing leaf tip burn and other toxicity symptoms.

In view of the above mentioned facts, the experiment was designed to standardize the best suitable variety, type of pinching and the concentration of boron for different varieties of carnation to study growth, quality and flowering in south Gujarat agroclimatic condition.

Materials and Methods
The experiment was carried out at Greenhouse Complex, Department of Floriculture and Landscape Architecture, Navsari Agricultural University, Navsari during the year 2014-15. The experiment was laid out in Completely Randomized Design (CRD) having three factors *viz.*, variety, pinching and boron. The varieties under evaluation were Baltico (V_1), Domingo (V_2), Penelope (V_3) and Kiro (V_4); four levels of pinching were no pinch (P_0), single pinch

(P_1), single and half pinch (P_2) and double pinch (P_3). Three levels of boron were control (B_0), 0.05% (B_1) and 0.1% (B_2).
In case of no pinch, plants were not pinched. In single pinching, pinching was done 25 days after transplanting at 6th node.In single and half pinch, half of the total shoots produced after single pinch were pinched by retaining 2 nodes after one month of single pinch.In case of double pinch, all shoots produced after single pinch were pinched by retaining 2 nodes after one month of single pinch.For preparation of 0.05 and 0.1 % boron solution, 2.5g and 5.0 g Di Sodium Octa borate Tetra Hydrate, respectively commercially available as 'Solubor' with 20 per cent available boron was dissolved in 1 litre water and used as foliar spray at monthly intervals.
All experimental plants received identical fertilizers, irrigation and other cultural practices during the period of investigation, except boron and pinching. The data on various vegetative and flowering observations were recorded during the course of investigation were statistically analyzed using Completely Randomized Design (FCRD) with factorial concept as described by Panse and Sukhatme (1967) [12]. The appropriate standard error of mean (S.Em.±) and the critical difference (C.D.) were calculated at 5 per cent level of probability.

Results and Discussion
The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Effect of variety
It is explicit from the data (Table 1) that variety Baltico (V_1) recorded significantly maximum plant height (99.39 cm) number of shoots (6.41) and internodal length (6.39 cm) while maximum number of internodes per stem (12.17) was significantly highest in Penelope. Variability in various vegetative attributes among the varieties is mainly due to genetic makeup which differs from one variety with the other. This was in accordance with the reports of Patil (2001) [14] and Shiragur (2002) [21] in carnation.
Among the various varieties, days to first flower bud initiation (86.55 days) and days to 50 per cent flowering (107.74 days) were significantly minimum in Penelope while duration of flowering was maximum (166.27 days) in Penelope (Table 1). Inherent characters of the variety govern the various characteristics of flowering apart from other environmental factors. These differences due to varietal difference were confirmed by Kumar and Yadav (2003) [8] and Ambad *et al*. (2001) [1] in gerbera.
The maximum diameter of bud (19.94 mm) and flower (5.66 cm), stalk girth (4.73 mm) and length of flower stalk (80.18 cm) were flower longevity (17.61 days) and vase life (7.67 days) as well as minimum calyx splitting (0.20%) were recorded in Domingo while maximum bud length (2.95 cm) was found in Baltico.
The variation in various floral quality parameters is attributed to the inherent genetic makeup of the variety. Thicker stems indicated that this variety has higher capacity of storing reserve food material. Similar conclusions due to varietal variation were in close conformity with Singh and Sangama (2003) [22], Ryagi *et al*. (2007) [17] and Rao *et al*. (2008) [16] in carnation.
Variety Penelope exhibited significantly highest number of flowers per plant (7.89) which was due to innate variation present in this variety leading to high photosynthetic efficiency and longer duration of flowering that lead to maximum number of flowers per plant.

Effect of pinching
Pinching showed prominent influence on all vegetative parameters (Table 1). Among the various methods of pinching, maximum plant height (107.84 cm), internodes per stem (15.09) and intermodal length (5.74 cm) were recorded in no pinching. This was in accordance with the reports of Dalal *et al*. (2006) [5] who reported that plant height was maximum in unpinched plants as compared to other treatments in carnation. Significantly highest number of shoots per plant (7.76) was observed in double pinch. Similar results were also obtained by Sharma *et al*. (2006) [19] they stated that by removal of the apical portion, more energy might have been diverted for the development of a higher number of side branches per plant in African marigold.
Minimum days to first flower bud initiation (54.20 days) and 50 per cent flowering (77.45 days) were recorded in no pinching while single and half pinch recorded longer duration of flowering (Table 1). Un pinched plants were able to initiate flower buds earlier as compared to pinched plants on account of earlier accumulation of assimilates. In case of single and half pinched plants, first half single pinch stems starts flowering then remaining half pinched stems starts flowering later so it produces flowering longer time (202.61 days).
It is apparent from the data (Table 2) that significantly maximum bud diameter (18.17mm), bud length (2.94 cm), flower diameter (5.53 cm), stalk girth (4.54 mm), length of flower stalk (85.87cm), *in situ* longevity (17.97 days) and vase life (8.12 days) were recorded in no pinching which is due to the utilization of all the photosynthates by a single flower stalk. Pathania *et al*. (2000) [13] also observed that un pinched plants had the longest stems, maximum flower size and *in situ* longevity.
Double pinching recorded significantly minimum percentage of calyx splitting (0.71) and highest number of flowers per plant (9.32). The maximum flowers per palnt in double pinched plants was recorded primarily due to the presence of highest number of productive stalks per plant. These results were in agreement with Chavan *et al*. (2004) [4] and Shinde *et al*. (2005) [22] in carnation

Effect of boron
Foliar spray of 0.1% boron significantly improved all vegetative parameters (Table 1). Among the various concentrations of boron, spray of boron @ 0.1 per cent recorded significantly maximum plant height (96.93 cm), shoots per plant (5.36), internodes per stem (12.03) and intermodal length (5.65).Boron performs an important role in the biosynthesis of auxins within the plants leading to increase in translocation of sugars, thereby increasing the number of lateral shoots. Similar observations were made by Rajput *et al*. (2003) [15] in African marigold and Lalit Bhatt *et al*. (2004) [9] in tomato.
Minimum days to first flower bud initiation (95.87 days), 50 per cent flowering (119.13 days) and maximum duration of flowering (164.14 days) were recorded in the plants treated with 0.1 per cent boron (Table 1). The reason behind the earliness and longer span in flowering might be the role of optimum boron favouring storage of carbohydrate and its metabolism through photosynthesis.
The maximum diameter of flower bud (17.39 mm), bud length (2.87 cm), flower diameter(5.36 cm), stalk girth (4.26 mm), length of flower stalk(79.98cm), *n situ* longevity (16.30 days) and vase life (7.62 days) of flowers were maximum

with application of 0.1 per cent boron (Table 2). It may be due to the positive effects of boron on reproductive stage of a plant as it increases the rate of translocation of sugars which are produced in the mature leaves into actively growing regions.

The treatment with foliar application of 0.1 per cent boron also recorded minimum incidence of calyx split (0%) while control recorded the highest calyx split (2.5%). Boron has a significant role in the reproductive physiology of the plant starting from bud initiation to paint brush stage of flower harvest. Reduction in calyx splitting might be due to the fact that the optimum dose of boron being involved in the formation of cell wall, also gets tied up with the protein in the protoplasm so w gives strength to the calyx as observed by Karthikeyan *et al.* (2009) [7] and (Jawaharlal *et al*., 2012) [6] in carnation.

Spray of 0.1 per cent boron showed significant effect on yield. Highest number of flowers per plant (10.93) were obtained in treatment B_2 (0.1% boron) as boron influences the activity of many essential enzymes and this might have led to increased flower yield (Table 2). Parallel inferences were recorded by Misra (2001) [10] in chrysanthemum by soil application of borax at the rate of 1.5 g per m^2 and Nath and Biswas (2002) [11] in tuberose by foliar application of boron @ 100 ppm twice at monthly intervals.

Table 1: Effect of variety, pinching and boron on growth and flowering of carnation.

Treatments	Plant height (cm)	Shoots per plant	Internodes per stem	Internodal length (cm)	Days to first flower bud initiation	Days to 50% flowering	Duration of flowering (days)
Variety (V)							
V_1-Baltico	99.39	6.41	11.92	6.39	94.34	111.86	159.38
V_2-Domingo	89.36	4.09	11.21	4.53	118.53	142.32	161.79
V_3-Kiro	93.18	4.70	11.53	5.67	95.07	120.72	160.10
V_4-Penelope	98.10	5.11	12.17	5.64	86.55	107.74	166.27
S.Em.±	0.14	0.02	0.02	0.01	0.1	0.09	0.08
C.D. at 5 %	0.39	0.06	0.06	0.02	0.27	0.25	0.22
Pinching (P)							
P_0- No pinch	107.84	1.00	15.09	5.74	54.20	77.45	133.30
P_1- Single pinch	92.89	4.64	12.53	5.54	100.32	123.14	160.08
P_2- Single and half pinch	93.05	6.20	12.54	5.54	99.87	123.61	202.61
P_3- Double pinch	86.24	7.76	6.67	5.41	140.11	158.43	151.55
S.Em.±	0.14	0.02	0.02	0.01	0.27	0.09	0.08
C.D. at 5 %	0.39	0.06	0.06	0.02	0.1	0.25	0.22
Boron spray (B)							
B_0- Control	93.15	4.69	11.38	5.46	101.76	122.16	159.93
B_1- 0.05 % Boron	94.93	5.18	11.71	5.56	98.24	120.70	161.59
B_2- 0.1 % Boron	96.93	5.36	12.03	5.65	95.87	119.13	164.14
S.Em.±	0.12	0.02	0.02	0.01	0.08	0.08	0.07
C.D. at 5 %	0.34	0.05	0.06	0.02	0.24	0.24	0.17

Table 2: Effect of variety, pinching and boron on flower quality and yield of carnation.

Treatments	Bud diameter (mm)	Bud length (cm)	Flower diameter (cm)	Stalk girth (mm)	Stalk length (cm)	Flower longevity (days)	Vase life (days)	Calyx splitting (%)	Flowers per plant
Variety (V)									
V_1-Baltico	16.16	2.95	4.90	3.84	78.98	16.30	7.43	1.59	6.59
V_2-Domingo	19.94	2.66	5.66	4.73	80.18	17.61	7.67	0.20	5.64
V_3-Kiro	15.14	2.85	5.36	4.51	78.54	15.56	7.28	1.24	7.16
V_4-Penelope	16.20	2.65	4.76	3.54	78.28	15.49	7.39	1.51	7.89
S.Em.±	0.05	0.01	0.02	0.003	0.09	0.04	0.02	0.06	0.03
C.D. at 5 %	0.14	0.03	0.06	0.009	0.25	0.11	0.05	0.18	0.08
Pinching (P)									
P_0- No pinch	18.17	2.94	5.53	4.54	85.87	17.97	8.12	1.56	4.24
P_1- Single pinch	16.70	2.85	5.38	4.16	81.96	15.99	7.47	1.25	6.06
P_2- Single and half pinch	16.65	2.71	4.93	4.09	81.45	15.76	7.21	1.02	7.66
P_3- Double pinch	15.92	2.60	4.84	3.83	66.71	15.23	6.97	0.71	9.32
S.Em.±	0.05	0.01	0.02	0.003	0.09	0.04	0.02	0.06	0.03
C.D. at 5 %	0.14	0.03	0.06	0.009	0.25	0.11	0.05	0.18	0.08
Boron spray (B)									
B_0- Control	16.38	2.66	4.99	4.06	78.09	15.90	7.28	2.54	6.57
B_1- 0.05 % Boron	16.81	2.79	5.16	4.14	78.92	16.26	7.43	0.94	6.82
B_2- 0.1 % Boron	17.39	2.87	5.36	4.26	79.98	16.56	7.62	0.00	7.08
S.Em.±	0.04	0.01	0.01	0.003	0.08	0.04	0.02	0.06	0.02
C.D. at 5 %	0.12	0.03	0.09	0.009	0.22	0.10	0.05	0.16	0.07

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