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# COMPARATIVE EVALUATION OF DIFFERENT PINCHING APPROACHES ON VEGETATIVE AND REPRODUCTIVE GROWTH OF CARNATION (*Dianthus caryophyllus*)

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Effect of pinching, both manual and chemical - using alar and cycocel (CCC), was ascertained for improving the production of compact dwarf carnation var. Red Sim. Two levels of each hormone, i.e., alar at 200 and 400 mg $L^{-1}$ and cycocel (ccc) at 500 and 1000 mg $L^{-1}$ were sprayed for the purpose. Plants were compact and dwarf with increased number of shoots and maximum number of flowers, when treated with higher level of cycocel (1000 mg $L^{-1}$) but leaf count and flower size were negatively affected. Dwarfness, number of branches and reduction in leaf area were directly correlated with the concentration of chemicals. Branch size increased with a concomitant reduction in number of branches $plant^{-1}$. Pinching delayed flowering and shortened the blooming period, while pinching and both chemicals decreased flower size considerably. Lower level of alar (200 mg $L^{-1}$) proved ineffective but higher concentration (400 mg $L^{-1}$) had remarkable effects on different vegetative and floral characteristics of carnation.

**Keywords:** Carnation, alar, cycocel, pinching, flowering.

## INTRODUCTION

Carnation, a highly appreciated flowering plant in many parts of the globe due to its captivating beauty, has earned a great reputation among ornamentalists and naturalists (Bylov and Smirnova, 1984), because of different uses such as garden display, superb cut flower, house beautification, pot plant and borders of lawns etc. Carnations have long been grown as cut flower in many parts of the world, while its production as a pot-plant is more recent and demands the development of dwarf species. 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). The aesthetic value can only be achieved by the increased number of healthy and beautiful flowers (Khristov and Pavlov, 1977; Bylov and Smirnova, 1984). However, the tendency of the first shoot to grow too long lowers the commercial value of these plants (Banon *et al.,* 2002).

In recent years, a number of plant growth retardants have been used in the field of agriculture for inducing more acceptable plant characteristics like compact growth, dwarfness and increased number of healthy branches (Messinger and Holcomb, 1986; Song and Lee, 1995 and Banon *et al.,* 2002), which are the desired traits in modern floriculture industry. Benzyladenine (Pro-Shear) has been used on white pine to increase lateral bud formation and subsequent growth and branching, while tetrapyranylbenzyladenine (Accel) has been introduced for carnations and roses to increase lateral branching (Gianfagna, 1995). The inhibiting effect of paclobutrazol on plant height of ornamental plants has been well reported in literature (Gad *et al.,* 1997; Dasoju *et al.,* 1998; Gonzalez *et al.,* 1999). Chlormequat chloride has been used to reduce stem height and lodging, increase stem diameter and to induce tillering in wheat (Humphries *et al*., 1965). Alar has been reported to reduce shoot and petiole length, leaf area and increase the number of side shoots in *Campanula poscharskayana* (Holmenlund, 1988) and was effective in inducing compact growth in the early flowering chrysanthemum (Malko and Karchenko, 1985). Significant reduction in plant height and leaf area was observed in Helianthus cultivars by Starman *et al.* (1989), by using ancymidal.

Contrary to the use of chemicals, a technique of forcing bloom in carnation for special market has been developed to enable ornamental growers to produce a large amount of cut carnation flowers by pinching of shoots and temperature control (Imamura and Suto, 2001). Suppressive as well as beneficiary effects of pinching in terms of delayed flowering and increased number of flowering stems, has been reported by researchers (Ubukata, 1999; Pathania *et al.,* 2000; Sawwan and Samawi, 2000). Although a lot of information is available to maximize flowering in commercially important plants yet comparative studies involving the use of growth retardants and pinching are scarce. Therefore, an experiment was carried out to compare the effects of two growth retardants (alar and cycocel) and manual pinching on carnation cultivar Red Sim. The objective of the study was to enhance production of best quality cut carnation flowers by applying different pinching approaches.

## MATERIALS AND METHODS

Seeds of carnation cv. "Red Sim" were sown in the nursery of floriculture area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan. Seedlings at two leaf stage were shifted to polythene tubes filled with leaf manure and soil in 1:1 ratio (by volume). Seedlings, when attained the height of 10-12cm, were transplanted in field experimental units of 1.8m x 1.2m, keeping row to row and plant to plant distance 60 and 45 cm, respectively. The physiological characteristics of soil were determined according to Jackson (1962). The saturation percentage of the soil was 33 with pH value of 7.9 and electrical conductivity 2.1 dS $m^{-1}$. The organic matter of the soil was 0.84% with $NO_3$-N and $NH_4$-N values of 6.9 and 3.4 mg $kg^{-1}$ of dry soil, respectively. Available phosphorus, calcium and potassium contents of the soil were 52, 214 and 127 mg $kg^{-1}$ of dry soil, respectively.

There were four chemical treatments, i.e., alar @ 200 and 400 mg $L^{-1}$ and cycocel @ 500 and 1000 mg $L^{-1}$ with one mechanical treatment (hand pinching). The chemicals were applied exogenously to the carnation plants as foliar spray until runoff, while plants sprayed with distilled water were used as control. The plants were sprayed twice in their life span; first application one month after transplanting and second 15 days after the first one.

The experiment was laid out in a randomized complete block design with four repeats. Data were collected for plant height (cm), number of shoots $plant^{-1}$, length of shoots (cm), number of leaves $plant^{-1}$, leaf area ($cm^2$), initiation of flowering, blooming period, number of flowers $plant^{-1}$ and size of flowers ($cm^2$). Data for all indices were analyzed statistically using Fisher's Analysis of Variance Techniques to determine the significance at 5% level of probability (Steel *et al.,* 1997).

## RESULTS

Both concentrations of cycocel were very effective in reducing plant height (Fig. 1). Minimum height of plants (44.63 cm) was recorded when treated with 1000 mg $L^{-1}$ cycocel. Untreated plants were tallest (59.91 cm), although statistically similar to plants treated with Alar @ 200 mg $L^{-1}$ (58.60 cm). Plants were of comparable height when sprayed with alar @ 400 mg $L^{-1}$ and cycocel 500 mg $L^{-1}$ i.e. 51.44 and 48.91 cm, respectively. Pinching also reduced plant height (55.68 cm) compared with control (59.91 cm) and lower concentration (200 mg $L^{-1}$) of alar (58.60 cm).

Cycocel application @1000 mg $L^{-1}$ induced maximum number of shoots (12.17) although results were statistically at par with cycocel applied @ 500 mg$L^{-1}$, i.e., 11.56. Minimum number (5.38) of shoots per plant was recorded in plants treated with alar @ 200 mg $L^{-1}$, statistically similar to untreated plants, i.e., control (5.99). Results of pinching (8.30) and alar @ 400 mg $L^{-1}$ (8.52) were statistically at par (Fig. 3).

Both the chemicals and hand pinching reduced length of the shoots effectively. Maximum reduction in shoot length was observed in cycocel treated plants, which had shoots of 27.62 and 31.22 cm length in plants treated @ 1000 and 500 mg $L^{-1}$, respectively. Shoots of maximum length were observed with control; although the results of alar @ 200 mg $L^{-1}$ were statistically similar, i.e., 50.74 and 47.35 cm, respectively (Fig. 1). Alar @ 400 mg $L^{-1}$ had effects similar to hand pinching, as shoots of 41.61 and 44.51 cm, respectively, were recorded in these treatments.

Spray of growth regulators and hand pinching increased the number of leaves $plant^{-1}$ considerably. Cycocel application @ 1000 and 500 mg $L^{-1}$ resulted in 193.84 and 169.80 leaves $plant^{-1}$, respectively (Fig. 2). Number of leaves was statistically similar in plants treated with alar @ 400 mg $L^{-1}$ (140.83) and pinching (130.12). Alar @ 200 mg $L^{-1}$ resulted same number of leaves $plant^{-1}$ (108.79) as control (106.57), which indicates that alar is ineffective at this concentration.

Significant reduction in leaf area was observed in treated plants; maximum reduction was recorded in plants treated with cycocel @ 1000 mg $L^{-1}$, in which individual leaves of 5.91 $cm^2$ area were observed as compared to 10.14 $cm^2$ leaves in untreated plants (Fig. 3). Cycocel @ 500 mg $L^{-1}$ also reduced single leaf area to 7.19 $cm^2$ while all other treatments were at par with each other and with control.

Results depicted early flower emergence in plants sprayed by both chemicals and cycocel treated plants took lesser number of days for flower initiation than alar. Flowering started first of all in plants treated with cycocel @ 1000 mg $L^{-1}$, i.e., after 71.35 days (Fig. 4), followed by plants treated with 500 mg $L^{-1}$ cycocel (74.35 days). Both concentrations of alar (200 and 400 mg $L^{-1}$) were statistically at par by producing first flower after 80.40 and 78.95 days, respectively. Pinching delayed flowering, as plants flowered almost at the same time when untreated plants started flowering, i.e., after 81.60 and 80.75 days, respectively. Flowering delayed with a concomitant decrease in the concentration of chemicals (Alar & CCC) and high concentration of both chemicals reduced crop duration.

Blooming period was calculated in terms of number of days for which the plant bears flowers. It ranged from 84.15 to 102.15 days in plants treated with growth retardants (Fig. 4). Longest blooming period was observed in plants treated with cycocel @ 1000 mg $L^{-1}$, i.e., 102.15 days, followed by the plants treated with the same chemical @ 500 mg $L^{-1}$ (95.40 days) and alar @ 400 mg $L^{-1}$ (90.35 days). Duration of blooming was statistically same for untreated, pinched and alar (@ 200 mg $L^{-1}$) treated plants, i.e., 86.55, 85.75 and 84.15 days, respectively.

**Fig. 1. Effect of cycocel, alar and pinching on plant height (cm) and length of shoots (cm).**

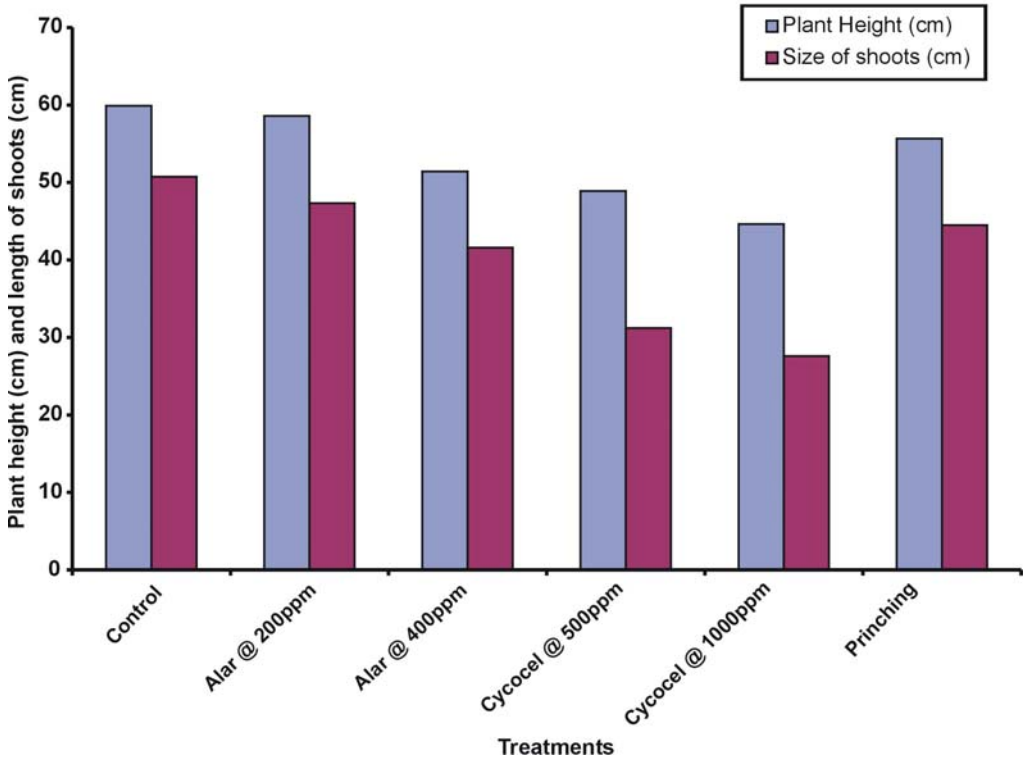
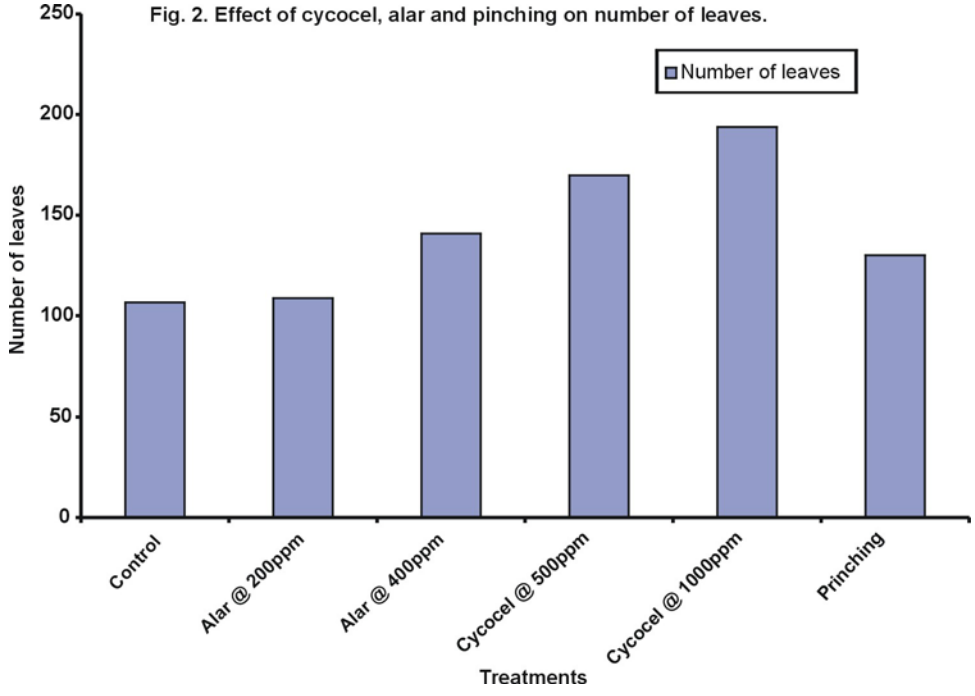



**Fig. 2. Effect of cycocel, alar and pinching on number of leaves.**



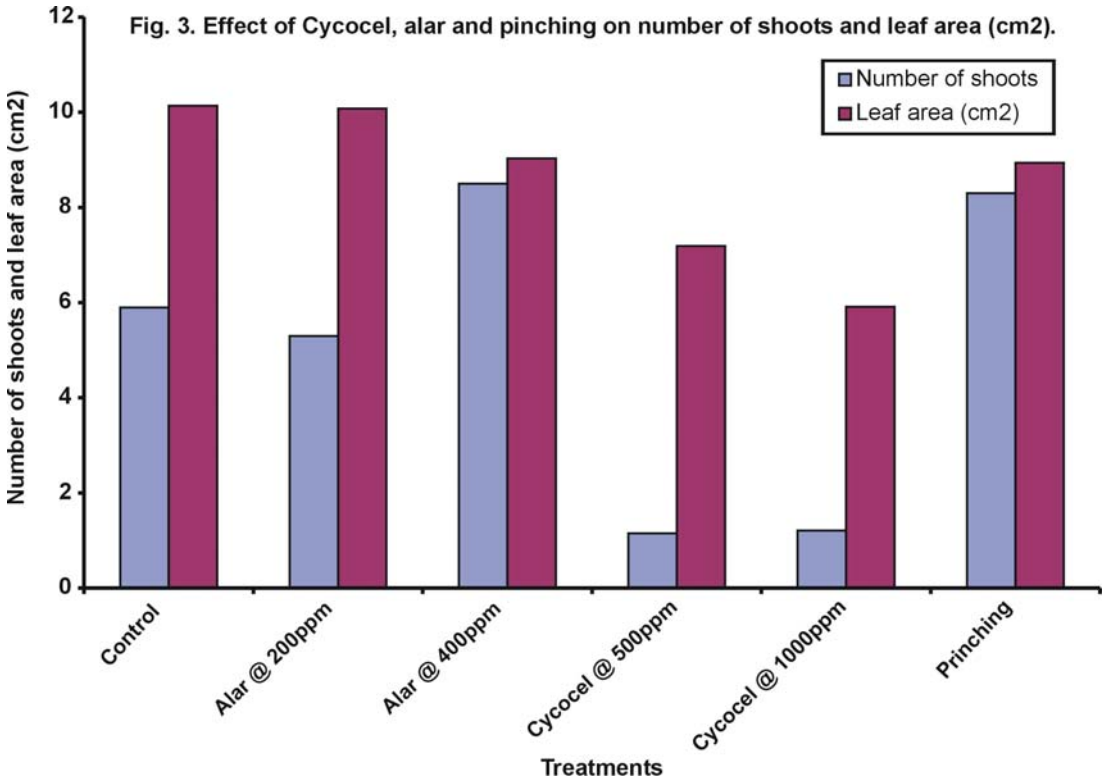



**Fig. 3. Effect of Cycocel, alar and pinching on number of shoots and leaf area (cm2).**

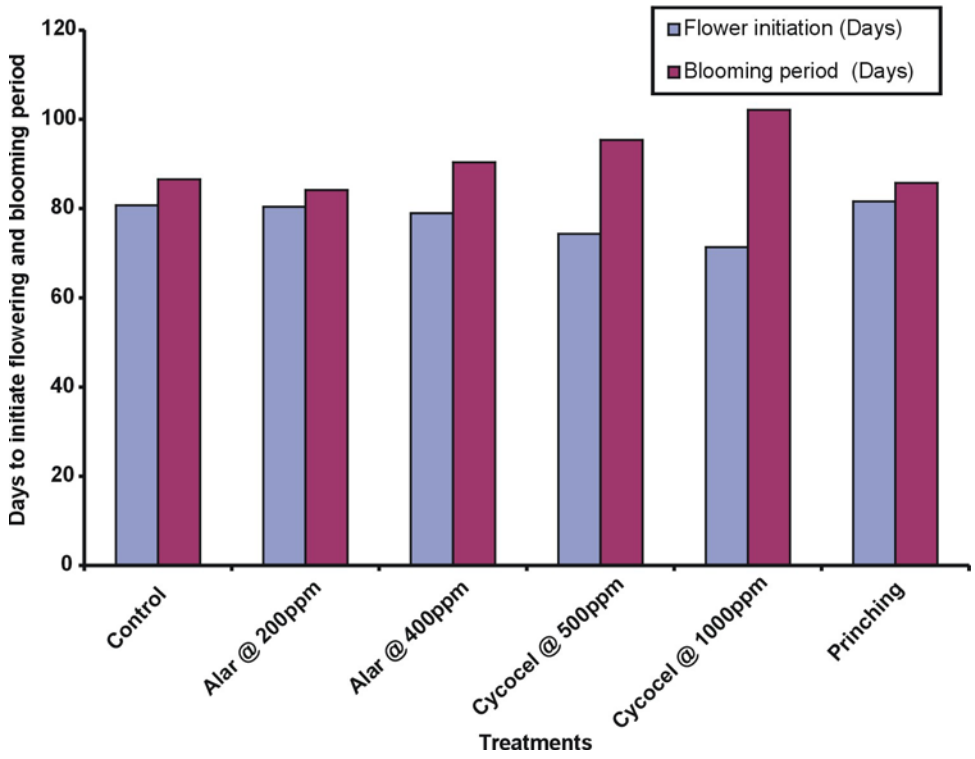
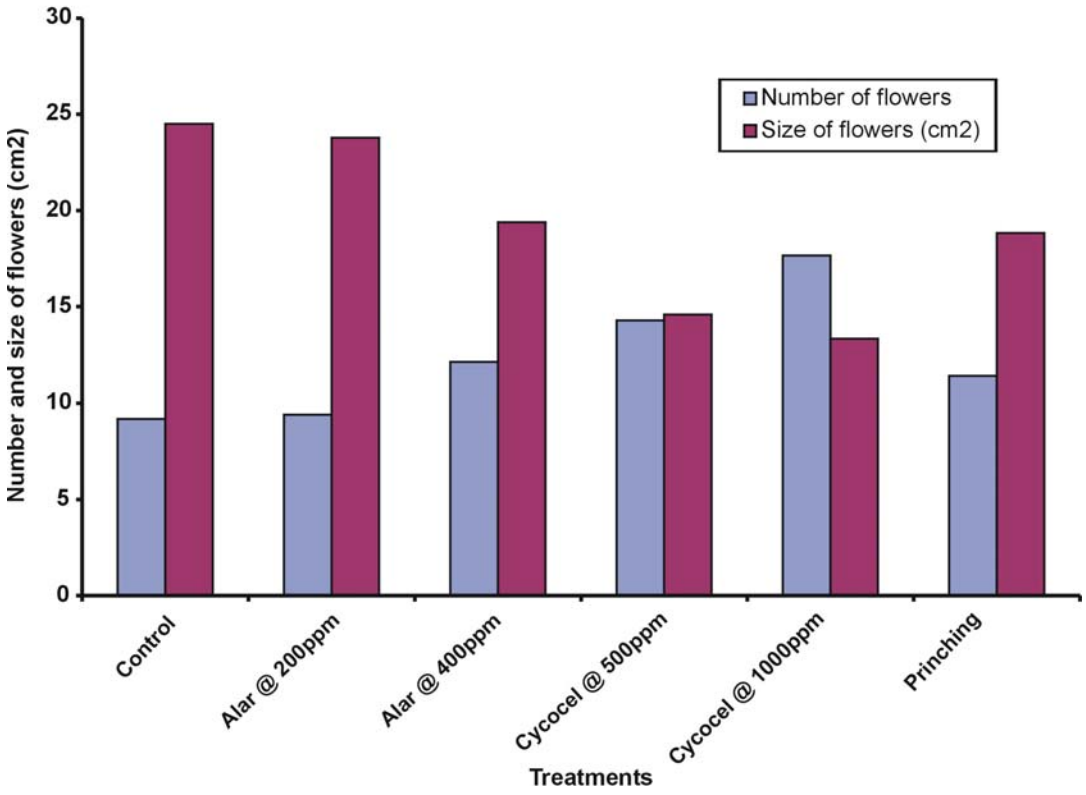



**Fig. 4. Effect of cycocel, alar and pinching on flower initiation and blooming period (Days).**

Both, chemical and mechanical treatments induced more number of flowers per plant as compared to control (Fig. 5). Cycocel exhibited superiority over all other treatments by producing maximum flowers per plant (17.66) when used @ 1000 mg $L^{-1}$. Cycocel @ 500 mg $L^{-1}$ also excelled all other treatments by producing 14.28 flowers per plant. Results for alar @ 400 mg $L^{-1}$ and pinching were statistically at par as they produced 12.12 and 11.39 flowers per plant, respectively. Results were statistically similar for untreated plants and those treated with alar @ 200 mg $L^{-1}$.

**Fig. 5. Effect of cycocel, alar and pinching on number of flowers and size of flowers (cm2).**




Results procured on size of flowers depicted adverse effects of cycocel when applied @ 1000 and 500 mg $L^{-1}$, resulting in flowers of smallest size i.e. 13.33 and 14.59 $cm^2$ respectively (Fig. 5). Application of alar @ 400 mg $L^{-1}$ and pinching had similar effects as flowers of 19.39 and 18.83 $cm^2$ were observed in these treatments. Untreated plants and those treated with alar @ 200 mg $L^{-1}$ were statistically at par by producing flowers of 24.51 and 23.79 $cm^2$, respectively.

## DISCUSSION

Results of the present experiment signify the better performance of cycocel as it reduced plant height more effectively than alar and hand pinching. Alar @ 200 mg $L^{-1}$ was ineffective as it did not reduce plant height significantly as compared to control, although the same chemical at higher concentration (400 mg $L^{-1}$) reduced plant growth more effectively. Considerable reduction in plant height by growth regulators as compared to control and hand pinching may probably be due to the change induced in the rate of cell division in the meristematic region. The amount of growth reduction was directly proportional to increase in concentration of both chemicals. Hamza and Helaly (1983) reported that alar induced dwarfness in carnation when used @ 1000 mg $L^{-1}$, while ancymidol in *Helianthus* cultivars, when sprayed @ 66 and 132 mg $L^{-1}$ (Starman *et al.,* 1989).

Results revealed that both the chemicals and hand pinching increased the number of shoots per plant significantly, particularly the cycocel. Effectiveness of chemicals on shoot production might be due to their retarding effect on apical growth which, in turn, encouraged lateral shoot growth. Moreover, number of shoots was directly correlated to the concentration of chemicals. Our results are verified by the findings of Bosma (1983) and Holcomb (1984), who reported that cycocel and alar produced more shoots in

chrysanthemum and ivy geranium. Results also envisaged that number of shoots increased with decrease in plant height, being maximum in cycocel treated plants and minimum in control and plants sprayed with alar @ 200 mg $L^{-1}$. The greater efficacy of pinching over lower concentration of alar and similar results as in case of higher dose of alar implies pinching as a substitute of chemicals, which is desirable both from an ecological and economical point of view.

Reduction in shoot size was in proportion to reduction in plant height, while branch size was inversely proportional to the number of shoots as well as the concentration of the chemicals. Cycocel and alar reduced shoot size in chrysanthemum (Menhenett, 1979) and hydrangeas (Scott, 1972). More shoot length in untreated plants than treated ones is in accordance with the findings of Pathania *et al*. (2000) who observed longest stems in unpinched Sim carnation plants.

Both the number of shoots and number of leaves were correlated with each other and also with the concentration of growth regulators. It is also clear that cycocel reduced plant height but increased the number of leaves, resulting in compact growth of carnation plants, which was due to reduced internodal distance. CCC increased the number of leaves in *Pelargonium* x *hortorum,* as reported by Welander (1984), which also verify our findings.

Pronounced reduction in leaf area might be due to some hormonal changes. Reduction in leaf area was in proportion to the concentration of the chemicals, as alar @ 400 mg $L^{-1}$ also reduced leaf area to some extent (9.03 $cm^2$). Leaf area and number of leaves per plant were inversely related, as plants having maximum number of leaves (treated with 1000 mg $L^{-1}$ cycocel) had leaves of minimum area, as compared to plants with minimum number of leaves of large area (control). Pinching also resulted in small (8.49 $cm^2$) sized leaves, although this reduction in area was statistically non-significant. Starman *et al.* (1989) reported that ancymidol significantly reduced leaf area of *Helianthus* cultivars, when sprayed @ 66 and 132 mg $L^{-1}$. These results corroborate the findings of Jasa *et al.* (1971) and Mikhailyuk (1977) that cycocel reduces leaf area of S*alvia splendens* and pears.

Reproductive maturity might be correlated with vegetative behavior as dwarfed plants with more branches and leaves matured earlier than the taller plants with lesser number of branches. Chemicals, especially cycocel seems to offset juvenility factor, which in turn, lead to earlier development of reproductive primordia, whereas, pinching promoted vegetative growth resulting in delayed flowering. Moreover, effectiveness of the chemicals for early flower emergence increased with increasing the concentration. These observations are in agreement with the findings of Miranda and Carlson (1980) and Bachthaler and Jansen (1980). Both of the above mentioned studies indicated that cycocel and alar induced early flowering in Pelargonium and Geraniums. Delayed flowering in carnation in response to pinching was also reported by Sawwan and Samawi (2000), which confirms our findings.

Both the chemicals increased blooming period significantly, except alar @ 200 mg $L^{-1}$. Prolonged flowering might be due to increased number of lateral shoots with more leaves, which matured and flowered at different times, as in case of cycocel (1000 and 500 mg $L^{-1}$) and alar (400 mg $L^{-1}$). Some other studies also revealed increased flowering in cycocel and alar treated plants like *Eustoma resselianum* (Hass and Miske, 1984). Our results are contrary to the findings of Ubukata (1999) who observed increase in flowering period by pinching out the flower buds in three carnation cultivarts, but this difference may be due to the difference in size of removed bud or the distance from the top of the pre-budding stem to the tip of the leaves (Imamura and Suto, 2001).

Results envisaged that number of flowers was directly proportional to the concentration of the chemicals, as the treatment, which induced maximum branching in carnation, yielded maximum number of flowers. It is also clear from the results that number of flowers and blooming period are correlated with number of branches per plant. These results are in agreement with some earlier studies, which indicated that the same treatments (pinching, CCC and alar) increases flowering in *Adonis autumnalis* (Abdalla *et al.,* 1985) and Marigold (Parmar and Singh, 1983). Pinching of flower buds in three carnation cvs. decreased number of flowers at the peak production stage (Ubukata, 1999), which is contrast to our findings, which might be due to late pinching of the plants.

Results revealed that both the chemicals and pinching reduced flower size; maximum reduction was induced by cycocel. Moreover, flower size was inversely related to the concentration of the chemicals and number of flowers, i.e., higher the concentration of chemicals, more was the number of flowers but of small size. Higher concentration of chemicals induced more branching but size of these branches remained small, with reduced leaf area, which might have resulted in small sized flowers due to diversion of photosynthates to a large number of shoots. Similar findings were recorded in chrysanthemum (Adriansen, 1985) and Azalea (Whealy *et al.,* 1988) after cycocel and alar application.

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