Efficacy of Planting Seasons and Macro Nutritional Levels on Growth, Yield and Vase Life of Carnation *Dianthus caryophyllus* L.

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Abstract: The present study was conducted to elucidate the effect of various planting seasons and macro nutritional (NPK) levels on vegetative, reproductive and vase life of carnation viz. Chaubad Mixed. There were two planting seasons (16th Nov. and 15th Feb.) and seven treatments (NPK combinations) were used. Planting season S₁ (16th Nov.) showed better results for indices like plant height, number of branches per plant, length of branches, number of leaves per plant, NPK contents, flower diameter, fresh weight of flower, fresh and dry weight ratio and flower quality as compared to planting season S₂ (15th Feb.). However, regarding treatments, T₂ (5:10:10 g pot⁻¹ NPK) showed positive correlation for morpho-physiological and bio-chemical traits like plant height, number of branches per plant, length of branches, number of leaves per plant, chlorophyll contents, NPK estimation and bud diameter by showing maximum values for the attributes with comparison to other treatments.

Key words: Carnation, NPK, nutrition, vase life, vegetative growth

INTRODUCTION

Carnation (*Dianthus caryophyllus*), a member of family caryophyllaceae, is a perennial flower which is mostly grown as annual in Pakistan. It has a variety of characteristics such as different growth habits, colors, sizes and its peculiar fragrance, which is a source of aesthetic gratification for the human beings. The plant is not only used for its garden beauty but has also been commercialized for its cut flowers. The species *caryophyllus* was once used as the generic name for clove, the basic fragrance of carnation, the common name; carnation is likely derived from “coronation” as the Greeks wove *Dianthus* flowers into crowns for their athletes. Carnation is indigenous to the Mediterranean region. In the world, areas of “natural climates” for carnation generally occur near 30° N or S latitude and on the Western edges of the continents. Examples are Southern California, the Mediterranean area and near Perth, Australia.

Carnation requires well balanced fertilizers application for optimum growth and quality production. The finest amount of nitrogen results in high flower yield in scania red carnation (Bloome and Roels, 1977). An increase in nitrogen level increased the growth and greatly

increased stalk length and number of gladiolus flowers (Shah *et al.*, 1984). By increasing nitrogen application, characteristics like plant height, number of branches per plant and seed yield become more whereas by increasing phosphorus number of pods per plant become greatest in *Impatiens balsamina* (Kumar and Kaur, 1996). Similarly, Khan *et al.* (2004) reported that *Zinnia elegans* cv. Meteor responded better to nitrogen application for improving its vegetative and floral characteristics.

Proper amount of fertilizer is indeed a secret of success and increase yield by enhancing the number and size of flowers (Damke and Bhattacharjee, 1997). Moreover, balanced nutrition also increases the vegetative and reproductive phase of growth (Sharaf and Ei-Naggar, 2003). Carnations are relatively slow growing plants. Therefore, it is utmost important for carnation grower to apply nutrients in the right quantity and frequency.

Carnation is high demanded in international cut flower market but short vase-life is major difficulty for distant marketing. Vase life allows some flexibility to regulate the market by supply of flowers during moderate market period and for having a greater supply during higher demand period. Carnation cultivars differ in length of their vase life (Nukui *et al.*, 2004) which is one of the characteristics determining the commercial value of the

ornamental flowers. As, there is an increasing demand for using carnations as a cut flower crop in the world including Pakistan, improved post harvest and maintenance techniques for extension of its vase-life are of greater economic importance.

The objective of this study was to elucidate the effect of best planting season and optimum level of macro nutrients (NPK) with suitable combination to get vigorous plant growth, maximum flower production and extension of vase-life of carnation flowers.

MATERIALS AND METHODS

Present study project was executed in greenhouse, Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad. Nursery was raised in greenhouse on finely prepared separate beds containing silt, sand and well rotten F.Y.M. (1:1:1). After sowing in greenhouse, light irrigation was given to plants. After two months of sowing, seedlings were transplanted into the 10 inches pots filled with silt and coal having 20:1 ratio according to the layout of the experiment. Prior to transplanting of seedling into pots, soil samples were collected randomly from the pots and were analyzed to check fertility status and other characteristics of the media. There were three plants in a treatment and seven treatments which were replicated twice and experiment was laid out according to completely randomized design with factorial arrangements. A commercial variety of carnation viz. Chabaud double mixed was planted in two different planting seasons viz. Autumn S_1 (16th Nov.) and Spring S_2 (15th Feb.) and compared to check their response to six combinations of NPK along with control.

Half dose of nitrogen with complete dose of phosphorus and potassium was applied according to treatments after one month of transplanting whereas remaining half dose of nitrogen will be applied after 30 days of first application. Nitrogen, phosphorus and potash will be applied in form of urea (46%), single super phosphate (18%) and sulphate of potash (50%), respectively. Healthy and vigorously growing plants were selected and tagged according to layout of the experiment. All other cultural practices, e.g., irrigation, weeding, hoeing, staking, pinching and IPM etc. were similar for all treatments during entire period of the study.

Growth parameters: Different growth parameters plant height (cm); number of branches, length branches (cm), number of leaves plant⁻¹, leaf area (cm²) (measured by leaf area meter), chlorophyll contents of leaves (mg g⁻¹) (measured by chlorophyll meter) were measured.

Other growth attributes like days to first flower emergence; number of flowers plant⁻¹ flower diameter (cm), fresh weight of a flower (g), dry weight of a flower

(g), fresh and dry weight ratio, flower quality and vase life (days) were observed.

For determining leaf analysis for nutrient procedure described by Van Lierop (1976) was used. Phosphorus was determined by spectrophotometer using standard curve (Hand Book 60, Method 61). Potash was determined with flame photometer (Hand Book 60, Method 5). A graded series of standards of KCL was prepared and standard curve was drawn. The values of K from flame photometer were compared for standard curve and total quantities were computed.

Data was analyzed statistically by using Fisher's analysis of variance technique and treatment means were compared by using Tuckey's test at 5% probability level (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Results revealed significant differences for plant height among planting seasons, macro nutritional levels and interaction between planting season and macro nutritional levels. As for as planting season S_1 (16th Nov.) was concerned, T_2 (5:10:10 g pot⁻¹ NPK) produced tallest plants with 91.39 cm plant height followed by T_1 (5:5:10 g pot⁻¹ NPK) with 87.80 cm and T_3 (5:15:10 g pot⁻¹ NPK) with 75.17 cm height. While, T_0 (Control) and T_6 (10:15:10 g pot⁻¹ NPK) were at bottom with 68.58 and 56.67 cm plant height (Fig. 1). Regarding planting season S_2 (15th Feb.), it was observed that T_2 (5:10:10 g pot⁻¹ NPK) excelled rest of the treatments by producing tallest plants with 82.20 cm plant height followed by T_1 (5:5:10 g pot⁻¹ NPK) with 79.99 cm height. While T_5 (10:10:10 g pot⁻¹ NPK), T_0 (Control) and T_6 (10:15:10 g pot⁻¹ NPK) were at bottom with 67.00, 66.67 and 63.37 cm plant height. Above results were in line with Default (1987), Van Iersel *et al.* (1998) and Indrajit and Nilimesh (2003), who observed that N (Urea) and P (SSP) at 200 ppm were applied resulted in highest plant height (44.69 cm), side shoots (12.44), leaves (523.17) and number of flowers (124.59), longest duration of flowering (147.35 days), vase life (7.33 days in tap water), flower stem length (36.30 cm) and flower weight (111.58 g/100 flowers). As for as planting seasons were concerned, it was observed that S_1 (16th Nov.) produced taller plants as compared to S_2 (15th Feb.). These finding collaborates with the findings of Zizzo *et al.* (1999) and Gursan (1999), who observed that Sep. and Jan. were found to be the best planting times for standard carnations.

Data regarding to number of branches is presented in Fig. 2 In planting season S_1 (16th Nov.), T_1 (5:5:10 g pot⁻¹ NPK) produced maximum with number of branches (48.23) followed by T_2 (5:10:10 g pot⁻¹ NPK) with 46.60 and T_3 (5:15:10 g pot⁻¹ NPK) with 40.60 number

Fig. 1: Effect of planting seasons and macro nutritional (NPK) levels on plant height of carnation (*Dianthus caryophyllus*)

Fig. 2: Effect of planting seasons and macro nutritional (NPK) levels on number of branches of carnation (*Dianthus caryophyllus*)

Fig. 3: Effect of planting seasons and macro nutritional (NPK) levels on length of branches of carnation (*Dianthus caryophyllus*)

branches plant⁻¹. While T₆ (10:15:10 g pot⁻¹ NPK) produced minimum 30.43 branches plant⁻¹. It is obvious that overall maximum branches plant⁻¹ was observed in T₂ (5:10:10 g pot⁻¹ NPK) that expressed significant superiority over other treatments and T₁ (5:5:10 g pot⁻¹ NPK) occupied second best position. It may also be stated that more nitrogen more will be plant height or vice versa. It can safely be said that application nitrogen is helpful for the development and consequent flowering the single dose

of P was applied, no matter how much N is applied. These results are with Default (1987), Van Iersel *et al.* (1998) and Indrajit and Nilimesh (2003). In case of planting season S₁ (16th Nov.) produced maximum number of branches as compared to S₂ (15th Feb.). These finding collaborates with the findings of Zizzo *et al.* (1999) and Gursan (1999).

It is obvious from the Fig. 3 that overall maximum length of branches plant⁻¹ were observed

Fig. 4: Effect of planting seasons and macro nutritional (NPK) levels on number of leaves per plant height of carnation (*Dianthus caryophyllus*)

Fig. 5: Effect of planting seasons and macro nutritional (NPK) levels on leaf area of carnation (*Dianthus caryophyllus*)

in T_2 (5:10:10 g pot^{-1} NPK) that expressed significant superiority over other treatments and T_1 (5:5:10 g pot^{-1} NPK) occupied second best position. Length of branches directly related to the Nitrogen fertilizer applied to the soil. But the fertilizer applied in combination always showed good performance as compared to fertilizer application as a single entity. There may be certain mechanisms of growth involved in increasing length of branches which are activated only in the presence of both N and P although the single dose of P was applied, no matter how N is applied. These results are in line with Default (1987), Van Iersel *et al.* (1998) and Indrajit and Nilimesh (2003).

In planting season S_1 (16th Nov.), T_1 (5:5:10 g pot^{-1} NPK) produced maximum 908.12 number of leaves plant^{-1} followed by T_2 (5:10:10 g pot^{-1} NPK) with 869.83 and T_3 (5:15:10 g pot^{-1} NPK) with 803.17 leaves plant^{-1} . Regarding planting season S_2 (15th Feb.), T_2 (5:10:10 g pot^{-1} NPK) produced maximum leaves plant^{-1} with 784.83 followed by T_1 (5:5:10 g pot^{-1} NPK) and T_3 (5:15:10 g pot^{-1} NPK) with 731.83 and 720.00 leaves plant^{-1} , respectively (Fig. 4). These finding collaborates with the findings of Zizzo *et al.* (1999) and Gursan (1999), who observed that Sep. and Jan. were found to be the best planting times for standard carnations.

Data presented in Fig. 5 showed that T_6 (10:15:10 g pot^{-1} NPK) produced maximum 4.46 cm^2 leaf area in S_1 (16th Nov.) planting season while, T_0 (Control) produced minimum 2.65 cm^2 leaf area. T_5 (10:10:10 g pot^{-1} NPK) produced maximum leaf area 4.60 cm^2 planting season S_2 (15th Feb.) but T_0 (Control) produced minimum 2.45 cm^2 leaf area. These results were contrast with the findings of Zizzo *et al.* (1999) and Gursan (1999), who observed that Sep. and Jan. were found to be the best planting times for standard carnations.

Maximum leaf chlorophyll contents (34.65 mg g^{-1}) were produced in planting season S_1 (16th Nov.) at 5:5:10 g pot^{-1} NPK. Minimum chlorophyll contents with 14.63 and 12.51 mg g^{-1} were produced in T_5 (10:10:10 g pot^{-1} NPK) and T_6 (10:15:10 g pot^{-1} NPK) treatments (Fig. 6). In S_2 (15th Feb.) planting season maximum leaf chlorophyll contents (38.89 mg g^{-1}) were produced in T_2 (5:10:10 g pot^{-1} NPK) and T_5 (10:10:10 g pot^{-1} NPK) and T_6 (10:15:10 g pot^{-1} NPK) produced minimum 20.30 and 15.01 mg g^{-1} chlorophyll contents, respectively.

Plants of carnation in S_1 (16th Nov.) planting season produced maximum nitrogen (1.366%) at T_2 (5:10:10 g pot^{-1} NPK) followed by T_1 (5:5:10 g pot^{-1} NPK) by producing 1.22% nitrogen. T_6 (10:15:10 g pot^{-1}

Fig. 6: Effect of planting seasons and macro nutritional (NPK) levels on leaf chlorophyll content of carnation (*Dianthus caryophyllus*)

Fig. 7: Effect of planting seasons and macro nutritional (NPK) levels on nitrogen of carnation (*Dianthus caryophyllus*)

Fig. 8: Effect of planting seasons and macro nutritional (NPK) levels on phosphorus level in carnation (*Dianthus caryophyllus*)

NPK) and T₀ (Control) were least effective treatments by at bottom with 0.975% N and 0.884% N, respectively. Maximum nitrogen (1.027 %) in S₂ (15th Feb.) planting season was produced at T₂ (5:10:10 g pot⁻¹ NPK) followed by T₁ (5:5:10 g pot⁻¹ NPK) with 0.961% nitrogen (Fig. 7). These in line with Default (1987) and Indrajit and Nilimesh (2003). S₁ (16th Nov.) planting season produces maximum nitrogen % age as compared to S₂ (15th Feb) (Zizzo *et al.*, 1999; Gursan, 1999).

In planting season S₁ (16th Nov.), T₂ (5:10:10 g pot⁻¹ NPK) produced maximum 0.293 mg g⁻¹ dry wt. phosphorus followed by T₁ (5:5:10 g pot⁻¹ NPK) with 0.243 mg g⁻¹ dry wt. phosphorus, While T₆ (10:15:10 g pot⁻¹ NPK) and T₀ (Control) were at bottom by producing 0.055 mg g⁻¹ dry wt. and 0.035 mg g⁻¹ dry wt. phosphorus, respectively (Fig. 8). As for as planting season S₂ (15th Feb.) is concerned, T₂ (5:10:10 g pot⁻¹ NPK) produced maximum phosphorus with 0.286 mg g⁻¹ dry wt. followed by T₁ (5:5:10 g pot⁻¹

Fig. 9: Effect of planting seasons and macro nutritional (NPK) levels on potassium level in carnation (*Dianthus caryophyllus*)

Fig. 10: Effect of planting seasons and macro nutritional (NPK) levels on flower emergence in carnation (*Dianthus caryophyllus*)

NPK) with 0.234 mg g⁻¹ dry wt. phosphorus. Whereas, While T₆ (10:15:10g pot⁻¹NPK) and T₀ (Control) were at bottom with 0.055 mg g⁻¹ dry wt. and 0.035 mg g⁻¹ dry wt. phosphorus, respectively. These results are in accordance with the findings of Indrajit and Nilimesh (2003).

According to the data presented in Fig. 9 T₂ (5:10:10 g pot⁻¹ NPK) produced maximum potash with 0.843 mg g⁻¹ dry wt. in S₁ (16th Nov.) planting season. On the other hand While T₀ (Control) and T₆ (10:15:10 g pot⁻¹ NPK) produced minimum 0.362 mg g⁻¹ dry wt. and 0.284 mg g⁻¹ dry wt. potash, respectively. As for as planting season S₂ (15th Feb.) is concerned, T₂ (5:10:10 g pot⁻¹ NPK) produced maximum potash with 0.806 mg g⁻¹ dry wt. While, T₆ (10:15:10 g pot⁻¹ NPK) and T₀ (Control) were at bottom with 0.329 mg g⁻¹ dry wt. and 272 mg g⁻¹ dry wt. potash, respectively.

In both planting seasons S₁ (16th Nov.) and S₂ (15th Feb.), T₀ (Control) took minimum days 101.12 and 69.52, respectively to first flower emergence of carnation. While

treatment T₂ (5:10:10 g pot⁻¹ NPK) took maximum 127.66 and 108.79 days, respectively to first flower emergence (Fig. 10).

In planting season S₁ (16th Nov.), T₁ (5:5:10 g pot⁻¹ NPK) produced maximum bud diameter (1.90 cm) followed by T₂ (5:10:10 g pot⁻¹ NPK) with 1.80 cm. While, T₅ (10:10:10 g pot⁻¹ NPK) and T₆ (10:15:10 g pot⁻¹ NPK) produced minimum 0.85 cm and 0.82 cm bud diameter. In planting season S₂ (15th Feb.), T₂ (5:10:10 g pot⁻¹ NPK) produced maximum bud diameter (1.87 cm) followed by T₁ (5:5:10 g pot⁻¹ NPK) with 1.77 cm (Fig. 11).

In both planting seasons S₁ (16th Nov.) and S₂ (15th Feb.), maximum flower diameter 4.70 cm and 4.53 cm was produced in T₃ (5:15:10 g pot⁻¹ NPK) respectively, While treatment T₀ (control) produced minimum 3.17 cm and 2.33 cm flower diameter, respectively (Fig. 12).

In planting season S₁ (16th Nov.) was concerned, T₁ (5:5:10 g pot⁻¹ NPK) produced maximum with 18.77 flowers plant⁻¹ followed by T₂ (5:10:10 g pot⁻¹ NPK) with 13.90 flowers plant⁻¹. While

Fig. 11: Effect of planting seasons and macro nutritional (NPK) levels on bud diameter in carnation (*Dianthus caryophyllus*)

Fig. 12: Effect of planting seasons and macro nutritional (NPK) levels on flower diameter in carnation (*Dianthus caryophyllus*)

Fig. 13: Effect of planting seasons and macro nutritional (NPK) levels on number of flowers per plant in carnation (*Dianthus caryophyllus*)

T₅ (10:10:10 g pot^{-1} NPK) and T₆ (10:15:10 g pot^{-1} NPK) was at bottom with 7.33 and 6.30 flowers plant^{-1} , respectively (Fig. 13). As in planting season S₂ (15th Feb.) is concerned, T₂ (5:10:10 g pot^{-1} NPK) produced maximum with 12.90 flowers plant^{-1} followed by T₁ (5:5:10 g pot^{-1} NPK) with 11.33 flowers plant^{-1} . While, T₅ (10:10:10 g pot^{-1} NPK) and T₆ (10:15:10 g pot^{-1} NPK) was at bottom with 7.10 and 5.80 flowers plant^{-1} , respectively.

Treatment T₃ (5:15:10 g pot^{-1} NPK) produced maximum (2.02 g) fresh weight of flower and T₀ (Control) produced minimum (1.10 g) fresh weight of a flower in S₁ (16th Nov.) planting season. Treatment T₃ (5:15:10 g pot^{-1} NPK) also produced maximum (1.67 g) fresh weight and T₀ (Control) minimum (1.14 g) (Fig. 14).

According to the data presented in Fig. 15, T₃ (5:15:10 g pot^{-1} NPK) produced maximum dry weight of

Fig. 14: Effect of planting seasons and macro nutritional (NPK) levels on fresh weight of flowers in carnation (*Dianthus caryophyllus*)

Fig. 15: Effect of planting seasons and macro nutritional (NPK) levels on dry weight of flowers in carnation (*Dianthus caryophyllus*)

Fig. 16: Effect of planting seasons and macro nutritional (NPK) levels on fresh and dry weight ratio in carnation (*Dianthus caryophyllus*)

a flower (0.45 g) in S₁ (16th Nov.) planting season but While T₀ (Control) was at bottom by producing 0.22 g dry weight of a flower. In planting season S₂ (15th Feb.) treatment T₁ (5:5:10 g pot⁻¹ NPK) produced maximum (0.45 g) dry weight of a flower, while T₀ (Control) produced (0.26 g) dry weight of flower.

Maximum (4.98) fresh and dry weight ratio in S₁ (16th Nov.) planting season was in T₀ (Control)

followed by T₃ (5:15:10 g pot⁻¹ NPK) with 4.77. While T₅ (10:10:10 g pot⁻¹ NPK), was at bottom with 4.26 fresh and dry weight ratio (Fig. 16). Maximum (4.55) fresh and dry weight ratio in S₂ (15th Feb.) planting season was produced in T₀ (Control) followed by T₄ (10:5:10 g pot⁻¹ NPK) with 4.08. But T₁ (5:5:10 g pot⁻¹ NPK) was at bottom with 3.38 fresh and dry weight ratio.

Fig. 17: Effect of planting seasons and macro nutritional (NPK) levels on vase life of carnation (*Dianthus caryophyllus*)

Fig. 18: Effect of planting seasons and macro nutritional (NPK) levels on flower quality of carnation (*Dianthus caryophyllus*)

In planting season S_1 (16th Nov.), T_4 (10:5:10 g pot⁻¹ NPK) gave maximum flower vase life with 10.83 days followed by T_3 (5:15:10 g pot⁻¹ NPK) with 10.70 days (Fig. 17). But treatment without growth regulator gave minimum 4.06 days vase life. In case of S_2 (15th Feb.) planting season, T_4 (10:5:10 g pot⁻¹ NPK) gave maximum flower vase life with 10.87 days followed by T_3 (5:15:10 g pot⁻¹ NPK) with 9.67 days. While T_0 (Control) was at bottom with 5.67 days vase life.

Data in Fig. 18 showed that T_4 (10:5:10 g pot⁻¹ NPK) produced highest flower quality score with 7.97 followed by T_3 (5:15:10 g pot⁻¹ NPK) with 7.83 in S_1 (16th Nov.) planting season but minimum flower quality was observed T_0 (Control) with 5.61 quality point. In planting season S_2 (15th Feb.), T_4 (10:5:10 g pot⁻¹ NPK) gave maximum flower quality score with 8.10 followed by T_3 (5:15:10 g pot⁻¹ NPK) with 7.97. While T_0 (Control) gave minimum results with 5.37 quality point (Fig. 18).

CONCLUSION

It was concluded that the overall best performance of carnation production such as plant height,

number of branches per plant, length of branches, number of leaves per plant, leaf area, NPK contents, flower diameter, flower quality and vase life was due to T_2 (5:10:10 g pot⁻¹ NPK) as far as macro nutritional (NPK) effect was concerned. Whereas, planting season S_1 (16th Nov.) performed better as compared to planting season S_2 (15th Feb.).

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