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Influence of NPK fertigation and foliar application on flower quality, media physico-chemical properties and foliar nutrient content in carnation (*Dianthus caryophyllus*) cv. Master

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ABSTRACT

Sixteen different fertilizer treatments were accessed in a completely randomized block design for their effects on cut- flower grades, media physicochemical properties and foliar nutrient content in carnation (*Dianthus caryophyllus* L.) cv. Master plants grown under naturally ventilated greenhouse conditions at the Research Farm of Department of Floriculture and Landscaping, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India during 2010 and 2011. Rooted cuttings were planted in a sterilized growing media comprising of soil: FYM: coco peat (2:1:1, v/v). Carnation cultivar Master plants fertilized with treatment comprising of 250 ppm N and K fertigation through urea and MOP + 250 ppm NPK (19:19:19) foliar spray once a week showed significant increase in quality parameters (i.e. percentage of A, B and C - grade flowers based on stem strength) in comparison to the recommended practices. Highest available NPK content in the media (371.03, 37.09, 276.87 kg/ha) as well as in foliage (2.867, 0.364, 3.954 %) were also recorded with the same treatment.

Key words: Carnation, Fertigation, Flower quality, NPK, Physicochemical properties

Carnation (*Dianthus caryophyllus* L.) is one of the most important cut flower crop ranking among the top 10 flowers in the global florist trade which may be attributed to its excellent keeping quality, wide range of available colours and ability to withstand long distance transportation. In general, balanced nutrition is very essential for obtaining optimum plant growth and higher yield of good quality flowers in carnation**.** The deficiency of any one or more of the major nutrients can drastically limit the growth of the plants leading to reduction in productivity and quality of the flowers produced. Over feeding of the plants, on the other hand, results in the accumulation of salts in the soils which prevents the uptake of water and sometimes causes wilting of them. Being a greenhouse crop, fertilizer applications play a key role in increasing quality and quantity of carnation. It is well established fact that carnation plants make a good reserve of N at tufting stage which is utilized during flowering (Arora and Gill 1995).

The sustainability of any production system warrants for the optimum utilization of resources like soil, water and nutrients in available form. Apart from economic considerations, it is well known fact that the injudicious use of water and fertilizers can also lead to far reaching implications on the environment. The crop response to fertilizer applications is expected to vary markedly with the type of fertilizer used and its mode of application. Fertigation enables the application of water soluble fertilizers and other chemicals along with irrigation water in the vicinity of the root zone. The application of water and nutrients in small doses at frequent intervals in the crop root zone ensures their availability to the plants optimally. Subsequently, fertigation helps in uniform distribution besides better timings for more accurate and timely nutrition leading to better yield and quality and considerable savings in quantity of fertilizers to be used in comparison to conventional fertilizer applications (Patel and Rajput 2000, Narda and Chawla 2002, Raina 2002, Raina *et al.* 2005). Foliar application method can be another choice to the old soil fertilization method. The efficacy of foliar fertilization is higher than that of soil fertilization because of the supply of required nutrient directly to the location of demand in the leaves and its relatively quick absorption.

Master is a red colour standard cultivar of carnation and was recommended by the University for commercial cultivation in the mid-hill zones of Himachal Pradesh.

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Comparatively, this cultivar is preferred by the consumers and its growers fetches better remunerative in the market. Hence, it necessiciated for the standardization of the nutritional schedule for its commercial cultivation so, that growers can obtain good yields and fetches better prices. Keeping in view the need and importance of this crop, the present investigation was carried out with the objective to optimize the dose of water soluble fertilizer (19:19:19 NPK) as fertigation and foliar application on growth and flowering of carnation grown under greenhouses in mid-hill conditions of Himachal Pradesh.

MATERIALS AND METHODS

A completely randomized block design was used to evaluate the effect of 16 different treatments on cut flower grades, media physicochemical properties and foliar nutrient content of carnation cultivar Master.

Treatments comprised of T_1 (Recommended practice, i.e. basal doses of NPK @10g/m^2 each + biofertilizer mixture (VAM+ Azospirillum +PSM) @5g/plant and 100 ppm N (60 ppm through Multi-K and calcium nitrate, 40 ppm through urea) and 140 ppm K (through Multi –K) twice a week after 40 days of planting), T_2 (75 ppm NPK (19:19:19) fertigation on alternate days), T_3 (150 ppm NPK (19:19:19) fertigation twice a week), T_4 (300 ppm NPK (19:19:19) fertigation once a week), T_5 (100 ppm NPK(19:19:19) fertigation on alternate days), T_6 (200 ppm NPK (19:19:19) fertigation twice a week), T_7 (400 ppm NPK (19:19:19) fertigation once a week), T_8 (125 ppm NPK (19:19:19) fertigation on alternate days), T_9 (250 ppm NPK(19:19:19) fertigation twice a week), T_{10} (500 ppm NPK (19:19:19) fertigation once a week), T_{11} (150 ppm N and K fertigation with urea and MOP + 150 ppm NPK (19:19:19) foliar spray once a week), T_{12} (200 ppm N and K fertigation with urea and MOP + 200 ppm NPK (19:19:19) foliar spray once a week), T_{13} (250 ppm N and K fertigation with urea and MOP + 250 ppm NPK(19:19:19) foliar spray once a week), T_{14} (150 ppm N and K fertigation with urea and MOP + 150 ppm NPK (19:19:19) foliar spray fortnightly), T_{15} (200 ppm N and K fertigation with urea and MOP + 200 ppm NPK (19:19:19) foliar spray fortnightly) and T_{16} (250 ppm N and K fertigation with urea and MOP + 250 ppm NPK (19:19:19) foliar spray fortnightly).

Rooted cuttings were planted in a sterilized growing medium consisting of soil: FYM: coco peat (2:1:1, v/v) at a spacing of 20 × 20 cm. Plots size of one square meter accommodating 25 plants per plot were used for allocation of treatments. The crop was raised following the standard cultural practices. The experimental treatments were started after 40 days of planting. Foliar spray was done during morning hours (8.00-9.00 AM) with the help of Knap-sack sprayer. Teepol (0.05%) was used as a surfactant. The plots receiving foliar application were sprayed till runoff point (2.5 l/m^2). Fertigation was done during the evening hours. Each plot was fertigated with 5 litres of nutrient solution as per the treatments. To estimate stem quality on the basis of stem strength, 20 cut flower stems per treatment having a stem length of 55 cm were held horizontally at a point 25 mm above the cut end and the deviation of the flower head below the horizontal plane with the natural curvature of the stem was recorded and divided in to 3 grades, viz. A- Grade (Deviation <15^o), B-Grade (Deviation 15^o-30^o) and C-Grade (Deviation >30^o).

The samples of the growing media were collected following the standard procedure initially at the time of bed preparation and after the termination of every flush. Available N was determined by alkaline potassium permanganate method (Subbiah and Asija 1956), Phosphorous by Olsen method (Olsen *et al*. 1954) and pottassium by neutral ammonium acetate method (Merwin and Peach 1951). Organic carbon was determined by Chromic acid titration method (Walkley and Black method 1934). The initial physicochemical properties of the medium was 340.48 kg N/ha, 28.6 kg P/ha and 242.2 kg K/ha. The electrical conductivity was 0.46 dS/m with organic carbon content of 0.5% and pH of 6.7. Leaf analysis for N, P and K was done at flower harvesting stage. N was determined by Micro Kjeldahl method (Jackson 1973), potassium by flame-photometry and phosphorous was determined by Vanado-molybdate yellow colour method (Jackson 1973).

The data relating to each parameter was statistically analyzed by applying the technique of analysis of variance using Completely Randomized Design separately for each flower flush (Gomez and Gomez 1984). Pooled analysis of variance was performed to test the significant differences of different treatments.

RESULTS AND DISCUSSION

Cut-flower grades

The results (Fig 1) revealed that treatment comprising of 250 ppm N and K fertigation with urea and MOP + 250 ppm NPK foliar spray (19:19:19) once a week (T_{13}) proved superior in recording maximum A-Grade flowers (90.00%)

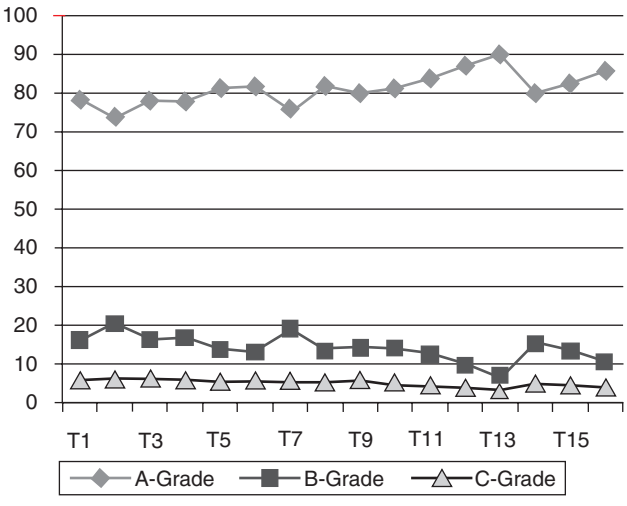

Fig 1 Cut flower grades (A-Grade, B-Grade and C-Grade) of carnation cultivar Master as influenced by different doses and methods of application of 19:19:19 NPK fertilizer

as well as minimum per cent B and C-Grade flowers (7.11% and 6.00%), respectively, as compared to recommended practices and other treatments tested during the course of investigation. Under fertigation, uniform distribution of the nutrients, coupled with confinement in the root zone, might have increased the nutrient uptake thereby leading to higher synthesis of metabolites and their subsequent translocation resulting in enhanced vegetative growth. Kowalczyk *et al*. (1992) reported increased percentage of grade 1 flowers with fertigation using water soluble fertilizer containing 1:0.25:0.9 NPK. Bhalla *et al*. (2007) recorded higher percentage of A-grade flowers (97.33%) with water soluble fertilizers in growing media comprising of sand: soil: vermicompost (1:1:1, v/v) of carnation cv. Raggio-de-Sole and Murcia. Also, the stimulatory effects of foliar application of higher doses of NPK might have resulted in better accumulation of assimilates thereby resulting in stronger and sturdier stems of A-grade cut flowers and lesser percentage of B and C-grade cut flower stems. Improvement in flower quality as evident from stem strength may be due to enhanced photosynthetic and metabolic activity which leads to an increase in various plant metabolites responsible for cell division and elongation as opined by Hatwar *et al*. (2003). The improved flower quality by foliar application of macronutrients is in agreement with the reports of Roy *et al*. (1995) in gladiolus, Verma (2001) in carnation and Muhammad *et al*. (2014) in dahlia. Muhammad *et al*. (2014) also suggested that foliar spray of macronutrients produced greater no. of leaves and hence better quality flowers.

Media physicochemical properties

In the present investigations, a residual effect of various nutritional treatments on the physicochemical properties of the growing medium was also studied. Macro-nutrients like N, P and K were quantified to assess the nutritional build up in the medium profile. Results in Table 1 revealed that after termination of the experiment, treatment T_{13} comprising 250 ppm N and K fertigation with urea and MOP + 250 ppm NPK (19:19:19) foliar spray once a week recorded significantly highest available N, P and K (371.03, 37.09

Table 1 Media physicochemical properties of carnation cultivar Master as influenced by different doses and methods of application of Sujala (19:19:19 NPK) fertilizer (Data are the pooled means of three flower flushes)

Treatments		Media physicochemical properties					
		Available nitrogen (kg/ha)	Available phosphorous (kg/ha)	Available potassium (kg/ha)	pH	Electrical conductivity (dS/m)	Organic carbon (%)
T_1	Recommended practice	357.50	23.88	267.10	7.03	0.58	0.652
T_2	75 ppm NPK (19:19:19) fertigation on alternate days	354.70	29.16	251.00	7.00	0.60	0.673
T_3	150 ppm NPK (19:19:19) fertigation twice a week	353.60	29.24	256.80	7.12	0.59	0.704
T_4	300 ppm NPK (19:19:19) fertigation once a week	354.00	32.97	260.10	7.20	0.53	0.702
T_5	100 ppm NPK (19:19:19) fertigation on alternate days in a week	355.50	33.44	258.90	7.29	0.64	0.678
T_6	200 ppm NPK (19:19:19) fertigation twice a week	358.10	34.89	266.30	7.15	0.54	0.691
T_7	400 ppm NPK (19:19:19) fertigation once a week	359.90	35.93	264.30	7.20	0.47	0.693
T_8	125 ppm NPK (19:19:19) fertigation on alternate days in a week	360.20	36.43	265.80	7.23	0.60	0.669
T_9	250 ppm NPK (19:19:19) fertigation twice a week	365.80	34.86	271.87	7.27	0.57	0.703
T_{10}	500 ppm NPK (19:19:19) fertigation once a week	366.23	34.01	269.80	7.27	0.62	0.708
T_{11}	150 ppm N and K fertigation with Urea and MOP + 150 ppm NPK (19:19:19) foliar spray once a week	356.90	32.38	261.00	7.22	0.56	0.700
T_{12}	200 ppm N and K fertigation with Urea and MOP + 200 ppm NPK (19:19:19) foliar spray once a week	361.70	33.79	262.30	7.34	0.69	0.735
T_{13}	250 ppm N and K fertigation with Urea and MOP + 250 ppm NPK (19:19:19) foliar spray once a week	371.03	37.09	276.87	7.31	0.86	0.764
T_{14}	150 ppm N and K fertigation with Urea and MOP + 150 ppm NPK (19:19:19) foliar spray fortnightly	351.80	33.21	258.80	7.25	0.75	0.688
T_{15}	200 ppm N and K fertigation with Urea and MOP + 200 ppm NPK (19:19:19) foliar spray fortnightly	360.70	35.27	260.20	7.17	0.66	0.699
T_{16}	250 ppm N and K fertigation with Urea and MOP + 250 ppm NPK (19:19:19) foliar spray fortnightly	366.50	35.44	269.90	7.18	0.67	0.728
CD (P=0.05)		0.32	2.26	0.33	NS	NS	0.016

Water soluble fertilizer "Sujala" containing 19% N, 19% P and 19% K was used for fertigation and foliar application; Urea, a water soluble fertilizer contains 46%N; Muriate of potash (MOP) contains 60%K and Multi –K contains 13%N, 0%P and 45%K is a water soluble fertilizer.

and 276.87 kg/ha, respectively) build-up in the growing medium. The increase in the available N, P and K under this combination might be ascribed to the high application rates which after meeting out the plant requirements have contributed to the build up of the available N, P and K in the medium. Thakur (1996) reported that the highest levels of NPK applied enhanced the status of the available nutrients in the soil after harvest in tomato. The results are in conformity with the findings of Bhan (2002) who reported significant increase in the available N, P and K content in the soil after harvest of potato with the subsequent increase in the dose of N, P and K. Similar findings have been reported by Bhalla *et al*. (2007) in carnation. The highest organic carbon content (0.764%) was recorded with treatment T_{13} comprising 250 ppm N and K fertigation with urea and MOP + 250 ppm NPK (19:19:19) foliar spray once a week whereas, lowest (0.652%) was recorded with T_1 (recommended practice) which might be attributed to the fact the plants treated with the foliar application of nutrients along with fertigation have added more biomass to the growing media. The subsequent decay of the plant biomass with time might have resulted in the more organic matter content was noticed in the present studies.

Foliar N, P and K content (%)

Foliar nitrogen content was recorded maximum (2.867%) with the treatment T_{13} and minimum (1.767%) with treatment T_2 (Fig 2). These results further reflect the positive relationship between the concentration of foliar fertilizers and the mineral content of the leaves. The high leaf N under fertigation may be due to increased uptake, owing to precise, frequent and direct application of water soluble fertilizers in the root zone which led to minimum leaching losses. This could also be attributed to rapid absorption of these elements by the plant surface, especially the leaves and their translocation within the plant. Nitrogen is highly mobile element in the plant tissues, its efficient translocation under abundant moisture and nutrient supply from root to leaves could have added to its enhanced accumulation in the leaves (Smith 1962). A close correlation between leaf nitrogen and photosynthetic rate has also been suggested (Lambers 1987). A comparison of data among different treatments indicates that the leaf N content increased proportionately with the increasing fertilizer doses. Similar findings have also been reported by El-Naggar (2009) who reported increased foliar N content with the application of higher dose of water soluble fertilizer Sangral (1.0%) in carnation cv. Red Sim. The observations are also in close agreement with the findings of Nielson *et al*. (2002). They also observed a positive relationship between N content in the soil and apple leaves. The phosphorous content was also recorded maximum (0.364%) with T_{13} and minimum (0.186) with T_1 (Recommended practice). Phosphorous content of the leaves was found to be related to nitrogen content. It might be due to the fact that at higher nitrogen content, there was more vegetative growth and better quality flowers which resulted in more uptake and utilization of phosphorous. The results are in consonance with the findings of Verma (2001) who reported maximum phosphorous content of carnation cv. Impala leaves with the foliar application of 1500 ppm N. Simllar findings have also been reported by El-Naggar (2009) and Qasim *et al.* (2008). Foliar potassium content was recorded maximum (3.954%) with treatment T_{13} and minimum (2.141%) with treatment T_1. It might also be due to non-antagonistic effect of phosphorous and potash or the increase in K-content can be attributed to positive response of phosphorous application. These results get support from the findings of Verma (2001) who also reported increase in the K content of the leaves by the application of 1500 ppm N and minimum under control. Similar results were also reported by Ram and Bose (1994), Qasim *et al*. (2008) and El-Naggar (2009).

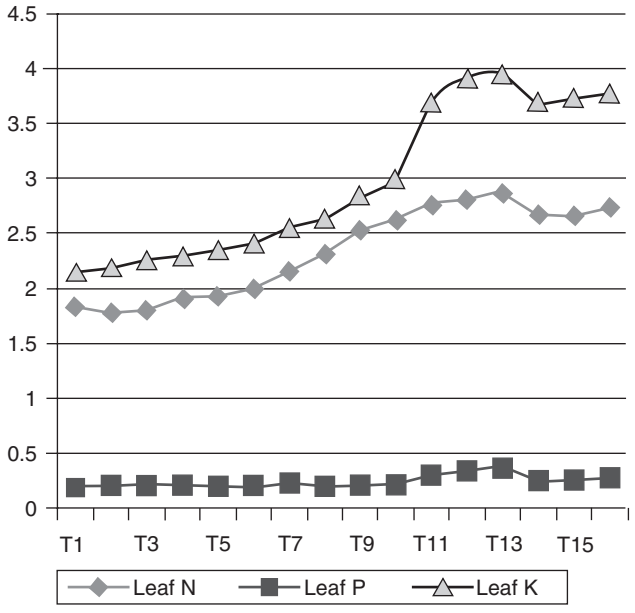

Fig 2 Foliar N, P and K content (%) of carnation cultivar 'Master' as influenced by different doses and methods of application of 19:19:19 NPK fertilizer.

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