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Influence of nutrient sources on performance of Carnation (*Dianthus caryophyllus* L.) Cv. Soto under naturally ventilated polyhouse

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Abstract
An emblem of Mother's day Carnation (*Dianthus caryophyllus* L.) is one of the world's most popular and leading cut flowers belongs to the family Caryophyllaceae. The study was conducted with 11 treatment combinations including RDF (250:80:200 g NPK + 2 kg FYM/m^2) as check to find out the best integrated nutrient approach with *Azospirillum* (60 g/m^2), PSB (60 g/m^2), FYM (2 kg/ m^2) and vermicompost (500 g/m^2) along with 75 per cent RDF (T_{11}). Increased plant height (96.55 cm), plant spread (36.86 cm), leaf area (1646.33 cm^2) leaf area index (7.92) after 150 days of planting were observed in (T_{11}). Maximum chlorophyll content (1.71 mg/g) of leaves and minimum mortality by insect pests (1.87 %), disease (3.41 %) were also noticed in the same treatment. Available nitrogen (263.15 kg/ha), phosphorus (37.97 kg/ha), potassium (126.27 kg/ha) in soil and total nitrogen (6.83 %), phosphorus (0.69 %) and potassium (3.97 %) content in plants were found maximum in the treatment T_{10} (*Azospirillum* + PSB + VC + 75 % RDF) and minimum in check.

Keywords: Carnation, NPK, Biofertilizers, Chlorophyll, Mortality

Introduction
Carnations are commonly referred to by their generic name, *"Dianthus"*, the name given by the Greek botanist Theopharastus who lived about 300 B.C. Carnations got the name *Dianthus* from two Greek Words - "dios", referring to the god "Zeus" and "anthos", meaning "flower". Carnations are thus "The Flowers of God" or "Flower of Love", though the Carnation is one of the important commercial flower crops of India. There is a need to standardize the optimum dose of nutrients to increase the yield, improving the soil structure, physico-chemical properties under potential environment. At present, nutrients *viz.*, NPK are supplied through chemical fertilizers. The indiscriminate and continuous use of chemical fertilizers has lead to an imbalance of nutrients in soil which adversely affect the soil health, yield and quality of the product.

Excessive use of inorganic fertilizers for increasing the cut flower production has led to the leaching of nutrients causing soil hazards, altering the soil fertility and leading to pollution of soil and water bodies. Use of organic manures and biofertilizers along with the balanced use of chemical fertilizers is known to improve physical, chemical and biological properties of soil, pH, water holding capacity and adds important nutrients to the soil. Increase in the nutrient availability and its ultimate adsorption by plant, besides improving the efficiency of applied fertilizers. Hence, the balanced nutrition is one of the most important factor influencing the growth and productivity of Carnation.

Material and Methods
The experiment was conducted in the Department of Floriculture and Landscape Architecture, College of Horticulture, Mudigere at 13^0-25' N latitude and 75^0-25' E longitude with an altitude of 982 m above mean sea level and the average maximum temperature of the location is 31.69°C and the average minimum temperature is 14.56°C and the relative humidity ranges from 62.18 to 90.29 per cent having red sandy loam soil with moderate fertility level having a pH of 6.0.

The RCBD design was followed with 11 treatments *viz.*, T_1 (100% RDF (250:80:200 g NPK + 2 kg FYM/m^2), T_2 (*Azospirillum* + 75% RDN + 100% RDP & K), T_3 (PSB + 75% RDP + 100% RDN & K), T_4 (*Azospirillum* + FYM + 75% RDF), T_5 (*Azospirillum* + VC + + 75% RDF), T_6 (PSB + FYM + 75% RDF), T_7 (PSB + VC + 75% RDF), T_8 (*Azospirillum* + PSB + 75% RDN & P + 100% RDK), T_9 (*Azospirillum* + PSB + FYM + 75% RDF), T_{10} (*Azospirillum* + PSB + VC + 75 % RDF), T_{11} (*Azospirillum* + PSB + FYM + VC + 75% RDF) replicated thrice, maintained spacing 20 x 15 cm. The recommended dose of organic manures like vermicompost at 500 g/m^2 and FYM at 2 kg/m^2 and Biofertilizers like *Azospirillum* and PSB at 60 g/m^2 each were mixed in the soil thoroughly before planting. The recommended dose of nitrogen, phosphorus and potash fertilizers (250:80:200 g/m^2) were at bimonthly interval after the single pinch and other practices carried out as per package of practice (UHS, Bagalkot).

Plant height was measured by scale and observations were recorded in centimeter. Leaf area index (LAI) was recorded with the help of scale by measuring length (L) and width (W) of 10 leaves selected at random, equally from top, middle and bottom of the plant. Leaf area can be computed by multiplying interaction term L x W by 0.91, *i.e.* LA = 0.91* (L x W) with the total number of leaves per plant and expressed in square centimeter. LAI was calculated by dividing the leaf area per plant by the land area (spacing) occupied by the plant. The plant spread was measured from the tagged plants in north to south directions at right angle to each other after 150 days of planting from centre of the plant using standard metric scale and their mean was calculated and expressed in centimetres

Chlorophyll content of leaf was analyzed by collecting fully matured healthy leaves from fifth node from the tip of stem at peak growth stage in the morning. Total chlorophyll content of leaf tissue was determined by using Dimethyl Sulfoxide (DMSO) as suggested by Shaof and Lium (1976) [9] and expressed in mg/g. Per cent mortality of plants recorded by observing the number of plants died due to *Fusarium* wilt and *Spodoptera litura* was recorded at the end of flowering season and expressed in percentage.

The available nitrogen content in the soil was determined by alkaline potassium permanganate method (Subbaiah and Asija, 1956) [11], the available phosphorus in soil was extracted by using Bray's extract method (Jackson, 1973) [5], available potassium in soil was determined by flame photometer method (Walkey and Black's, 1965) [15] and expressed in kg/ha. The total nitrogen of leaves was determined by Kjeldhal method. Total phosphorus was measured by the absorbance at 430 nm by visible spectrophotometer. The readings for total potassium were recorded by feeding the digested samples fed to flame photometer and expressed in percentage (Tandon, 1973) [14].

Result and Discussion

The data pertaining to the plant height, plant spread, leaf area, leaf area index at 150 days after planting. Chlorophyll content of the leaves, per cent mortality of plants, NPK status in soil and total nutrient content in different treatments after final harvesting of flowers is given in table 1 &2.

Among the growth parameters, significantly maximum plant height (96.55 cm) due to Enhanced plant height may also be attributed to the presence and synthesis of gibberellins in vermicompost and by *Azospirillum,* plant spread (36.86 cm) which lead by maximum length of leaves in all directions and the growth regulators like NAA and cytokinin released by *Azospirillum* and PSB might have resulted in breaking of apical dominance there by production of higher number of branches. These results were supported by (Renukaradya *et al*., 2011 [8], Balla *et al*., 2006 [1] and 2007 [2] in Carnation, Pandey *et al*., 2010 [7] in Chrysanthemum.

Leaf area and leaf area index values were 1646.33 cm^2 and of 7.92 recorded respectively, which might be due to the presence of growth promoting substances present in the organic manures and biofertilizers. Similar results were reported by Renukaradya *et al*., 2011 [8] and Krishna *et al.,* 1999 [6] in Carnation. Chlorophyll content (1.76 mg/g) were recorded with the combined application of *Azospirillum*, PSB, VC and 75 per cent recommended (T_{10}). Application of 100 per cent RDF reported the lowest values of these parameters. Maximum chlorophyll content in the leaves might be due to the indirect role of iron and presence of iron would have enhanced the functioning of photo system, ultimately increased the chlorophyll content in the leaves. These findings were in confirmation with the results obtained previously in African Marigold by Bhat *et al.*, 2010 [3], Singh *et al.*, 2005 [10] in Rose and Renukaradya *et al*., 2011 [8] in Carnation).

The per cent incidence of insect pest and disease was significantly varied within the treatment combination. The minimum per cent mortality due to insect (1.87%) and disease (3.41%) was observed in the treatment T_{11} (*Azospirillum* (60 g/m^2) + PSB (60 g/m^2) + FYM (2 kg/m^2) + vermicompost (500 g/m^2) and 75 per cent RDF) whereas, maximum was observed in control (3.41 and 4.40, respectively). Biofertilizers are useful as biological agents, since they control many plant pathogens and insect pests (Sukhada, 1999) [12]. It also control several soil borne, seed borne and air borne diseases caused by fungi and bacteria, which lysis the cell wall of these pathogens and damage them. The invaded fungus eventually collapses and disintegrates. The similar findings were obtained by Renukaradya, *et al*., 2011 [8] in Carnation and Swaminathan *et al.*, 1999 [13] in Tuberose.

Table 1: Effect of biofertilizers and inorganics on vegetative traits, chlorophyll content and mortality in Carnation (*Dianthus caryophyllus* L.) cv. Soto

Treatments	Plant height (cm)	Plant Spread (cm)	Leaf Area (cm^2)	Leaf Area index	Total chlorophyll Content (mg/g)	Mortality (%)*	
						Insect pests	Disease
T_1	75.82	21.52	462.72	2.22	1.16	3.41 (10.63)	4.40 (12.02)
T_2	90.49	22.40	586.63	2.95	1.31	2.86 (9.63)	3.96 (11.39)
T_3	89.90	23.39	866.20	4.38	1.24	2.75 (9.45)	3.74 (11.09)
T_4	88.69	31.42	627.29	3.30	1.27	2.75 (9.80)	3.85 (11.24)
T_5	91.65	32.40	701.56	3.87	1.25	2.97 (9.81)	4.18 (11.68)
T_6	93.57	29.29	526.93	2.36	1.27	2.53 (9.09)	4.07 (11.54)
T_7	95.98	30.37	531.94	2.80	1.28	2.64 (9.28)	4.18 (11.68)
T_8	92.31	32.33	1125.05	6.85	1.65	2.09 (8.18)	3.52 (10.78)
T_9	91.26	32.27	824.43	5.06	1.44	2.75 (9.45)	3.96 (11.39)
T_{10}	94.61	35.32	1281.89	7.53	1.76	1.98 (7.97)	3.63 (10.93)
T_{11}	96.55	36.86	1646.33	7.92	1.71	1.87 (7.70)	3.41 (10.63)
S. Em±	0.49	0.58	16.24	0.09	0.03	0.1	0.16
CD @ 5%	1.47	1.55	47.92	0.26	0.10	0.5	0.48

*Values in parenthesis are in Arcsine root transformed

T_1 (100% RDF (250:80:200 g NPK + 2 kg FYM/m^2), T_2 (*Azospirillum* + 75% RDN + 100% RDP & K),

T_3 (PSB + 75% RDP + 100% RDN & K), T_4 (*Azospirillum* + FYM + 75% RDF),
T_5 (*Azospirillum* + VC + + 75% RDF), T_6 (PSB + FYM + 75% RDF)
T_7 (PSB + VC + 75% RDF), T_8 (*Azospirillum* + PSB + 75% RDN & P + 100% RDK),
T_9 (*Azospirillum* + PSB + FYM + 75% RDF), T_{10} (*Azospirillum* + PSB + VC + 75 % RDF),
T_{11} (*Azospirillum* + PSB + FYM + VC + 75% RDF) RDF = Recommended Dose of Fertilizer

Available NPK status in soil was found maximum in the treatment T_{10} (263.15, 37.97 and 126.27 kg/ha, respectively) and total NPK content in plant was more in the same treatment 6.83, 0.69 and 3.97 per cent, respectively which is at par with T_{11}. Less availability and nutrients in soil and nutrient content in plant was found in control (Farina and Lupi, 1987 [4] and Renukaradya *et al*., 2011 [8] in Carnation).

The increased availability of NPK content in the soil can be attributed more activity and multiplication of *Azospirillum* and PSB in the soil and the decomposition and mineralization of FYM and also vermicompost might have contributed to more available nutrients in the soil. Most of the photosynthetic pathways depends on enzymes and coenzymes which are synthesized and catalyzed by nutrient elements. Plant NPK content was maximum in T_{10} {(*Azospirillum* (60 g/m2) + PSB (60 g/m2) + VC (500 g/m2) + 75% RDF)} and minimum in 100 per cent. The maximum NPK content is attributed to the better availability at correct growth and flowering stage and uptake of nutrients facilitated by biofertilizers and vermicompost will helps to increase more production of Carnation flowers.

Table 2: Available NPK status in soil and total nutrient content in Carnation (*Dianthus caryophyllus* L.) cv. Soto as influenced by biofertilizers and inorganics after harvest

Treatments		Available nutrients in soil			Nutrient content (%) in plants		
		Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Nitrogen	Phosphorus	Potassium
T_1	100% RDF (250:80:200 g NPK + 2 kg FYM /m^2)	197.78	21.78	107.25	5.52	0.41	2.72
T_2	*Azospirillum* + 75% RDN + 100% RDP & K	204.57	22.96	110.41	5.62	0.43	2.92
T_3	PSB + 75% RDP + 100% RDN & K	216.50	27.27	114.15	5.75	0.57	3.17
T_4	*Azospirillum* + FYM + 75% NPK	210.27	24.71	118.11	5.88	0.49	3.30
T_5	*Azospirillum* + VC + + 75% RDF	223.71	24.88	120.35	6.67	0.56	2.98
T_6	PSB + FYM + 75% RDF	230.05	24.62	118.56	6.69	0.57	3.55
T_7	PSB + VC + 75% RDF	210.37	23.84	110.17	5.81	0.50	3.30
T_8	*Azospirillum* + PSB + 75% RDN & P + 100% RDK	238.38	28.82	121.22	6.68	0.61	3.77
T_9	*Azospirillum* + PSB + FYM + 75% RDF	225.62	22.24	112.88	5.78	0.57	3.25
T_{10}	*Azospirillum* + PSB + VC + 75 % RDF	263.15	37.97	126.27	6.83	0.69	3.97
T_{11}	Azospirillum + PSB + FYM + VC + 75% RDF	254.17	31.19	122.19	6.76	0.65	3.89
SEM±		1.40	0.64	1.13	0.16	0.01	0.01
CD @ 5%		4.13	1.91	3.34	0.49	0.03	0.05

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