The Bioscan 11(4): 2691-2694, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

GROWTH AND DEVELOPMENT OF CARNATION [*DIANTHUS CARYOPHYLLUS* L.] AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT

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KEYWORDS
Organic and inorganic nutrient sources
Integrated nutrient management
Vermicompost
Carnation

Received on :
09.11.2016

Accepted on :
18.12.2016

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ABSTRACT
The study was conducted with 12 treatment combinations including RDF as check to find out the best integrated nutrient approach for carnation production under polyhouse condition at the Department of Horticulture, University of Agricultural Sciences, Bangalore. The experiment was conducted by applying different combinations of organic and inorganic nutrient sources. Among the observed parameters, significantly highest plant height (92.60 cm), number of branches per plant (6.00), number of leaves per plant (171.30), individual leaf area (6.20 cm^2), leaf area per plant (1062.06 cm^2) and flower yield per m^2 for two years (739.59 respectively) and significantly lowest percentage of calyx splitting (0.67) and plants susceptible to pest and disease (2.14) were recorded in plants receiving 75 per cent recommended dose of nitrogen and phosphorus and 100 % potassium + *Azospirillum brasilense* + *Bacillus megaterium* + *Glomus fasciculatum* (VAM Fungi) + *Trichoderma harzianum* + vermicompost + panchagavya + jeevamrutha (T_7) as compared to 100 per cent RDF (T_1). Hence treatment T_7 *viz*., 75 per cent recommended dose of nitrogen and phosphorus and 100 % potassium + *Azospirillum brasilense* + *Bacillus megaterium* + *Glomus fasciculatum* (VAM Fungi) + *Trichoderma harzianum* + vermicompost + panchagavya + jeevamrutha was best for healthy growth and development.

INTRODUCTION

Carnation is an important flower crop having great commercial value as a cut flower. These are preferred to Rose and Chrysanthemum in several exporting countries, due to its long lasting keeping quality, attractive form, wide range of colours, ability to withstand long distance transportation and remarkable ability to rehydrate after continuous shipping (Renukaradya *et al.,* 2011). The lucrative and flourishing business of cut flowers has led to uncontrolled and indiscriminate use of chemical fertilizers, insecticides, fungicides and growth promoters. There is a need to reduce the mineral fertilizers consumption due to unprecedented hike in price of fertilizers, non availability and also causing soil and water pollution which aggravates the problem of soil health (Bhatia and Gupta, 2007). Potential alternatives or supplements and eco-friendly products have to be tested and popularized to educate the farming community so that they can minimise the use of chemical fertilizer by relying on organic and eco-friendly supplements.

In recent times, organic manure, biofertilizers and biostimulants have emerged as supplements to mineral fertilizers and hold a promise to improve the yield as well as quality of the crop. They have capable of mobilizing nutritive elements from non-usable form to usable form through biological processes (Vanilarasu and Balakrishnamurthy, 2014). Yathindra *et al.* (2016) observed that use of organic and inorganic nutrient combinations was found to be significantly superior in improving growth parameter in bird of paradise. Mridubhashini Patanwar *et al.* (2014) also observed increased vegetative growth parameters in chrysanthemum when nutrients were supplied in combination with organic and inorganic nutrient sources. Hence, use of stimulants, organic manures and bio-fertilizers along with chemical fertilizers in an integrated manner on a long run helps in reducing the use of fertilizers thereby improving the soil health.

Basic concept of Integrated Nutrient Management (INM) is maintenance and improvement of fertility for sustaining the crop productivity on a long-term basis. Sustained productivity may be achieved through the combined use of various sources of nutrients and also by managing them scientifically for optimum growth, yield and quality of different agro-ecological conditions (Mamta Bohra and Ajit Kumar, 2014). In order to exploit advantages of integrated nutrient management a study was carried out using different organic and inorganic nutrient sources with the objectives to know the influence of organic manures, biofertilizers and biostumulants with graded levels of inorganic fertilizers on growth parameters of carnation.

MATERIALS AND METHODS

The field experiment was laid out in CRD design with three replications during 2010-2012 at Department of Horticulture, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bangalore-560 065. The experimental station is located at 12°58'N latitude and 77°35'E longitude with an elevation of 930 meters above mean sea level. The climate was moderate and favourable for cut flower production round the year under poly house.

Uniformly grown well rooted tissue cultured plants having 4-5 leaves were selected and planted at a spacing of 20 cm x 15 cm. Treatment combination consisted of use of inorganic fertilizers, vermicompost (2.5 kg/m^2/year), biofertilizers namely, *Azospirillum brasilense*, *Bacillus megaterium*, *Glomus fasciculatum* (VAM Fungi) @ 10g/m^2 and *Trichoderma harzianum* @ 10g/m^2 and biostimulants namely panchagavya (3 %) and jeevamrutha (10 ml/m^2). The recommended dose of fertilizers applied was 250:80:200g NPK/m^2/year. Foliar application of Panchagavya @ 3 per cent and Jeevamrutha @ 10ml/m^2 applied to the soil at once in a month as per treatment specifications. Panchagavya and Jeevamrutha were prepared as per the standard procedure. To prepare panchagavya, fresh cow dung (5 kg), cow urine (3 litre), cow milk (2 litre), cow curd (1 litre), cow ghee (100 g), sugar cane juice (3 litre), tender coconut water (3 litre) and banana fruit (12 No.) were mixed and kept for three months in a plastic drum covered with muslin cloth under shade and thoroughly stirred daily. After three months the mixture was filtered and diluted to 3 per cent and then used at monthly interval as foliar spray as per the treatment specifications.

For preparing jeevamrutha, fresh cow dung (5 kg), cow urine (7.5 litres), jaggery (3 kg), pulse flour (1kg) and water (100 litres) were mixed and kept for 4 days in a drum covered with muslin cloth under the shade and stirred daily. Then the mixture was applied to the soil @ 10 ml/ m^2 at monthly intervals as per the treatment specifications.

Common basal dose consisted of FYM @ 5 kg/m^2/year and Neemcake @ 1 kg/m^2/year applied to the soil at the time of planting and foliar application of micronutrients @ 2.5 ml/l at monthly intervals was taken up irrespective of treatments. Biofertilizers were applied at the time of planting and later once in six months through soil application as per treatment specifications. Well decomposed farm yard manure, sand and coconut coir pith in 2:1:1 proportion was applied and mixed thoroughly with the soil. Observations were recorded on important traits *viz.*, plant height, number of branches, number of leaves, individual leaf area, leaf area per plant, flower yield per m^2, incidence of calyx splitting and disease susceptibility. Data were analyzed and pooled mean values are presented in Table 1.

RESULTS AND DISCUSSION

Perusal of data in Table 1 clearly showed that the growth and development of carnation was better when inorganic fertilizers were supplemented with the organic manure, biofertilizers and stimulants compared to solitary application of either organic manure or biofertilizers along with inorganic fertilizers. Significantly highest plant height (92.60 cm), Number of branches per plant (6.00), number of leaves per plant (171.30), individual leaf area (6.20 cm^2) and leaf area per plant (1062.06 cm^2) were recorded in treatment receiving 75 % RD NP and 100 % K + *Azospirillum brasilense* + *Bacillus megaterium* + VAM + Vermicompost + Panchagavya + Jeevamrutha + *Trichoderma harzianum* (T_7) followed by T_5 (91.14 cm, 5.89, 165.07, 6.09 cm^2 and 1005.64 cm^2 respectively). Increased

Table 1: Influence of integrated nutrient management on vegetative growth and flower yield of carnation [*Dianthus caryophyllus* L.]

Treatments	Plant height (cm)	Number of branches / plant	Number of leaves /plant	Leaf area (cm^2)	Leaf area/ plant (cm^2)	Number of flowers/m^2
T_1: 100% Recommended dose of N, P and K	78.83	4.67	132.1	4.94	652.72	522.95
T_2: T_1 + Vermicompost	81.31	4.78	135.67	5.05	685.13	539.61
T_3: 75 % recommended dose of Nitrogen, Phosphorus and 100 % Potassium + *Azospirillum brasilense* + *Bacillus megaterium* + VAM + Vermicompost	86.72	5.22	153.5	5.65	867.27	651.94
T_4: T_3 + *Trichoderma harzianum*	88.95	5.44	157.2	5.82	914.85	668.59
T_5: T_3 + Jeevamrutha	91.14	5.89	165.07	6.09	1005.64	716.6
T_6: T_3 + Panchagavya	90.46	5.67	162.87	5.94	967.51	701.93
T_7: T_3 + Panchagavya + Jeevamrutha + *Trichoderma harzianum*	92.6	6	171.3	6.2	1062.06	739.59
T_8: 50 % recommended dose of Nitrogen, Phosphorus and 100 % Potassium + *Azospirillum brasilense* + *Bacillus megaterium* + VAM + Vermicompost	82.01	4.89	138.33	5.19	717.93	551.94
T_9: T_8 + *Trichoderma harzianum*	82.92	4.89	141.43	5.28	746.86	571.94
T_{10}: T_8 + Jeevamrutha	85.28	5.11	149.17	5.53	824.91	619.6
T_{11}: T_8 + Panchagavya	84.43	5	145.67	5.39	785.16	605.27
T_{12}: T_8 + Panchagavya + Jeevamrutha + *Trichoderma harzianum*	87.52	5.33	155.73	5.71	889.22	654.27
F-test	*	*	*	*	*	*
S. Em±	0.85	0.14	3.43	0.05	6.96	11.21
C.D. at 5%	2.5	0.43	10.02	0.14	20.33	32.72

* Significant at 5%

Table 2: Influence of integrated nutrient management on incidence of calyx splitting and disease susceptibility of carnation [*Dianthus caryophyllus* L.]

Treatments	Incidence of Calyx splitting (%)	Disease susceptibility (%)
T_1: 100% Recommended dose of N, P and K	5.5	19.45
T_2: T_1 + Vermicompost	5.27	16.75
T_3: 75 % recommended dose of Nitrogen, Phosphorus and 100 % Potassium + *Azospirillum brasilense* + *Bacillus megaterium* + VAM + Vermicompost	2.4	10.98
T_4: T_3 + *Trichoderma harzianum*	2	2.56
T_5: T_3 + Jeevamrutha	1.4	6.85
T_6: T_3 + Panchagavya	1.1	10.35
T_7: T_3 + Panchagavya + Jeevamrutha + *Trichoderma harzianum*	0.67	2.14
T_8: 50 % recommended dose of Nitrogen, Phosphorus and 100 4.63 % Potassium + *Azospirillum brasilense* + *Bacillus megaterium* + VAM + Vermicompost	14.19	
T_9: T_8 + *Trichoderma harzianum*	4.4	3.66
T_{10}: T_8 + Jeevamrutha	3.43	8.21
T_{11}: T_8 + Panchagavya	3.27	12.63
T_{12}: T_8 + Panchagavya + Jeevamrutha + *Trichoderma harzianum*	2.6	3
F-test	*	*
S. Em ±	0.2	0.32
C.D. at 5%	0.6	0.95

* Significant at 5%

observations in treatment T_7 might be due to combined application of organic manures, biofertilizers, biostimulants and inorganic fertilizers, might have helped in progressive mineralization of nutrients which in turn was available constantly throughout the crop growth. Increase in plant height in T_7 may be due to the supplementation of balanced nutrition for crop growth due to quick and greater availability of plant nutrients providing a better environment for root growth and proliferation. It also creates more adsorptive surface for uptake of nutrients. Higher availability of nitrogen favours apical dominance and maintains proper rate of cell division, which inturn leads to increased rate of meristematic activity resulting in better plant height (Basavaraj Dalwai and Hemla Naik, 2014). The growth regulators like NAA and cytokinins released by *Azospirillum,* VAM and PSB might have resulted in breaking of apical dominance and accelerated higher number of branches (Sunitha and Ravi Hunje, 2010). Vermicompost and biostimulants might have been a better source of nutrient and which were applied to the soil and foliage as foliar application accordingly, as it contain nitrogen in available form, which increased the number of leaves (Somasundaram *et al*., 2004). Increased leaf area could be attributed to active substances produced by VAM and other microbial amendments, better availability of micronutrients, thereby increasing the length and breadth of leaves (Singh Prashant, 2015). The results are in agreement with the findings of Singh *et al*. (2008) in calendula, Mashaldi (2000) in marigold, Kulkarni *et al*. (1996) in China aster, Gotmare *et al*. (2007) and Mittal *et al*. (2010) in marigold.

Maximum number of flowers per m^2 for two years (739.59) was recorded in treatment receiving T_7 followed by T_5 (716.60) and it was minimum in T_1 (522.95). The increase in number of flowers may be due to possible role of bioinoculants such as *Azospirillum,* VAM and phosphobacteria through better nitrogen fixation from atmosphere, better root proliferation, uptake of nutrients and water. Besides this, increase in flower yield may be attributed to increased availability of phosphorous and its greater uptake due to application of PSB. Vermicompost, being the source of macro and micro nutrients like Fe and Zn, enzymes, growth hormones and beneficial effects of microflora might have played a secondary role in increasing the flower yield (Mridubhashini Patanwar *et al*., 2014). The higher flower yield due to application of vermicompost has been reported in chrysanthemum (Pandey Geeta *et al.,* 2010) and in gladiolus (Pansuriya and Chauhan, 2015).

Drastic reduction in disease was observed especially in treatment where *Trichoderma harzianum* was used (Table 2). Percentage of plants susceptible for pest and disease was minimum in T_7 followed by T_4 whereas it was maximum in treatment T_1 (100 % RDF). This was due to the biofertilizers especially *Trichoderma* which controlled the Fusarium wilt effectively due to secretion of an antibiotic substance called gliotoxins. This results were in accordance with Renukaradhya *et al*. (2011) in carnation. Panchagavya and Jeevamrutha is also known to contain naturally occurring, beneficially effective microorganism (EMO's), predominantly lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and plant protection substrates (Pseudomonas and saprophytic yeasts) which are responsible for controlling the pest and diseases (Somasundarum, 2004). In addition, Jeevamrutha contains enormous amount of microbial load which multiplies in the soil and acts as a tonic to enhance microbial activity in soil and thus acting indirectly in controlling diseases (Palekar, 2006).

It was interesting to note that there was very minimal (0.67 %) calyx splitting in T_7 followed by T_6. Reduced calyx splitting may be due to the effect of vermicompost and Panchagavya, as the vermicompost contains both macro and micronutrients especially Ca, Fe, Zn and B which helps in easy availability of macro and micronutrients to the plants (Polar *et al.,* 2014). The results were in accordance with the earlier findings of Renukaradhya (2011).

Considering the above results, treatments consisting of 75 per cent recommended dose of Nitrogen, Phosphorus and 100 per cent Potassium along with Vermicompost, *Azospirillum brasilense*, *Bacillus megaterium*, VAM fungi, Panchagavya, Jeevamrutha and *Trichoderma*. Even application of 50 per cent reccomended dose of fertilizers along with biofertilisers, organic manures and biostimulants are better than depending on inorganic source of nutrients alone. These results suggest that combined application of inorganic fertilizers, biofertilizers and vermicompost was superior over their individual application for better plant growth.

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