

Review Article

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Integrated Nutrient Management (INM) Approaches in Flower Crops

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ABSTRACT

Sustainable agriculture has become a burning issue due to “energy crisis” and “environmental protection”. One aspect of sustainable agriculture is Integrated Nutrient Management (INM). Many regions in India like Kashmir, Himachal and other hilly regions have huge potential for quality flower production. Since floriculture is energy and cost intensive type of farming, the input cost of fertilisers is very high, which can be avoided by going for alternative methods like INM. There is scant information available concerning the use of organic fertilizer as the sole source of nutrients in flower production, especially in the cultivation of flowers has made its applicability more difficult. INM is a practice that is being rapidly adopted by growers, combines the use of adjusted nutrient rates, more efficient fertilizer sources, organic matter and soil inoculation. INM holds great promise in exhibiting the growing nutrient demands of intensive farming like Floriculture and maintaining productivity at its optimum with holistic improvement in the quality of resource base, which is very much important in-case of cut and bulbous flowers. Investigations by many researchers have revealed the beneficial influence of INM, on vegetative (plant height, leaf area, leaf number), floral (first bud appearance, floral diameter, weight of flower) and yield attributes (seed weight, seed production) of many flower crops, reduced the cost of fertilizer inputs and increased the B/C ratio, despite maintaining a good soil physico-chemical environment. It can be concluded that by reducing the levels of chemical fertilizer and optimizing the dose of different organic fertilizer can improve yield and quality in ornamental crops without adversely affecting the edaphic and environmental features. Therefore this discourse will mainly discuss on the integrative approaches on production and management of many flower crops, commercially grown in India and Kashmir valley.

Keywords

Bio-fertilizers, energy, flowers, microbial inoculants, nutrients, INM, yield.

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Introduction

Floriculture is a branch of horticulture concerning cultivation of flowering and ornamental plants for gardens and floristry. It includes cut flowers, cut greens, bedding plant, houseplants, flowering garden and potted plants etc. The rising living standards and unabated urbanization in the present day

the world has led to growing demand of flowers and their products thereby making the floriculture an important commercial trade. Commercial floriculture has higher potential per unit area than the field crops and is therefore evolving as a lucrative business all over the world (Misra and Sudip, 2016). The area and under floriculture in India are about

253.65 thousand hectare with production of 1.652 million tonnes loose flowers and 76.73 million tonnes cut flowers (NHB, 2012). Indian floriculture industry stands 2nd in world production (Shilpa and Narpat, 2016) and occupies 51st in terms of exports and contributes rupees 455 crores which is 0.06 percent of global trade (De and Singh, 2016). Floriculture has vast scope and potential in Kashmir valley which is evident from the fact that during 1996, an area of 80 hectare was under flower cultivation and has now expanded to 350.0 hectare with an annual turnover of 1350 lac. Further, commercial floriculture engages directly more than 1500 youth in the Valley (Muneeb *et al.*, 2016) and thus offers a unique scope for judicious employment of existing resources and exploration of avenues yet untouched. There is as such an urgent need of scientific approach and wise use to promote the relevant management practices, improvement of flower germplasm, balanced nutrient management, modern production technology, quality planting material, precision farming etc., for conservation and commercialization of the floriculture industry and diversification from the traditional field crops due to higher returns per unit area. The overall strategy for increasing crop yields and sustaining them at high level must include integrated approach to the management of nutrients. The sustainability in agriculture system is a global issue. Integrated nutrient management program is a critical component of the type of integrated farming systems (Edwards *et al.*, 1990). The program involves maximize biological inputs to crop production and minimize the use of inorganic amendments so as to create a much more sustainable pattern of crop production, not only ecologically but also environmentally (National Research Council, 1991). Since the nutrient turnover in soil plant system is considerably high in intensive farming, integrated approach of chemical, organic and biological sources can

achieve sustainable production. Practice of INM is the better option for the improvement of physical, chemical and biological properties of soils (Das *et al.*, 2015). To maintain productivity and reduce dependence on chemical fertilizers alone is increasingly becoming important to flower growers. It is important to exploit the potential of organic manures, composts, crop residues, biofertilizers and their synergistic effect with chemical fertilizers for increasing balanced nutrient supply (Wani *et al.*, 2016). This kind of intervention is of paramount importance in horticulture in general and ornamentals in particular. The use of biofertilizers reduces per unit consumption of inorganic fertilizers and increase the quality and quantity of flower (Syamal *et al.*, 2006). The growth and quality of flower are greatly influenced by numerous environmental factors like soil type and nutrient availability being the most essential factors for appropriate growth (Tariq *et al.*, 2012). The quality and production of cut flowers is primarily a varietal trait, it is greatly influenced by climatic, geographical and nutritional factors. The quality and quantity of applied fertilizer are the key factor affecting the growth, yield and quality of the cut flower (Dufour and Guejrin, 2005). The quality of flowers is influenced both by quantity and source of nutrients as well. This paper attempts to review the latest information regarding the role of integrated nutrient management in flower crop production both under both greenhouse as well as open field conditions.

INM investigations in some flower crops

China aster (*Callistephus chinensis* (L) Nees)

In an investigation Chaitra and Patil (2007) assessed integrative response of various fertilizers on flowering and yield attributes of China aster cv. Kamini (Fig. 1). They

reported that the treatment T₁₁ (Azo + PSB + C + 50% RDF) significantly improved flower diameter, flower yield and the overall yield per unit area. The results strongly endorse the integrative approaches for over all optimum growth and yield inoculation of *Azospirillum* and PSB, enhanced the cell division and enlargement and also produced growth hormones, which is possible reason for increased growth. These results were incongruent with the findings of Ravichandran (1991) in crossandra and Mononmani (1992) in jasmine.

Chrysanthemum (*Dendranthema grandiflora*)

Angadi (2014) evaluated the influence of integrated nutrient management on yield and relative economics of garland chrysanthemum. The reports suggested that (Table 1) yield traits like number of flowers/plant, flower yield/plant and flower yield/ha were significantly higher in treatment T₉ (Azospirillum + PSB + 50 per cent vermicompost equivalent to RDN + 50 per cent recommended NPK). The same treatment also recorded maximum net returns (Rs. 1,95,135/ha) and high B:C ratio (4.23) compared to control. This might be due to the beneficial effect of vermicompost and biofertilizers in combination with recommended dose of inorganic fertilizers which lead to better root proliferation, uptake of nutrients and water and better plant growth. This is in conformity to the findings of Chandrikapure *et al.*, (1999) in marigold, Chaitra and Patil (2007) in China aster, Deshmukh *et al.*, (2008) in gaillardia and Meshram *et al.*, (2008) in annual chrysanthemum. This gives a tremendous scope for the yield improvement in garland chrysanthemum with the integrated nutrient management practices. In addition, this study also throws light on reduction in the quantity of chemical fertilizer application when

applied along with biofertilizers and organic manures to get yield at par with recommended dose of inorganic fertilizers. The present investigation shows that among all the treatments, the treatment (T₉) receiving combination of Azospirillum, PSB, 50 per cent vermicompost equivalent to RDN and 50 per cent recommended NPK gave highest flower yield of (9.65 t/ha) with the maximum net returns per rupee invested (1: 4.2) (Table 1).

Rose (*Rosa spp.*)

Lambat and Pal (2012) while studying the effects of organic manures and biofertilizers on growth and flowering of *Rosa* cv. Madgod observed that more length of flower bud (3.03 cm) was obtained when plant treated with neem cake 400 g + PSB 1 g + *Azotobacter* 1 gm⁻² and minimum under control (2.66cm) as shown in figure 2. Among the treatments maximum flower diameter (2.50 cm) was observed with neem cake 400 g + PSB 1 g + *Azotobacter* 1 gm⁻² followed by linseed cake 400 g m⁻² + PSB 1 g + *Azotobacter* 1 g m⁻² (2.46 cm). Results revealed that the treatments of organic manures and biofertilizer showed significant influence on flower yield. Plants treated with neem cake 400 g + PSB 1 g + *Azotobacter* 1 gm⁻² recorded maximum (201.03) number of flowers followed by mustard cake 400 g + PSB 1g + *Azotobacter* 1 gm⁻² (166.88). Vase life (6.0 days) of flowers was maximum under neem cake 400 g + PSB 1 g + *Azotobacter* 1 g m⁻². These results are in close line with the findings of Yadav *et al.*, (1989) and Sinha *et al.*, (1981).

Statice (*Limonium caspia*)

Gayathri *et al.*, (2004) evaluated the integrative effects of different fertilizers of flowering parameters of statice cv. blue diamond (Fig. 3). The results revealed that the

treatment T10 (50% NP + 100%K + VC + *Azotobacter* + PSB) significantly improved the spike length, spike spread and the number of branches per spike. Significant increase in plant height and spread due to combined application of *Azospirillum*, PSB and inorganic fertilizers has been reported earlier in *Valeriana jatamansi* (Salathia, 2005) and gladiolus (Srivastava and Govil, 2005).

Marigold (*Tagetes spp.*)

In a study conducted by Sunitha and Hunje (2010), to ascertain the response of integrated nutrient management on growth and yield on African marigold, used different combinations of fertilizes treatments (Fig. 4). The study revealed that the treatment F₅ (50% RDF+VC (50% RDF) had a significant effects in the number of flowers per plant and the treatment was at par with that of F₃ (RDF + VC 5t / ha). Same trend was observed with that of seed yield per hectare.

The investigation also reported that the an application of vermicompost as 50% RDN along with 50% RDF recorded significantly higher plant height, maximum number of primary branches, flowers, seed yield per plant (18.6g) and per hectare (499.00 kg compared to RDF alone. Biofertilizer-inoculated plants may be ascribed to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinin to the axillary buds, resulting in breakage of apical dominance.

Ultimately, this has resulted in a better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. In this way the biofertilizers helped in improving overall growth and yield of marigold. These results were in conformity with the findings of Karuppaiah and Krishna (2005) in French marigold and Jenny Marks *et al.*, (2006) in ajowan.

Tuberose (*Polianthes tuberosa*)

Mayuri *et al.*, (2013) evaluated the response of INM on sprouting, plant height, plant spread (E-W and N-S) and number of leaves per clump in tuberose cv. Double (Fig. 5). The data showed significant variation and minimum days for sprouting after cutting (18.47 days), maximum plant height at full bloom stage (61.67 cm) and plant spread at EW and N-S (37.93 cm and 37.07 cm, respectively) were recorded with an application of FYM @ 30 t/ha + PSB @ 2 g/m² + *Azotobacter* 2 g/m² (T₁₃). This might be due to better nutrient uptake, photosynthesis, source-sink relationship, besides excellent physiological and biochemical activities due to presence of *Azotobacter* and PSB. The present finding are in close conformity with findings of Kukde *et al.*, (2006) in tuberose; Gupta *et al.*, (2008) and Ranjan and Mansee (2007) in gladiolus; Khan *et al.*, (2009) in tulip and Bhatia and Gupta (2007) in carnation.

Gerbera (*Gerbera jamesonii* Bolus ex. Hook)

In an investigation Kreditsu (2012b), evaluated the influence of integrative approach of organic and inorganic manures on flowering and yield attributes of *Gerbera jamesonii* (Fig. 6). The results suggested significant that treatment T₄ (50% RDF+25% Cocopith+25% Pig manure) improved both flower size/fresh weight of flowers (g) and flower yield (kg/ha).

Gladiolus (*Gladiolus grandifloras*)

An investigation was undertaken by Madinatul-Nisa *et al.*, (2016) aimed to evaluate the response of integrative nutrient application on overall yield of gladiolus. Significant differences were observed amongst all the treatments (Table 2). The results endorsed

that the treatment T₆ (Azotobacter 1 litre/10 kg + Azospirillum 1 litre/10 kg + 80% N +100% PK) significantly improved the number of florets spike⁻¹ (14.20), number of spikes m⁻² (32.00), corms plant⁻¹ (3.2) and corms m⁻² (74.70). This may be due to the combined action of biofertilizers and inorganic fertilizers, which resulted in more number of leaves plant⁻¹, alternatively resulted in more assimilation of photosynthates towards sink, and there by increased the yield characters

(Dalve *et al.*, 2009; Wani *et al.*, 2015). The maximum weight of corms m⁻² (3.07 kg), weight of cormels plant⁻¹ (22.1g) and weight of cormels m⁻² (0.53 kg) observed in treatment T₁₂ (VAM 250g m⁻² + PSB 1 litre/10kg + 80% P +100% NK). The maximum size (5.62cm) of corm plant⁻¹ has been reported in treatment T₁₀ (PSB 1 litre/10kg + 80% P +100% NK). The results are in close agreement with those obtained by Singh and Sujahata (1990) and Sehrawat *et al.*, (2003).

Table.1 Effect of integrated nutrient management on yield attributes and economics of garland chrysanthemum

Treatments	Number of flowers/plant	Flower yield (g/plant)	Flower yield (t/ha)	Net returns (Rs.)	B:C ratio
T1 – Absolute control	22.87	20.43	2.27	20,600	0.57
T2 – 100% RDF + FYM (20 t/ha)	35.84	57.71	6.52	1,16,962	2.54
T3 – 50% VC equivalent to RD‘N’ + 50% RDF	29.67	42.78	4.70	73,585	1.63
T4 – Azospirillum + 75% RD‘N’ + 100% RD‘P’ and ‘K’	28.26	38.32	4.20	65,839	1.62
T5 – PSB + 75% RD‘P’ + 100% RD‘N’ and ‘K’	31.51	55.25	6.25	1,15,814	2.86
T6 – Azospirillum + 50% VC equivalent to RD‘N’ + 50% RDF	31.34	51.55	5.73	97,360	2.12
T7 – PSB + 50% VC equivalent to RD‘N’ + 50% RDF	38.73	73.34	8.15	1,57,860	3.44
T8 – Azospirillum + PSB + 50% RD‘N’ and ‘P’ + 100% D‘K’	31.32	44.37	4.93	83,720	3.12
T9 – Azospirillum + PSB + 50% VC equivalent to RD‘N’+50% RDF	42.33	86.8	9.65	1,95,135	4.23
S.E.±	0.95	1.52	0.59		
C.D. (P=0.05)	2.85	4.56	1.77		

Angadi (2014)

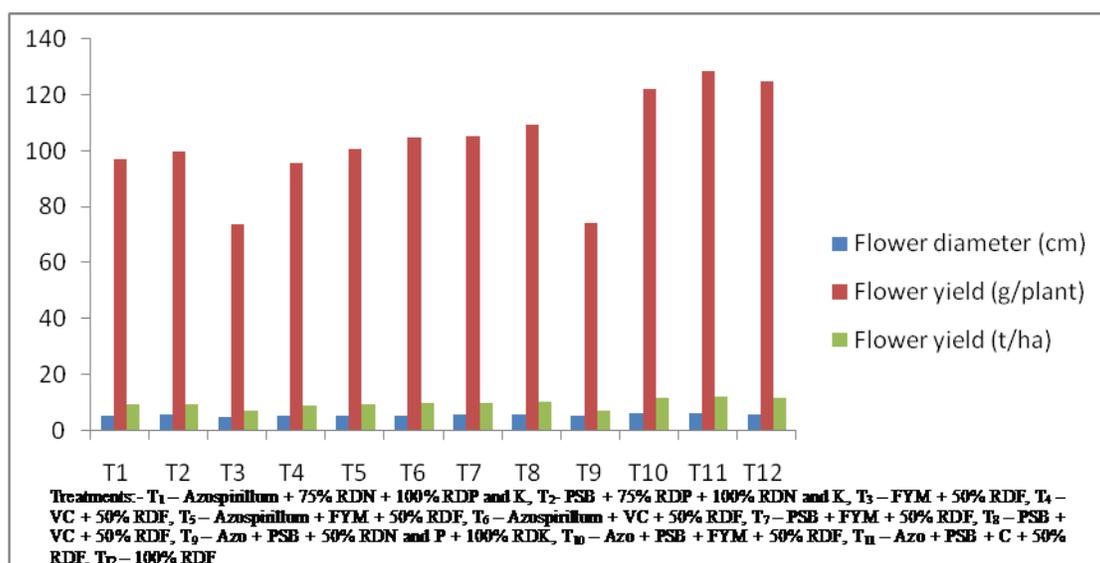
FYM = Farm yard manure, PSB = Phosphate solubilizing bacterium, VC = Vermicompost, RDF = Recommended dose of fertilizer (150:100:100 NPK kg/ha).

Table.2 Effect of biofertilizers on yield characters in gladiolus cv. Priscilla

Treatments	No. of florets spike ⁻¹	No. of florets open at one time	No. of spikes m ⁻²	No. of corms plant ⁻¹	No. of corms m ⁻²	No. of cormels plant ⁻¹	Weight of corms (kg m ⁻²)	Weight of cormels (g plant ⁻¹)	Weight of cormels (kg m ⁻²)	Size of corm (cm)
T ₁	12.60	5.10	26.00	2.13	46.83	32.60	1.40	12.9	0.28	4.73
T ₂	13.53	4.40	31.00	2.73	61.13	35.50	1.90	15.5	0.34	4.78
T ₃	12.85	4.73	27.50	2.55	59.13	33.25	2.44	14.3	0.32	5.31
T ₄	13.80	5.20	31.50	3.05	66.66	36.45	2.76	16.4	0.35	5.04
T ₅	13.05	4.50	28.50	2.63	60.66	33.85	2.17	17.5	0.40	4.91
T ₆	14.20	4.23	32.00	3.20	74.70	38.10	2.35	17.6	0.41	4.67
T ₇	14.13	4.03	24.00	1.70	37.86	25.80	1.40	16.8	0.37	4.88
T ₈	13.13	4.60	29.00	1.90	39.83	34.20	1.71	16.7	0.36	5.35
T ₉	12.93	4.70	24.50	2.30	48.23	27.10	1.79	19.1	0.45	4.81
T ₁₀	13.30	4.33	29.33	2.83	68.86	34.50	3.33	19.0	0.43	5.62
T ₁₁	12.03	4.80	25.50	2.43	54.30	29.05	1.81	20.6	0.46	5.01
T ₁₂	13.40	4.93	30.50	2.93	71.30	34.80	3.07	22.1	0.53	5.37
T ₁₃	11.20	3.50	23.50	1.20	27.26	25.20	1.26	12.5	0.28	4.50
C.D(<i>p</i> <0.05)	1.21	0.65	2.61	0.27	6.05	1.80	0.25	1.10	0.09	0.33

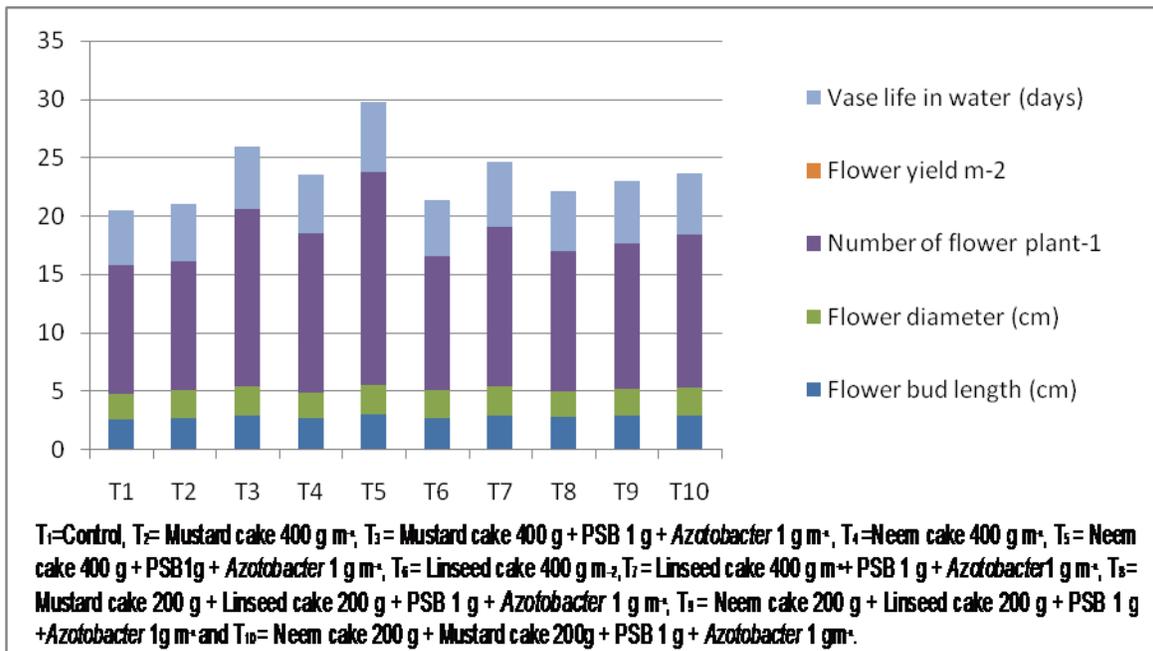
Madinat-ul-Nisa *et al.*, 2016

Fig.1 Influence of biofertilizers, vermicompost with inorganic fertilizers on flowering and yield of China aster cv. Kamini



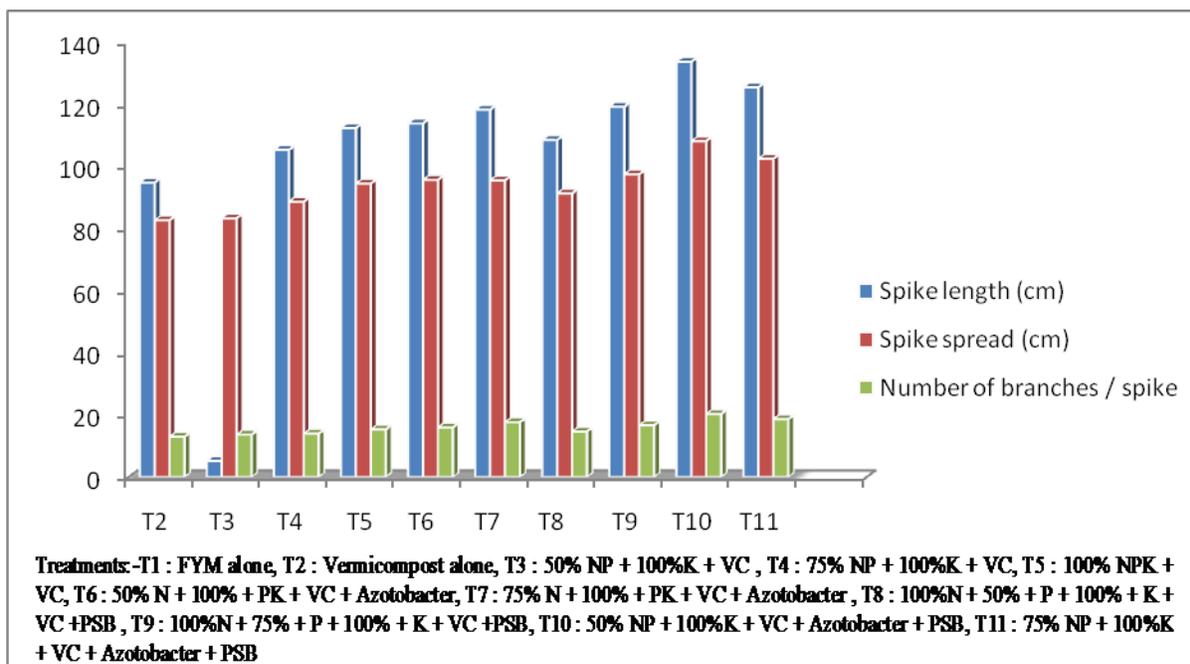
Chaitra and Patil (2007)

Fig.2 Effect of organic manures and biofertilizer on growth and yield attributes of Rosa cv. Madgod



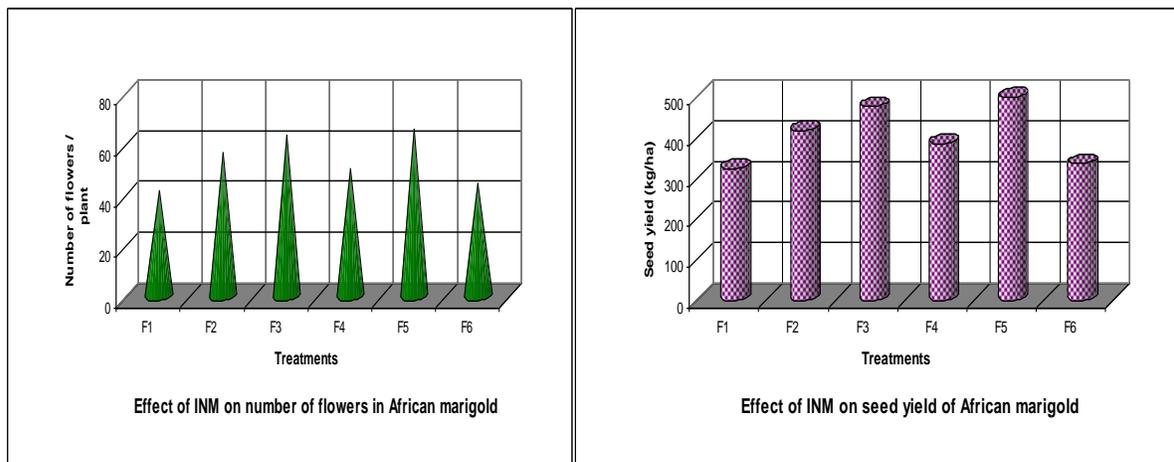
Lambat and Pal (2012).

Fig.3 Influence of bio-fertilizers, vermicompost with different levels of N, P and K on flowering in Statice cv. Blue Diamond



Gayathri et al. (2004)

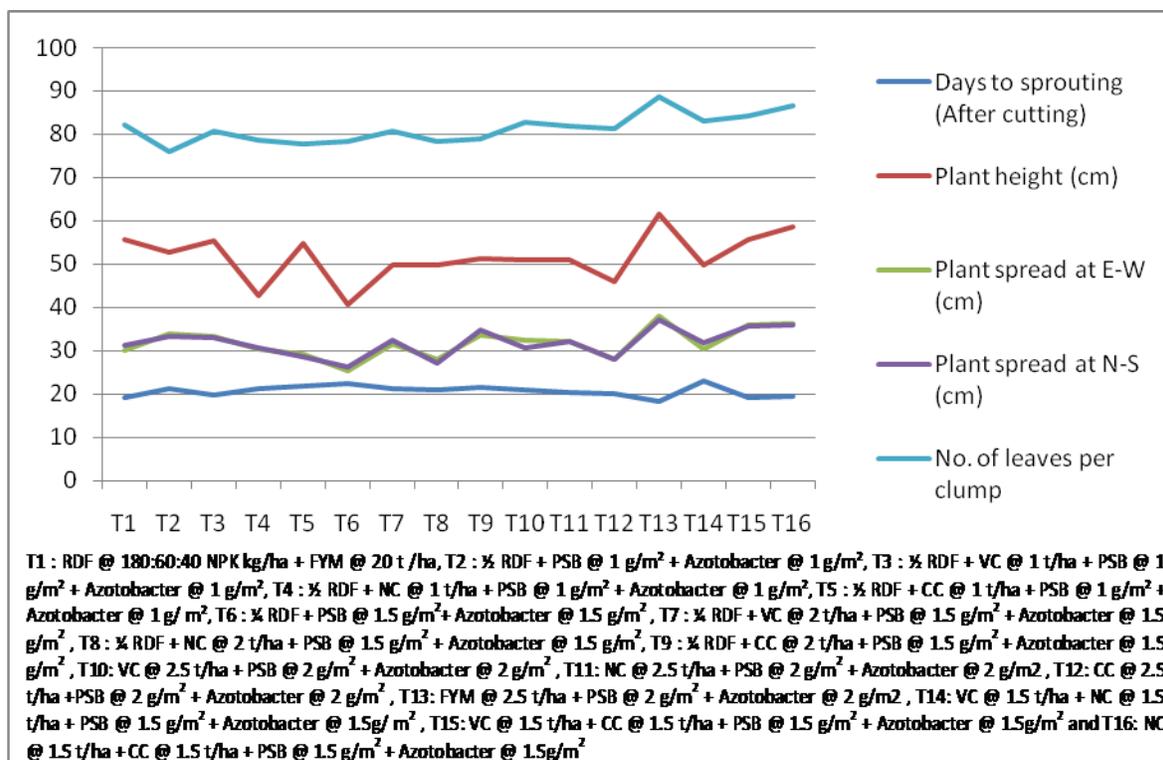
Fig.4 Effect of INM on number of flowers per plant and seed yield of African marigold



Sunitha and Hunje (2010)

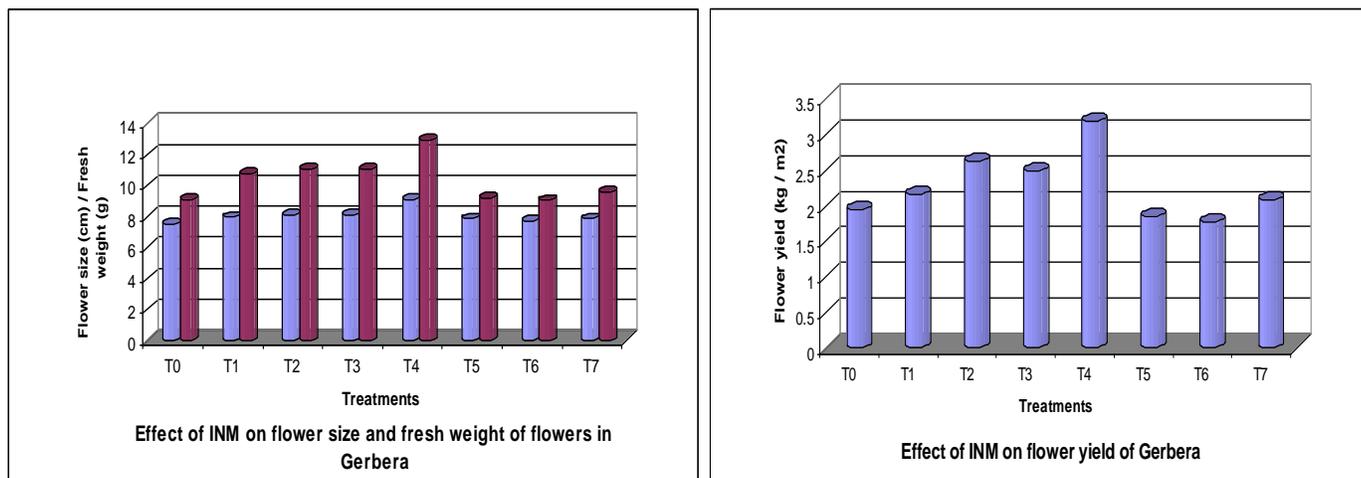
F₁: RDF (225:60:60 kg ha⁻¹), F₂: RDF+FYM@ 20 ton ha⁻¹, F₃: RDF + VC @ 5ton ha⁻¹, F₄: 50% RDF + FYM (50% RDN), F₅: 50% RDF+VC (50%RDF), F₆: FYM (50%RDN)+ VC (50% RDN)

Fig.5 Effect of integrated nutrient management on days to sprouting, plant height, plant spread (E-W and N-S) and no. of leaves per clump in ratoon tuberose cv. Double



Mayuri et al., 2013

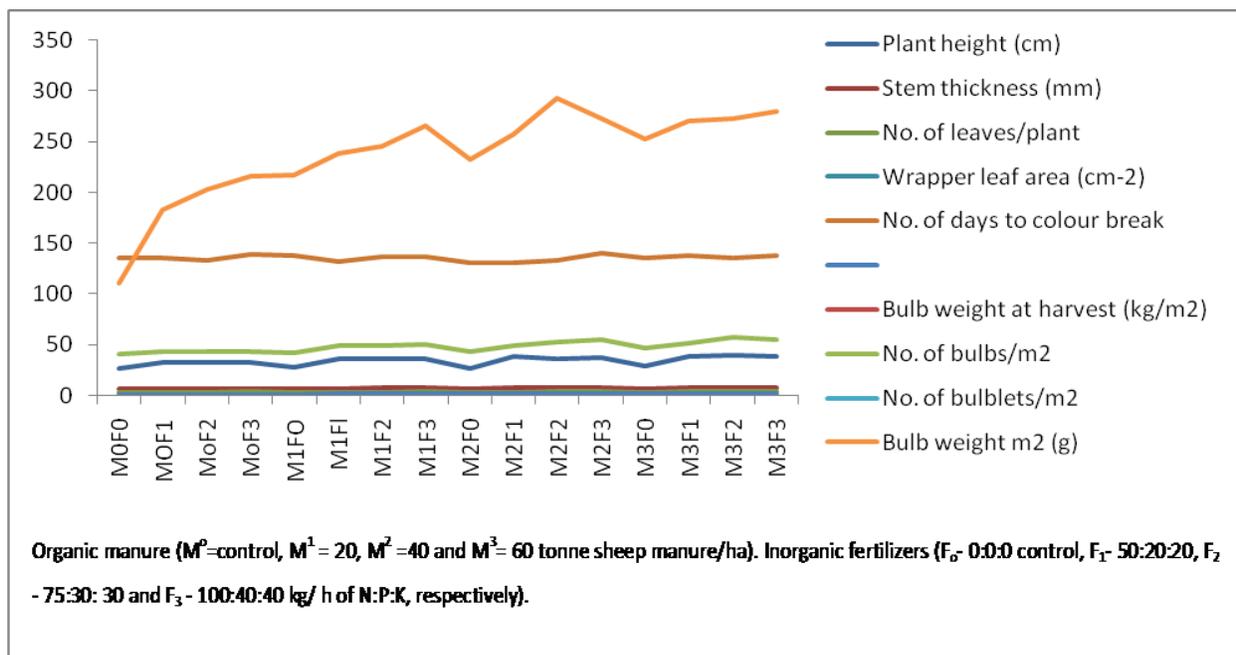
Fig.6 Effect of INM on flowering and yield parameters of *Gerbera jamesonii*



Keditsu 2012b

T₀–100% RDF (Recommended doses of fertilizers), T₁–50% RDF+50% Cocopith, T₂ –50% RDF+50% Pig manure, T₃–50% RDF+50% FYM, T₄–50% RDF+25% Cocopith+25% Pig manure, T₅–50% RDF +25% Pig manure+25% FYM, T₆–50% RDF+25% FYM+25% Cocopith, T₇ – 50% Cocopith + 25% Pig manure + 25% FYM

Fig.7 Interaction effect of M x F on growth and bulb production parameters in tulip cv. Apeldoorn



Jhon *et al.*, 2007

Tulip (*Tulipa gesneriana* L.)

An experiment was carried out by Jhon *et al.*, (2007) to assess the interaction impact of

organic manure and inorganic fertiliser (M x F) on growth and bulb production in tulip cv. Apeldoorn. The results (Fig. 7) unveiled that interaction of organic manure and mineral

fertility levels showed significant effect on plant height, wrapper leaf area, number of bulbs and their weight, large sized bulbs, number of bulblets and their weight m^{-2} , while number of days taken to and percentage sprouting, stem thickness, number of leaves $plant^{-1}$, days to colour break, bulb weight at harvest. Number of bulbs ranged from 40.50 to 55.50 m^{-2} . They observed that organic manure (60 tonnes ha^{-1}) in conjugation with inorganic fertilizers ($N_{75} P_{30} K_{30}$ kg/ha) improved plant height (39.50 cm), wrapper leaf area (139.77 cm^2), total number of bulbs (57.50 m^{-2}), large sized bulbs of > 11 cm (16.00), 9-11 cm (18.50) circumference and number of bulblets m^{-2} (130.50).

In conclusion, the increase in the degradation and deterioration of soil physico-chemical properties because of synthetic fertilizers had led find out the natural or alternate methods of soil amendments. Therefore INM strategies are best methods to avoid these problems. INM leads to increased B/C ratio, as this approach mainly uses organic sources of fertilizers, being very cheap in cost. Therefore, it can be concluded that by reducing the level of chemical fertilizer and optimizing the dose of different organic fertilizer can optimize the yield in ornamental crops and improve overall soil health without depleting the environment.

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