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Impact of integrated nutrient management on growth and flowering of gladiolus (*Gladiolus grandiflorus* L.) cv. American beauty

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Abstract
The present investigation entitled "Impact of integrated nutrient management on growth and flowering of gladiolus (*Gladiolus grandiflorus* L.) cv. American Beauty" was carried out at Floriculture Research Farm, Navsari Agricultural University, Navsari (Gujarat) during the year 2015-16. The experiment was conducted in Randomized Block Design (RBD) with three replications and ten treatments consisting of bio-fertilizers (*Azotobacter*, PSB and KMB), different levels of inorganic fertilizers and their combinations. Among all treatments application of 100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer was found most effective in plant height at 60 and 120 days (59.73 and 84.00 cm), number of leaves/plant (19.87), minimum days taken to spike initiation (48.10), days to harvesting of spike from initiation of spike (16.57 days), maximum spike length (66.63 cm), rachis length (39.53 cm), number of florets per spike (11.30), diameter of 2nd floret (8.50 cm), vase life of the spike (14.93 days), with highest production of spikes/plant (2.50).

Keywords: gladiolus, INM, bio-fertilizer, FYM, growth and flower characters

Introduction
Gladiolus (*Gladiolus grandiflorus* L.) belongs to family Iridaceae and is native of South Africa and Asia Minor. It is grown for garden decoration, cut flower production and has year round demand in towns and cities for bouquets, flower vases, garden and interior decoration. Popularity of this flower is increasing day by day because of its majestic spikes having florets of huge form, dazzling colour which covers the spectrum of white, pink, red, purple, yellow, orange, salmon and even green are available along with many bicolour and multicolour. Out of the various factors affecting the growth and flowering of gladiolus, balanced nutrition is very important. After green revolution the continuous use of fertilizers has led to an increase in crop production but decline the nutrient-use efficiency making fertilizer consumption uneconomical and producing adverse effects on atmosphere and groundwater quality, causing health hazards. Therefore, it was suggested to replace some of the applied chemical fertilizers by some of the well-known bio-fertilizers. Balanced use of inorganic fertilizers is of paramount importance in Horticulture in general and Floriculture in particular, as the integrated nutrient management concept is one of the eco-friendly approaches. Bio-fertilizers have been found beneficial in flower crops like gladiolus, tuberose, rose, chrysanthemum and marigold (Maurya and Beniwal, 2003) [9]. Keeping in view the need and importance, present investigation was undertaken to study the impact of integrated nutrient management on growth and flowering of gladiolus under south Gujarat conditions.

Materials and Methods
The present experiment was carried out at Floriculture Research Farm, Navsari Agricultural University, Navsari (Gujarat) during the year 2015-16. The experiment was conducted in Randomized Block Design (RBD) with three replications. The experiment was consisted of ten treatments *viz*., 100% recommended dose of fertilizers (T_1), 50% RDF + FYM @ 15 t/ha (T_2), 75% RDF + FYM @ 7.5 t/ha (T_3), 100% RDF + FYM @ 7.5 t/ha (T_4), 50% RDF + FYM @ 15 t/ha + *Azotobacter* + PSB + KMB (T_5), 75% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB (T_6), 100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB (T_7), T_1 + *Azotobacter* + PSB + KMB (T_8), T_1 + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer (T_9) and T_7 + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer (T_{10}).

However, minimum plant height at 60 & 120 DAP (48.33 & 64.67 cm) and number of leaves per plant (14.73) was recorded in treatment T_1 *i.e.*100% RDF 200:200:200 NPK kg/ha). This might be due to the fact that growth and development of above ground parts of plant are determined primarily by the activity of apical meristem, because the leaf primordial is formed there. The stem elongation depends initially on the new tissue formed at the apex and many of the hormonal signals which determine the later growth and development of all plant parts. It becomes clear that, higher dose of inorganic fertilizers along with manures and bio-fertilizers increased availability of nutrients. Similar findings have been reported by Syamal *et al.* (2006) [13] in marigold. Moreover, *Nouroji* novel organic liquid fertilizer contain nutrients like nitrogen, potassium which ultimately increased the vegetative growth. These nutrients also play an important role in metabolic activities of the plant resulting in the synthesis of chlorophyll and cytochromes which are essential for photosynthesis and respiration process in the plants. Similar increase in vegetative growth with increase in level of nitrogen was also reported by Neelima *et al*. (2015) [10] in chrysanthemum, Gayithri *et al*. (2004) [6] in statice and Kumar (2014) [7] in gladiolus.

Effect of INM on flowering parameters

The data presented in Table 2 show that the flowering characters were significantly affected by the application of different doses of nitrogen, phosphorus, potash and various doses of farm yard manure, bio-fertilizers and foliar spray of *Nauroji* Novel Organic Liquid Fertilizer. The treatment receiving T_{10} *i.e.* 100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer recorded minimum days taken to spike initiation (48.10) and days to harvesting of spike from initiation of spike (16.57) which was at par with treatment T_7 (100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB) and T_6 (75% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB). Whereas delayed in spike emergence and days to harvesting of spike from initiation of spike was recorded with treatment T_1 *i.e.* (100% RDF (200: 200: 200 NPK kg/ha) being 61.10 and 22.00 days.

The earliness in floral parameters in treatment T_{10} can be attributed to amplification of nutrients especially, nitrogen from different sources *viz*., inorganic and organic fertilizers which promote the translocation of phytohormones to the shoots resulting in early flower initiation. The results are in line with the findings of Kumar (2014) [7] in gladiolus, Gangadharan and Gopinath (1997) [5], Dubey and Misra (2005) [4] in gladiolus and Yadav *et al.* (2005) [14] in tuberose on the effect of NPK along with bio-fertilizers in the advancement of flowering. It can also be due to the presence of GA_3 and cytokinin in *Nauroji* Novel Organic Liquid Fertilizer which is associated with regulation of flowering.

Among different treatment combinations, treatment containing 100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer had positive influence on other flower characters (Table 2). This treatment recorded significantly maximum spike length (66.63 cm), rachis length (39.53 cm), number of florets per spike (11.30), diameter of 2nd floret (8.50 cm), vase of spike (14.93 days) and number of spikes per plant (2.50) which were at par with treatments T_7 (100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB) and T_6 (75% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB). However, minimum spike length of (52.67), rachis length (30.93), number of florets per spike (10.77), diameter of 2nd floret (6.87 cm), vase life of spike (12.10 days) and number of spikes per plant (2.17) were recorded under the treatment of T_1 (100% RDF 200: 200:200 kg/ha). Similar results were also reported by Kumari Vasantha *et al*. (2008) [8] and Basoli *et al*. (2014) [2] in gladiolus.

The beneficial effect of nitrogen and phosphorus nutrients on flower size and length of spike might be due to that nitrogen increase the protein synthesis, thus promote the development of floral primordial, while phosphorus found to be involved in formation of floral primordial resulting more number of flower obtained which was also found by Singh *et al*. (2015) [12] in marigold. The application of nitrogen, phosphorus, potash, manures, bio-fertilizer and *Nouroji* Novel Organic Liquid Fertilizer in favoured to synthesize of amino acid act as precursor of polyamine and secondary messenger in spike length, characters and initiation and development of flower characters. Synthesis of this amino acid is also influenced by phytohormones which are formed in plant due to the application of chemical and bio-fertilizers were reported by Barman *et al*. (2003) [1] in tuberose.

The significant increase in number of spikes per plant might be due to active and rapid multiplication of bacteria especially in rhizosphere creating favourable condition for nitrogen fixation and phosphorus solubilization at higher rate through nitrogen supply by nitrogenous fertilizers and supply of other nutrients, bacterial secretion, hormone production and supply of antibacterial and antifungal compounds, which were favourable for growth and ultimately increased yield. These findings corroborate with that of Yadav *et al.* (2005) [14] in tuberose and Basoli *et al.* (2012), Dalve *et al*. (2009) [3] in gladiolus.

Table 1: Effect of Integrated Nutrient Management on growth parameters in gladiolus (*Gladiolus grandiflorus* L.) cv. American Beauty

S. No	Treatments	Days to sprouting	No. of tillers per corm	Plant height (cm)		No. of leaves per plant
				60 DAP	120 DAP	
T_1	100% RDF (200:200:200 NPK kg/ha)	10.70	1.80	48.33	64.67	14.73
T_2	50% RDF + FYM @ 15 t/ha	10.57	2.07	50.00	72.67	17.30
T_3	75% RDF + FYM @ 7.5 t/ha	10.50	2.13	50.70	68.33	16.47
T_4	100% RDF + FYM @ 7.5 t/ha	10.07	2.20	50.73	72.33	17.40
T_5	50% RDF + FYM @ 15 t/ha + *Azotobacter* + PSB + KMB	10.03	2.27	51.00	74.33	17.43
T_6	75% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB	9.23	2.37	51.67	74.33	18.53
T_7	100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB	9.43	2.47	57.67	76.33	17.47
T_8	T_1 + *Azotobacter* + PSB + KMB	9.53	2.23	51.63	73.00	17.00
T_9	T_1 + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer	10.13	2.17	50.97	72.33	17.33

T_{10}	T_7 + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer	9.27	2.60	59.73	84.00	19.87
	S.Em±	0.50	0.16	2.26	3.19	0.79
	C.D. at 5%	NS	NS	6.70	9.47	2.36
	C.V.%	8.75	12.18	7.48	7.54	7.93

Table 2: Effect of Integrated Nutrient Management on floral parameters in gladiolus (*Gladiolus grandiflorus* L.) cv. American Beauty.

Treatments	Days to spike initiation	Days to harvesting of spike from initiation of spike	Spike length (cm)	Rachis length (cm)	Number of florets/spike	Diameter of 2nd floret (cm)	Number of spikes/plant	Vase life (days)
T_1 - 100% RDF (200:200:200 NPK kg/ha)	61.10	22.00	52.67	30.93	9.37	6.87	1.77	12.10
T_2 - 50% RDF + FYM @ 15 t/ha	57.30	20.63	55.00	31.53	9.43	7.07	1.83	12.17
T_3 - 75% RDF + FYM @ 7.5 t/ha	55.87	21.43	56.43	32.47	9.43	7.20	1.97	12.53
T_4 - 100% RDF + FYM @ 7.5 t/ha	56.90	20.20	56.87	34.00	9.53	7.30	2.07	12.73
T_5 - 50% RDF + FYM @ 15 t/ha + *Azotobacter* + PSB + KMB	56.53	19.77	57.37	34.20	9.87	7.40	2.13	12.80
T_6 - 75% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB	52.63	19.20	60.23	36.47	10.77	7.93	2.27	13.37
T_7 - 100% RDF + FYM @ 7.5 t/ha + *Azotobacter* + PSB + KMB	51.67	18.60	65.83	38.43	10.30	7.63	2.40	13.53
T_8 - T_1 + *Azotobacter* + PSB + KMB	55.83	19.59	56.30	34.37	9.93	7.07	2.10	12.20
T_9 - T_1 + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer	56.97	20.53	54.00	34.20	9.90	7.23	2.07	12.63
T_{10} - T_7 + 1% foliar spray of *Nauroji* Novel Organic Liquid Fertilizer	48.10	16.57	66.63	39.53	11.30	8.50	2.50	14.93
S.Em±	2.28	0.91	2.95	1.70	0.41	0.30	0.09	0.54
C.D. at 5%	6.77	2.70	8.77	5.04	1.20	0.90	0.27	1.59
C.V.%	7.14	7.93	8.80	8.48	7.03	7.07	7.43	7.21

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