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Effect of integrated nutrient management on growth, flowering and yield of gladiolus cv. PDKV gold

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Abstract
The present investigation entitled, "Effect of integrated nutrient management on growth, flowering and yield of gladiolus cv. PDKV Gold" was carried out during the years 2018-19 and 2019-20 at College of Agriculture Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.). The experiment was laid out in Randomized Block Design with three replications and thirteen treatments. The results of the experiment revealed that, growth parameters *viz*., minimum days to 50 per cent sprouting of corms, maximum height of plant and leaves plant^{-1} were recorded with the treatment of 75% RDF + 8 t Vermicompost + Azotobacter + PSB. Whereas, flowering parameters *viz*., minimum days to first spike emergence, days to opening of first pair of florets were recorded under treatment 75% RDF + 8 t Vermicompost + Azotobacter + PSB. Flower yield in respect of number of spikes plant^{-1} and ha^{-1} were harvested maximum with the treatment 75% RDF + 8 t Vermicompost + Azotobacter + PSB.

Keywords: Azotobacter, gladiolus, growth, flowering, PSB, yield

Introduction
Gladiolus is commonly known as sword lily, corn flag, gladioli, etc. It has also known as 'queen of bulbous flowers, has ever increasing demand in the flower markets (Roy *et al.* 2017) [20]. Botanically gladiolus is known as *Gladiolus grandiflorus* L and belongs to Iridaceae family. In India the major gladiolus growing states are West Bengal, Karnataka, Tamil Nadu, Maharashtra, Uttar Pradesh, Madhya Pradesh and Bihar. It is one of the most economic and commercially grown flower crop in Maharashtra. There has been a constant demand for gladiolus spikes particularly from the European markets during winter months and throughout the year in India. Conventional chemical based farming is not sustainable because of many problems such as loss of soil productivity from excessive erosion and associated plant nutrient loss, surface and ground water pollution from fertilizers and sediment, impeding shortages of non-renewable resources and low farm income from high production costs (Pandey *et al*. 2010) [15]. The soils of India are impoverished and hungry of plant nutrients. What is needed is a procured use of optimum input and not of increasing inputs. Considering economic, energy and environment, it is imperative that plant nutrients to use effectively by adopting proper nutrient management system to ensure high yield and to sustain the availability in soil at the optimum level for getting high yield and quality flower production, nutrient management is necessary (Choudhary and Trivedi, 2008) [3]. Therefore, the present study was planned to ascertain the effect of conjoint use of chemical fertilizers, organic manures and biofertilizers on growth, flowering and yield of gladiolus.

Material and Methods
The investigation entitled "Effect of integrated nutrient management on growth, flowering and yield of gladiolus cv. PDKV Gold" was carried out at College of Agriculture Garden, Dr. PDKV., Akola (M.S.) during the *kharif* season of the years 2018-2019 and 2019-2020. The experiment was laid out in Randomized Block Design with thirteen treatments viz., T_1 - 100% RDF (500:200:200 kg NPK ha^{-1}), T_2 - 32 t Vermicompost, T_3 - 32 t Vermicompost + Azotobacter + PSB, T_4 - 100 t FYM, T_5 - 100 t FYM + Azotobacter + PSB , T_6 - 75% RDF + 8 t Vermicompost, T_7 - 75% RDF + 8 t Vermicompost + Azotobacter + PSB , T_8 - 50% RDF + 16 t Vermicompost, T_9 - 50% RDF + 16 t Vermicompost + Azotobacter + PSB, T_{10} - 75% RDF + 25 t FYM, T_{11} - 75% RDF + 25 t FYM + Azotobacter + PSB, T_{12} - 50% RDF + 50 t FYM and T_{13} - 50% RDF + 50 t FYM + Azotobacter + PSB which were replicated thrice.
The gladiolus corms were collected from the Department of Horticulture. Healthy and uniform size corms (4.0-5.0 cm diameter) were selected and used as experimental material.

The spacing between row to row and plant to plant was 45 x 20 cm and plot size was 3.15 m x 1.80 m (5.67 m^2). FYM and vermicompost were added at the time of land preparation whereas, Azotobacter and Phosphate solubilising bacteria (PSB) applied to the soil @5 kg ha^{-1} each by mixing with farm yard manure before planting as per treatments. A recommended dose of N, P and K i.e. 500, 200 and 200 kg ha^{-1}, respectively were applied as per treatment. The full dose of phosphorous and potash as per treatment was given in the form of SSP and MOP at the time of preparation of experimental beds. While, the nitrogen was given in three equal split doses, at two leaves, four leaves and six leaves stages in the form of urea. The observations were recorded in respect of growth parameters *viz*., days to 50 per cent sprouting of corms, height of plant and leaves $plant^{-1}$. In respect of flowering parameters *viz*., days to first spike emergence, days to opening of first pair of florets and in respected of flowers yield *viz*., number of spikes $plant^{-1}$ and spikes ha^{-1}. The data obtained on various parameters was statistically analyzed as per methods suggested by Panse and Sukhatme (1967) [16].

Results and Discussion

Growth parameters

The data in respect of the growth parameters were found to be significant in both years of experimentations as influenced by different treatments of integrated nutrient management is presented in Table 1.

The treatment T_7 had recorded significantly minimum days to 50 per cent sprouting of corms (12.67, 12.33 and 12.50 days), maximum plant height (115.97, 116.91 and 116.44 cm) and leaves $plant^{-1}$ (11.67, 11.80 and 11.73) during the years 2018-19, 2019-20 and in pooled data, respectively. Whereas, treatment T_4 had recorded significantly maximum days to 50 per cent sprouting of corms (17.00, 16.67 and 16.83 days), minimum plant height (81.73, 82.68 and 82.20 cm) and leaves $plant^{-1}$ (7.80, 7.93 and 7.87) during the years 2018-19, 2019-20 and in pooled data, respectively. The increase in growth parameters with an application of 75% RDF + 8 t Vermicompost + Azotobacter + PSB (T_7) might be due to higher nutrient availability. The higher availability of nitrogen could have resulted in more cell division and cell elongation. Similarly, high levels of available phosphorous could have supported better energy metabolism and potassium might have played a catalytic role. Vermicompost contains beneficial microorganisms, enzymes, vitamins and growth hormones and therefore, its application have led to greater vigor in the sprouts. The increase in plant height might be due to better uptake of nutrient elements, solubilization and mobilization of insoluble forms of phosphorus in the soil by organic acids, better photosynthetic rate, and source-sink relationship, besides excellent physiological and biochemical activities due to presence of biofertilizers. The vermicompost might acts as a source of macro and micronutrients (Zn, Fe, Cu, and Mn), enzymes and growth hormones in the early crop growth phase, which in turn encouraged early vigorous growth. The photosynthetic system is activated for enhanced biological efficiency, enabling synthesis of maximum metabolites and photosynthates, thus encouraging quick growth, which ultimately leads to increased plant height. Godse *et al*. (2006) [7] revealed that, an application of vermicompost or FYM along with Azotobacter + PSB + 80% RDF were found most beneficial in accelerating the vegetative growth of gladiolus at all the phages of crop growth. Similar results were observed by Gangadharan and Gopinath (2000) [6], Sharma *et al*. (2008) [22], Kumar *et al*. (2011) [10], Chaudhary *et al*. (2013) [2], Mageswari *et al*. (2017), Sathyanarayana *et al.* (2017) [21], Adhikari *et al*. (2018) [1], Meena *et al*. (2018) [13], Pal and Singh (2019) [14] and Jha *et al*. (2020) [8] in gladiolus.

Flowering parameters

The data in respect of flowering parameters as influenced by different treatments of integrated nutrient management in gladiolus is presented in Table 2.

During the years 2018-19, 2019-20 and in pooled data, significantly minimum days for emergence of first spike (67.07, 66.73 and 66.90 days, respectively) and days to opening of first pair of florets (76.47, 76.40 and 76.43 days, respectively) had recorded under the treatment T_7 which was significantly superior over all other treatments. Whereas, treatment T_4 had recorded maximum days for emergence of first spike (75.93, 75.27 and 75.60 days) and days to opening of first pair of florets (88.13, 87.67 and 87.90 days) during the years 2018-19, 2019-20 and in pooled data, respectively. The earliness in flowering might be attributed to amplification of nutrients especially, nitrogen, phosphorus and potassium from different sources *viz*., organic manures, inorganic fertilizers and biofertilizer, which promoted the translocation of phytohormones to the shoots resulting in the early flower initiation. It might also be due to presence of gibberellins in vermicompost which was associated with regulation of flowering as well as azotobacter and phosphobacterium might have indirect role, which makes the nutrient radially available along with presence of plant growth promoting substances which leads to early flowering through better uptake of nutrients. Optimum availability of all the nutrients to the plants thereby, plant completed its vegetative growth soon, resulting in early flowering. Similar results have been reported by Dongardive *et al*. (2007) [5], Chaudhary *et al*. (2013) [2], Singh *et* al. (2014) [23], Mageshwari *et al*. (2017) [12], Adhikari *et al*. (2018) [1], Meena *et al*. (2018) [13] and Kumar *et al*. (2019) [9] in gladiolus.

Yield parameters

The data in respect of yield parameters in gladiolus as influenced by different treatments of integrated nutrient management were foundsignificant and ispresented inTable 2.

The treatment T_7 recorded significantly maximum number of spikes $plant^{-1}$ (2.47, 2.67 and 2.57) and spikes $hectare^{-1}$ (2.74, 2.96 and 2.85 lakh) during the years 2018-19, 2019-20 and in pooled data, respectively. Whereas, treatment T_4 were noted significantly minimum number of spikes $plant^{-1}$ (1.20, 1.33 and 1.27) and spikes $hectare^{-1}$ (1.33, 1.48 and 1.41 lakh) during the years 2018-19, 2019-20 and in pooled data, respectively. The increase in flower yield might be due to the application of vermicompost and biofertizers along with chemical fertilizers favoured to synthesize of amino acid which act as precursor of polyamine and secondary messenger in flower initiation and development of more number of flowers per plant. Synthesis of this amino acid is also influenced by phytoharmone which are formed in plant due to the application of chemical and biofertilizers. In combination of vermicompost, biofertilizer with chemical fertilizers increased the soil microorganism, promotes the microbial population, support to better aeration of plant root, increases the availability of macro and micronutrients and thereby uptake by the plants resulting better number of flowers per plant. Similar findings were registered by Dongardive *et al.* (2007) [5], Dalve *et al.* (2009) [4], Kumari *et al.* (2014) [11], Singh *et al.* (2014) [23], Pansuriya and Chauhan (2015) [18], Mageswari *et al. (*2017), Sathyanarayana *et al. (*2017) [21], Tirkey *et al.* (2017), Adhikari *et al.* (2018) [1], Pansuriya *et al.* (2018) [17], Kumar *et al.* (2019) [9]b, Pal and Singh (2019) [14] in gladiolus and Rao *et al.* (2015) [19] in tuberose.

Table 1: Effect of integrated nutrient management on growth parameters of gladiolus

Treatments	Days to 50 per cent sprouting of corms (days)			Height of plant (cm)			Leaves plant^{-1}		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1- 100% RDF (500:200:200 kg NPK ha^{-1})	13.33	13.33	13.33	109.35	110.34	109.85	10.67	10.73	10.70
T_2- 32 t Vermicompost	16.67	16.33	16.50	87.09	88.04	87.56	8.80	9.00	8.90
T_3- 32 t Vermicompost + Azotobacter + PSB	16.00	16.33	16.17	92.07	93.04	92.56	9.00	9.20	9.10
T_4- 100 t FYM	17.00	16.67	16.83	81.73	82.68	82.20	7.80	7.93	7.87
T_5- 100 t FYM + Azotobacter + PSB	15.67	15.33	15.50	93.97	94.94	94.46	9.13	9.40	9.27
T_6- 75% RDF + 8 t Vermicompost	15.00	14.67	14.83	96.50	97.46	96.98	9.67	9.80	9.73
T_7- 75% RDF + 8 t Vermicompost + Azotobacter + PSB	12.67	12.33	12.50	115.97	116.91	116.44	11.67	11.80	11.73
T_8- 50% RDF + 16 t Vermicompost	15.33	15.00	15.17	95.12	96.06	95.59	9.47	9.60	9.53
T_9- 50% RDF + 16 t Vermicompost + Azotobacter + PSB	13.00	12.67	12.83	110.64	111.57	111.11	10.87	11.00	10.93
T_{10}- 75% RDF + 25 t FYM	14.67	14.33	14.50	100.47	101.41	100.94	10.07	10.20	10.13
T_{11}- 75% RDF + 25 t FYM + Azotobacter + PSB	14.33	14.00	14.17	103.16	104.03	103.60	10.27	10.40	10.33
T_{12}- 50% RDF + 50 t FYM	15.00	14.67	14.83	97.90	98.83	98.36	9.87	10.00	9.93
T_{13}- 50% RDF + 50 t FYM + Azotobacter + PSB	13.67	13.67	13.67	107.08	107.99	107.54	10.53	10.60	10.57
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) $\pm$	0.57	0.44	0.40	1.79	1.25	1.16	0.14	0.12	0.10
CD at 5%	1.67	1.29	1.19	5.24	3.66	3.42	0.41	0.34	0.28

Table 2: Effect of integrated nutrient management on flowering and yield parameters of gladiolus

Treatments	Days to first spike emergence (days)			Days to opening of first pair of florets (days)			Spikes plant^{-1}			Spikes hectare^{-1} (lakh)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
T_1- 100% RDF (500:200:200 kg NPK ha^{-1})	69.07	68.73	68.90	79.00	78.67	78.83	1.93	2.13	2.03	2.15	2.37	2.26
T_2- 32 t Vermicompost	74.33	73.33	73.83	85.93	85.33	85.63	1.33	1.40	1.37	1.48	1.56	1.52
T_3- 32 t Vermicompost + Azotobacter + PSB	73.67	73.00	73.33	85.20	84.67	84.93	1.40	1.47	1.43	1.56	1.63	1.59
T_4- 100 t FYM	75.93	75.27	75.60	88.13	87.67	87.90	1.20	1.33	1.27	1.33	1.48	1.41
T_5- 100 t FYM + Azotobacter + PSB	73.13	72.07	72.60	84.00	83.67	83.83	1.47	1.53	1.50	1.63	1.70	1.67
T_6- 75% RDF + 8 t Vermicompost	71.60	71.00	71.30	82.53	82.40	82.47	1.60	1.67	1.63	1.78	1.85	1.81
T_7- 75% RDF + 8 t Vermicompost + Azotobacter + PSB	67.07	66.73	66.90	76.47	76.40	76.43	2.47	2.67	2.57	2.74	2.96	2.85
T_8- 50% RDF + 16 t Vermicompost	72.40	71.67	72.03	83.60	83.27	83.43	1.53	1.60	1.57	1.70	1.78	1.74
T_9- 50% RDF + 16 t Vermicompost + Azotobacter + PSB	68.60	68.33	68.47	78.47	78.27	78.37	2.00	2.20	2.10	2.22	2.44	2.33
T_{10}- 75% RDF + 25 t FYM	70.73	70.07	70.40	80.93	80.67	80.80	1.73	1.80	1.77	1.93	2.00	1.96
T_{11}- 75% RDF + 25 t FYM + Azotobacter + PSB	69.67	69.33	69.50	80.33	80.07	80.20	1.80	1.93	1.87	2.00	2.15	2.07
T_{12}- 50% RDF + 50 t FYM	71.00	70.33	70.67	81.27	81.00	81.13	1.67	1.73	1.70	1.85	1.93	1.89
T_{13}- 50% RDF + 50 t FYM + Azotobacter + PSB	69.27	68.93	69.10	79.33	79.00	79.17	1.87	2.00	1.93	2.07	2.22	2.15
'F' Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE (m) $\pm$	0.38	0.36	0.25	0.56	0.65	0.47	0.12	0.11	0.10	0.14	0.13	0.12
CD at 5%	1.11	1.06	0.73	1.64	1.91	1.38	0.36	0.33	0.30	0.40	0.37	0.34

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