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Response of integrated nutrient management on vegetative growth and flowering characters of gladiolus (*Gladiolus grandiflorus*) cv. white prosperity

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Abstract
The experiment was conducted in Randomized Block Design with 13 treatments and 3 replications. The experimental findings was revealed that the treatment T_{11} (75% RDF+ FYM +Azotobacter +PSB) showed better response viz. early sprouting, number of sprouts, number of leaves, fresh and dry weight of plant in and T_{12} (75% RDF+ VC +Azotobacter +PSB) better response viz. plant height, early spike initiation, opening of first floret, duration of flowering, length of spike, diameter of spike, length of rachis, number of florets per spike, diameter of florets, spike yield of gladiolus.

Keywords: INM, vegetative growth, flowering characters, gladiolus

Introduction
Gladiolus (*Gladiolus grandiflorus* L.) is a queen of bulbous ornamental plants. It is one of the most important bulbous cut flower grown in India and other countries. It belongs to family Iridaceae. The genus gladiolus contains about 260 species. The history of gladiolus cultivation dates back to17th century when some species commonly known as "Corn lily" were grown in part of Asia Minor. Mr. Charles Gray of Conoor was the first person to grow gladiolus in India during the 19th century. Gladiolus is rockery, pot and also used commercially as cut flower. Gladiolus is one of the popular cut flower in India and cut flowers used for vase decoration and preparation of bouquets. The climate in our hills during summer and in the plains during winter is ideal for gladiolus cultivation. Area and production of cut flower in India is 3, 09,000 hectare and 5, 93,000 MT (Anonymous 2016-17) [2]. Integrated Nutrients Management (INM) including use of organic manure and biofertilizers along with appropriate dosage of fertilizer is cost effective method to achieve more yield and better quality crop. Farm yard manure is prepared basically using cow dung, cow urine, waste straw and other dairy wastes. Application of FYM improved soil fertility. The term "vermicompost" originated from a latin word "vermes" meaning "worms" and the process of composting of organic material using earthworms is known as vermicomposting. Poultry litter refers to the manure mixed with some of the bedding material. Use of bio-fertilizer offers an economically attractive and ecologically sound means for reducing external input and improving the quality and quantity of input resources. Use of phosphorus solubilising bacteria as inoculants increases P uptake. The azotobactor genus was discovered in 1901 by Dutch microbiologist. These bacteria utilize atmospheric nitrogen gas for their cell protein synthesis. Azotobacter represents the main group of heterotrophic free living nitrogen-fixing bacteria.

Materials and methods
An experiment was conducted during winter season of 2014-15 and 2015-16 at Main Experiment Station, Horticulture, Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The corms of gladiolus variety White Prosperity was obtained from NBRI Lucknow for planting in experimental field. Before planting the corms were dipped in Bavistin (0.2%) solution for one hour to reduce the incidence of corm rotting and dried in shade. The experiment was conducted in Randomized Block Design with 13 treatments and 3replications *viz*. RDF (300: 200: 200 kg NPK/ha), organic manure FYM (20t/ha), vermicompost (5t/ha), poultry manure (5t/ha).

Two bio-inoculants PSB (5kg/ha) and azotobacter (5kg/ha) were tested alone in their combination along with graded dose 75% (RDF) and 50% (RDF) were applied in the form of urea, single super phosphate and MOP respectively. Application of half dose Nitrogen (N), full dose of Phosphorus (P) and potash (K) at the time of sowing of corms. The crop was top dressed with remaining half dose of nitrogen at 40 days after planting. The planting of corms was done on 16/10/2014 and 20/10/2015 at plot size of 2.0x1.0 m distance 20 cm × 40 cm and 6 cm deep in soil during both the years of investigation. Similar technique was adopted in next year of investigation. The data recorded on important vegetative characters viz. sprouting of corm, number of sprouts, plant height, number of leaves, fresh and dry weight of plant and flowering characters viz. days taken for initiation of spike, days taken for opening of first floret, duration of flowering, length of spike, diameter of spike, length of rachis (cm), number of florets / spike, diameter of florets (cm), number of spike/plant, number of spike/ha (Lakh).

Finding Results and Conclusion

All the parameters were significantly influenced by application of integrated nutrient management during both the years (table.1) Integrated nutrient management under the experiment significantly influences the days to complete sprouting of corm and number of sprout. During the study of corms with (75% RDF +FYM +Azotobacter +PSB) found to significantly superior in respect of highest number of sprout, induced earliest sprouting. The better growth recorded due to application of FYM, NPK along with inoculation of biofertilizers may prove to be beneficial to fix the atmospheric nitrogen. The similar findings were also reported by Dubey *et al.* (2003) [5]. The maximum plant height was recorded (89.33 and 90.13cm) with application of (75% RDF +VC +Azotobacter +PSB). It is now well demonstrated the role and stimulatory effects on non-symbiotic N-fixing bacteria (Azotobacter) in combination with N-fertilization, because these nutrients are essential for increasing the microbial activity in soil. Gangadharan and Gopinath (2000) [6]. The maximum number of leaves (7.13 and 7.27), fresh weight (103.00 and 103.33g) and dry weight (25.00 and 25.33g) of plant was recorded with (75% RDF +FYM +Azotobacter +PSB). These growth promoting substances might have resulted in increased cell division and elongation leading to enhanced leaf expansion, thus leading to increase the fresh and dry weight. Similar results were reported by Munichaluvaiah (2004) [8].

The earliest spike initiation (82.47 and 81.53 days), earliest floret opening (100.20 and 98.40), duration of flowering (14.97 and 14.70 days) was found to be enhanced maximum with application of (75% RDF +VC +Azotobacter +PSB). This may be ascribed to easy uptake of nutrients and simultaneous transport of growth promoting substances like cytokinins to the auxiliary buds resulting in breakage of apical dominance. Ultimately, they resulted in better sink for faster mobilization of photosynthesis and early transformation of plant parts from vegetative to reproductive phase. Similar observation was also recorded by. Kukde *et al.* (2006) [7]. The maximum Length of spike (101.40 and 100.53 cm), diameter of spike (2.01 and 2.06 cm), length of rachis (53.40 and 53.60 cm) and diameter of floret (10.67 cm and 10.93 cm) were recorded with the application of (75% RDF +VC +Azotobacter +PSB). It might be due to synthesis of nitrogenous compounds such as amino acid (Arginin), which is a precursor of polyamines and also function as secondary messenger in flower initiation and development of more number of florets per spike as influenced by phytoharmones due to interaction of bioinoculants with NPK. Similar observations were also recorded by Chaudhary *et al.* (2013) [13] and Dalve *et al.* (2009) [4]. The number of spikes per plant and per hectare was reported significantly maximum with application of (75% RDF+VC +Azotobacter +PSB). Ajitkumar (2002) [1] reported that highest flower yield per hectare.

Thus, it mightg be concluded that treatment (T_{12}) 75% RDF+VC +Azotobacter +PSB ha^{-1} can be recommended to flower growers for gladiolus production in the eastern Uttar Pradesh.

Table 1: Effect of integrated nutrient management on vegetative growth of gladiolus.

	Treatments	Days taken for complete sprouting		No. of sprouts per corm		Height of plant (cm)		Number of leaves		Fresh weight of plant		Dry weight of plant	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1	RDF (300: 200: 200 kg NPK/ha)	22.33	22.00	1.60	1.53	87.00	86.80	6.20	6.13	99.33	98.33	19.67	19.33
T_2	75% RDF+ FYM+Azotobacter	22.00	21.00	1.53	1.47	85.73	85.57	6.33	6.40	92.00	92.33	21.33	21.67
T_3	75% RDF+VC + Azotobacter	21.00	20.67	1.53	1.60	87.73	89.00	6.60	6.33	97.33	92.67	20.67	21.67
T_4	75% RDF+PM + Azotobacter	21.67	22.33	1.47	1.40	85.93	86.27	5.87	5.93	94.67	94.67	19.33	19.67
T_5	50% RDF+FYM+Azotobacter	23.67	22.67	1.60	1.53	76.80	77.00	6.00	5.67	92.00	93.33	19.33	19.00
T_6	50% RDF+VC + Azotobacter	24.00	22.33	1.60	1.67	81.07	81.27	6.00	6.07	90.67	89.33	18.33	18.67
T_7	50% RDF+PM + Azotobacter	23.33	23.00	1.53	1.60	78.80	78.53	5.80	5.87	97.33	93.33	20.33	21.00
T_8	50% RDF+FYM+Azotobacter+PSB	23.00	22.33	1.67	1.53	86.07	85.93	5.93	6.00	74.67	77.33	18.67	19.33
T_9	50% RDF+VC +Azotobacter +PSB	22.67	22.33	1.73	1.60	83.93	85.47	6.13	6.20	97.33	94.67	20.33	20.67
T_{10}	50% RDF+PM +Azotobacter +PSB	22.67	21.67	1.67	1.67	82.27	82.33	6.13	6.20	94.67	95.67	20.33	20.67
T_{11}	75% RDF+FYM+Azotobacter+PSB	20.00	19.33	1.80	1.87	85.93	86.47	7.13	7.27	103.00	103.33	25.00	25.33
T_{12}	75% RDF+VC +Azotobacter +PSB	21.33	21.67	1.73	1.80	89.33	90.13	6.60	6.67	100.67	99.33	22.67	22.00
T_{13}	75% RDF+PM +Azotobacter +PSB	21.00	21.67	1.73	1.73	87.33	87.53	6.53	6.47	94.33	93.33	19.67	20.00
	SEm±	0.67	0.50	0.07	0.07	1.91	1.81	0.21	0.21	2.80	3.35	1.10	0.92
	CD at 5%	1.95	1.46	0.19	0.21	5.56	5.27	0.62	0.61	8.17	9.77	3.21	2.70

Table 2: Effect of integrated nutrient management on flowering characters of gladiolus

Treatments		Days taken for initiation of spike		Days taken for opening of first floret		Duration of flowering (days)		Length of spike (cm)		Diameter of spike (cm)	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1	RDF (300: 200: 200 kg NPK/ha)	89.00	89.20	104.67	103.00	12.40	12.47	100.73	100.53	1.91	1.90
T_2	75% RDF+ FYM+Azotobacter	91.27	91.20	107.53	107.33	13.00	12.87	99.67	99.73	1.91	1.92
T_3	75% RDF+VC + Azotobacter	84.67	85.60	100.87	100.00	13.00	13.07	96.20	96.33	1.91	1.92
T_4	75% RDF+PM + Azotobacter	89.93	91.13	106.33	105.20	12.67	12.73	97.87	98.07	1.89	1.87
T_5	50% RDF+FYM+Azotobacter	89.53	88.67	105.80	105.60	13.07	13.00	95.80	96.40	1.92	1.93
T_6	50% RDF+VC + Azotobacter	93.00	92.93	110.07	108.60	13.53	13.07	96.80	96.93	1.94	1.96
T_7	50% RDF+PM + Azotobacter	93.07	93.07	109.47	108.67	13.13	13.00	93.67	93.60	1.90	1.91
T_8	50% RDF+FYM+Azotobacter+PSB	94.60	94.27	110.87	110.47	13.33	13.00	95.53	95.87	1.90	1.91
T_9	50% RDF+VC +Azotobacter +PSB	91.73	91.33	109.33	109.07	13.73	13.40	95.33	95.67	1.89	1.90
T_{10}	50% RDF+PM +Azotobacter +PSB	90.40	90.73	108.07	107.20	12.93	12.93	93.00	93.40	1.88	1.90
T_{11}	75% RDF+FYM+Azotobacter+PSB	85.00	84.80	104.87	105.07	13.67	13.73	95.40	95.67	1.88	1.89
T_{12}	75% RDF+VC +Azotobacter +PSB	82.47	81.53	100.20	98.40	14.67	14.70	101.40	100.53	2.01	2.06
T_{13}	75% RDF+PM +Azotobacter +PSB	90.20	90.33	105.87	104.87	13.27	13.07	93.93	94.27	1.92	1.93
	SEm±	2.17	2.23	2.09	2.18	0.17	0.32	1.28	1.24	0.02	0.03
	CD at 5%	6.34	6.52	6.10	6.36	0.49	0.93	3.75	3.61	0.06	0.09

Table 3: Effect of integrated nutrient management on flowering characters of gladiolus

Treatments		Length of rachis (cm)		Number of florets / spike		Diameter of florets (cm)		Number of spike/plant		Number of spike/ha (Lakh)	
		2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
T_1	RDF (300: 200: 200 kg NPK/ha)	48.00	51.80	14.20	14.00	7.67	7.40	1.53	1.47	1.63	1.56
T_2	75% RDF+ FYM+Azotobacter	45.00	44.27	13.67	13.80	8.47	8.67	1.47	1.40	1.56	1.49
T_3	75% RDF+VC + Azotobacter	49.33	47.47	14.00	14.13	9.20	9.27	1.60	1.67	1.70	1.77
T_4	75% RDF+PM + Azotobacter	46.40	47.93	14.07	14.00	8.40	8.53	1.53	1.40	1.63	1.49
T_5	50% RDF+FYM+Azotobacter	47.20	47.33	13.60	13.67	8.00	8.20	1.47	1.53	1.56	1.63
T_6	50% RDF+VC + Azotobacter	42.33	47.40	13.37	13.60	8.20	8.53	1.53	1.60	1.63	1.70
T_7	50% RDF+PM + Azotobacter	44.53	44.73	13.50	13.63	8.07	8.20	1.47	1.53	1.56	1.63
T_8	50% RDF+FYM+Azotobacter+PSB	45.07	44.67	13.53	13.73	7.93	8.53	1.60	1.47	1.70	1.56
T_9	50% RDF+VC +Azotobacter +PSB	49.07	48.80	13.47	13.67	7.87	8.60	1.60	1.53	1.70	1.63
T_{10}	50% RDF+PM +Azotobacter +PSB	44.67	44.93	13.50	13.70	8.33	8.53	1.67	1.60	1.77	1.70
T_{11}	75% RDF+FYM+Azotobacter+PSB	48.07	48.40	14.00	14.20	9.60	9.60	1.60	1.67	1.70	1.77
T_{12}	75% RDF+VC +Azotobacter +PSB	53.40	53.60	15.80	16.13	10.67	10.93	1.73	1.80	1.84	1.91
T_{13}	75% RDF+PM +Azotobacter +PSB	47.00	47.47	14.67	14.60	9.40	9.73	1.67	1.73	1.77	1.84
	SEm±	1.46	1.70	0.34	0.30	0.32	0.29	0.05	0.07	0.06	0.06
	CD at 5%	4.25	4.96	0.98	0.88	0.93	0.84	0.16	0.21	0.18	0.17

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