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Maximizing growth, flowering and corm productivity of gladiolus (*Gladiolus* spp.) varieties under integrated nutrient management system

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ABSTRACT

Gladiolus (*Gladiolus* spp.) is widely used in flower arrangement, bouquets, bunches, baskets and indoor decorations. The growth, flower spikes, number of florests and yield of corms can be improved by adopting proper nutrient management practices. Research experiments were conducted to maximize growth, flowering and corm productivity of gladiolus varieties under integrated nutrient management system at the research farm of the Division of Floriculture & Landscaping, ICAR-Indian Agricultural Research Institute, New Delhi for two consecutive winter seasons during 2016-17 and 2017-18.Two gladiolus varieties as Pusa Red Valentine and Jyotsna in split-plot design were used and replicated three times with 12 treatment combinations. The study revealed that application of organic, inorganic and biofertilizers under INM system had showed significant effect on vegetative, flowering and yield of corm parameters. Significantly the maximum sprouting (98.75%) at 30 DAP, number of florets per spike (17.75) and the minimum days required for 50% blooming (100.10 days) were recorded with the application of 75% RDF+Vermicompost @ 10 t/ha + *Azospirillum* + PSB (T_{10}), whereas maximum plant height (119.90 cm), spike length (108.92 cm), number of corm per plant(2.83) and number of cormels per plant (27.17 were observed with the application of 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}).The integrated nutrient management had also significantly recorded maximum vegetative, flowering and yield of corm parameter in variety Pusa Jyotsna as compared to Pusa Red Valentine variety during the study.

Key words: Corms productivity, Flowering, Gladiolus, INM

Gladiolus (*Gladiolus* spp.) is an important bulbous flower grown throughout the world. It was originated from South Africa and belongs to the family *Iridaceae*. It is popular for its majestic spikes which contain attractive, elegant, dazzling and delicate florets.It is one of the easiest flowers to arrange and ever favourite with flower arrangers, amateurs and experts.In recent years, several new cultivars of gladiolus with wide range of colours have been developed by research and development organizations and these varieties require more nutrients for higher growth, production and quality of flowers. The yield, quality flowers and corms can be improved by adopting proper nutrient management practices (Singh *et al*. 2006). The growing imbalance of nutrients in soils is posing a threat to sustain soil health and productivity. Inorganic fertilizers are very costly and their agronomic efficiency is poor under field conditions.

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The quality of flowers is influenced both by quantity and source of nutrients as well.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, therefore, 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*. 2015). Qasim *et al*. (2014) revealed that gladiolus responded well to microbial culture and significant improvement was observed in different vegetative and flowering traits, corms productivity and leaf chemical composition of gladiolus. Among different treatments, considerable increase in both vegetative and reproductive attributes was observed when corms were treated with *Azospirillum*. Jha *et al*. (2012) revealed that application of FYM and vermicompost in combination with various doses of inorganic fertilizer in gladiolus variety Candyman recorded better results in terms of spike length, plant height corms and cormels yield when applied with 75% RDF+FYM 10 t/ha, however, number of florets per spikes vase life of cut spikes were found maximum with the application of 75% RDF + vermicompost 3.0 t/ha.

Considering the increasing demand of gladiolus flower and corms, there is a need to supply balance amount of nutrients for higher sustainable production of gladiolus. Therefore, keeping the above facts in view, the present experiments were formulated and conducted to maximize, growth, flowering and corm productivity of gladiolus varieties under integrated nutrient management system.

MATERIALS AND METHODS

The experiments were conducted at the Research Farm of Division of Floriculture and Landscaping, ICAR- Indian Agricultural Research Institute, New Delhi during the year 2016-2017 and 2017-2018. The soil of experimental plot was alluvial, sandy loam in texture, alkaline in reaction, having pH 7.4 and free from salinity occurring on nearly level to very gently sloping land. After executing the plan of lay-out, the recommended dose of NPK fertilizers @ 200:100:100 kg/ha was given treatment-wise as 125, 100, 75 and 50%. These fertilizers were applied in the form of urea, single superphosphate and muriate of potash.Well decomposed farmyard manure, vermicompost, entire dose of phosphorus and potassium and half dose of nitrogen were given as a basal dose during the last ploughing and remaining dose of nitrogen was applied after 30 days of planting as per the treatment combinations.The experiement in both the years (2016-17 and 2017-18) was laid out on October 25, and completed in April 2017 and 2018, respectively.

Plots were made with a gross plot size of 4 m^2 (2 × 2 m^2) according to the layout plan. The corm of variety Pusa Red Valentine and Pusa Jyotsna were cleaned by removing the dry scales and treated with bio-fertilizers (*Azospirillum* and PSB). These corms were planted at a spacing 50 cm × 10 cm in each row along the sides of ridges at a depth of 6-7 cm. Light irrigation was given immediately after planting.The details of treatment combinations were as: T_1, Control, T_2, 75% RDF, T_3, 100% RDF (200:100:100 kg/ha NPK), T_4, FYM @ 10 t/ha, T_5, Vermicompost @ 10 t/ha, T_6, 100% RDF + FYM @ 5 t/ha, T_7, 100% RDF + Vermicompost @ 5 t/ha, T_8, 125% RDF + Azospirillum + PSB, T_9, 75% RDF +FYM @ 10 t/ha + Azospirillum + PSB, T_{10}, 75% RDF + Vermicompost @ 10 t/ha + *Azospirillum* +PSB, T_{11}, 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB and T_{12}, 50% RDF +FYM @ 5 t/ha + Vermicompost @ 5 t/ha + liquid NPK respectively. The gladiolus varieties were kept as main plot and treatments as sub-plot, there were 12 integrated nutrient management treatments replicated three times. Need based plant protection measures were taken up to protect the plants from pests and diseases. The spikes were harvested at the first 2-4 florets show color and used for recording different parameters. The corm and cormels were lifted from the ground when the foliage turned yellow. The observations on vegetative, flowering and corm characters were recorded from five randomly tagged plants in each treatment and the mean values of five selected plants in each plot was taken to represent a particular character. The data on various observations were statistically analyzed using split plot design as suggested by Panse and Sukhatme (1967). The appropriate standard error of mean (SEm±) and the critical difference (C D) were calculated at 5 per cent level of significance.

RESULTS AND DISCUSSION

Vegetative parameters

A perusal of the data presented in Table 1 that the sprouting per cent at 30 DAP was significantly influenced by integrated nutrients on varieties during first year, but, it was found statistically non-significant during second year.The sprouting per cent at 30 DAP was significantly influenced by different treatments on varieties and it was maximum sprouting per cent (96.98%) in variety Pusa Jyotsna and (94.75%) in Pusa Red Valentine; while during 2017-18, the same trend was observed and it was 98.02 and 97.25% in Pusa Jyotsna and Pusa Red Valentine respectively. The effect of organic, inorganic and bio-fertilizers with respect to sprouting per cent at 30 DAP was found statistically significant during the year 2016-17 and it was non-significant during the year 2017-18. The maximum (98.12%) sprouting at 30 DAP was obtained with application of 75% RDF + Vermicompost @ 10 t/ha + *Azospirillum* + PSB (T_{10}) which was found at par with treatment of 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}), and 50% RDF +FYM @ 5 t/ha + Vermicompost @ 5 t/ha + liquid NPK (T_{12}). The minimum sprouting % at 30 DAP was obtained with control treatment (92.70%). All the treatment combinations had significant effect over control.The data also revealed that the interaction effect of treatment and varieties was found non-significant during both the years with respect to sprouting per cent at 30 DAP. Jha *et al*. (2012) recorded better sprouting in gladiolus with the application of organic and inorganic sources of fertilizers. These findings confirm the results of present investigation.

The variation in plant height was significantly influenced by organic, inorganic and biofertilizers during the year 2016-17, 2017-18 and mean of two years (Table 1). However, the effect of treatments on varieties and their interaction was found non-significant during both the years. The maximum plant height (119.5 cm and 120.3 cm) was recorded with the application of 75% RDF + FYM @ 5 t/ha +Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}) which was at par with treatments T_8, T_{10}, T_{12} and T_9 during the year 2016-17 and 2017-18. The minimum plant height (98.1 cm and 104.6 cm) was recorded with control (T_1) during both the years. All other organic, inorganic and bio-fertilizers had significant effect over control.Jha *et al*. (2012) recorded improvement in number of leaves and plant height with the application of organic and inorganic sources of fertilizers. Kumar (2014) reported that the application of 75% RDF+ 25% VC + 2.0 g/plant *Azospirillum* + 2.0 g/plant PSB, significantly induced the days taken to sprouting and increased the height of plant in gladiolus. Pradhan *et al*. (2017) reported that application of 75% RDF + FYM (1 kg/m^2) + Vermicompost (300 g/m^2) + *Azospirillum*+

Table 1 Effect of integrated nutrient management on sprouting percentage at 30 days after planting and plant height

Treatment	Sprouting percentage at 30 days after planting							Plant height (cm)						
	Pusa Red Valentine	Pusa Jyotsna	Mean	Pusa Red Valentine	Pusa Jyotsna	Mean	Mean of two year	Pusa Red Valentine	Pusa Jyotsna	Mean	Pusa Red Valentine	Pusa Jyotsna	Mean	Mean of two year
	2016-17			2017-18				2016-17			2017-18			
T_1	91.66	93.75	92.70	95.83	95.83	95.83	94.27	98.0	98.3	98.1	103.6	105.6	104.6	101.4
T_2	95.00	95.42	95.20	96.25	96.66	96.45	95.83	108.0	108.3	108.1	110.6	111.0	110.8	109.5
T_3	93.75	96.66	95.20	96.25	96.66	96.45	95.83	109.0	109.6	109.3	111.3	111.6	111.5	110.4
T_4	94.58	95.00	94.79	95.83	97.08	96.45	95.62	104.3	104.6	104.5	108.6	109.0	108.8	106.7
T_5	93.75	97.50	95.62	95.83	97.91	96.87	96.25	107.3	107.6	107.5	110.6	111.0	110.8	109.2
T_6	93.75	96.66	95.20	97.50	97.08	97.29	96.25	109.6	110.0	109.8	112.6	113.3	113.0	111.4
T_7	93.75	97.08	95.41	96.66	97.91	97.29	96.35	112.0	113.3	112.6	113.0	113.6	113.3	113.0
T_8	96.25	97.91	97.08	98.33	99.58	98.95	98.02	117.3	119.6	118.5	119.3	121.0	120.1	119.3
T_9	94.58	97.08	95.83	97.50	99.16	98.33	97.08	116.0	116.3	116.1	116.0	116.6	116.3	116.2
T_{10}	97.08	99.16	98.12	99.58	99.16	99.37	98.75	118.0	118.3	118.1	118.0	119.0	118.5	118.3
T_{11}	96.67	99.25	97.95	98.75	99.58	99.16	98.56	118.3	120.6	119.5	120.0	120.6	120.3	119.9
T_{12}	96.25	98.33	97.29	98.75	99.58	99.16	98.23	117.3	117.6	117.5	119.0	119.3	119.1	118.3
Mean	94.75	96.98		97.25	98.02			111.2	112.0		113.5	114.3		
	CD at 5%	*SEm (±)*		*CD at 5%*	*SEm (±)*			*CD at 5%*	*SEm (±)*		*CD at 5%*	*SEm (±)*		
Variety	1.84	0.28		1.05	0.17			NS	0.51		NS	0.91		
Treatment	1.45	0.50		NS	0.36			5.72	2.00		5.28	1.84		
Treatment at same level of variety	NS	0.97		NS	0.59			NS	1.76		NS	3.17		
Variety at same level of treatment	NS	0.74		NS	0.52			NS	2.76		NS	2.66		

PSB recorded maximum plant height, number per plant in tuberose. Similar findings were also reported by Ali *et al*. (2014), Tirkey *et al*. (2017) and Akter *et al*. (2017) in gladiolus.

Flowering parameter

Days required for 50% flowering was significantly influenced by organic, inorganic and biofertilizers during the year 2016-17, 2017-18 and mean of two years (Table 2).The interaction effect of varieties and treatments also found significant during both the years. The maximum days required for 50% blooming (104.1 days and 101.6 days**)** was recorded in Pusa Red Valentine, whereas, the minimum days required for 50% blooming (99.42 and 100.8 days) was observed in Pusa Jyotsna during first and second year respectively.Examination of data also reveals that organic, inorganic and biofertilizers significantly influenced the days required for 50% blooming during both the years of study. The maximum days required for 50% flowering (103.6 days, 102.3 days and 103.0 days**)** was recorded with control (T_1), whereas, the minimum days required for 50% flowering (100.3, 99.8 and 100.1 days**)** was recorded with the application of 75% RDF + Vermicompost @ 10 t/ha + *Azospirillum* + PSB (T_{10}) during the year 2016-17, 2017-18 and mean of two years, respectively. The data indicates that the maximum days required for 50% flowering (105.6 days) was recorded in Pusa Red Valentine with the control (T_1) which was at par with T_3, T_4, T_6, T_{11} and T_{12} while it was (101.6 days) in Pusa Jyotsna with the control (T_1) which was at par with T_2, T_3, T_6 and T_{12} and minimum days required for 50% flowering (102.3 days) was recorded in Pusa Red Valentine with the application of 75% RDF + Vermicompost @ 10 t/ha + *Azospirillum* + PSB (T_{10}) while it was (98.0 days) in Pusa Jyotsna with the application of 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}) and 125% RDF + *Azospirillum* + PSB (T_8) during the year 2016-17. The maximum days required for 50% flowering **(**103.3 days) was seen in Pusa Red Valentine with the control (T_1) which was at par with T_4 while it was (102.3 days) in Pusa Jyotsna with the control (T_1) which was at par with T_3 and minimum days required for 50% blooming (100.3 days) was recorded in Pusa Red Valentine with the application of Vermicompost @ 10 t/ha (T_5) and 50% RDF +FYM @ 5 t/ha + Vermicompost @

Table 2 Effect of integrated nutrient management on days required for 50% blooming and spike length

Treatment	Days required for 50% blooming							Spike length (cm)						
	Pusa Red Valentine	Pusa Jyotsna	Mean	Pusa Red Valentine	Pusa Jyotsna	Mean	Mean of two year	Pusa Red Valentine	Pusa Jyotsna	Mean	Pusa Red Valentine	Pusa Jyotsna	Mean	Mean of two years
	2016-17			2017-18				2016-17			2017-18			
T_1	105.6	101.6	103.6	103.3	102.3	102.3	103.0	86.00	90.00	88.00	88.00	89.66	88.33	88.17
T_2	103.6	100.3	102.0	102.0	101.3	101.6	101.8	94.66	97.66	96.16	97.66	98.00	97.83	97.00
T_3	104.3	100.6	102.5	102.3	102.2	102.2	102.4	96.33	98.33	97.33	98.33	99.66	99.00	98.17
T_4	105.6	98.3	102.0	103.2	100.3	101.7	101.8	93.33	96.33	94.83	95.66	96.00	95.83	95.33
T_5	103.0	98.3	100.6	100.3	99.4	99.9	100.2	93.33	97.00	95.16	97.33	98.00	97.66	96.41
T_6	104.3	101.3	102.8	101.3	100.3	100.8	101.8	99.33	98.00	98.66	99.00	100.00	99.50	99.08
T_7	103.3	98.3	100.8	102.3	101.3	101.8	101.3	99.00	98.66	98.83	102.00	103.00	102.50	100.67
T_8	103.3	98.0	100.6	100.3	100.3	100.3	100.5	106.33	105.66	106.00	106.66	108.33	107.50	106.75
T_9	103.0	99.3	101.1	102.3	101.3	101.8	101.5	99.00	102.00	100.50	105.00	105.66	105.33	102.92
T_{10}	102.3	98.3	100.3	100.3	99.3	99.8	100.1	102.33	103.66	103.00	106.00	108.00	107.00	105.00
T_{11}	105.3	98.0	101.6	101.3	101.3	101.3	101.5	107.33	109.66	108.50	108.66	110.00	109.33	108.92
T_{12}	105.3	100.3	102.8	100.3	100.3	100.3	101.6	104.00	104.00	104.00	106.66	107.66	107.16	105.58
Mean	104.1	99.42		101.6	100.8			98.41	100.08		100.9	102.0		
	CD at 5%	*SEm (±)*		*CD at 5%*	*SEm (±)*			*CD at 5%*	*SEm (±)*		*CD at 5%*	*SEm (±)*		
Variety	0.78	0.11		0.12	0.02			NS	0.92		NS	0.49		
Treatment	0.90	0.31		0.13	0.04			5.61	1.96		6.47	2.26		
Treatment at same level of Variety	1.40	0.41		0.21	0.06			NS	3.20		NS	1.71		
Variety at same level of treatment	1.39	0.44		0.21	0.06			NS	2.81		NS	3.10		

5 t/ha + liquid NPK(T_{12}) while it was (99.3 days) in Pusa Jyotsna with the application of 75% RDF + Vermicompost @ 10 t/ha + *Azospirillum* + PSB (T_{10}) during the year 2017-18. Dalve *et al*. (2009) also observed that in gladiolus flowering parameters like days required for 50% flowering, were significantly influenced by the application of the bio fertilizers in combination with nitrogen.

From the data enumerated in Table 2 indicated that the length of spike was significantly affected by organic, inorganic and bio-fertilizers. Length of spike was ranged from 88.00 to 109.33 cm during the year 2016-17 and 2017-18, respectively. However, the effect of treatments on varieties and their interaction was found non-significant during both the years. The data also revealed that maximum spike length (108.50 cm, 109.33 cm and 108.92 cm) was recorded with the application of 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}) during the year 2016-17, 2017-18 and mean of two years, respectively. Increase number of florets per spike might be due to higher protein synthesis and thus improved the vegetative growth, dry matter accumulation and partitioning of nutrients towards the developing spikes. As a result photosynthetic products and their translocation through phloem to root zone also increased which may have helped in production of spike length. Satapathy *et al.* **(**2016**)** revealed that 75% RDF (100:50:60 kg NPK/ha) in combination with vermicompost and bio-fertilizer increased spike length and number of florets per spike in gladiolus. Similar findings were also reported by Mageswari *et al.* (2017), Akter *et al*. (2017) and Durga *et al*. (2018) in gladiolus.The improved floral characters might be due to increased availability of N and P required for flower development as *Azospirillum* fixes nitrogen and PSB makes the insoluble phosphorus available by secreting organic acids, mainly oxalic acid (Dave and Patel 2003).

Number of florets per spike was significantly influenced by organic, inorganic and biofertilizers (Table 3).The effect of treatments on varieties was found significant during the year 2016-17 and it was non-significant during the year 2017-18. However, the interaction effect of varieties and treatments found non-significant during both the year. The effect of organic, inorganic and biofertilizers

Table 3 Effect of integrated nutrient management onnumber of florets per spike and number of corm per plant

Treatment	Number of florets per spike							Number of corms per plant						
	Pusa Red Valentine	Pusa Jyotsna	Mean	Pusa Red Valentine	Pusa Jyotsna	Mean	Mean of two year	Pusa Red Valentine	Pusa Jyotsna	Mean	Pusa Red Valentine	Pusa Jyotsna	Mean	Mean of two years
	2016-17			2017-18				2016-17			2017-18			
T_1	12.66	13.33	13.00	12.66	13.66	13.16	13.08	1.33	1.33	1.33	1.66	1.66	1.66	1.50
T_2	14.33	15.00	14.66	14.33	15.33	14.83	14.75	1.66	2.00	1.83	1.66	2.00	1.83	1.83
T_3	14.66	15.33	15.00	15.00	15.66	15.33	15.17	1.33	2.33	1.83	2.00	2.00	2.00	1.92
T_4	14.66	14.66	14.66	14.66	15.66	15.16	14.91	1.33	2.00	1.66	1.66	2.00	1.83	1.75
T_5	15.00	15.00	15.00	15.00	15.33	15.16	15.08	1.33	2.00	1.66	1.66	2.00	1.83	1.75
T_6	15.33	15.66	15.50	15.66	16.00	15.83	15.67	1.66	2.00	1.83	1.66	2.00	1.83	1.83
T_7	15.66	16.33	16.00	16.00	16.00	16.00	16.00	1.66	2.33	2.00	2.00	2.33	2.16	2.08
T_8	16.66	17.00	16.83	17.00	17.00	17.00	16.92	2.00	2.66	2.33	2.33	3.00	2.66	2.50
T_9	15.66	16.66	16.16	16.33	17.33	16.83	16.50	1.66	2.33	2.00	2.00	2.33	2.16	2.08
T_{10}	17.00	18.33	17.66	17.00	18.00	17.50	17.58	2.00	3.00	2.50	2.33	3.00	2.66	2.58
T_{11}	17.00	18.33	17.66	17.33	18.33	17.83	17.75	2.33	3.33	2.83	2.33	3.33	2.83	2.83
T_{12}	16.66	17.33	17.00	16.66	17.66	17.16	17.08	1.66	2.33	2.00	2.00	2.66	2.33	2.17
Mean	15.44	16.08		15.63	16.33			1.66	2.30		1.94	2.36		
	CD at 5%	*SEm (±)*		*CD at 5%*	*SEm (±)*			*CD at 5%*	*SEm (±)*		*CD at 5%*	*SEm (±)*		
Variety	0.68	0.10		NS	0.38			0.56	0.08		0.38	0.05		
Treatment	1.47	0.51		1.40	0.49			0.66	0.23		0.50	0.17		
Treatment at same level of variety	NS	0.36		NS	1.34			NS	0.29		NS	0.20		
Variety at same level of treatment	NS	0.70		NS	0.77			NS	0.32		NS	0..24		

had significantly recorded maximum number of florets per spike (16.08 and 16.33**)** during 2016-17 and 2017-18 in Pusa Jyotsna as compared to Pusa Red Valentine.The data indicated that maximum number of florets per spike (17.66) was recorded with the application of 75% RDF Vermicompost @ 10 t/ha + *Azospirillum* + PSB (T_{10}) and 75% RDF + FYM @ 5 t/ha +Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}) which was at par with T_8 and T_{12} during the year 2016-17. During the year 2017-18 the maximum number of florets per spike (17.83) was recorded with the application of 75% RDF + FYM @ 5 t/ha +Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}) which was at par with $T_{8,}$ $T_{9,}$ T_{10} and T_{12}. Kathiresan and Venkatesha (2002) reported early flowering in gladiolus with bio-fertilizers + NPK. Similar findings were also reported by Kumari *et al*. (2013), Singh *et al*. (2015) and Chaudhary *et al*. (2013) in gladiolus.

Corm and cormels parameters

Number of corms per plant was significantly influenced by integrated nutrient management. However, the interaction effect of varieties and treatments was found non-significant during both the years. The effect of organic, inorganic and bio-fertilizers had significantly recorded maximum number of corms per plant (2.30 and 2.36**)** in Pusa Jyotsna as compared to Pusa Red Valentine (1.66 and 1.94) during both the years respectively.The maximum number of corm per plant (2.83 and 2.83) was recorded with the application of 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}) which was at par with $T_{8,}$ $T_{10,}$ and T_{12} during the year 2016-17 and 2017-18. Satapathy *et al.* **(**2016**)**revealed that application of 75% RDF, vermicompost and bio-fertilizers resulted in maximum diameter and daughter corm as well as number and weight of cormels per plant.

The application of organic, inorganic and biofertilizers significantly influenced the number of cormels per plant. However, the interaction effect of varieties and treatments was found non-significant during both the years. The data also reveals that maximum number of cormels per plant (22.69 and 23.72**)** found in Pusa Red Valentine as compared to Pusan Jyotsna (21.97 and 21.94) during both the years respectively. Further, organic, inorganic and bio-fertilizers significantly influenced the number of cormels per plant during the year 2016-17, 2017-18 and mean of two years. The maximum number of cormels per plant (26.50 and

Table 4 Effect of integrated nutrient management on number of cormels per plant

Treatment	Number of cormels per plant						
	Pusa Red Valentine	Pusa Jyotsna	Mean	Pusa Red Valentine	Pusa Jyotsna	Mean	Mean of two year
	2016-17			2017-18			
T_1	17.67	13.67	15.66	18.66	12.33	15.50	15.58
T_2	21.33	21.33	21.33	21.66	21.33	21.50	21.42
T_3	21.00	22.67	21.83	22.00	21.66	21.83	21.83
T_4	19.00	18.33	18.66	20.00	17.66	18.83	18.75
T_5	20.33	19.67	20.00	21.33	19.66	20.50	20.25
T_6	22.00	21.67	21.83	23.00	22.00	22.50	22.17
T_7	22.33	22.00	22.16	23.66	22.33	23.00	22.58
T_8	25.67	24.67	25.16	26.33	25.66	26.00	25.58
T_9	24.00	24.00	24.00	25.33	22.66	24.00	24.00
T_{10}	26.33	25.00	25.66	27.00	26.33	26.66	26.16
T_{11}	27.00	26.00	26.50	29.00	26.66	27.83	27.17
T_{12}	25.67	24.67	25.16	26.66	25.00	25.83	25.50
Mean	22.69	21.97		23.72	21.94		
	CD at 5%	*SEm (±)*		*CD at 5%*	*SEm (±)*		
Variety	0.25	0.03		1.73	0.26		
Treatment	1.99	0.66		2.93	1.02		
Tre. at same level of Var.	NS	0.13		NS	0.91		
Var. at same level of Tre.	NS	0.94		NS	1.41		

27.83) was observed with the application of 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB (T_{11}) during 2016-17 and 2017-18. Ali *et al*. (2014) observed that treatment containing *Azospirillum* gained more cormels per plant.

Conclusion

The results of the study concluded thatthe maximum number of florets per spike, and minimum days to 50% floweringwas recorded with the application of 75% RDF + Vermicompost @ 10 t/ha + *Azospirillum* + PSB; whereas plant height, number of corms per plant and maximum number of cormels per plant were recorded with the application of 75% RDF + FYM @ 5 t/ha + Vermicompost @ 5 t/ha + *Azospirillum* + PSB. Hence, these two INM treaments were found to be recommended for maximizing the gladiolus flowering and yield attributes.

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