Integrated Nutrient Management on Growth, Quality, Yield and Soil Fertility of Gladiolus in Lower Gangetic Plain of India

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Abstract

A field experiment was carried out at the Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal representing the lower Gangetic plain of India during the winter seasons of 2011-12, 2012-13 and 2013-14 on integrated nutrient management of inorganic fertilizers and organic manure on growth, floral attributes and yield of Gladiolus hybridus. Maximum flower yield (9731 kg/ha), number of corms per plant (3.5), growth and quality parameters was recorded with integration of 50% recommended dose of chemical fertilizers (RDF) with vermicompost @ 2.5 ton/ha. The build-up of available N, P and K in soil and consequent higher plant leaf nutrients was also detected with 50% RDF + vermicompost @ 2.5 ton/ha. In contrast, minimum growth, quality parameters, less number of corms per plant and flower yield, lower plant leaf nutrients and higher depletion of available N, P and K in soil were observed under unfertilized control treatment. Thus the conjunctive use of 50% RDF with vermicompost @ 2.5 ton/ha may be recommended for improving the quality and productivity of G. hybridus and improvement of available N, P and K status in soil.

Keywords
Gladiolus hybridus, Inorganic fertilizers, Flower yield, Soil fertility, Vermicompost.

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Introduction

Gladiolus hybridus is one of the most popular ornamental bulbous plants grown in many parts of the world for its dazzling florets colour, sturdy spike, size, attractive appearance and keeping quality. At present, the productivity and quality of gladiolus in the international market are declining considerably due to climatic aberrations and mismanagement of soil and nutritional factors. The inadequate and imbalanced use of inorganic fertilizers accompanied with the restricted use of organic manures adversely affects the growth and yield of plant (Singh et al., 2011). Simultaneously, prolonged chemical fertilization resulted in yield reduction, soil health deterioration, water pollution and increasing disease and pest infestation (Okwuagwu et al., 2003). The supplementary and complementary use of organic manures and inorganic chemical fertilizers remains the alternative choice of growers for sustainable production and maintaining the soil health (Singh and Pandey, 2006). The vermicompost is an excellent source of organic matter which not only supplies macro- and micronutrients to plants, but also improves the physical, chemical and biological properties of soil (Sinha and Sunil, 2009). The plants require both organic manures and inorganic fertilizers.
in adequate amounts and in right combination to promote better yield and quality of produce. The objective of the present study was to evaluate the response of *Gladiolus hybridus* to integrated nutrient management using organic manure (vermicompost) and inorganic fertilizers on the growth, floral characteristics, flower yield, leaf nutrients contents and soil fertility improvement as regards to available N, P and K in soil.

**Materials and Methods**

The field experiments were conducted during the winter seasons of 2011-12, 2012-13, 2013-14 at the Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya under the jurisdiction of lower Gangetic plain of West Bengal, India to study the response of integrated nutrient management on *Gladiolus hybridus* cv. American beauty. The site is located between 23°N latitude and 89°E longitude at an altitude of 9.75 m above the mean sea level. The study area falls under sub-humid tropic characterized by hot dry summer months (May-June) and cold winter (December-January). The average temperature ranges between 37.6 and 25.4 °C in summer and between 23.7 and 10.5 °C in winter. The soil was sandy loam in texture (Typic Fluvaquept). The physical and chemical properties of the experimental soil are presented in tables 1 and 2. The available N, P and K in 0-15 and 15-30 cm depths of soil profile were 158.3 and 140.5; 23.9 and 21.6 and 141.5 and 127.3 kg/ha, respectively. The net plot dimension was 3.0 m x 1.0 m leaving 0.5 m bund width and 1.0 m irrigation channel. The experiment consisted of four treatments viz., T₁: control (without fertilizers and manure), T₂: 100:60:60 kg NPK/ha, T₃: 50:30:30 kg NPK/ha + vermicompost @ 2.5 ton/ha and T₄: vermicompost @ 5 ton/ha each replicated four times was laid out in a randomized block design. The recommended fertilizer doses of 100:60:60 kg NPK/ha were applied in form of urea, muriate of potash and single superphosphate for N, P and K, respectively. The organic source of fertilizer *i.e.* vermicompost containing N 2.1%, P 1.25%, K 1.07%, Ca 1.4%, Zn 350 ppm, Mn 294 ppm, Cu 237 ppm was incorporated in the soil during the final land preparation. Full dose of phosphorus and potassium and one-third of nitrogen was applied as basal as per treatments. The remaining two-third of nitrogen was applied in two equal splits at interval of 30 and 60 days after application of basal dose. Medium sized corms were planted during second week of November each year in lines maintaining row and plant spacing of 30 and 25 cm, respectively at a depth of 5 cm. Flower was harvested 5-times between mid January and first week of February. The growth and flowering parameters, corms and flower yield data were recorded. The soil samples at 0-15 and 15-30 cm depth were collected before and after harvest of plant. Plant leaf samples were also collected at seedling, flowering and harvesting stages *i.e.* at 30, 60 and 90 days after planting. These samples were processed and analyzed for physical and chemical properties and available N, P and K for soils and plant leaf concentrations for N, P, and K following the standard procedures (Jackson, 1973). The data obtained were subjected to the proper statistical analysis (Gomez and Gomez, 1984).

**Results and Discussion**

**Growth parameters**

Application of inorganic fertilizers and organic manure either alone or, their combination had significant effect in improving the growth characters of plants over control without manure and fertilization (Table 3). Among the different treatments, the conjunctive use of 50% RDF + vermicompost @ 2.5 ton/ha (*T₃*) recorded the maximum
plant height (54.3 cm), minimum days to
corm sprouting (12.6), maximum number of
leaves per plant (11.9) and maximum length
of longest leaf per plant (38.3 cm), which was
superior to that with the sole application of
100% RDF (T2) or, vermicompost (T4). This
implies that the integration of both easily
available inorganic fertilizers and slowly
available organic manure in supplying
macronutrients are essential for enhancing the
plant growth parameters. These results are
competitive with the findings of Singh et al.,
(2013) who reported the higher plant height,
number of leaves per plant, length of longest
leaf per plant and minimum days to sprouting
were obtained with 50% RDF (NPK
150:100:100 kg/ha) + vermicompost (2
ton/ha). The consistent supply of N, P and K
through integrated nutrient management may
play a vital role in promoting growth and
development of plant and thus resulted in
higher growth attributes (Sharma and Singh,
2007). Similarly, maximum number of corms
(3.5) and cormlets (12.1) per plant was also
obtained in T3 treatment followed by T2 and
T4, respectively. The beneficial effect of
integrated nutrient management on the
improvement of growth parameters and
enhanced corms and cormlets per plant might
be ascribed to the higher and steady supply of
easily available NPK nutrients provided with
some essential micronutrients and growth
promoting substances through vermicompost
throughout the growth stages (Singh et al.,
2013). On the other hand, minimum number of
corms and cormlets per plant (2.3 and 8.4,
respectively) was noticed in control treatment
receiving no extraneous supply of NPK
nutrients.

Floral parameters

The organic and inorganic sources of
nutrients either sole or, their combined
application recorded positive significance
influence on different floral parameters of
plants over control (Table 4). However, the
integration of 50% RDF + 2.5 ton/ha of
vermicompost (T3) significantly increased the
spikes/plot (68.7), number of florets per spike
(9.6), longer spike length (63.3 cm), weight of
single spike (42.8 g), diameter of flower (8.5
cm), longevity of spike (20.6 days) and vase
life of flower at room temperature (19.7 days)
and was superior to that of 100% RDF (T2)
and vermicompost addition (T4). The results
are in close conformity with the findings of
with Kabir et al., (2011) who had reported
that floral characters like bulb length, bulb
diameter, bulb yield, rachis length, spike
length and diameter and number of florets per
spike in Polianthes tuberose were greater in
organic fertilizers supplemented with half
chemical fertilizers than absolute use of
chemical fertilizers. The incorporation of
organic manure like vermicompost with
chemical fertilizers thus greatly helped in
improving the flower attributes. This was
most probably due to the increased
availability of macro- and micronutrients in
the soil and increased level of growth
promoting substances which resulted in better
plant vigour and enhanced uptake of nutrients
and water by plants (Patel et al., 1997).

Flower yield

The addition of inorganic and organic sources
nutrients and their combination had
pronounced effect on the flower yields of
gladiolus over the control in all the three
years (Table 5). Maximum yield was obtained
with 50% RDF in conjunction with
vermicompost @ 2.5 ton/ha (T3) and was
found superior to the remaining treatments.
These results are in consistent with the
findings of Padaganur et al., (2010) and Kabir
et al., (2011) who observed the significantly
higher flower yield in Polianthes tuberose
with organic fertilizers enriched with half
chemical fertilizers than recommended
chemical fertilizers only. This implies that the
combined application of inorganic fertilizers and organic manure was more effective in enhancing the yield contributing characters which resulted in higher flower yield, possibly due to the increased availability of primary and secondary nutrients in soil during the entire crop growth period and their subsequent uptake by the plants. In addition, the integrated nutrient supply involving organic and inorganic components resulted in greater stimulation of the rates of various physiological and metabolic processes leading to better plant growth and floral characteristics and ultimately flower yield (Singh et al., 2013). Application of vermicompost manure registered low flower yields, thereby suggesting that vermicompost alone could not sustain high flower yield probably due to slow release of nutrients in lower amounts during the vegetative and reproductive growth stages of the plants.

Table.1 Physical properties of the experimental field soil

| Depth (cm) | Sand (%) | Silt (%) | Clay (%) | Bulk Density (g/cm$^3$) | HC (cm/hr) | WHC (%) |
|------------|----------|----------|----------|------------------------|------------|---------|
| 0-15       | 70.2     | 14.4     | 15.5     | 1.47                   | 2.74       | 49.0    |
| 15-30      | 68.1     | 15.2     | 16.7     | 1.51                   | 2.18       | 50.2    |

Table.2 Chemical properties of the experimental soil

| Depth (cm) | pH (1:2.5) | EC (dS/m) | Organic Carbon (%) | Available N (kg/ha) | Available P (kg/ha) | Available K (kg/ha) |
|------------|------------|-----------|--------------------|---------------------|---------------------|---------------------|
| 0-15       | 6.8        | 0.1       | 0.46               | 158.3               | 23.9                | 141.5               |
| 15-30      | 6.38       | 0.08      | 0.4                | 140.5               | 21.6                | 127.3               |

Table.3 Effect of integrated nutrient management on growth parameters and corms yield of *Gladiolus hybridus* (pooled over 2011-’12, 2012-’13, 2013-’14)

| Treatments | Plant Height (cm) | Number of Leaves | Largest Leaf Length (cm) | Days to Sprouting | No. of Corms /Plant | No. of Cormlets/Plant |
|------------|-------------------|------------------|--------------------------|-------------------|---------------------|----------------------|
| $T_1$ = Control (without Manure and Fertilizer) | 49.1              | 10.1             | 35.8                     | 14.4              | 2.3                 | 8.4                  |
| $T_2$ = 100% RDF | 53.2              | 11.2             | 37.9                     | 13.2              | 3.2                 | 10.9                 |
| $T_3$ = 50% RDF + VC @ 2.5 ton/ha | 54.3              | 11.9             | 38.3                     | 12.6              | 3.5                 | 12.1                 |
| $T_4$ = VC @ 5 ton/ha | 51.5              | 10.7             | 37.4                     | 13.8              | 2.8                 | 9.2                  |
| CD (5%)    | 1.2               | 0.5              | 0.8                      | 0.4               | 0.3                 | 0.9                  |

RDF: Recommended dose of fertilizers, VC: Vermicompost
**Table.4** Effect of integrated nutrient management on floral parameters of *Gladiolus hybridus* (pooled over 2011-’12, 2012-’13, 2013-’14)

| Treatments | No. of Spikes/Plot | No. of Florets/Spike | Spike Length (cm) | Wt. of a Single Spike (g) | Diameter of Flower (cm) | Longevity of Spike (days) | Vase Life of Cut Flower at Room Temperature (days) |
|------------|-------------------|---------------------|-------------------|--------------------------|------------------------|--------------------------|-----------------------------------------------|
| T1 = Control (without Manure and Fertilizer) | 58.4 | 7.4 | 56.4 | 38.1 | 7.3 | 18.5 | 17.1 |
| T2 = 100% RDF | 66.2 | 8.8 | 61.8 | 41.4 | 8.1 | 20.1 | 18.8 |
| T3 = 50% RDF + VC @ 2.5 ton/ha | 68.7 | 9.6 | 63.3 | 42.8 | 8.5 | 20.6 | 19.7 |
| T4 = VC @ 5 ton/ha | 61.8 | 8.2 | 59.3 | 39.6 | 7.8 | 19.2 | 17.9 |
| CD (5%) | 2.3 | 0.6 | 1.1 | 0.9 | 0.3 | 0.4 | 0.6 |

**Table.5** Effect of integrated nutrient management on flower yield of *Gladiolus hybridus* during 2011-’12, 2012-’13, 2013-’14

| Treatments | Flower Yield (kg/ha) | 2011-’12 | 2012-’13 | 2013-’14 | Mean |
|------------|----------------------|----------|----------|----------|------|
| T1 = Control (without Manure and Fertilizer) | 8114 | 8034 | 8151 | 8110 |
| T2 = 100% RDF | 9155 | 8965 | 9643 | 9254 |
| T3 = 50% RDF + VC @ 2.5 ton/ha | 9592 | 9428 | 10174 | 9731 |
| T4 = VC @ 5 ton/ha | 8467 | 8572 | 8695 | 8586 |
| CD (5%) | 322 | 363 | 407 | 384 |

**Table.6** Available N, P and K contents at two depths of soil profile as influenced by integrated nutrient management on *Gladiolus hybridus*

| Treatments | Available N (kg/ha) | Available P (kg/ha) | Available K (kg/ha) |
|------------|---------------------|---------------------|---------------------|
|             | Soil Depth (cm)     | 0-15 | 15-30 | 0-15 | 15-30 | 0-15 | 15-30 |
| T1 = Control (without Manure and Fertilizer) | 142.2 | 135.4 | 20.2 | 19.3 | 128.2 | 122.7 |
| T2 = 100% RDF | 166.1 | 155.8 | 25.6 | 22.2 | 143.4 | 135.3 |
| T3 = 50% RDF + VC @ 2.5 ton/ha | 172.4 | 161.3 | 26.1 | 23.7 | 145.7 | 137.5 |
| T4 = VC @ 5 ton/ha | 148.9 | 142.6 | 22.8 | 21.5 | 138.6 | 130.6 |
| CD (5%) | 5.8 | 6.2 | 1.3 | 0.9 | 2.7 | 4.1 |
Table 7 Plant nutrient concentration at vegetative, flowering and harvesting stages of *Gladiolus hubridus* as influenced by integrated nutrient management

| Treatments | Plant N (%) | Plant P (%) | Plant K (%) |
|------------|-------------|-------------|-------------|
|            | V | F | H | V | F | H | V | F | H |
| T<sub>1</sub> = Control (without Manure and Fertilizer) | 1.10 | 1.28 | 1.20 | 0.42 | 0.46 | 0.43 | 2.48 | 2.72 | 2.40 |
| T<sub>2</sub> = 100% RDF | 1.46 | 1.36 | 1.31 | 0.56 | 0.52 | 0.49 | 2.63 | 2.83 | 2.72 |
| T<sub>3</sub> = 50% RDF + VC @ 2.5 ton/ha | 1.48 | 1.64 | 1.41 | 0.60 | 0.58 | 0.54 | 2.87 | 3.12 | 2.78 |
| T<sub>4</sub> = VC @ 5 ton/ha | 1.20 | 1.31 | 1.27 | 0.44 | 0.49 | 0.45 | 2.54 | 2.76 | 2.46 |
| CD (5%) | 0.04 | 0.03 | 0.07 | 0.02 | 0.02 | 0.02 | 0.08 | 0.08 | 0.09 |

V: vegetative stage, F: flowering stage, H: harvesting stage

**Soil fertility**

Available N, P and K status in surface and subsurface layers of soil after harvest of gladiolus plants was significantly influenced by the application of inorganic fertilizers, organic manure (vermicompost) and their combination compared with the control (Table 6). Maximum improvement in the available N, P and K nutrients was recorded by integrating the use of 50% recommended dose of fertilizers (RDF) with 2.5 ton/ha of vermicompost (T<sub>3</sub>), followed by that of 100% RDF (T<sub>2</sub>). Conversely, minimum values of available N, P and K status in soil layers at post-harvest was found under unfertilized control treatment (T<sub>1</sub>), indicating the depletion of reserve soil nutrients as compared to the initial level under condition of no extraneous supply of NPK fertilizers or manure. The same trend in surface soil layer was also observed in vermicompost treatment (T<sub>4</sub>), but the magnitude of decline was relatively low. However, the plant nutrient status in subsurface soil layer was remained unaltered or, marginally increased. These results are competitive with the findings of Tiwari et al., (2002) who observed the considerable improvement of available N, P and K contents in soil with the application of recommended dose of NPK with FYM @ 15 ton/ha in soybean-wheat system. Similarly, Singh and Pandey (2006) also noticed a significant increase in available N, P and K status in soil over control with the integrated use of 75% NPK + FYM @ 10 ton/ha in onion. The solubilization of unavailable soil P by the liberated organic acids from decomposition of vermicompost or by complexation of the cations like Ca, Mg and Al responsible for the fixation of P might have enhanced the availability of P in soil from native as well as applied fertilizers (Singh et al., 2011). The higher availability of native soil K and the status of labile K in soil due to conjugal application of fertilizer N and FYM were reported earlier by Singh and Singh (1995).

**Leaf nutrient**

The leaf nutrient concentrations of N, P and K at vegetative, flowering and harvesting stages of plant under the influence of inorganic fertilizers and organic manure and their integration was significantly affected over control treatment (Table 7). Maximum concentrations of N, P and K in leaves at all the plant physiological stages were recorded at 50% RDF with vermicompost @ 2.5 ton/ha (T<sub>3</sub>). This could be attributed to the optimal supply of NPK nutrients through conjugal use of inorganic fertilizers and organic manure during the growth period which ensured the uniform translocation of nutrients in plant (Singh et al., 2011). The effect of recommended dose of NPK fertilization (T<sub>2</sub>) in increasing the leaf NPK concentrations was, however, inferior to the combined application of inorganic fertilizers and organic manure (T<sub>3</sub>). Higher accumulations of leaf nutrients in flowering
stage of gladiolus plant might be due to the rapid physiological activity and homeostatic preparation for expensive flowering phase.

In conclusion the above results indicated that application of integrated use of 50% recommended dose of inorganic fertilizers (50:30:30 NPK kg/ha) with organic manure (vermicompost @ 2.5 ton/ha) markedly improved the growth and floral characters and flower yield of *Gladiolus hybridus*, besides the maintenance and improvement of soil fertility. Addition of vermicompost or recommended fertilizers dose alone was not enough to meet the plant nutrients requirement. Thus it may be concluded that combined use of half recommended inorganic fertilizers dose with organic manure could be benevolent to the gladiolus growers of lower Gangetic plain of India in achieving the highest yield with improved flower quality and soil fertility status.

**References**

Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. Johnwiley and Sons, Newyork.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Kabir, A.K.M.R., M.H. Iman, M.M.A. Mondal and S. Chowdhury. 2011. Response of tuberose to integrated nutrient management. *J. Environ. Sci. Natural Res.*, 4(2): 55-59.

Okwuagwu, M.I., M.E. Alleh, and I.O. Osemwota. 2003. The effects of organic and inorganic manure on soil properties and yield of okra in Nigeria. *African Crop Sci. Congress Proceedings*, 6: 390-393.

Padaganur, V.G., A.N. Mokashi and V.S. Patil. 2010. Flowering, flower quality and yield of tuberose as influenced by vermicompost and farmyard manure. *Karnataka J. Agri. Sci.*, 18: 729-734.

Patel, B.M., B.N. Patel and R.L. Patel. 1997. Effect of spacing and fertilizer levels on growth and yield of tuberose (*Polianthes tuberosa* L.) cv. “Double”. *J. Appl. Horticulture*, 3(1/2): 98-104.

Sharma, G. and P. Singh. 2007. Response of NPK on vegetative growth, flowering and corm production in gladiolus under mango orchard. *J. Ornamental Horticulture*, 10(2): 52-54.

Singh, R., M. Kumar, S. Raj and S. Kumar. 2013. Effect of integrated nutrient management (INM) on growth and flowering in gladiolus (*Gladiolus grandiflorus* L.) cv. “White prosperity”. *Annals of Horticulture*, 6(2): 242-251.

Singh, S.R., M.Y. Zargar, G.R. Najar, F.A. Peer and M.I. Ishaq. 2011. Integrated use of organic and inorganic fertilizers with bio-inoculants on yield, soil fertility and quality of apple (*Malus domestica* L.). *J. Indian Society of Soil Sci.*, 59(4): 362-367.

Singh, V. and M. Pandey. 2006. Effect of integrated nutrient management on yield of and nutrient uptake by onion and on soil fertility. *J. Indian Society of Soil Sci.*, 54: 365-367.

Sinha, R. and H. Sunil. 2009. The emerging co-effective and sustainable technology of 21st century for multiple uses of land management to safe and sustainable food production. *Environ. R.J.NY*, USA, 3(2-3): 10-19.

Tiwari, A., A.K. Dwivedi and P.R. Dikshit. 2002. Long term influence of organic and inorganic fertilization on soil fertility and productivity of soybean - wheat system in a vertisol. *J. Indian Soc. Soil Sci.*, 50: 472-475.

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