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# Influence of biofertilizers and chemical fertilizers on flowering characters of gladiolus var. Arka Amar

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**Abstract**
A field study was carried out at Agricultural Research Station, Binjhagiri, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, during the year 2021-22 to find out the influence of biofertilizers along with chemical fertilizers on different flowering characters of gladiolus var. Arka Amar. And the study revealed that, application of $T_6$ (100% RDF + Azotobacter + PSB) significantly increased number of florets/spike (19.13), diameter of floret (12.96), length of floret (7.32), spike length (84.56) and rachis length (73.41). The minimum days taken for initiation of spike (68.73), days taken for colour break stage (81.6), days taken for opening of first floret (85.26), highest longevity of floret (8.2) and flowering duration of spike (16.43) were recorded in $T_7$ 50% RDF + Azotobacter + PSB.

**Keywords:** Gladiolus, azotobacter, *Azospirillum*, phosphorus solubilizing bacteria (PSB), recommended dose of fertilizer (RDF)

## Introduction

Gladiolus (*Gladiolus grandiflorus* L) is an important commercial flower known as queen of the bulbous plants, belongs to Iridaceae family. It is one among the top ten elite cut flowers due to their different shapes, dazzling colors, varying sizes and excellent vase life. Its considerable demand in both domestic and export markets and over 450 acres annually are under the cultivation of Gladiolus in Punjab province. Today, Agrochemicals are being used excessively in crop production due to high trend in industrialization and population explosion in the world. Their continuous application has introduced major challenges for farmers in the form of soil infertility, nutrient imbalance, accumulation of toxic chemicals in the soil and food products which have an adverse effect on the soil productivity, ecosystem destruction, environmental degradation and also affecting the yield and quality of the product. In that condition, sustainable agricultural practices have become a very difficult job for commercial growers now-a-days. To cope with all these problems a cheaper, better and safer way is necessary in order to improve the soil fertility status, maximize the agricultural productivity with minimum eco-hazards. All these criteria can be achieved through application of bio-fertilizers which is known as "microbial inoculants", these are the products containing the living cells (Mainly bacteria & fungi) that naturally activate the microorganisms found in the soil, restoring the soil fertility and improve physico-chemical and biological properties of soil. These essential substances are the bio-stimulants, which act as a growth booster by inflicting positive effects on plant nutrition and crop protection against stress and diseased conditions. Certain strains of bio-fertilizers which are being commercially used in horticultural crops are; Azotobacter, *Azospirillum* and phosphate solubilizing bacteria. As reported in numerous studies, *Azospirillum* and *Azotobacter* are well known symbiotic N-fixing bacteria which help the plants indirectly through better nitrogen (N) fixation or improving the nutrient availability in the soil. They have the ability to fix 20-200 kg N ha–1and increase crop yield by 10-50%. Bio-fertilizers seems to be a feasible option for sustained agriculture on a commercial and profitable scale. In addition, they are eco-friendly, easily available and cost effective. Present study was formulated to find out the influence of biofertilizers and chemical fertilizers on flowering characters of gladiolus var. Arka Amar in a sustainable agricultural production system in order to reduce the amount of excessive chemical material released to the environment.

## Materials and Methods

The present study was executed at Agricultural Research Station, Binjhagiri, Chatabara of the Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha during November 2021 to March 2022. The maximum and minimum temperature recorded in the experimental plot was 28.370 C and17.220 C respectively, with a relative humidity of 95%. The experiment consists of nine treatments such as T1 (control), T2 (100% RDF + Azotobacter), T3 (100% RDF + *Azospirillum*), T4 (50% RDF + Azotobacter), T5 (50% RDF + *Azospirillum*), T6 (100% RDF + Azotobacter + PSB), T7 (50% RDF + Azotobacter + PSB), T8 (100% RDF + *Azospirillum* + PSB) and T9 (50% RDF + *Azospirillum* + PSB). The treatments were replicated thrice in a Randomized Block Design. Corms of gladiolus were planted at a spacing of 40 cm x 40 cm to accommodate twenty plants per plot. Both fertilizers and biofertilizers were applied to the corms as soil application. Biofertilizers like PSB, *Azospirillum* and Azotobacter were applied @ 4 kg/ha in two split doses, first before spike emergence stage and second after harvesting of spikes for better corm growth. Similarly, fertilizers were applied in three split doses, first as basal, second before spike emergence and third after harvesting of spikes. Observations were taken on different growth characteristics like days taken for initiation of spike, days taken for colour break stage, number of branching per spike, days taken for opening of first floret, number of florets per spike, length of floret, diameter of floret, spike length, rachis length, longevity of floret and flowering duration of spike. And the data obtained from various characters under study were analyzed by the statistical analysis of variance and test of significance through the procedure described by Panse and Sukhatme (1967) [26].

## Results and Discussion

The data presented in Table-1 concluded that treatment $T_7$ (50% RDF + *Azotobacter* + PSB) has taken minimum days (68.73) to initiate spikes followed by 70.33 days in treatment $T_9$ (50% RDF + *Azospirillum* + PSB). However, the plants grown in control i.e. $T_1$ took maximum days (78.8 days) for spike initiation. Which is in confirmation with Madinat-ut-Nisa *et al.* (2016) who concluded that biofertilizer application along with reduced doses of chemical fertilizers responded well and causes significant improvement in floral characters of gladiolus. It is a true fact that nitrogen promotes vegetative growth and causes a concurrent delay in attainment of reproductive stage (Kumar and Misra, 2003) [15]. The results recorded for different flowering characters confirmed the same, as due to the application of nitrogen supplying biofertilizers especially *Azotobacter* and *Azospirillum* results in the more accumulation and availability of nitrogen to the plant which caused a significant delay in different flowering characters. Similar observations were recorded in tuberose by Pandhre, (2003) [19] and Gayathri *et al.* (2004) [10] in statice. A balanced supply of nitrogen promotes the translocation of phyto hormones, which probably induces early flowering, whereas, delayed flowering emergence due to higher N doses might be due to prolonged vegetative growth (Potti and Arora, 1986 and Sharma and Singh, 2001) [20, 21]. Davel and Patel stated that *Azotobacter* and PSB helps in increasing the availability of N and P required for flower development as *Azotobacter* fixes nitrogen and PSB makes the insoluble phosphorus available by secreting certain organic acids, mainly oxalic acid.

The data presented in Table-1 revealed that minimum days taken to first floret opening (81.6 days) were recorded in treatment $T_7$ (50% RDF + *Azotobacter* + PSB) followed by 82.4 days in treatment $T_9$ (50% RDF +*Azospirillum* + PSB) and maximum days taken to first floret opening (91.73 days) was observed in control ($T_1$). The result is in confirmation with Chakradhar *et al.* (2019) [4] who concluded that, earliness in first floret opening in treatment$T_8$ might be due to easy uptake of nutrients by the use of biofertilizers and simultaneous transport of growth promoting substances to the auxiliary buds resulting in breakage of apical dominance. Ultimately, they resulted in better sink for faster mobilization of photosynthates and early transformation of plant parts from vegetative to reproductive phase. A similar trend was also observed by Kumar *et al*. (2011) [16], Singh *et al*. (2013) [23] and Srivatsava and Govil (2007) [24] in gladiolus.

The data pertaining to the number of branching/spike is depicted in Table-1. The data showed that application of biofertilizers was found non-significant in respect to branching. Minimum number of branching/spike were recorded in $T_5$ (50% RDF + *Azospirillum*) i.e. 0.8 nos. Whereas, maximum number (1.2 nos.) of branching/spike were recorded in $T_9$ (50% RDF + *Azospirillum* + PSB). It might be due to the influence of combination of biofertilizers and RDF which increased the availability of nitrogen and phosphorus as well as micronutrient like Zn. Zn is precursor of auxin, which improves the vegetative growth, dry matter accumulation and their partitioning towards the development of spikes in gladiolus. The results were in accordance with the reports of Chauhan and Kumar (2007) [5] in marigold and Kumari *et al*. (2014) [17] in gladiolus.

The data depicted in Table-1 revealed that, minimum days (85.26 days) taken to full bloom were recorded in $T_7$ (50% RDF + *Azotobacter* + PSB) followed by 86.53 days in $T_9$ (50% RDF +*Azospirillum* + PSB). Whereas maximum days taken for opening of first floret were recorded in control $T_1$ (98 days). Similar confirmation was given by Meena *et al.* (2018) [18] that the minimum days taken for opening of first floret was observed in $T_{12}$ (12.50 days) RDF 75% + PSB +*Azotobacter* + Mycorrhiza, whereas the most late first floret opening was observed in control $T_0$ (16.30 days). This is due to the beneficial effect of INM of earliness of spike emergence could be attributed to the good vegetative and reproductive growth of plant which in turn resulted in early floret opening (Kumari *et al.,* 2014) [17]. The present findings are also in agreement with the observations of Sharma *et al.* (2008) [22] and Kumar (2014) [14] in gladiolus.

The data recorded on number of florets per spike are presented in Table-1. It revealed that maximum number of florets per spike (19.13) was observed from the treatment $T_6$ (100% RDF + *Azotobacter*+ PSB) followed by 18.6 nos. in $T_8$ (100% RDF + *Azospirillum* + PSB). However, minimum number of florets per spike (15.6) was observed in control ($T_1$). Similar observation was given by Sathyanarayana *et al.* (2017) [27] who revealed that the significant increase in these parameters 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 those of Yadav *et al.*, (2005) [25] in tuberose and Basoli *et al.*, (2014) [3] in gladiolus, Ali *et al.*, (2013) [1] in gladiolus

**Table 1:** Effect of biofertilizers and RDF on various flowering characteristics

| Treatments | | Days taken for initiation of spike (days) | Days taken for colour break stage (days) | No. of branching/ spike (nos) | Days taken for opening of first floret (days) | No. of florets/ spike (nos) |
|---|---|---|---|---|---|---|
| $T_1$ | Control | **78.80** | **91.73** | 1.20 | **98** | **15.60** |
| $T_2$ | 100% RDF + *Azotobacter* | 75.06 | 86.66 | 1.06 | 90.26 | 17.66 |
| $T_3$ | 100% RDF + *Azospirillum* | 76.13 | 87.26 | 0.86 | 91.20 | 17.20 |
| $T_4$ | 50% RDF + *Azotobacter* | 73.40 | 84.60 | 1 | 88.40 | 16.86 |
| $T_5$ | 50% RDF + *Azospirillum* | 74.20 | 85.06 | 0.80 | 89.06 | 16.06 |
| $T_6$ | 100% RDF + *Azotobacter* + PSB | 71.33 | 82.20 | 1.06 | 86.20 | 19.13 |
| $T_7$ | 50% RDF + *Azotobacter* + PSB | 68.73 | 81.60 | 1.06 | 85.26 | 18.20 |
| $T_8$ | 100% RDF + *Azospirillum* + PSB | 72.46 | 83.33 | 1 | 87.26 | 18.60 |
| $T_9$ | 50% RDF + *Azospirillum* + PSB | 70.33 | 82.46 | 1.2 | 86.53 | 18.06 |
| SEM | | 0.395 | 0.347 | 0.222 | 0.326 | 0.119 |
| CD 5% | | 1.186 | 1.042 | 0.667 | 0.978 | 0.357 |

On the perusal of data presented in Table-2, it is clear that highest floret diameter (12.96 cm) was observed in treatment $T_6$ (100% RDF + *Azotobacter*+ PSB) followed by 12.7 cm in $T_8$ (100% RDF + *Azospirillum* + PSB). Minimum floret diameter 11.74 cm was recorded in treatment $T_1$ (control). The data showed that all the treatments significantly improved the floret diameter as compared to control ($T_1$). This is in confirmation with Meena *et al.* (2018) [18] that the largest floret was observed in RDF 75% + PSB + *Azotobacter* + Mycorrhiza, while the smallest was recorded in control. Increased attributes is due to application of biofertilizers in combination with RDF because of balanced nutrition and better availability of nutrients due to fungal and bacterial activity in the root zone. Bio-fertilizers and inorganic fertilizers with combination have improved the diameter of florets significantly.

The data pertaining to the effect of biofertilizers on floret length is depicted in Table-2 revealed that the maximum floret length (7.32 cm) was obtained in $T_6$ (100% RDF + *Azotobacter* + PSB) followed by 7.24 cm in $T_8$ (100% RDF + *Azospirillum* + PSB). While, the minimum floret length (6.29 cm) was recorded in control ($T_1$). Similar finding was given by Choudhury and Sarangi (2020) [7]. It clearly showed that all the treatments had significantly improved the length of florets by enhancing the nutrient uptake, especially helped in production of auxin like substances which was translocated to apical region and increased the floret length respectively (Kumari *et al*., 2014) [17] and Chauhan and Kumar (2007) [5].

The data presented in Table-2 showed that, the treatment $T_6$ (100% RDF + *Azotobacter* + PSB) produced significantly longest spike (84.56 cm) followed by 83.16 cm in $T_8$ (100% RDF + *Azospirillum* + PSB). Whereas, the plants grown in control ($T_1$) produced shortest spike (72.88 cm). Similar confirmation was given by Meena *et al.* (2018) [18]. It is evident from the results that spike length was directly correlated with plant height. Combined application of chemical fertilizers and biofertilizers showed a significant influence on growth of gladiolus cv. American Beauty (Shrivastva and Govil, 2007) [24]. Application of biofertilizers and chemical fertilizers alone and combination resulted in more spike length. The enhanced spike length may be due to more availability of nitrogen and other nutrients. Nitrogen is a main constituent of chlorophyll, protein and amino acids and plays an important role in cell division, protein synthesis and metabolite transport that help to build the plant tissues. The increased spike length may also be attributed to the favorable effects of phytohormones like auxin and gibberellins produced by *Azotobacter*, PSB and Mycorrhiza which might have improved the root system of the plant, which in turn might have helped in better nutrient uptake and this might have enhanced the spike length (Gupta *et al.*, 2004) [12]. Similar findings have also been reported by Singh *et al.* (2003) [6] in rose, Yadav *et al.* (2005) [25] and Chaudhary *et al*. (2013) [6] in gladiolus.

The data presented in Table-2 revealed that, the treatment $T_6$ (100% RDF + *Azotobacter* + PSB) produced significantly longest spike length (73.41 cm) followed by 72.06 cm in $T_8$ (100% RDF +*Azospirillum* + PSB). Whereas, the plants grown in control ($T_1$) produced shortest spike length (63.12 cm). Similar confirmation was given by Meena *et al.* (2018) [18] that the longest rachis was observed with treatment (39.03) RDF 75% + PSB + *Azotobacter* + Mycorrhiza, while the shortest rachis was recorded in control (33.53). It is also clear that combined application of chemical fertilizers along with biofertilizers at higher rates showed the beneficial effect on various growth and flowering attributes. It might be due to that *Azotobacter* accumulate the nitrogen near the root zone of plant and PSB convert unavailable phosphorus to available form and increase the availability of phosphorus to plants (Kumar *et al*., 2012). It directly translocates the nutrients like phosphorus, Zn, Cu, K, Al, Mn and Mg from the soil to root cortex and increase the growth of associated plants by producing auxins, antibiotics etc. (Chauhan and Kumar, 2007) [5].

The data regarding the character, longevity of individual floret is depicted in Table-2. Maximum longevity of floret i.e. 8.2 days were recorded in $T_7$ (50% RDF + *Azotobacter* + PSB) followed by 7.73 days in $T_6$ (100% RDF + *Azotobacter* + PSB). Whereas, minimum longevity was recorded in $T_1$ i.e. Control (6.46 days). Biofertilizers influenced flower longevity due to the increased nutrient uptake by plant and greater development of water conductivity tissues. The delay in senescence may be due to presence of ethylene inhibitors in plant which delay senescence of florets. These results are in corroboration with the findings of Barreto *et al.* (2002) [2] in gerbera. It might be due to overall food and nutrient status of flowers under the treatment.

The data presented in Table-2 showed that, Longest flowering duration i.e. 16.43 days were recorded in $T_7$ (50% RDF + *Azotobacter* + PSB) followed by 16 days in $T_6$ (100% RDF

+*Azotobacter* + PSB). Whereas, smallest flowering duration (12.2 days) is observed in $T_1$ i.e. Control. The improvement in flowering duration might be because of the fact that the combined application of biofertilizers improved the soil health, water retention capacity and availability of micro-organisms. The result is in close conformity with the findings of Gangadharan and Gopinath (2000) [9], Godse *et al.* (2006) [11], Dalve *et al.* (2009) [8] in gladiolus.

**Table 2:** Effect of biofertilizers and RDF on various flowering characteristics

| Treatments | | Diameter of floret (cm) | Length of floret (cm) | Spike length (cm) | Rachis length (cm) | Longevity of floret (days) | Flowering duration of spike (days) |
|---|---|---|---|---|---|---|---|
| $T_1$ | Control | 11.74 | 6.29 | 72.88 | 63.12 | 6.46 | 12.20 |
| $T_2$ | 100% RDF + *Azotobacter* | 12.32 | 7.06 | 79.95 | 68.43 | 7.20 | 13.60 |
| $T_3$ | 100% RDF + *Azospirillum* | 12.18 | 6.92 | 79.14 | 67.90 | 7.06 | 12.76 |
| $T_4$ | 50% RDF + *Azotobacter* | 12.26 | 6.90 | 77.22 | 66.20 | 7.33 | 15.06 |
| $T_5$ | 50% RDF + *Azospirillum* | 12.04 | 6.70 | 76.20 | 65.36 | 7.26 | 14.13 |
| $T_6$ | 100% RDF + *Azotobacter* + PSB | 12.96 | 7.32 | 84.56 | 73.41 | 7.73 | 16 |
| $T_7$ | 50% RDF + *Azotobacter* + PSB | 12.47 | 7.18 | 82.53 | 69.81 | 8.20 | 16.43 |
| $T_8$ | 100% RDF + *Azospirillum* + PSB | 12.70 | 7.24 | 83.16 | 72.06 | 7.0 | 15.43 |
| $T_9$ | 50% RDF + *Azospirillum* + PSB | 12.44 | 7.11 | 81.40 | 68.79 | 7.53 | 15.63 |
| SEM | | 0.086 | 0.042 | 0.191 | 0.276 | 0.076 | 0.209 |
| CD 5% | | 0.259 | 0.126 | 0.573 | 0.829 | 0.230 | 0.627 |

## Conclusion

The results may be concluded as application of biofertilizers singly or in different combinations has significant effect on all flowering characters. Among various biofertilizers and their combinations, (*Azotobacter* + *phosphobacteria*) were found best, followed by *Azospirillum* + *Phosphobacteria* and control treatment show least value for these parameters.

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