

**“EFFECT OF BIOFERTILIZERS WITH DIFFERENT LEVELS
OF NITROGEN AND PHOSPHORUS ON GROWTH AND
FLOWER YIELD OF GLADIOLUS
(*Gladiolus grandiflorus* L.)”**

M.Sc. (Hort.) Thesis

by

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INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (Chhattisgarh)
2016**

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Thesis

Submitted to the

Indira Gandhi Krishi Vishwavidyalaya, Raipur

by

SUSHIL KUMAR KASHYAP

**IN PARTIAL FULFILMENT OF THE
REQUIREMENTS FOR THE
DEGREE OF**

Master of Science

In

(Horticulture)

College ID -120114202

U.E. ID - 20141520421


JUNE, 2016

CERTIFICATE - I

This is to certify that the thesis entitled "Effect of biofertilizers with different levels of nitrogen and phosphorus on growth and flower yield of gladiolus (*Gladiolus grandiflorus* L.) cv. Candyman" Submitted in partial fulfillment of the requirement for the degree of "Master of science in Horticulture" of the Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) is a record of the bonafide research work carried out by **Sushil kumar kashyap** under my guidance and supervision. The subject of the thesis has been approved by the students Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published / published part has been fully acknowledged. All the assistance and help received during the course of the investigation have been duly acknowledged by him.

Date: 25.6.2012


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Advisory Committee

THESIS APPROVED BY THE STUDENT ADVISORY COMMITTEE

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(Major Advisor and Chairman)


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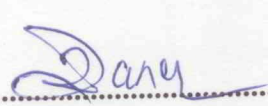
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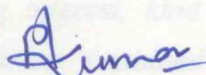

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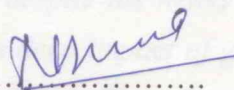
CERTIFICATE - II

This is to certify that the thesis entitled **“Effect of biofertilizers with different levels of nitrogen and phosphorus on growth and flower yield of gladiolus (*Gladiolus grandiflorus* L.) cv. Candyman”** Submitted by **Sushil Kumar Kashyap** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur in partial fulfillment of requirements for the degree of M.Sc. (Hort.) in the Department of Floriculture and Landscape Architecture has been approved by the External Examiner and Students Advisory Committee after oral examination.

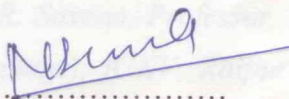
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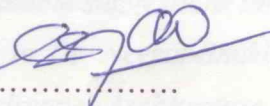
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ACKNOWLEDGEMENT

“The beauty of the destination is half veiled and the fragrance of the success half dull until the traces of all those enlightening the path are left to fly with the wind spreading word of thankfulness”.

*Keeping this in view; it would be unfair on my part if I don't think the mentioned few. With a sense of high resolve and reverence my sincere and deep sense of gratitude to adorable, **Dr. Neeraj Shukla** Professor and Head, Department of Floriculture and Landscape Architecture, college of Agriculture, Raipur who is chairman of my advisory committee, for his inspiring guidance, constructive criticism and timely advisement during the entire course of investigation and preparation of manuscript.*

I feel immense pleasure in expressing my heartiest thank and deep sense of gratitude to my co-advisor Shri T. Tirkey, Assistant Professor, Department of Floriculture and Landscape Architecture for his enduring interest, kind attitude, scholastic guidance, inspiring suggestions, constant supervision, sustained support, constructive criticism coupled with kindness and patience in leading my path to achieve the destination during the entire move despite his heavy schedule of work. With a sense of high resolve and reverence, in a deep impact of gratefulness, thanks to the members of my advisory committee, Dr. Tapas Chowdhury, Senior Scientist, Department of Microbiology, IGKV, and Dr. R.R. Saxena, Professor, Department of Agricultural Statistics and Social Science (Language), IGKV, Raipur for their kind cooperation, guidance, continued inspiration and valuable suggestions throughout the tenure of this investigation. My sincere most thanks to Dr. Neeraj Shukla, Professor and Head, Department of Floriculture and Landscape Architecture, college of Agriculture, Raipur.

I am highly obliged to Hon'ble Vice- Chancellor Dr. S.K. Patil, Dr. S.K. Rao, Dean, College of Agriculture, Dr. J.S. Urkurkar, Director Research Services, Dr. M.P. Thakur, Director Extension Services, Dr. S.S. Shaw, Director of Instructions and Dr. O.P. Kashyap, Dean Student Welfare IGKV, Raipur for providing necessary facilities to conduct the investigation.

I feel honored to express my deep sense of gratitude to Dr. Neeraj Shukla, Dr. Gaurav Sharma, Sh. T. Tirkey, Dr. L.S. Verma, and other technical and non-technical staff members of the Department of Floriculture and Landscape Architecture, IGKV, Raipur for their help, affectionate encouragement and useful suggestions during the tenure of this investigation.

I do respectfully acknowledge Shri. T. Tirkey, Assistant Professor, Department of Floriculture and Landscape Architecture, IGKV, Raipur for his kind attention and constant support for helping during the period of investigation.

I do respectfully acknowledge Shri G.L. Sharma, Assistant Professor, Department of Fruit Science, IGKV, Raipur for his kind attention and constant support for helping during the period of investigation.

I would like to thanks to the unrelenting support of non technical staff of my department Gautam bhaiya, Radhe bhaiya, Harsh bhaiya for their help during this piece of work.

I would like to express my sincere gratitude to Dr. M. Pandey (Librarian, Nehru Library, Raipur) and Shri U.K. Watti for giving me there kind help during my present study.

I am grateful to all of my respected seniors Vikas sir, Vivek sir, Ptram sir, Upenra sir, Pankaj sir for their support, affection, encouragement and cooperation which made my path easier.

I would like to express my special thanks to my friends and batchmates Abhilash, Dhanesh, Nutan, Neelima, Amit, Pramod, Mukesh, Jitendra, Tamleshwar, Ramsing, who remain always very close to my heart and shared my all bright and dull phases of life with lots of smiles and courage.

Such endeavor is impossible without family support and I was lucky to enjoy this at all stages. Thus word cannot express my heartiest gratitude for my father Shri. Kamal Ram Kashyap, my mother Smt. Dumri Bai Kashyap, My grandfather Shri. Harinath Kashyap, My grandmother Smt. Chayati Bai Kashyap, My brother Gokul Kumar Kashyap, My Sister Hem Kumari Baghel whose sincere prayers have become light for the successful completion of this investigation.

I am deeply indebted to all my well wishers who helped me directly or indirectly to complete this investigation. I have no works to convey by name, but each of them knows that they have my cordial thanks.

At last but not least, I am thankful to the almighty God for all the blessings bestowed upon me, and because of which I am at this position today. "For you will light my lamp; the lord my God will my Darkness."

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Date:*

(Sushil Kumar Kashyap)

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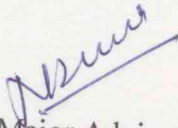
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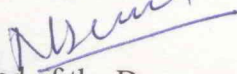
%	-	Per cent
/	-	Per
@	-	At the rate
°C	-	Degree Centigrade
Azt.	-	Azotobacter
PSB	-	Phosphate solubilizing bacteria
CD	-	Critical difference
<i>et al.</i>	-	Et alia (others)
Fig.	-	Figure
G	-	Gram
ha	-	Hectare
K	-	Potassium
kg	-	Kilogram
M	-	Meter
cm	-	Centimetre
N	-	Nitrogen
No.	-	Number
N.S.	-	Non Significant
P	-	Phosphorus
Q	-	Quintal
SEm±	-	Standard error of mean
Sig.	-	Significant
T	-	Treatment
cv.	-	Cultivar
wt.	-	Weight
<i>i.e.</i>	-	That is
ml	-	millilitre
vol.	-	Volume
viz.	-	Namely
max.	-	maximum
min.	-	minimum
RDF	-	Recommended dose of fertilizer

THESIS ABSTRACT

- a) Title of the thesis : "Effect of biofertilizers with different levels of Nitrogen and Phosphorus on growth and flower yield of Gladiolus (*Gladiolus grandiflorus* L.) cv. Candyman "
- b) Name of student : Sushil Kumar Kashyap
- c) Name and Address of of major Advisor : Dr. Neeraj Shukla
(Professor and Head, Department of Floriculture and Landscape Architecture)
- d) Degree to be awarded : M.Sc. (Hort.) Floriculture and Landscape Architecture)
- e) Year of award of degree : 2016
- f) Major subject : Floriculture and Landscape Architecture


Signature of Major Advisor


Signature of the Student


Signature Head of the Department

Date: 25.6.2012

ABSTRACT

An experiment entitled "Effect of biofertilizers with different levels of nitrogen and phosphorus on growth and flower yield of gladiolus (*Gladiolus grandiflorus* L.) cv. Candyman". The experiment was conducted at the Horticulture Nursery, Department of Floriculture and Landscape Architecture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.) during the year 2015-16.

The studies consisted of seven treatments which were combinations of 100% RDF to 75% RDF of Nitrogen and Phosphorus fertilizers with and without biofertilizers Azotobacter and PSB and were replicated thrice in Randomized Block Design (RBD).

The results revealed that plants receiving 75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azotobacter + PSB significantly increased growth, flowering, quality and yield attributes of gladiolus viz., days required for sprouting of corms, days required for spike emergence, days required for opening of first pair of florets, days required for 50% flowering, length of fully opened florets, diameter of fully opened florets, length of spike, length of rachis, number of florets spike⁻¹, number of spike plant⁻¹, number of spike plot⁻¹, number of spike ha⁻¹, number of corms plant⁻¹ and number of cormels plant⁻¹ when compared with RDF and other treatments. As regarding diameter of fully opened florets the treatment of 75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azotobacter + PSB, 100% N and P (150:100:80 kg NPK ha⁻¹) + Azotobacter + PSB and RDF alone were found significantly *at par* with each other. 100% N and P (150:100:80 kg NPK ha⁻¹) + Azotobacter + PSB also increased growth, flowering, yield and quality of gladiolus significantly over RDF except days required for sprouting of corms, days required for 50% flowering, length of spike, number of corms plant⁻¹ and number of cormels plant⁻¹.

शोध ग्रंथ सारांश

- अ. शोध ग्रंथ का शीर्षक :- "जैविक खाद का विभिन्न स्तर के नत्रजन व स्फुर खाद का ग्लेडीयोलस के विकास एवं पुष्प उत्पादन पर प्रभाव"
- ब. छात्रा का नाम :- सुशील कुमार कश्यप
- स. मुख्य सलाहकार का नाम एवं पता :- "नीरज शुक्ला, इं.गां.कृ.वि. विद्यालय, रायपुर"
इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर (छ.ग.)
- द. उपाधि :- एम. एस. सी. (उद्यानिकी)
- ई. मुख्य विषय :- पुष्प विज्ञान एवं भुदृश्य वास्तुकला

मुख्य सलाहकार का हस्ताक्षर

तारीख : 25/6/2016

छात्र का हस्ताक्षर

विभागाध्यक्ष का हस्ताक्षर

सारांश

प्रयोग शीर्षक "जैविक खाद का विभिन्न स्तर के नत्रजन व स्फुर खाद का ग्लेडीयोलस के विकास एवं पुष्प उत्पादन पर प्रभाव"। प्रयोग कार्य उद्यानिकी नर्सरी, इंदिरा गांधी कृषि विश्वविद्यालय, रायपुर, (छ.ग.) में 2015-16 के दौरान आयोजित किया गया।

इस अध्ययन में सात ट्रिटमेंट रखा गया जहाँ 100% आर.डी.एफ. तथा 75% आर.डी.एफ. के नत्रजन, स्फुर खाद के मिश्रण को ऐजेटोबैक्टर तथा पी.एस.बी. जैविक खाद के साथ तथा के बीना तीन अनुकरणों में यादृच्छिक ब्लोक अभिकल्पना (आर.बी.डी.) में सुनियोजित किया गया।

परिणाम से व्यक्त होता है कि 75% नत्रजन तथा स्फुर (112.5: 75: 80 कि.ग्रा. नत्रजन, स्फुर, पोटाश, प्रति हेक्टेयर) + ऐजेटोबैक्टर + पी.एस.बी सार्थकता से ग्लेडीयोलस के विकास, पुष्पन, गुण तथा उत्पादन विशेषण क्रमशः कंद के अंकुरित होने के लिए आवश्यक दिन, पुष्प बाली के अन्मुलन के लिए आवश्यक दिन, प्रति जोड़े पुष्पक के खुलने लिए आवश्यक दिन, पुष्पक की लम्बाई, मेरूदण्ड की लम्बाई, पुष्पक की संख्या प्रति बाली, पुष्पक की संख्या प्रति पौधा, पुष्पक की संख्या प्रति हेक्टेयर, प्रति पौधे द्यनकंद की संख्या, प्रति पौधे छोटे द्यनकंद की संख्या में आर.डी.एफ. तथा अन्य ट्रिटमेंट की तुलना में अधिक बढ़ोतरी प्राप्त हुई। पुर्णतः खीले

पुष्प के व्यास के संबंध में ट्रिटमेन्ट 75% नत्रजन और स्फुर (112.5:75:80 कि.ग्रा. नत्रजन, स्फुर, पोटाश) + ऐजेटोबैक्टर + पी.एस.बी., 100% नत्रजन और स्फुर (150:100:80 कि.ग्रा. नत्रजन, स्फुर, पोटाश) ऐजेटोबैक्टर + पी.एस.बी. तथा केवल आर.डी.एफ. एक दूसरे की तुलना में समतुल्य सार्थक प्राप्त हुए। 100% नत्रजन और स्फुर (150:100:80 कि.ग्रा. नत्रजन, स्फुर, पोटाश) + ऐजेटोबैक्टर + पी.एस.बी. से भी विकास में वृद्धि, पुष्प उत्पादन और ग्लेडीयोलस के गुणों में सार्थकता से वृद्धि प्राप्त हुई परन्तु अपवादतः द्यनकंद अन्मुलन में लगे दिन, 50% पुष्पन में लगे दिन, मेरूदण्ड की लम्बाई, प्रति पौधा द्यनकंद की संख्या, प्रति पौधे छोटे द्यन कंद की संख्या में वृद्धि हेतु अधिक दिन लगे।

CHAPTER- I

INTRODUCTION

Gladiolus (*Gladiolus grandiflorus* L.) is an important ornamental and commercial flower known as queen of the bulbous plants, belongs to the family Iridaceae. Gladiolus is a flower of glamour and perfection which is known as the queen of bulbous flowers due to its flower spikes with florets of massive form, brilliant colours, attractive shapes, varying size and excellent self life. It is a popular flowering plant and is a native of South Africa and Asia Minor. It is one of the most important bulbous ornamental flowers, occupying fifth positions in International floriculture trade (Sharma and Sharga, 1994). Gladiolus is grown as flower bed in gardens and used in floral arrangements for interior decoration as well as making high quality bouquets (Lepchaet *al.*, 2007).

In India, Floriculture is now practiced in over an area of 2.54 lakh hectares (Anon., 2012a) which has increased from 4000 hectares in 1962 to 7500 hectares in 1976. A large portion of this area has occupied by rose, chrysanthemum, marigold, gladiolus, carnation, and tuberose. Gladiolus is the second most important bulbous cutflower and is being grown around the world (Cohat, 1993). The major gladiolus growing area in India are Kalimpong (West Bengal), New Delhi, Srinagar (Jammu and Kashmir), Pune, Ludhiana, Bangalore and Nainital (Uttarakhand). This phenomenal growth of floriculture in India during the last couple of decade has led the world floriculture experts to visualize for country as major player in floriculture trade infuture.

The agroclimatic condition of chhattisgarh are favourable for cultivation of gladiolus and is cultivated in 1496 ha. area. There are heavy demands of flowers during marriage ceremonies, festivals and other social functions and most of the requirements are fulfilled by growers and suppliers of Kolkata and Nagpur, respectly. There is a large gap between the supply and demand which the local growers may utilize to their advantage. Gladiolus is one of the dominating flowers in the flower market of Chhattisgarh. State is blessed with many natural advantages like abundant sunshine, favourable temperature for its growth. These congenial

factors place the region in an ideal position to become a leading producer in National and international market. Hence there is much scope for increase of gladiolus cultivation in Chhattisgarh.

There is urgent need to increase the area and productivity in Chhattisgarh. Today, agrochemicals are being used excessively to increase the crop productivity and their continuous application has adversely affected the soil fertility, nutrient balance, accumulation of toxic chemicals in the soil, 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 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 ecohazards. 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 and fungi) that naturally activate the microorganisms found in the soil, restoring the soil fertility and improve physico-chemical and biological properties of soil. Bio-fertilizers are less expensive, eco-friendly, sustainable and do not require non renewable source of their production and improve crop growth and quality of crop by production of plant hormones. They increase sustainability of soil and make it productive . The beneficial microbes in the soil, which are of great significance to horticultural situation, are the biological nitrogen fixers.

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 disease conditions. Certain strains of bio-fertilizers which are being commercially used in horticultural crops are; *Azotobacter*, *Azospirillum*, *Phosphate solubilizing bacteria* (PSB) and Vesicular Arbuscular Mycorrhiza (VAM) fungi. As reported in numerous studies, *Azospirillum* and *Azotobacter* are well known symbiotic Nitrogen-fixing bacteria which help the plants indirectly through better nitrogen (N) fixation or improving the nutrient availability in the soil, while PSB solubilizes unavailable forms of phosphorous to available forms to plants.

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. Bio-fertilizers are potential sources of plant nutrients. It is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host plant. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus and stimulating plant growth through the synthesis of growth promoting substances.

The microorganisms in biofertilizers restore the soils natural nutrient cycle and build soil organic matter. Through the use of biofertilizers, healthy plants can be grown while enhancing the sustainability and the health of soil. Since they play several roles, a preferred scientific term for such beneficial bacteria is plant growth promoting rhizobacteria (PGPR). Therefore, they are extremely advantageous in enriching the soil fertility and fulfillment of the plant nutrient requirements by supplying the organic nutrients through microorganisms and their by product. Hence, it does not contain any chemicals which are harmful to the living soil. They are ecofriendly organic agro input and more cost effective than chemical fertilizers.

Bio-fertilizers are microbial culture, which make availability of certain plant nutrients to crops by various actions. *Rhizobium*, *Azotobacter* and *Azospirillum* fixes atmospheric nitrogen while certain bacteria/ fungal culture viz; *Bacillus polymyxa* / *Aspergillus awamori* helps in phosphate solubilization of both native and applied sparingly soluble phosphate. Looking to the rising price of chemical fertilizers, microbial cultures can provide an eco-friendly viable support to small and marginal farmers by partly replacing inorganic fertilizers use in crop production.

Bio-fertilizers seem 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 investigate the potential role of bio-fertilizers application for enhancing growth, yield and improving quality of *Gladiolus grandiflorus* in a sustainable agricultural production system in order to reduce the amount of excessive chemical material released to the environment.

Azotobacter is group of free- living, aerobic, non-symbiotic nitrogen fixing bacterias, which can substitute part of nitrogen fertilizers. *Azotobacter* saves

addition of nitrogenous fertilizers by 10-20 % *i.e.* it fixes nearly 20-40 Kg N per hectare while PSB provide 1.5 to 2 times more phosphorus.

There is no information is available on the effect of biofertilizer on the gladiolus flower production and flower quality under Chhattisgarh plains. Therefore the experiment entitled “**Effect of biofertilizers with different levels of nitrogen and phosphorus on growth and flower yield of gladiolus (*Gladiolus grandiflorus* L.) cv. Candyman**” was carried out with the following objectives.

1. To study the effect of biofertilizers with different levels of Nitrogen and Phosphorus on growth and flower yield of gladiolus.
2. To find out the best combination of biofertilizer with different levels of Nitrogen and Phosphorus on growth and flower yield of gladiolus.

CHAPTER- II

REVIEW OF LITERATURE

The present research work is carried out to study the “Effect of biofertilizers with different levels of Nitrogen and Phosphorus on growth and flower yield of Gladiolus (*Gladiolus grandiflorus* L.) cv. Candyman.” Chemical fertilizers are very important for growth and yield of any crop but the cost of chemical fertilizers is increasing day by day and this results in increased cost of production and its higher use also damages the soil and environment. Therefore, it is necessary to find out alternative nutrients which reduce the cost of production with less damage to the environment. So the current trend is to supplement the chemical fertilizers with organic ones, more particularly the biofertilizers of microbial origin.

Flowers are gaining popularity day by day and so the area under these crops is increasing at a faster rate. Though there is a vast scope to use biofertilizers in floriculture crops, limited literature is available on their use in floricultural crops. Therefore, the present review includes work done on the use of biofertilizers in horticultural crops, which is presented in the following heads.

2.1 Effect of biofertilizers with different levels of Nitrogen and Phosphorus on vegetative growth.

Gupta (1997) observed that the height of the plant, number of leaves, main stem diameter and leaf area per plant were significantly increased in the treatment receiving Azotobacter and PSB through soil application and seedling application with 75% recommended dose of nitrogen in marigold.

Chandrikapure (1998) conducted an experiment on marigold and observed that the plant height, stem diameter, number of leaves and branches were maximum under treatments receiving bioinoculants Azotobacter and PSB with 100% N.

Deshmukh (1998) conducted an experiment on Gaillardia and observed that all the growth characters such as plant height, stem diameter, number of leaves, branches and leaf area were maximum in treatments inoculated with Azotobacter

and PSB in combination with 75% and 100% recommended dose of nitrogen application compared to uninoculated treatments.

Kaloti (1998) conducted an experiment on aster and found that the plant height, number of branches, number of leaves, main stem diameter and leaf area per plant were significantly increased in treatment receiving Azotobacter + PSB with 75% and 100% recommended dose of N.

Chandrikapur *et al.* (1999) conducted an experiment on marigold and observed that the vegetative growth of plant like height, stem diameter, number of leaves and branches were maximum under treatment receiving Azotobacter compared to uninoculated.

Mostafa (2002) conducted experiment on Calendula cv. Muraj and Decklonis and found that biofertilizers increased leaf area of cultivar Muraj while plant height, inflorescence diameter of Decklonis.

Debnath and Wange (2002) reported that inoculation of gladiolus corms with Azotobacter chroococcum strain followed by application of 325 kg N/ha was found to be significantly effective showing improvement in plant growth, increased the yield of above and under ground part, gave higher monetary return and saved 75 kg N/ha over recommended dose of nitrogen (400 kg N/ha) during rabi season.

Prabhat Kumar *et al.* (2003) stated that application of biofertilizers like PSB + VAM proved to be most effective in increasing plant height, number of leaves, leaf area and number of branches in China aster.

Rathod *et al.* (2003) reported that the effect of biofertilizers Azotobacter in combination with PSB along with 100 % NPK showed improved growth of gaillardia with respect to highest number of branches (41) and highest number of leaves (218.67).

Sharma *et al.* (2008) stated that minimum days to sprouting, maximum plant height and number of leaves per plant were recorded when plants were received recommended does of NPK alongwith vermicompost and dual inoculation of Azotobacter and PSB in gladiolus.

Abbasniyare *et al.* (2012) Carried out an experiment using in Spathiphyllum illusion, Nitrokara (nitrogen biofertilizer), urea, Nitokara + urea , Barvar-2 (phosphate biofertilizer), triple super phosphate , triple super phosphate+

Barvar-2, Barvar-2 + Nitrokara. The results showed the treatment “triple super phosphate+Baravar 2” was increasing leaves number , dry and fresh weight of leaves and the size of spadix. “Barvar-2+Nitrokara” has the best effect on leaf size, height of flower stalk and chlorophyll content. The maximum amount of absorbing nitrogen was obtained under urea application.

Habib and Zaghoul (2012) studied the effect of biofertilizers (Nitrogen and Phosphorene), tamariend seed gum, compost and potassium fertilizer on growth of *Chrysanthemum frutescence* plants and reported that all biofertilizers had a positive effect on growth except Tamarind seed gum treatment.

Hadwani *et al.* (2013) reported application of FYM @ 30 t/ha + PSB @ 2 g/m² + Azotobacter @ 2 g/m² took minimum days to sprouting whereas, maximum plant height and plant spread at E-W and N-S were recorded in treatment ½ RDF + NC @ 1 t/ha + PSB @ 1g/m² + Azotobacter @ 1 g/m².

Moghadam and Shoor (2013) studied the effect of vermi-compost and two bio-fertilizer applications on growth, yield and quality of petunia (*Petunia hybrid*) The treatment receiving *Azospirillum* + Phosphate solubilizing bacterium + Vermicompost + NPK (25% of recommended dose) recorded the highest plant height, number of branches, plant spread, leaf area index and dry matter accumulation.

Kumar *et al.* (2013) conducted an experiment on integrated nutrient management in gladiolus and revealed that the treatment 80% R.D. of NPK (96 kg N, 80 kg P and 80 kg K/ha) + vermicompost (128 q/ha) + *Azotobacter* (5.28 kg/ha) showed better response to plant height, number of leaves and other growth parameters.

Basoli *et al.* (2014) investigated the impact of integrated nutrient management on gladiolus cv. Novalux and revealed that application of 3/4th recommended dose of N, P and K+ *Azotobacter* + PSB + KSB was found most effective in weight of corm /plant, size of corm, available N and K content in soil. The number of florets opened per spike and available P content in soil were recorded maximum with application of ½ recommended dose of N, P and K+ *Azotobacter* + PSB + KSB. Whereas, 3/4th recommended dose of N, P and K+ *Azotobacter* + PSB resulted maximum number of corms and cormels /plant.

Anop Kumari *et al.* (2014) conducted an experiment in the screen-house to investigate the effect of different levels of nitrogen (0, 10, 20 and 30 g/m²) and biofertilizers (*Azotobacter* and *Azospirillum*) on growth, yield and nutrient content of *Chrysanthemum* and revealed that interaction effect of different levels of nitrogen and biofertilizers on number of branches per plant was found to be non-significant. The maximum fresh weight of plant (102.36 g) was noticed with the application of *Azospirillum* along with nitrogen 20 g/m², whereas, in second year, it was maximum (103.45 g) with the application of *Azospirillum* in combination of nitrogen 30 g/m². The maximum dry weight of plant (10.52 and 10.50 g) was observed in the application of *Azospirillum* along with nitrogen 20 g/m², which was at par with *Azospirillum* along with nitrogen 30 g/m² (10.06 and 10.40 g).

Ahmad Ali *et al.* (2014) stated that the treatment containing *Azospirillum* gained highest values in terms of plant height, florets spike⁻¹, Spike length, Florets fresh weight and earlier sprouting than rest of the treatments in gladiolus.

Hoda and Mona (2014) reported that the petunia plants when sprayed with *Azospirillum lipoferum* (nitrogen fixing bacteria, N.F.B.) and *Bacillus polymxa* (phosphate dissolving bacteria P.D.B.) showed significantly increases in the studied vegetative growth (*i.e.*, plant height, branches number, leaf area, dry weights of shoots and roots) when compared with the control (full dose of NPK chemical fertilizer = 5 g plant⁻¹ twice).

Sarwa *et al.* (2014) found that application of *Azospirillum* + *Azotobacter* + 100% recommended dose of NPK had noted significant effect on plant height and number of leaves, when compared to control in petunia.

2.2 Effect of biofertilizers with different levels of Nitrogen and Phosphorus on flower yield and quality parameters.

Baig and Madalgiri (1989) studied the effect of *Azotobacter* inoculation by root dipping at the time of transplanting and obtained enhanced yield level much as that of 75 kg N ha⁻¹ along resulting in saving nearly 30 % nitrogen.

Kulkarni and Khonde (1990) observed that application of 75 kg N ha⁻¹ along with *Azotobacter* and *Azospirillum* help to increasing the flower yield of aster.

Martinez *et al.* (1993) reported that soil inoculation of *Azotobacter chroococcum* improved the flower quality in terms of diameter and weight in balsam.

Wange and Patil (1994) reported that application of 100 kg N ha⁻¹ alone as well as with inoculated the soil with *Azotobacter* + *Azospirillum* were significantly increased the number of flowers and flower yield per stem in *Polianthus tuberosa* cv. Single in pot experiment.

Patil *et al.* (1995) stated that for getting increased yield of under ground part, floral stalk as well as more monetary return, the tuberose crop should be inoculated with biofertilizers individuals or in combination of fertilizers.

Wange *et al.* (1995) studied the effect of biofertilizers alone and in combination of different levels of nitrogen on tuberose cv. Single petal and observed that bulb yield was highest in treatment receiving 50 kg N ha⁻¹ inoculated with *Azospirillum*.

Misra (1997) found that gladiolus corms treating with Nafed Super Culture (NSC) containing *Azotobacter*, significantly increased the number of florets per spike of gladiolus plant, number of cormels per plant and weight of cormels per plant.

Ramaswamy *et al.* (1999) found that the PSB treatment resulted in highest mean spike length, number of flower per spike, flower weight, number of tubers and tuber weight per plant and yield of 3.088 tones ha⁻¹ for first year and 2.75 tones per hectare for second year in tuberose.

Shitre (1999) conducted an experiment on tuberose and revealed that yield contributing characters like number of florets per spike ,number of florets per plant, weight of loose flower per plant and size of florets were maximum with application of 150 kg N ha⁻¹ along with *Azotobacter* and *Azospirillum*.

Swaminathan *et al.* (1999) conducted an experiment on tuberose and observed that application of *Azospirillum* and phosphobacteria in combination with inorganic nutrients significantly increased, number of florets per spike, spike yield and floret quality.

Parthiban *et al.* (2001) observed that treating amaranthus with *Azotobacter* resulted in maximum flower yield of 17,736 kg per hectare in pink and 17,132 kg per hectare in white type flower during kharif season.

Rathod *et al.* (2003) found that application 100% recommended dose of NPK of the recommended dose and Azotobacter with PSB improved flower diameter and early flowering in gaillardia.

Venkatesha *et al.* (2003) observed that days for spike emergence, days for 50% flowering, number of spike ha^{-1} , cormels ha^{-1} , florets per spike, rachis length, vase life was significant influenced with application of Azospirillum and vespercular Arbuscular Mycorrhiza (VAM) combined with different rates of N and P in gladiolus cv. White prosperity.

Rathod *et al.* (2003) reported that the highest number of flowers per plant (70.23) and yield of flowers ha^{-1} (87.11 q ha^{-1}) were recorded in gaillardia with application of 100% NPK of recommended dose along with Azotobacter in combination with phosphorus solubilizing bacteria.

Pandhre (2003) conducted an experiment on tuberose and revealed that days required for spike emergence, days required for 50% flowering, number of florets per spike, length of spike, size of florets were maximum with application of Azotobacter + PSB+ 75% NP + 100% recommended dose of K/ha.

Prabhat kumar *et al.* (2003) stated that application of biofertilizers like PSB and VAM proved to be most effective in increasing flower weight diameter, number of flowers and flower yield in china aster.

Gayithri *et al.* (2004) conducted an experiment on statice and observed that flower components were significantly increased by application of 75% recommended dose of N and P + 100% K + Vermicompost + Azotobacter + PSB and was at par with 50% N and P + 100% K + Vermicompost + Azotobacter + PSB in respect of spike emergence, initiation of flowers, flower harvesting, spike length, spread and number of branches per spike.

Godes (2005) conducted an experiment on gladiolus and found that days required for flowering, number of florets per spike, spikes ha^{-1} were found maximum with application of 80% RDF with Vermicompost + Azotobacter + PSB.

Kukde *et al.* (2006) studied the effect of organic manures and bio-fertilizers on growth, flowering and yield of tuberose cv. Single and revealed that the tuberose bulb treated with Azotobacter and PSB at 2.5 g kg^{-1} , was early opening of first pair of floret, better flower quality parameter, maximum yield of flower ha^{-1}

and fresh recorded weight of bulb plant⁻¹ followed by application of vermicompost @ 10t ha⁻¹.

Godse *et al.* (2006) revealed that plants receiving vermicompost 8 t ha⁻¹+ Azotobacter and PSB @ 25 kg ha⁻¹ each + 80% RDF significantly increased yield and quality attributes of gladiolus viz., number of spikes ha⁻¹, length of spike and number of florets spike⁻¹ when compared with RDF and other treatments.

Sharma *et al.* (2008) Stated that minimum days to sprouting, maximum spike length and number of florets per spike quality of corms and cormels were recorded when plants were received recommended does of NPK along with vermicompost and dual inoculation of Azotobacter and PSB in gladiolus.

Habib and Zaghoul (2012) studied the effect of biofertilizers (Nitrogen and Phosphorus), tamariend seed gum, compost and potassium fertilizer on flowering behavior of *Chrysanthemum frutescence* plants and reported that all biofertilizers had a positive effect on flowering and flower yield except Tamarind seed gum treatment.

Kumar *et al.* (2012) observed that application of PSB and boron in tuberose gave the better performance in flowering and yield comparison to control, while best were recorded under the combined application of PSB inoculation and boron at higher doses (PSB @ 200 g/l + Boron @ 0.6%).

Kumar *et al.* (2013) conducted an experiment on integrated nutrient management in gladiolus and revealed that the treatment 80% R.D. of NPK (96 kg N, 80 kg P and 80 kg K/ha) + vermicompost (128 q/ha) + *Azotobacter* (5.28 kg/ha) showed better response to plant growth, flowering and its attributes.

Moghadam and Shoor (2013) revealed that yield attributes such as number of flowers per plant, number of flowers per plot, flower yield/plant, flower yield/plot were maximum in treatment receiving *Azospirillum* sp. + Phosphate solubilizing bacterium + Vermicompost + NPK (25% of recommended dose). The early flower bud initiation, 50 percent flowering and more flowering duration was achieved in the treatment receiving *Azospirillum* sp. + Phosphate solubilizing bacterium + Vermicompost + NPK (25% of recommended dose).

Thumar *et al.* (2013) noticed that 70% RDF + 2 t ha⁻¹ vermicompost + Azotobacter + *Azospirillum* + PSB significantly was gave higher yield parameter

viz. flower yield per plant and flower yield per hectare in marigold whereas, quality parameters *viz.* shelf life of flower was significantly highest in treatment 200 kg N/ha + 100 kg P₂O₅/ha + 100 kg K₂O/ha + 15 t ha⁻¹ FYM .

Hadwani *et al.* (2013) revealed that application of FYM @ 30 t/ha + PSB @ 2 g/m² + Azotobacter @ 2 g/m² was recorded maximum length of spike, number of florets per spike, number of spike per plant, longest vase life and *in situ* longevity of spike were recorded in treatment ½ RDF + NC @ 1 t/ha + PSB @ 1g/m² + Azotobacter @ 1 g/m².

Anop Kumari *et al.* (2014) revealed that maximum flower yield per plant (59.16 and 67.22 g) was recorded with *Azospirillum* application along with nitrogen 20 g/m².

Ahmad Ali *et al.* (2014) stated that the treatment containing *Azospirillum* gained highest values in terms of plant height, florets spike-1, Spike length, Florets fresh weight and earlier sprouting than rest of the treatments in gladiolus.

Hoda and Mona (2014) reported that *Petunia* plants sprayed with *Azospirillum lipoferum* (nitrogen fixing bacteria, N.F.B.) and *Bacillus polymyxa* (phosphate dissolving bacteria, P.D.B.) showed significantly increases in the flower parameters *i.e.* flowering date, number of flower/branch and flowering period) when compared with the control (100% RDF).

Sarwa *et al.* (2014) observed that the application of *Azospirillum* + Azotobacter + 100% dose of NPK was increases the quality and yield of the flowers, when compared to control in *petunia*.

CHAPTER- III

MATERIALS AND METHODS

The present study entitled “**Effect of biofertilizers with different levels of Nitrogen and Phosphorus on growth and flower yield of Gladiolus (*Gladiolus grandiflorus* L.) cv. Candyman**” was conducted at the Horticulture Nursery, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2015-16.

The details regarding materials used and techniques applied during the course of investigation have been described in this chapter.

3.1 Experimental site

The experimental site was located at the Horticultural Research cum Instructional Farm of College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh.

3.2 Geographical Situation

Raipur, the capital of Chhattisgarh state of India is situated in the central part of Chhattisgarh and lies between 21⁰14'06.8" N latitude and 81⁰42'41" E longitude at an altitude of 289.56 m above mean sea level.

3.3 Agro-climatic condition

Raipur is located in dry sub humid agro-climatic region. May is the hottest month and December is the coolest. The pattern of rainfall particularly during June to September varies greatly. The maximum temperature of this region may reach as high as 46⁰C during summer and minimum may fall of 16⁰C during winter. During crop periods, the total rainfall 16.1 mm was received. The atmospheric humidity is high from June to October. Meteorological details about the weather conditions prevailing during the course of experiment, as recorded at Meteorological Observatory, IGKV, Raipur have been presented in Appendix-I and depicted through Fig. 1.

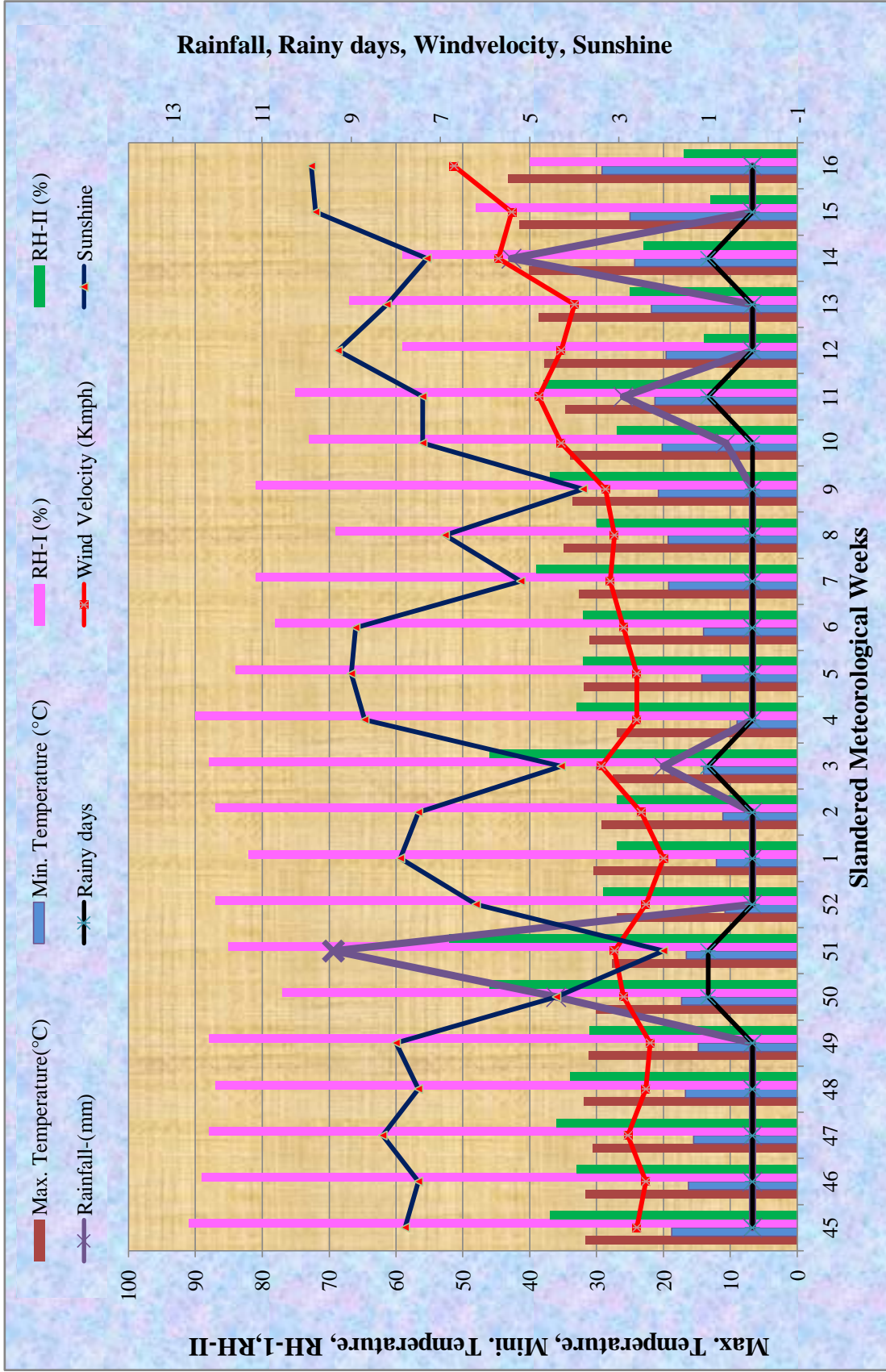


Fig. 1 Meteorological details about the weather conditions prevailing during the course of experiment

3.6 Cultural operations

3.6.1 Field preparation

Field preparation is done by ploughing the field with mould board plough once, followed by harrowing, leveling and collection of crop debris during harrowing. Then the field was divided into three blocks spaced at one meter distance. Each block was further sub-divided into seven sub-plots at a distance of 0.5 m.

3.6.2 Corms treatment

Gladiolus corms were dipped in the slurry of biofertilizers (Azotobacter and PSB) made by mixing 5g of culture in jaggery water for 1 kg of corms.

3.6.3 Treatment details

T₁ : 100% RDF (150:100:80 kg NPK ha⁻¹) as Control

T₂ : 100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azotobacter

T₃ : 75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azotobacter

T₄ : 100% N and 100% P (150:100:80 kg NPK ha⁻¹) + PSB

T₅ : 100% N and 75% P (150:75:80 kg NPK ha⁻¹) + PSB

T₆ : 100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azotobacter + PSB

T₇ : 75% N and 100% P (112.5:75:80 kg NPK ha⁻¹) + Azotobacter + PSB

Note:-

- Full dose of potassium *i.e.* 80 kg/ha as a basal dose was applied in all of the treatments during the experiment.
- Nitrogen and Phosphorus was applied as per the treatments mentioned above.



Plate I: A view of experimental site

3.6.4 Planting

The usual method of propagation of gladiolus is through corms and cormels. Healthy uniform sized corms ranged between 3 cm to 5 cm diameter were planted after treating with fungicides thiram.

3.6.5 Manure and fertilizer application

Recommended fertilizer doses *i.e.* nitrogen (150 kg/ha), phosphorus (100 kg/ha) and potassium (80 kg/ha) were applied as per the treatments. Full doses of potassium and phosphorus were given as basal application at the time of planting whereas, nitrogen was given in 2 split doses at 3 and 6 leaf stages.

3.6.6 Irrigation

Pre emergence irrigation was given just after planting of corms and then irrigation was given to crop at an interval of 8-10 days as per the requirement.

3.6.7 Weeding and earthing up

Intercultural operations followed by weeding and earthing up was done at 40 and 60 days after planting, respectively to avoid weed competition and to cover up the exposed corms and also to prevent the crop from lodging.

3.6.8 Plant protections measures

Fusarium wilt, thrips and tobacco caterpillar were noticed during growing period. Monocrotophos @ 2% and Carbendazim @ 0.1% were sprayed in order to protect the crop from insect, pests and fungal diseases.

3.6.9 Harvesting of spikes

Gladiolus spike were harvested when lower 1-2 florets has shown colour. Harvesting of spikes is done at 2-3 days intervals.

3.7 Lifting of corms and cormels

The corms and cormels were lifted about 60 days after cutting of spikes. The corms are lifted with the tools like digging fork, garden spade or khurpi. The infected and injured corms and cormels, stone and pebbles were removed. The corms are then dried in shade for one week.

3.7.1 Observations to be taken

3.7.1 Growth parameters

3.7.1.1 Days required for sprouting of corms

Number of days required for sprouting of corms was counted from the date of planting to the initiation of few sprouts.

3.7.1.2 Number of leaves per plant

Total number of leaves per plant were counted in tagged plants. The number of leaves per plant was recorded up to the 90 days at an interval of 30 days.

3.7.1.3 Height of plant (cm)

Height of labeled plants were recorded at 30 days interval up to 90 days.

3.7.2 Flowering parameters

3.7.2.1 Days required for spike emergence

Count the number of days required for 50 percent emergence of spikes after planting of corms.

3.7.2.2 Days required for opening of first pair of florets

Number of days required for opening of first pair of florets on spike after planting was counted and recorded.

3.7.2.3 Day required for 50% flowering

Number of days required for opening of first pair of florets in 50 percent population of plants in was recorded.

3.7.3 Quality parameters

3.7.3.1 Length of fully opened florets (cm)

Length of fully opened florets were measured with the help of scale from its base to the tip and its diameter with the help of vernier calipers.

3.7.3.2 Diameter of fully opened florets (cm)

Diameter of fully opened florets were measured with the help of scale from its base to the tip and its diameter with the help of vernier calipers.

3.7.3.3 Length of spike (cm)

Length of spike was measured from the point of its emergence to the top.

3.7.3.4 Length of rachis (cm)

Length from basal floret to the top most floret was measured as rachis length.

3.7.4 Yield attributing characters

3.7.4.1 Number of florets per spike

Total number of florets on the spike was counted.

3.7.4.2 Number of spikes per plant

Total number of spikes per plant was counted.

3.7.4.3 Number of spikes per plot and per hectare

Total number of spikes produced per net plot and per ha. was recoded and calculated for per counted and recorded.

3.7.4.4 Number of corms and cormels per plant

At the end of experiment the corms and cormels were taken out from the plot and the observations in respect of corms and cormels per plant were recorded .

3.8 Statistical analysis

The data were arranged in tabular form. The statistical analysis was done for RCBD (Randomized Complete Block Design) according to the method given by Panse and Sukhatme (1985). The calculated “F” value is compared with table F values at 5% and 10% level of significance. If the calculated “F” value was greater than the table value the difference was said to be significant and critical difference was calculated for further comparison. The data collected from various observations recorded in the field as well as laboratory were subjected to statistical analysis to know the degree of variation amongst all the treatments. The analysis of variance was carried out for each character separately as per method of Panse and Sukhatme (1985). Significance of differences among treatments was tested using the following skeleton.

Source of variation	Degree of freedom	Sum of squar	Mean sum of squar	“F” cakulated	“F” tabulated
Replication	(r-1)	RSS	RMSS	RMSS/ErMSS	
Treatment	(t-1)	TrSS	TrMSS	TrMSS/ErMSS	
Error	(r-1)(t-1)	ErSS	ErMSS		
Total	(rt-1)	TSS			

Where,

r = Replication

t = Treatment

RSS = Sum of square for Replication

TrSS = Sum of square for Treatment

ErSS = Error sum of square

RMSS = Mean sum of square for replication

TrMSS = Mean sum of square for treatment

ErMSS = Mean sum of square for error

In order to compare the mean value of treatment, standard error and critical values were calculated as follows.

a. Standard Error of mean

$$S\text{ Em } \pm = \sqrt{\frac{EMS}{r}}$$

Where,

S Em = Standard error of mean

EMS = Error Mean of square

r = Number of replications

b. Critical Difference

CD = SEd x t Value at 5% at error degree of freedom

$$S\text{ Ed} = \sqrt{\frac{2EMS}{r}}$$

Where,

S Ed = Standard error of difference between two treatment means

EMS = Error Mean of square

r = Number of replications

CHAPTER- IV

RESULTS AND DISCUSSION

The result on different parameters in respected of growth, flowering, yield attributing characters and flower quality studied during the course of investigation were statistically analyzed and the findings obtained are presented below. Data recorded on various aspects during the course of investigation revealed interesting facts, which are briefly described in this chapter under the following heads.

4.1 Vegetative growth characters

4.2 Flowering characters

4.3 Corm and cormel yield characters

4.1 Effect of biofertilizers with different levels of nitrogen and phosphorus on growth.

Vegetative growth parameters of gladiolus were significantly affected by the treatments of biofertilizers with different levels of nitrogen and phosphorus.

4.1.1 Day required for sprouting of corms

The observation regarding days required for sprouting of corms after planting are presented in Table 4.

From the data it was revealed, that the significant difference was observed among treatments in respect of number of days required for spouting of corms. Numerically early sprouting was recorded (4.33 days) in treatments T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB}, while maximum days were required (7.33 days) in treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.} followed by T₄ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + PSB}. Treatments T₄, T₃, T₁, T₅ and T₂ were statistically *at par* with each other.

Table 4: Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for sprouting of corms.

Treatments	Days required for sprouting of corms
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	7.00
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	6.33
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	7.33
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	7.33
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	6.67
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	4.33
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	4.33
SE (m)±	2.13
CD at 5 %	1.89

From these observation, it is clear that application of T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} and T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. +PSB} both were recorded early sprouting and it may be due to the combined effect of chemical fertilizers and biofertilizers which provide easy and early energy to the corms thus, it accelerated physiological activity within the corms and early sprouting.

Similar results was also reported by Sharma *et al.* (2008) in gladiolus, who started that all the growth parameters showed positive effect with application of integrated nutrient management. Hadwani *et al.* (2013) also reported early sprouting with application of Azotobacter and PSB in tuberose.

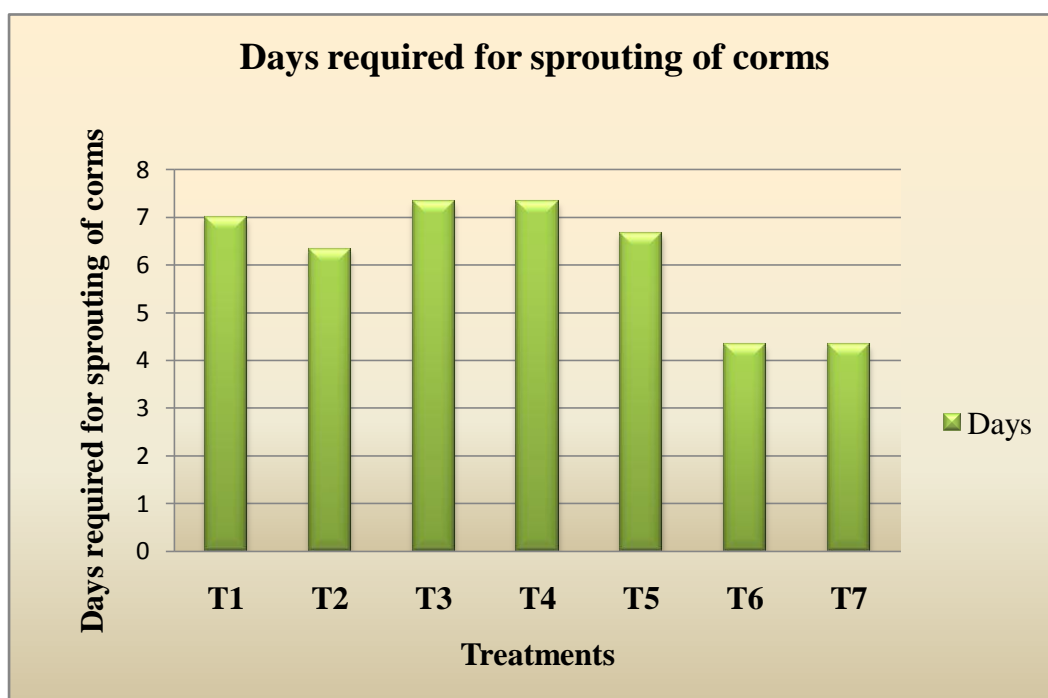


Fig.3 Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for sprouting of corms

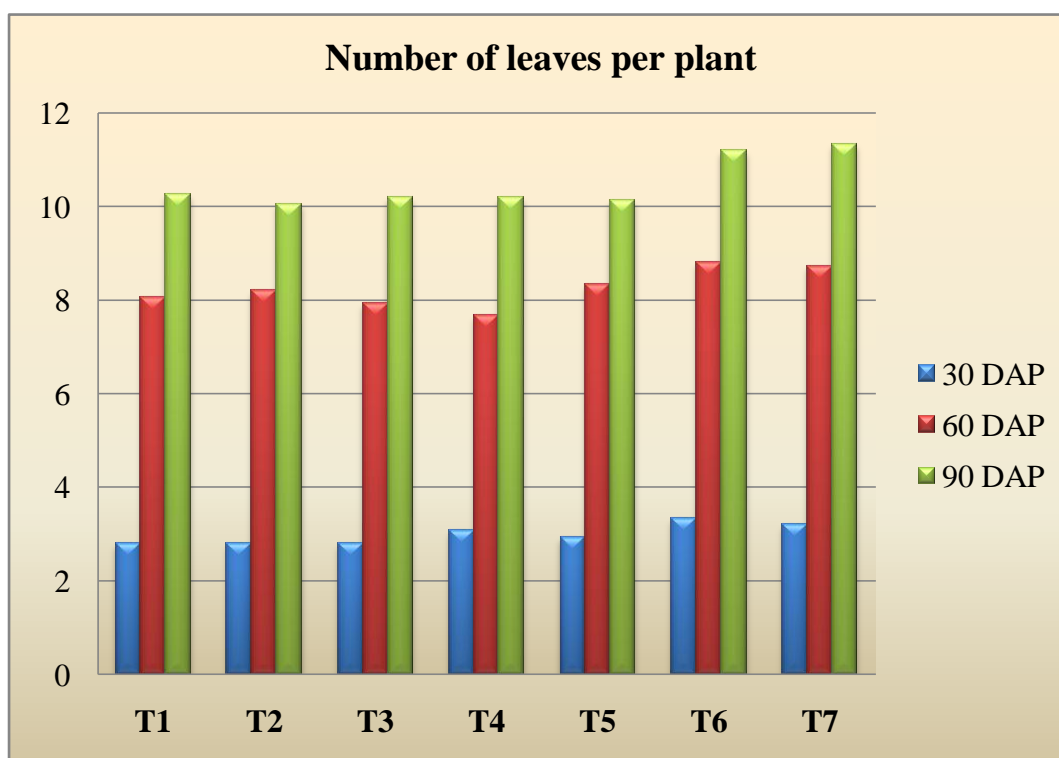


Fig.4 Effect of biofertilizers with different levels of nitrogen and phosphorus on number of leaves per plant

4.1.2 Number of leaves per plant

The periodical data in respect of number of leaves per plant was recorded and presented in Table 5 and depicted in Fig. 4.

Table 5: Effect of biofertilizers with different levels of nitrogen and phosphorus on number of leaves per plant.

Treatments	Number of leaves per plant		
	30 DAP	60 DAP	90 DAP
T1	2.80	8.07	10.27
T2	2.80	8.20	10.07
T3	2.80	7.93	10.20
T4	3.07	7.67	10.20
T5	2.93	8.33	10.13
T6	3.33	8.80	11.20
T7	3.20	8.73	11.33
SE (m)±	0.51	0.74	0.84
CD at 5 %	N.S.	0.65	0.74

Data indicated that, the significant differences were noted in among the treatments at 90 days after planting while no significant differences were recorded among the treatments at 30 days and 60 days after planting.

At 90 days after planting maximum number of leaves per plant (11.33) were observed under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} which was *at par* with T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} with 11.20 leaves. The minimum number of leaves (10.07) was observed under treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.}. This might be due to the application of appropriate dose of nitrogen and phosphorus with biofertilizer which enhanced nutrient absorption by increasing microbial activity

Similarly results were obtained by Basoli *et al.* (2014) in gladiolus by using 3/4th N, P and K+ *Azotobacter* + PSB + KSB. Kukde *et al.* (2006) in Tuberose by using *Azotobacter* and PSB at 2.5 g kg⁻¹ and Godse *et al.* (2006) in Gladiolus by using vermmicompost 8 t ha⁻¹ + *Azotobacter* and PSB @ 25 kg ha⁻¹ each + 80 % RDF.

4.1.3 Height of plant (cm)

The periodical observation in respect of height of plant were recorded and presented in Table 6 and depicted in Fig. 5. / The data indicated that there were significant differences observed among the treatments in respect of plant height from 60 and 90 days after planting, while no significant differences were recorded among the treatments at 30 days after planting.

At 60 days after planting application of T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} closely followed by T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 94.27 cm and 92.40 cm respectively were recorded significantly higher plant height. The minimum plant height (87.00 cm) was recorded under the treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}. Treatments T₅, T₄, T₁ and T₃ are statistically *at par* with each other in respect of plant height.

Table 6: Effect of biofertilizers with different levels of nitrogen and phosphorus on height of plant.

Treatment	Height of plant (cm)		
	30 DAP	60 DAP	90 DAP
T ₁	38.93	88.07	141.13
T ₂	38.93	91.07	145.80
T ₃	39.07	87.00	141.80
T ₄	38.60	88.40	138.13
T ₅	39.67	89.27	144.13
T ₆	42.33	94.27	153.33
T ₇	42.40	92.40	150.00
SE (m)±	5.57	4.88	8.08
CD at 5%	N.S.	4.33	10.06

At 90 days after planting application of T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 153.33 cm and 150.00 cm respectively were recorded significantly higher plant height. The minimum plant height (138.13 cm) was recorded under the treatment T₄ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + PSB}.

From these observations, it is clear that application of T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} recorded maximum plant height followed by T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}. It may be due to presence of nitrogen and phosphorus with Azotobacter and PSB which improves the absorption of macro and micro nutrients.

Similarly results were recorded by Godse *et al.* (2006) also reported that 80% RDF with application of PSB with Azotobacter significantly increased plant in gladiolus. Hadwani *et al.* (2013) in tuberose by using (1 / 2 RDF + NC @ 1t / ha + PSB @ 1g/m² +Azotobacter @ 1g/m²). Thumar (2013) also reported that maximum plant height was obtained in marigold by using 70% RDF + 2t ha⁻¹ vermicompost + Azotobacter + Azospirillum + PSB. Chandrikapure *et al.* (1998) and Gupta (1997) also reported that application of Azotobacter and PSB with sufficient dose of N increase plant height in marigold.

4.2 Effect of biofertilizer with different levels of nitrogen and phosphorus on flowering .

4.2.1 Days required for spike emergence

Data regarding number of days required for spike emergence from the planting of corms influenced by different treatment was recorded and presented in Table 7 and depicted in Fig 6.

Result revealed that there were significant differences among the treatment in respect of number of days required for spike emergence.

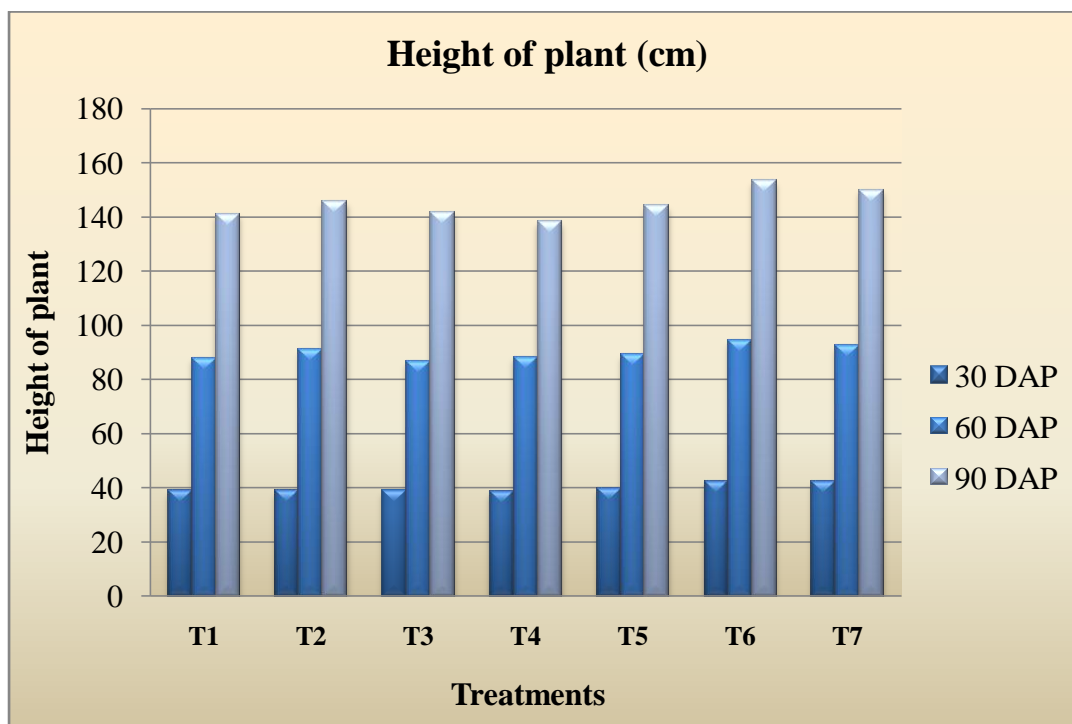


Fig.5 Effect of biofertilizers with different levels of nitrogen and phosphorus on height of plants

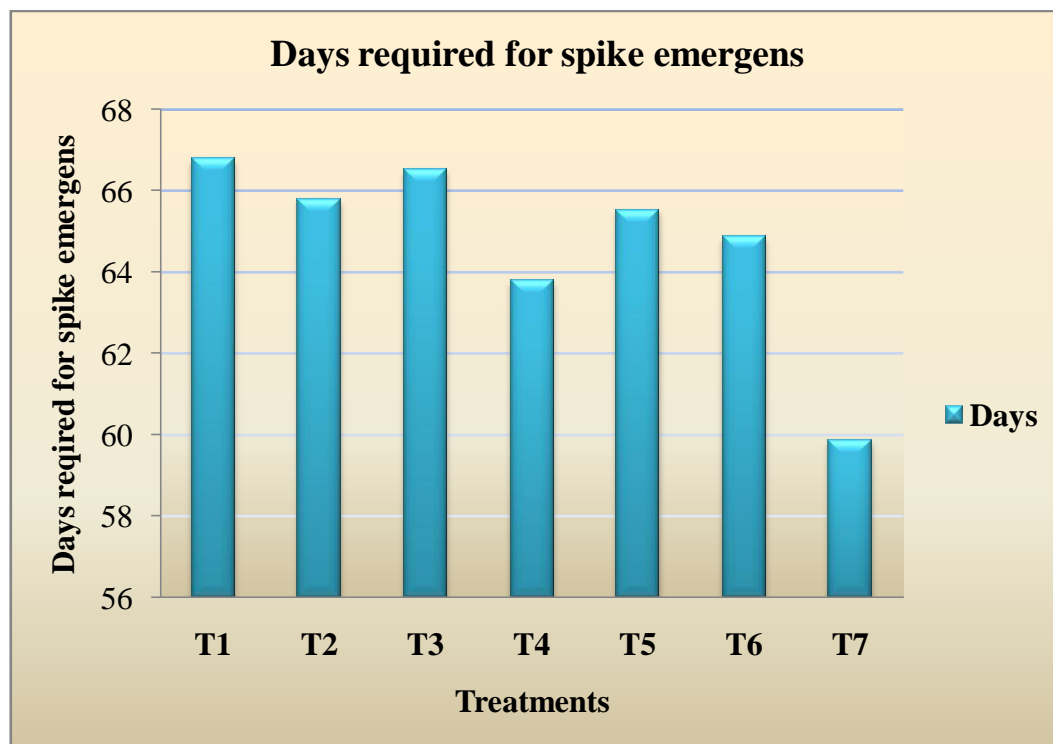


Fig.6 Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for spike emergence

Data presented in Table 7 indicates that, application of sufficient dose of inorganic fertilizers along with corms treated with biofertilizers T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azotobacter + PSB} was recorded minimum days (59.87 days) for spike emergence whereas, T₁ {100% RDF (150:100:80 kg NPK ha⁻¹)} control was recorded significantly more number of days (66.80) followed by T₃ (66.53) for spike emergence. / The early spike emergence was observed under T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azotobacter + PSB} and it might be due to more number of leaves and maximum plant height were recorded in this treatment. It is fact that application of biofertilizers with in combination of inorganic fertilizers easy and early supplies the nutrients to the plants, which increased vegetative growth.

These results are similar with Pandhre (2003) also reported minimum days was noticed for initiation flowering in Azotobacter + PSB + 75 % N and P + 100 % k/ha in tuberose.

Table 7: Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for spike emergence.

Treatments	Days required for spike emergence
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	66.80
T ₂ : 100% N and 100% P (150:100:80 kg NPK ha ⁻¹) + Azt.	65.80
T ₃ : 75% N and 100% P (112.5:100:80 kg NPK ha ⁻¹) + Azt.	66.53
T ₄ : 100% N and 100% P (150:100:80 kg NPK ha ⁻¹) + PSB	63.80
T ₅ : 100% N and 75% P (150:75:80 kg NPK ha ⁻¹) + PSB	65.53
T ₆ : 100% N and P (150:100:80 kg NPK ha ⁻¹) + Azt. + PSB	64.87
T ₇ : 75% N and P (112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	59.87
SE (m)±	3.55
CD at 5%	3.16

4.2.2 Days required for opening of first pair of florets on spike

Data in respected of days required for opening of first pair of florets on spike as influenced by different treatments was recorded and presented in Table 8 and depicted in Fig 8.

The data revealed that early opening of first pair of florets on spike (74.80 days) were observed under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}.

Table 8: Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for opening of first pair of florets on spike.

Treatment	Days required for opening of first pair of florets
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	78.93
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	77.87
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	78.93
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	78.07
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	77.47
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	75.87
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	74.80
SE (m) ±	1.10
CD at 5 %	0.98

The maximum days (78.93) were required for opening of first pair of florets were observed in treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.} followed by treatment T₄ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + PSB}.

The early opening of first pair of florets was recorded in T₇, whereas late opening of first pair of florets was observed in T₃ and T₄ and it may be due to profuse vegetative growth which were recorded in T₇. Similar observation were recorded in tuberose with application of Azotobacter + PSB + 75 % NP + 100% k/ha by Pandhre (2003) in tuberose and Gayithri *et al.* (2004) in static.

4.2.3 Days required for 50% flowering

Data in respected of days required for 50% flowering as influenced by different treatments was recorded and presented in Table 9 and depicted in Fig 7.

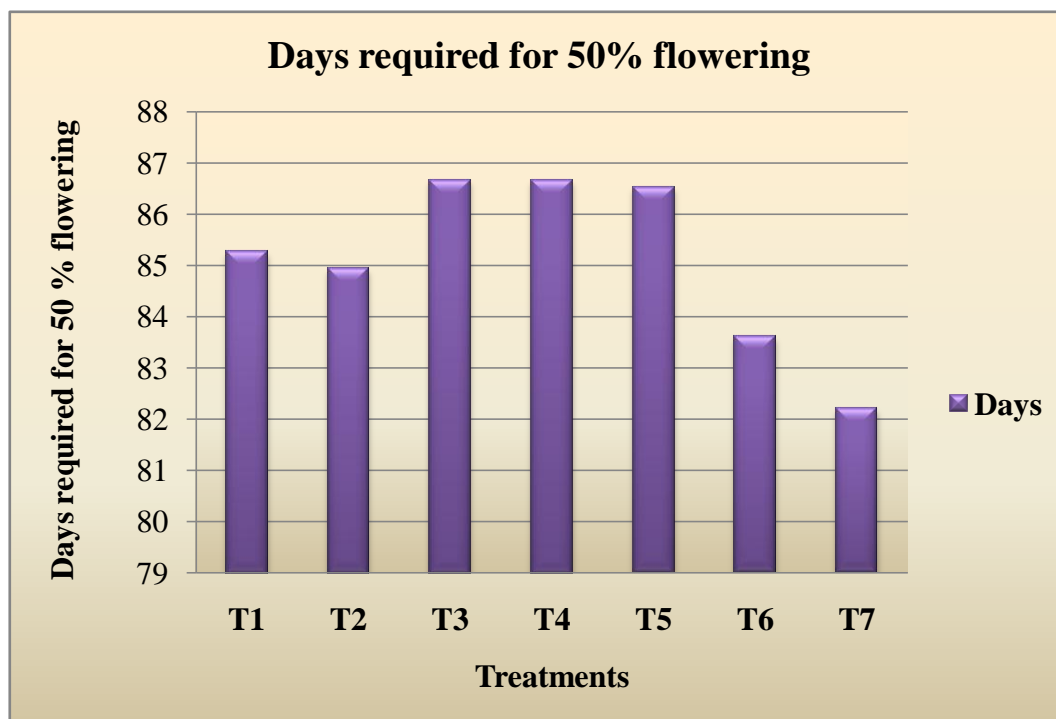


Fig.7 Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for 50% flowering

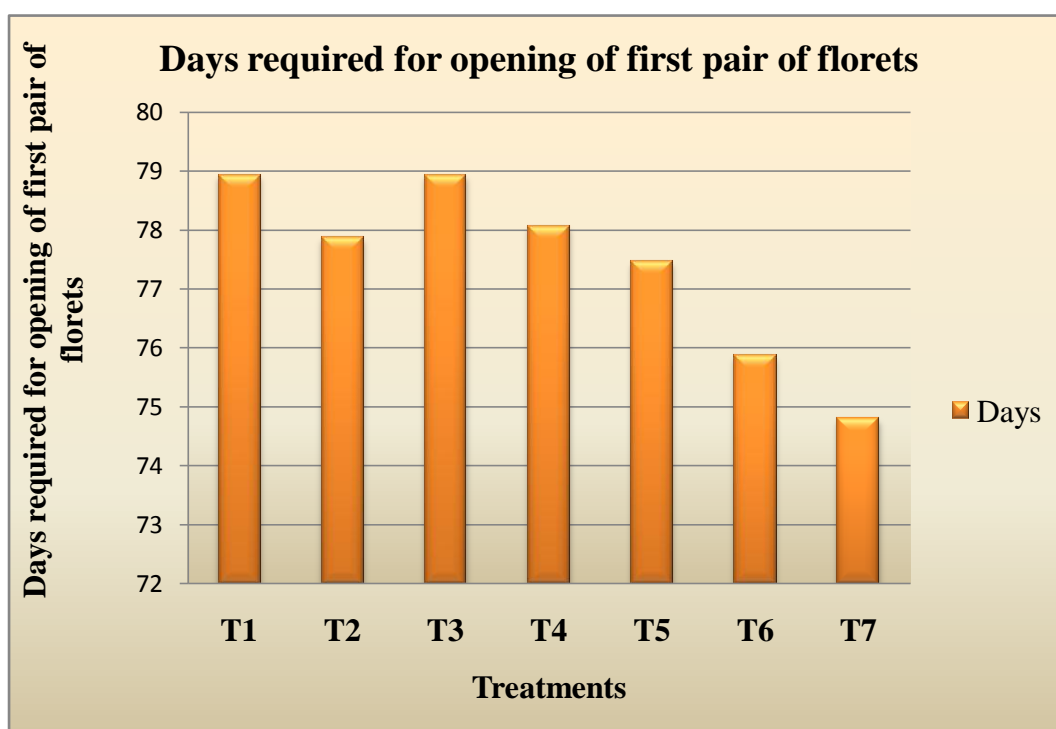


Fig.8 Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for opening of first pair of florets

Table 9: Effect of biofertilizers with different levels of nitrogen and phosphorus on days required for 50% flowering.

Treatment	Days required for 50% flowering
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	85.27
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	84.93
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	86.67
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	86.67
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	86.53
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	83.60
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	82.20
SE (m) ±	2.43
CD at 5 %	2.16

Findings revealed, that the minimum days (82.20 days) required for 50% plant population for flowering were observed under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}, which was *at par* with T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB}, whereas maximum days required for 50% flowering (86.67 days) under treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}.

The minimum days for 50% flowering was observed under the treatment T₇ and it may be due to early opening of florets was recorded in this treatment. Similar observation were recorded by Thumar *et al.* (2013) in African marigold by using 70% RDF + 2t ha⁻¹ vermicompost + Azotobacter + Azospirillum + PSB.

4.3 Effect of biofertilizer with different levels of nitrogen and phosphorus on flower quality.

4.3.1 Length of fully opened florets (cm)

Data regarding to length of fully opened florets as influenced by various treatment are presented in Table 10 and depicted in Fig. 9.

Table 10: Effect of biofertilizer with different levels of nitrogen and phosphorus on length of fully opened florets.

Treatments	Length of fully opened florets
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	7.91
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	8.03
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	7.73
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	8.18
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	7.83
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	8.41
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	8.70
SE (m) ±	0.33
CD at 5 %	N.S.

Results revealed, that there were no significant difference observed among treatment, for length of fully opened florets. As per the mean value the maximum length of fully opened florets was under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} (8.70 cm) and minimum was observed under treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.} *i.e.* 7.73 cm and it may be due to good growth which was recorded in T₇.

Similar results were also obtained by Venkatesha *et al.* (2002) with application of Azospirillum and Vesicular Arbuscular Mycorrhiza (VAM) with different rates N and P.

4.3.2 Diameter of fully opened florets (cm)

Data regarding diameter of fully opened florets as influenced by various treatment are presented in Table 11 and depicted in Fig.10.

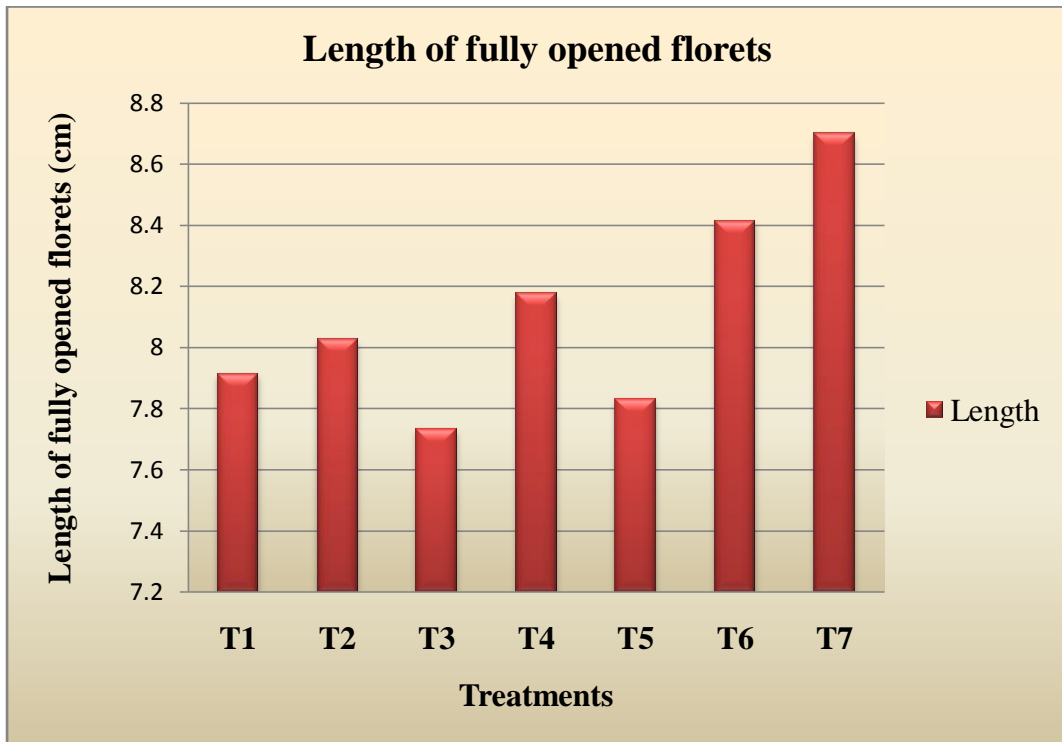


Fig.9 Effect of biofertilizers with different levels of nitrogen and phosphorus on length of fully opened florets

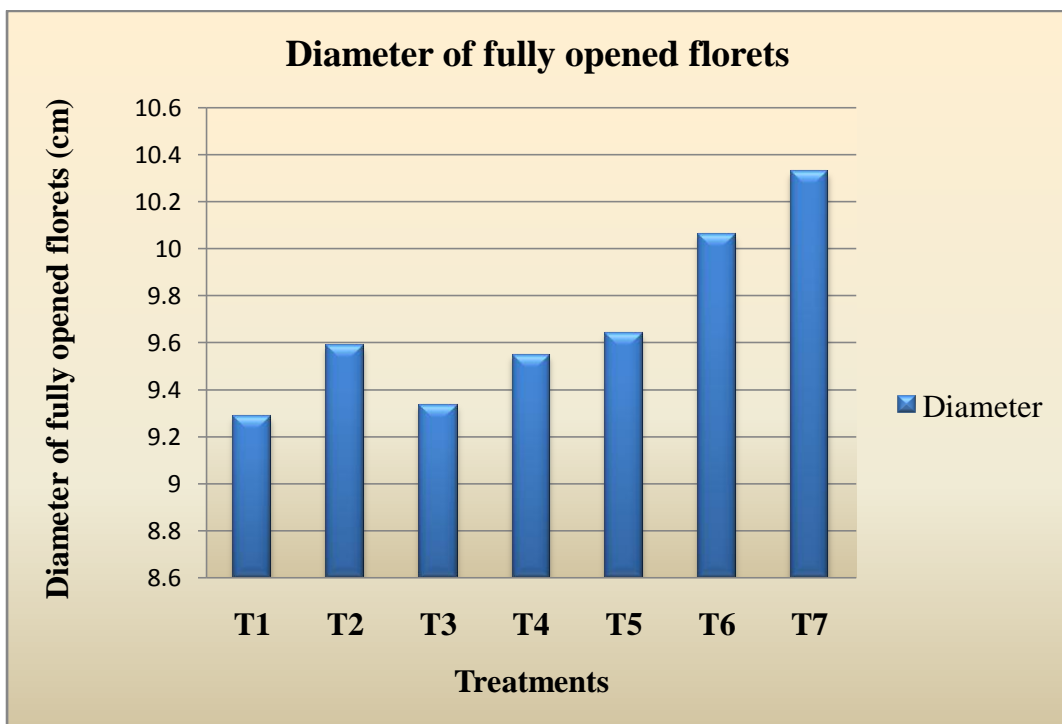


Fig.10 Effect of biofertilizers with different levels of nitrogen and phosphorus on diameter of fully opened florets

Table 11: Effect of biofertilizer with different levels of nitrogen and phosphorus on diameter of fully opened florets.

Treatments	Diameter of fully opened florets
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	9.29
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	9.59
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	9.33
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	9.55
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	9.64
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	10.06
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	10.33
SE (m) ±	0.58
CD at 5 %	0.51

In case of diameter of fully opened florets, it was maximum (10.33 cm) under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} which was *at par* with T₆ and minimum diameter (9.29 cm) of florets was observed under the control treatment T₁ {100% RDF (150:100:80 kg NPK ha⁻¹) as Control}.

It is observed that the application of both the biofertilizers with sufficient levels of nitrogen and phosphorus in T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} and in T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} were recorded significantly higher diameter of fully opened florets and these combinations were superiorly over all other treatments. This may be due to recorded more number of leaves which synthesized more food resulted good growth of florets.

Similar results were reported by Chandrikapure (1998) , who noted that flower size was increased with the application of Azotobacter and PSB in combination with nitrogen in marigold. Godse *et al.* (2006) also reported that 80% RDF with biofertilizer increased the diameter in gladiolus. Venkatesha *et al.* (2003) observed that application of Azospirillum and Vesicular Arbuscular Mycorrhiza (VAM) with different rates N and P significantly increased floret quality in gladiolus, cultivar- White Prosperity. Flower diameter was increased with application of biofertilizers in China aster reported by Prabhat Kumar *et al.* (2003).

4.3.3 Length of spike (cm).

Data regarding the length of spike as influenced by different treatment was recorded and presented in Table 12 and depicted in Fig 11.

The maximum length of spike (77.13 cm) was observed under the treatment T₇ which was *at par* with treatment T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} and significantly superior over all other treatments. The minimum length of spike (65.47 cm) was recorded under treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}.

Data indicated that the treatment with combination of Azotobacter and PSB along with different levels of nitrogen and phosphorus was showed best results. This may be due to the addition of biofertilizer with inorganic fertilizers which increased the availability of nutrients.

Table 12: Effect of biofertilizers with different levels of nitrogen and phosphorus on length of spike.

Treatment	Length of spike (cm)
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	67.87
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	68.00
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	65.47
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	71.60
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	66.00
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	75.93
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	77.13
SE (m) ±	3.24
CD at 5 %	2.87

Similar results were also obtained by Swaminathan *et al.* (1999) where they used Azospirillum and Phosphobacteria along with inorganic nutrients and reported increased spike length in tuberose. Uday Sharma *et al.* (2008) also reported that the maximum spike length of gladiolus was observed with recommended dose of NPK with Vermicompost and Azotobacter and PSB. Gayithri *et al.* (2004) also observed that spike length was increased by application of 50% N and P + 100% K + V.C. + Azotobacter + PSB in static.



Plate II : Response of biofertilizer on length of spike

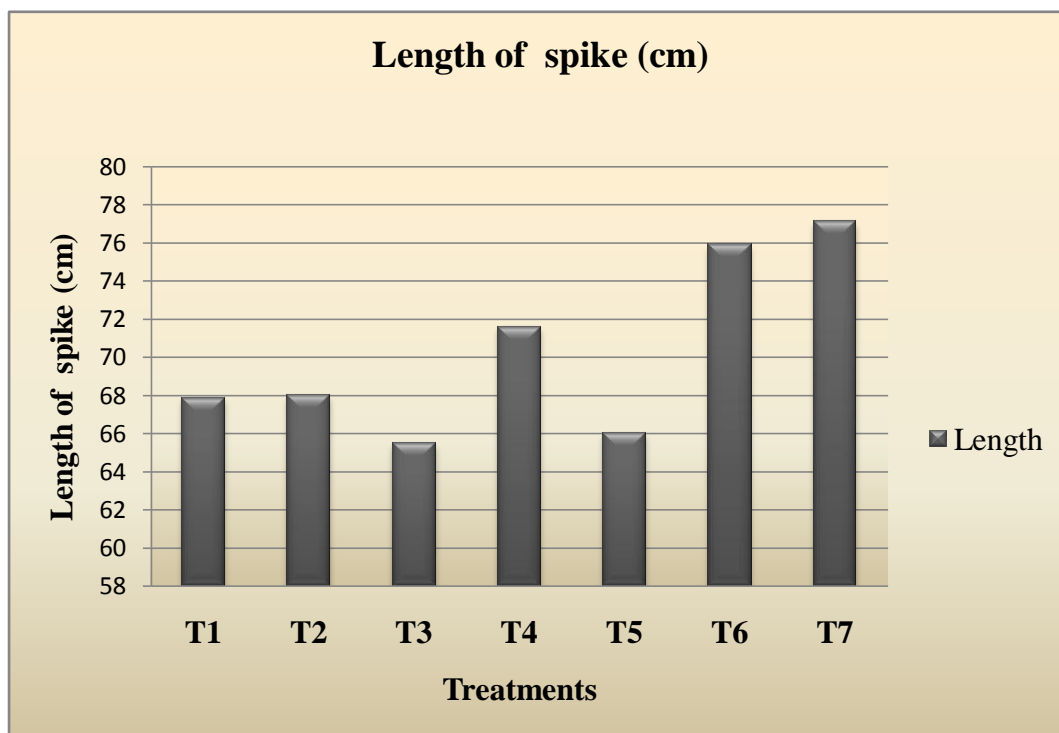


Fig.11 Effect of biofertilizers with different levels of nitrogen and phosphorus on length of spike (cm)

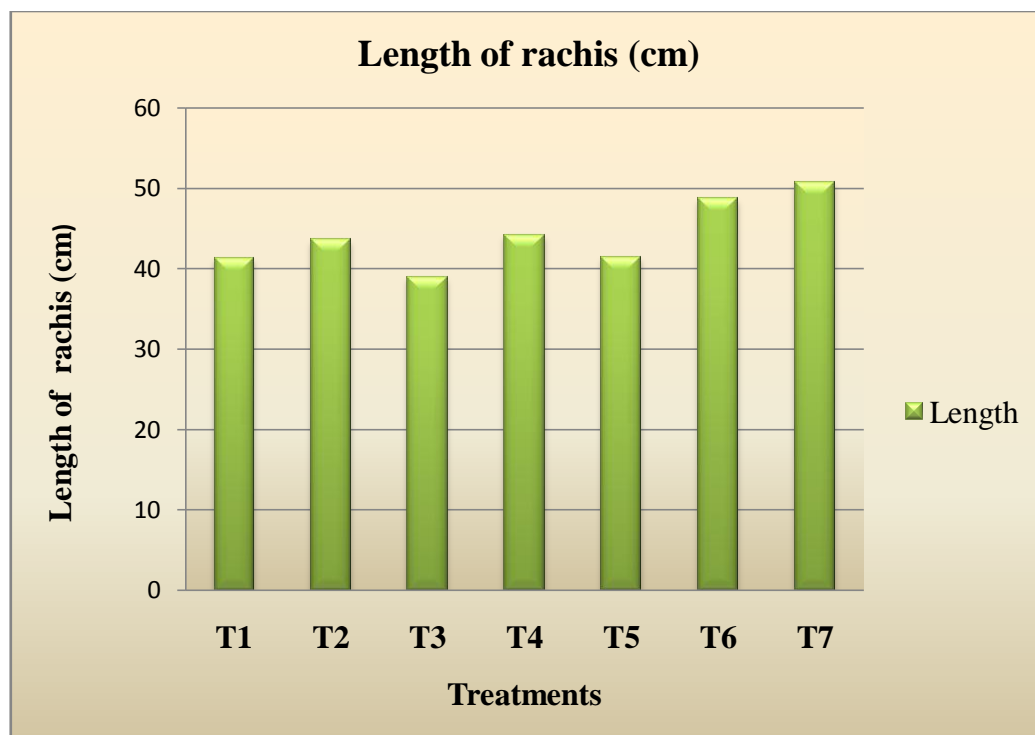


Fig.12 Effect of biofertilizers with different levels of nitrogen and phosphorus on length of rachis (cm)

4.3.4 Length of rachis (cm).

Data regarding the length of rachis were influenced by different treatments and presented in Table 13 and depicted in Fig 12.

Table 13: Effect of biofertilizers with different levels of nitrogen and phosphorus on length of rachis.

Treatment	Length of rachis (cm)
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	41.27
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	43.53
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	38.93
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	44.20
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	41.40
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	48.67
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	50.73
SE (m) ±	3.41
CD at 5 %	3.03

Data shows that the maximum length of rachis (50.73 cm) was observed under the treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}, which was *at par* with T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. +PSB} *i.e.* 48.67 cm. The minimum length of rachis (38.93 cm) was recorded under treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}. Treatment T₇ and T₆ were significantly superior over all other treatments and it may be due to maximum length of spike which were recorded in these treatments and therefore produced good length of rachis.

Similar results were also obtained by Gayithri *et al.* (2004) reported that the spike length was favorably influenced by application of 50% NP + 100% K + V.C. + Azotobacter + PSB in static.

4.4 Effect of biofertilizer with different levels of nitrogen and phosphorus on yield attributing characters.

4.4.1 Number of florets per spike

Data regarding number of florets per spike as influenced by different treatment was recorded and presented in Table 14 and depicted in Fig 13.

Data indicated that the maximum number of florets per spike (14.87) was observed under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. +PSB}

(14.40) which were *at par* with each other. The minimum number of florets per spike (13.13) was observed under treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹)+ Azt.}. The treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} and T₆ were found significantly superior over all the treatment. It may be due the application of biofertilizers with sufficient dose of NPK, increases the availability of nutrients and early mobilization from soil by the beneficial micro organisms.

Table 14: Effect of biofertilizer with different levels of nitrogen and phosphorus on number of florets per spike.

Treatment	Number of florets per spike
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	13.60
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	13.13
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	11.80
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	13.47
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	13.13
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	14.40
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	14.87
SE (m) ±	1.11
CD at 5 %	0.99

Similar results were reported by Misra (1997) who observed that the application of Nafed Super Culture containing Azotobacter significantly increased florets per spike in gladiolus. Wange *et al.* (1995) and Shitre (1993) also reported that more florets on spike was noticed with application of biofertilizers in tuberose. Ahmad Ali *et al.* (2014) also reported that biofertilizer like Azotobacter increased the number of floret per spike in gladiolus.

4.4.2 Number of spikes per plant.

Data regarding the number of spikes per plant as influenced by different treatments was recorded and presented in Table 15 and depicted in Fig.14.

The result revealed that there was significant difference among the treatments in respect of spikes per plant.

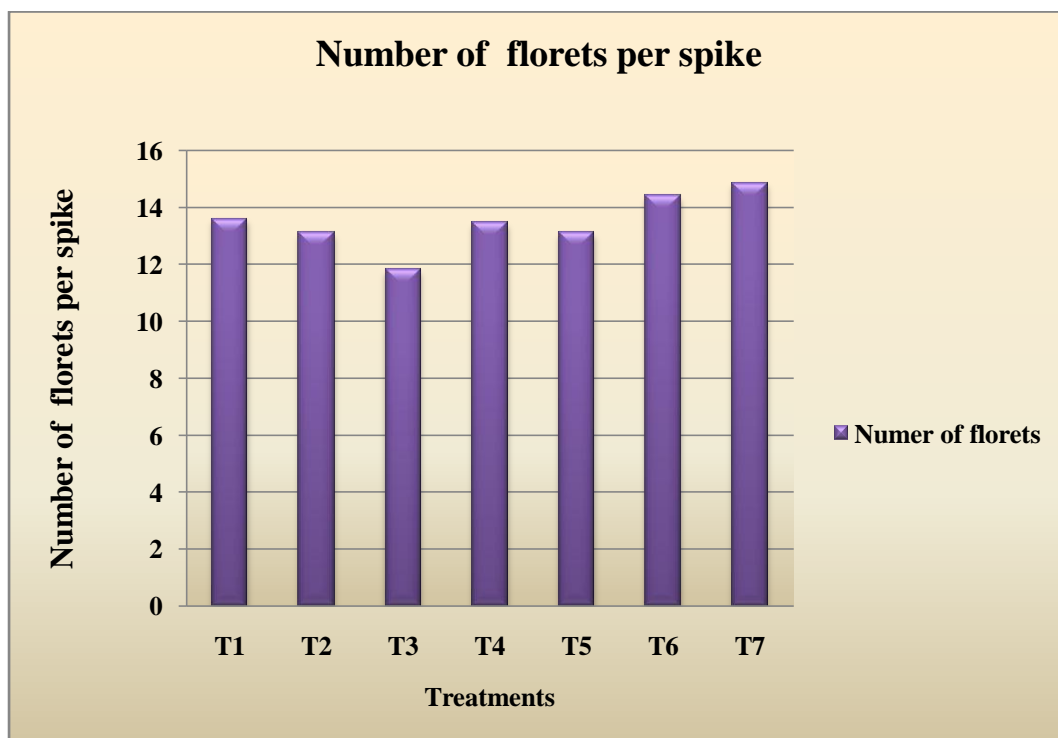


Fig.13 Effect of biofertilizers with different levels of nitrogen and phosphorus on number of florets per spike

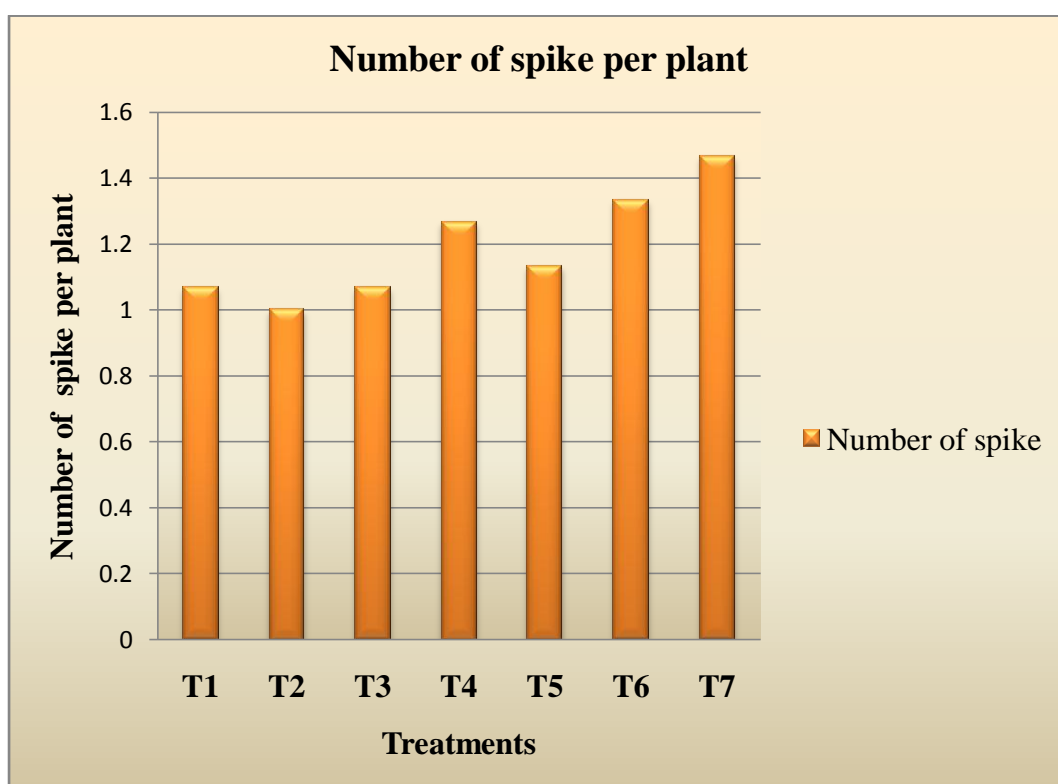


Fig.14 Effect of biofertilizers with different levels of nitrogen and phosphorus on number of spike per plant

The maximum number of spike per plant (1.47) was observed under the treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} (1.33) and T₄ (1.27) which were *at par* with each other. The minimum number of spike per plant (1.00) was observed under treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.}.

The treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} was found significantly superior over all the treatment except T₆ and T₄. It might be due to application of Azotobacter and PSB and balanced nutrition with nitrogen and phosphorus, which causes profuse vegetative growth resulting more synthesis of food material and such plant produce more number of florets and spikes.

Table 15: Effect of biofertilizer with different levels of nitrogen and phosphorus on number of spikes per plant.

Treatments	Number of spikes Per plant
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	1.07
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	1.00
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	1.07
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	1.27
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	1.13
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	1.33
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	1.47
SE (m) ±	0.29
CD at 5 %	0.26

These finding was in close conformity with the result of Gayithri *et al.* (2004) with application of 50% N and P + 100% K + VC + Azotobacter + PSB in *Statice* and Godse *et al.* (2006) in *gladiolus*.

4.4.3 Number of spike per plot.

From the data it is revealed that there was non significant difference among the treatments in respect of number of spike per plot. However the maximum number of spike per plot (55.33) was observed under the treatment T₇. The

minimum spike per plot were observed under T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.} (49).

Table 16: Effect of biofertilizer with different levels of nitrogen and phosphorus on number of spikes per plot.

Treatments	Number of spikes Per plot
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	49.66
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	49.00
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	52.00
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	49.33
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	52.66
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	54.66
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	55.33
SE (m) ±	2.53
CD at 5 %	N.S.

4.4.4 Number of spike per hectare

Data depicted in Table 17 regarding the number of spike per hectare is calculated on the basis of per plot and it revealed, that there was significant difference among the treatments.

The maximum number of spike per hectare was recoded under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 293330 and significantly higher in compared to other tested treatments followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. +PSB} (266660) whereas, minimum number of spikes per hectare (20000) was observed under treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.}.

These findings were also in close conformity with the result of Venkatasha *et al.* (2003) in gladiolus who showed that number of spikes per hectare with application of Azospirillum and VAM in combination with N and P.

The increase the number of spike might be due to the availability of nutrition and elevated levels of macronutrients which have positive effect of floral characteristics. Similar results were obtained by maghadam and shoor (2013) in petunia.

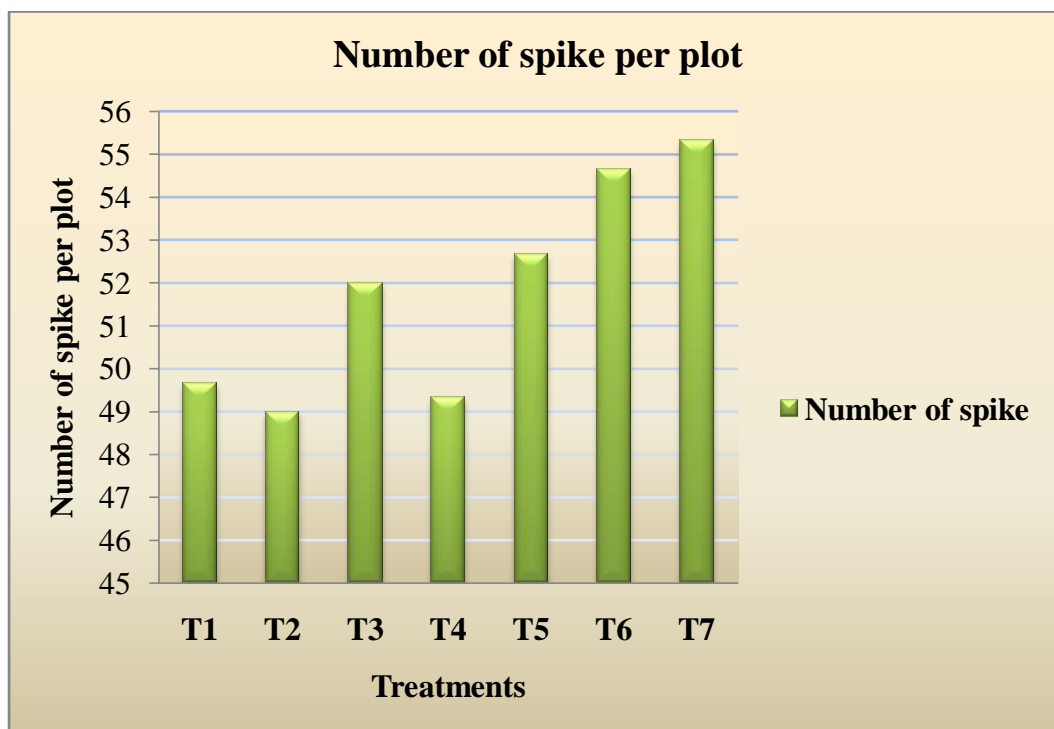


Fig.15 Effect of biofertilizers with different levels of nitrogen and phosphorus on number of spike per plot

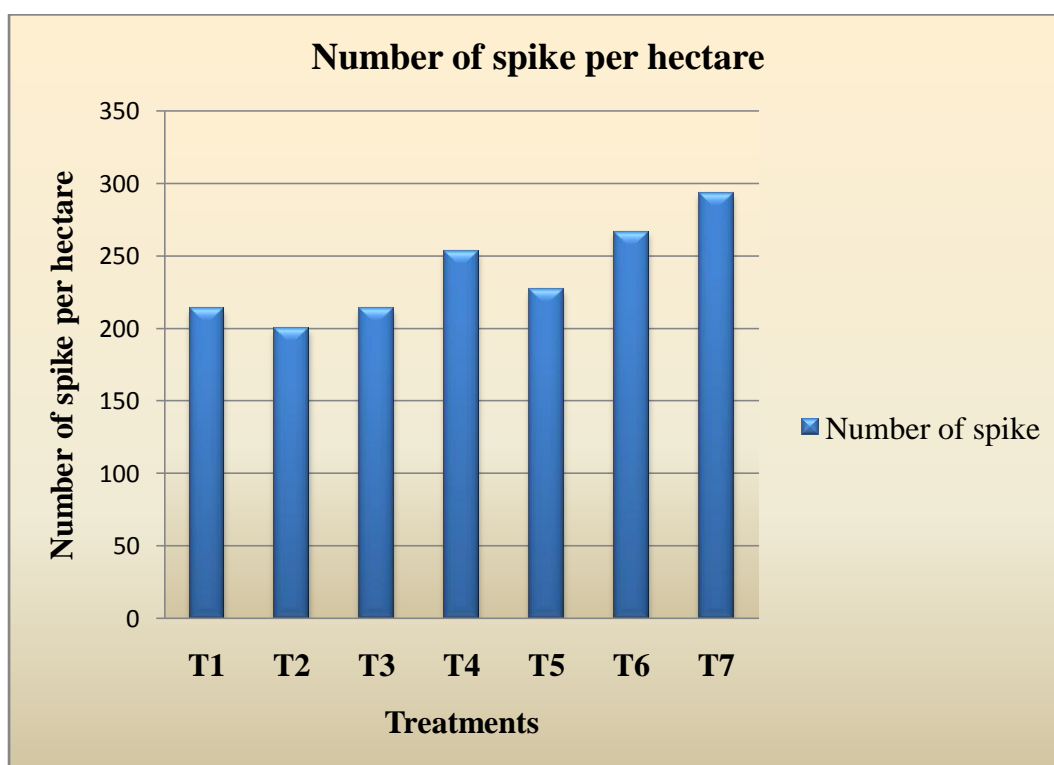


Fig.16 Effect of biofertilizers with different levels of nitrogen and phosphorus on number of spike per hectare

Table 17: Effect of biofertilizer with different levels of nitrogen and phosphorus on number of spikes per hectare.

Treatments	Number of spikes Per hectare (, 000)
T ₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	213.33
T ₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	200.00
T ₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	213.33
T ₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	253.33
T ₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	226.66
T ₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	266.66
T ₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	293.33
SE (m) ±	16.58
CD at 5 %	51.67

4.4.5 Number of corms and cormels per plant

Data regarding the number of corms and cormels per plant as influenced by different treatment was recorded and presented in Table 18 and depicted in Fig 17 and Fig 18.

Data shows that there was significant difference among the treatments in respect of number of corms and cormels per plant.

The maximum number of corms per plant was recorded under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 1.93 followed by T₆ {100% N and P(150:100:80 kg NPK ha⁻¹) + Azt. +PSB} and *at par* with each other whereas, minimum number of corms was observed under control treatment T₁ {100% RDF (150:100:80 kg NPK ha⁻¹) as Control} (1.33).

In case of number of cormels per plant, it were recorded maximum (65.46) under treatment T₇ and *at par* (65.46) with T₆ while, minimum number of (54.78) cormels were recorded under the treatment T₂.

The maximum number of cormels were recorded in T₇ followed by T₆ and it may be due to more accumulation of food material because of more number of leaves and than accumulated food material transferred to store energy which resulted increased the number of corms and cormels per plant.

These results are also in accordance with Misra (1997) who observed application of Nafed Super Culture containing Azotobacter significantly increased florets per spike in gladiolus, similarly Venkatesha *et al.* (2002) concluded that

application of Azospirillum and VAM in combination with N and P increased number of corms and cormels per plant and per hectare in gladiolus.

Table 18: Effect of biofertilizers with different levels of nitrogen and phosphorus on number of corms and cormels per plant.

Treatments	No. of corms per plant	No. of cormels per plant
T₁ : 100% RDF (150:100:80 kg NPK ha ⁻¹) as Control	1.33	55.67
T₂ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹)+ Azt.	1.40	54.78
T₃ : 75% N and 100% P(112.5:100:80 kg NPK ha ⁻¹) + Azt.	1.47	56.16
T₄ : 100% N and 100% P(150:100:80 kg NPK ha ⁻¹) + PSB	1.53	60.51
T₅ : 100% N and 75% P(150:75:80 kg NPK ha ⁻¹) + PSB	1.60	59.46
T₆ : 100% N and P(150:100:80 kg NPK ha ⁻¹) + Azt. +PSB	1.80	61.76
T₇ : 75% N and P(112.5:75:80 kg NPK ha ⁻¹) + Azt. + PSB	1.93	65.46
SE (m) ±	0.09	1.52
CD at 5 %	0.28	4.73

Similar results were reported by Gangadhar and Gopinath (2000) in gladiolus. Ahmad Ali (2014) also reported that biofertilizer have the role in cormels production in gladiolus. Wange *et al.* (1995) who observed that increased yield of bulbs in tuberose receiving 50 kg N per hectare and inoculation with Azospirillum in tuberose.



Plate III : Response of biofertilizer on corms and cormels

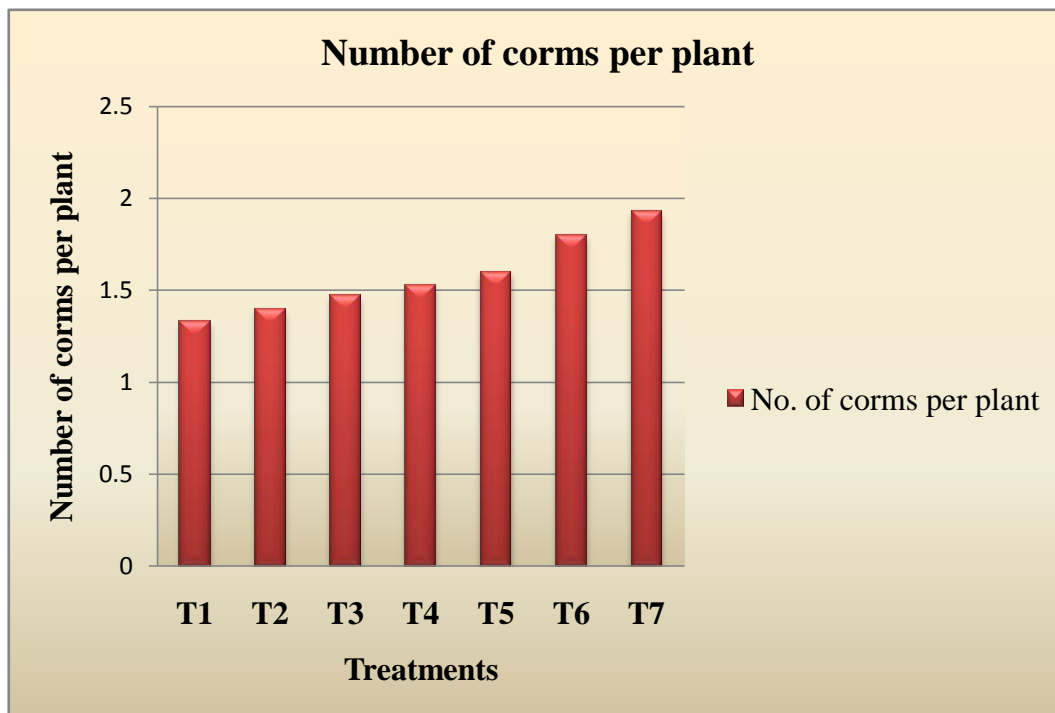


Fig.17 Effect of biofertilizers with different levels of nitrogen and phosphorus on number of corms per plant

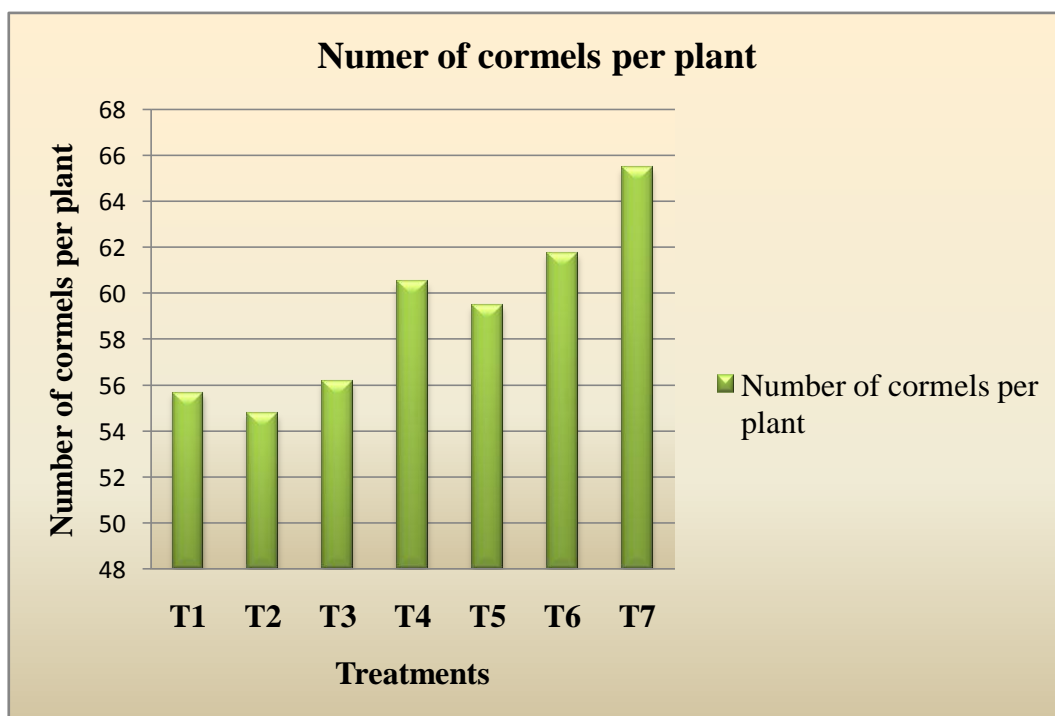


Fig.18 Effect of biofertilizers with different levels of nitrogen and phosphorus on number of cormels per plant

CHAPTER V

SUMMARY AND CONCLSUION

The present experiment entitled, “Effect of biofertilizers with different levels of Nitrogen and Phosphorus on growth and flower yield of *Gladiolus grandiflorus* L.) cv. Candyman ” was conducted at the Horticulture Nursery, Department of Floriculture and Landscape Architecture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2015-16.

The experiment was laid out in Randomized Block Design with three replications. Treatment were undertaken by using Azotobacter and PSB culture with different levels of nitrogen and phosphorus. Preplanting application of biofertilizers to corms was given 15 minutes before sowing and kept in shade.

The observation recorded in respect of growth studies, flowering , flower quality and yield attributing characters are summarized below.

5.1 Growth characters

1. There were significant difference was observed among treatments in respect of number of days required for spouting of corms. Numerically early sprouting was recorded (4.33 days) in treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}, followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB}, while maximum days were required (7.33 days) in treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}, followed by T₄ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + PSB}.
2. The maximum number of leaves per plant (11.33) were observed under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. +PSB} (11.20) number of leaves. The minimum number of leaves (10.07) was observed under treatment T₂ {100% N and (100% P (150:100:80 kg NPK ha⁻¹) + Azt.}.
3. Application of T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} closely followed by T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} were recorded significantly tallest plant *i.e.* 94.27 cm and 92.40 cm respectively.

5.2 Flowering

1. T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azotobacter + PSB} was taken minimum days (59.87 days) for spike emergence, while T₁ {100% RDF (150:100:80 Kg NPK ha⁻¹) as Control recorded significantly more number of days (66.80).
2. Early opening of first pair of florets on spike (74.80 days) were observed under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}. Whereas, maximum days (78.93) were required for opening of first pair of florets T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.} closely followed by treatment T₄ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + PSB} *i.e.* (86.67 days).
3. Early 50% flowering (82.20 days) was observed under the treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} which was *at par* with T₆. Whereas, late 50% flowering (86.67 days) was observed in T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}.

5.3 Flower quality

1. The maximum length of fully opened floret was obtained under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} (8.70 cm) followed by treatment T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} (8.41 cm) and minimum length of florets was observed under the control treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.} (7.73 cm).
2. The maximum diameter of fully opened floret was obtained under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} (10.33 cm) followed by treatment T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. +PSB} and *at par* with each other whereas, minimum diameter of florets was observed under the control treatment T₁ {100% RDF (150:100:80 kg NPK ha⁻¹)}.
3. The maximum length of spike (77.13 cm) was observed under the treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}, and *at par* with treatment T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB}. The minimum length of spike (65.47 cm) was recorded under treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}.

4. The maximum length of rachis (50.73 cm) was observed under the treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB}, followed by treatment T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} were found *at par* with each other. The minimum length of rachis (38.93 cm) was recorded under treatment T₃ {75% N and 100% P (112.5:100:80 kg NPK ha⁻¹) + Azt.}.

5.4 Yield attributing characters

1. The maximum number of florets per spike (14.87) was observed under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 14.40 whereas, the minimum number of florets per spike (13.13) was observed under treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.}.
2. The maximum number of spikes per plant (1.47) was observed under the treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} (1.33). The minimum number of spikes per plant (1.00) was observed under treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.}.
3. The maximum number of spike per plot (55.33) was observed under the treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 54.66 while the minimum spike per plot were observed under T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.} (49).
4. The maximum number of spike per hectare was recorded under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 293330 followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 266660 whereas, minimum number of spikes per hectare 200000 was observed under treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.}.
5. The maximum number of corms per plant (1.93) was recorded under treatment T₇ {75% N and P (112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} (1.93) which was *at par* with T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} (1.80) whereas, minimum number of corms was observed under control treatment T₁ {100% RDF (150:100:80 kg NPK ha⁻¹) as Control} (1.33). In case of number of cormels per plant, it was recorded maximum under treatment T₇ {75% N and P

(112.5:75:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 65.46 followed by T₆ {100% N and P (150:100:80 kg NPK ha⁻¹) + Azt. + PSB} *i.e.* 61.76 while minimum cormels were recorded under the treatment T₂ {100% N and 100% P (150:100:80 kg NPK ha⁻¹) + Azt.} *i.e.* 54.78.

Conclusion

The results of present experiment indicated that the Azotobacter and PSB along with 75% of nitrogen and phosphorus (112.5:75:80 kg NPK ha⁻¹) were improved vegetative growth, flowering, flower quality, number of spike and corms and cormels yield.

Since the conclusion based on study of only one season it is necessary to repeat the experiment for confirmation of results.

Suggestions for future research work

- On the basis of the results obtained, following suggestions are made for future line of work.
- Bio fertilizers should be fresh and mode of methods properly used.
- The experiment may be repeated to confirm the result.
- The same studies can be carried out for different types as well as varieties of gladiolus.
- Similar or same study can be conducted at different locations of Chhattisgarh.
- The effect of biofertilizers like Azotobacter and PSB on gladiolus can be studied under Chhattisgarh plains.

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Appendix - I: Meteorological details about the weather conditions prevailing during the course of experiment

Wk No.	Date	Max. Temp. (°C)	Min. Temp. (°C)	Rain-fall (mm)	Rainy days	Relative Humidity (%)		Vapour Pressure (mm of Hg)		Wind Velocity (Kmph)	Evapo-ration (mm)	Sun Shine (hours)
						I	II	I	II			
45	Nov 05-11	31.7	18.8	0.0	0	91	37	15.8	12.4	2.6	3.5	7.8
46	12-18	31.7	16.3	0.0	0	89	33	13.3	11.0	2.4	3.3	7.5
47	19-25	30.6	15.5	0.0	0	88	36	12.6	11.3	2.8	3.3	8.3
48	26-02	31.9	16.7	0.0	0	87	34	13.4	11.6	2.4	3.3	7.5
49	Dec 03-09	31.2	14.8	0.0	0	88	31	12.0	10.0	2.3	3.0	8.0
50	10-16	30.1	17.3	4.4	1	77	46	12.2	13.6	2.9	2.7	4.4
51	17-23	27.7	16.6	9.4	1	85	52	13.1	13.3	3.1	2.3	2.0
52	24-31	26.9	10.8	0.0	0	87	29	9.1	7.4	2.4	2.6	6.2
1	Jan 01-07	30.5	12.1	0.0	0	82	27	9.2	8.2	2.0	2.9	7.9
2	08-14	29.3	11.1	0.0	0	87	27	9.4	7.9	2.5	3.1	7.5
3	15-21	27.6	14.0	2.0	1	88	46	11.1	11.6	3.4	2.5	4.3
4	22-28	27.0	9.0	0.0	0	90	33	8.3	8.9	2.6	3.0	8.7
5	29-04	31.9	14.3	0.0	0	84	32	10.6	10.9	2.6	3.6	9.0
6	Feb 05-11	31.1	14.0	0.0	0	78	32	10.2	10.6	2.9	4.2	8.9
7	12-18	32.6	19.2	0.0	0	81	39	14.2	13.9	3.2	3.7	5.2
8	19-25	34.9	19.3	0.0	0	69	30	12.8	11.7	3.1	4.6	6.9
9	26-04	33.6	20.8	0.0	0	81	37	15.8	13.4	3.3	4.1	3.8
10	Mar 05-11	34.0	20.2	0.6	0	73	27	13.7	11.1	4.3	5.5	7.4
11	12-18	34.6	21.3	2.9	1	75	38	14.8	13.8	4.8	5.4	7.4
12	19-25	37.8	19.6	0.0	0	59	14	11.6	6.5	4.3	7.6	9.3
13	26-01	38.6	21.8	0.0	0	67	25	14.8	12.2	4.0	6.3	8.2
14	Apr 02-08	40.1	24.3	5.4	1	59	23	14.9	11.8	5.7	8.3	7.3
15	09-15	41.5	25.0	0.0	0	48	13	13.0	7.8	5.4	9.3	9.8
16	16-22	43.2	29.2	0.0	0	40	17	14.0	10.9	6.7	11.2	9.9

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