

## Effects of Nitrogen, Phosphorous and Potassium level on growth and floral attributes of *Gladiolus (Gladiolus grandiflorus L.)* cv. Nova Lux

### Abstract

*Gladiolus (Gladiolus grandiflorus L.)* is a noteworthy flower crop in India. The crop's growth and flowering have been notably impacted by the prevailing climate and agro-climatic conditions of the region, resulting in decreased yield and productivity. One of the main contributing factors is the absence of fertilizer recommendations tailored to specific locations, among other factors. Thus, field experiments were conducted for two consecutive seasons during 2020-2021 and 2021-2022. A field study was carried out at the Horticulture Research Farm, Department of Horticulture, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.). The experiment used a Randomized Block Design with 13 treatments and three replications of different levels of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. The experiment's major goals were to assess the effects of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on the growth and floral attributes of *Gladiolus (Gladiolus grandiflorus L.)* Cv. Nova Lux. According to the results of the current study, Treatment T<sub>11</sub> (NPK @150:100:120) had the best effects on growth attributes like Days to 50% sprouting [8.65 (2020-21), 8.69 (2021-22) and 8.67 (Pooled)] days, Plant height [77.87 (2020-21), 80.57 (2021-22) and 79.22 (Pooled)] cm at harvest, Number of leaves per plant [8.77 (2020-21), 8.95 (2021-22) and 8.86 (Pooled)] at harvest; and Days to emergence of spike [71.45 (2020-21), 71.21 (2021-22) and 71.33 (Pooled)] days. It also had significant effects on flowering attributes like flowering duration [16.80 (2020-21), 16.92 (2021-22), and 16.86 (Pooled)] days, length of spike [87.35 (2020-21), 87.79 (2021-22), and 87.57 (Pooled)] cm, Days taken for first floret opening [109.95 (2020-21), 110.25 (2021-22), and 110.10 (Pooled)] days, Length of florets [9.87 (2020-21), 9.93 (2021-22), and 9.90 (Pooled)] cm, Diameter of florets [7.78 (2020-21), 7.87 (2021-22), and 7.83 (Pooled)] cm; and Number of florets opened at a time (125 DAP), i.e., [5.67 (2020-21), 5.71 (2021-22), and 5.69 (Pooled)].

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**Keywords:**Floral, Gladiolus, *Gladiolus grandiflorus* L., Growth, Nitrogen, Nova Lux, Phosphorous, Potassium.

UNDER PEER REVIEW

## 1. INTRODUCTION

Gladiolus is recognized as one of the most well-known and widely ~~acceptable~~accepted bulbous cut flowers found all over the world. In recent years, there has been a substantial increase in the volume of domestic consumption of gladiolus; consequently, gladiolus now ranks, after rose, as the country's second most important crop in the category of cut flowers (**Tripathi, 2014**). It is a perennial geophyte and a semi-rustic herb (**Demir and Celikel 2019**). It belongs to the family Iridaceae and has chromosome number  $n = 15$ . It is estimated that there are about 260 species of it, 250 of which are indigenous to sub-Saharan Africa, the majority of which are found in South Africa, and about 10 species are indigenous to Eurasia (**Amehet *al.*, 2011**).

The United States (namely Florida and California), Holland, Italy, France, Bulgaria, Brazil, Australia, Israel, and India are the top gladiolus producers (**Kumar *et al.*, 2017**). Though in India, it is mostly produced for commercial purposes on the northern plains of Delhi, including those in the states of Haryana, Punjab, and Uttar Pradesh, as well as Maharashtra and Karnataka (**FAO 2013**). Gladiolus cultivation in India covers 11.16 thousand hectares (ha) and generates 102.91 thousand metric tons (**NHB, 2014-15**).

It is common knowledge that the aesthetic quality of plants is inextricably tied to an ideal balance of nutrients (**Netoet *al.*, 2015**). The production process is significantly impacted by nutrient elements. Nitrogen is a fundamental component of every protein and an essential component of the protoplasm that makes up living things. Nitrogen is also present in purines, pyrimidines, porphyrines, and in the molecules that make up coenzymes (**Tharakaet *al.*, 2021**). Phosphorous, much like nitrogen, is also an essential component in the structure of the cell membrane and the organelles of the cell (such as chloroplasts, mitochondria, and ribosomes). It is a component of nucleic acid, as well as phospholipids, nucleol proteins, flavin, and other nucleotides and lipids. It plays a role in the fundamental reactions of photosynthesis and is also responsible for the activation of a number of enzymes (**Ahemadet *al.*, 2009**). Phosphorous is another crucial nutrient that must be present for healthy plant growth and development. It makes the shoots more resistant to damage, enhances the quality of the seeds, controls the rate of photosynthesis, and contributes to the expansion of the cells and the nitrogen fixation process. In addition to this, it contributes to the development of resistance to diseases. It is possible that an optimal balance of nitrogen and phosphorus will result in a significant boost in the yield of crops (**Haokip and Singh, 2005**).

**Patokaret et al. (2022)** carried out research during the years 2018-19 and 2019-20 to assess the effects of INM on growth, flowering, and yield of gladiolus cv. PDKV Gold in which 75% RDF + 8 t Vermicompost + Azotobacter + PSB resulted in the best growth metrics. In Islamabad, Pakistan, **Zaminet et al. (2020)** also studied the effects of varying rates of nitrogen and potash fertilizer on gladiolus and found that nitrogen and potash @100N +200K kg/ha resulted in the maximum number of florets per spike (11.42). **Kumar et al. (2019)** in an experiment also reported that 75% RDF+ VC +Azotobacter +PSB had the best effects on spike length, floret opening rate, floret droop, floret opening time, and spike longevity. **Sabastian et al. (2017)** also found minimum days to spike emergence (60.65), first opening of florets(78.13), maximum floret size (10.22 cm) and most florets per spike (15.48) with incorporation of Phosphorous @ 200 kg/ha. **Kumari et al. (2014)** & **Preeti et al. (2014)** also found longest vase life of the spike, the earliest development of the first flower bud, and the greatest number of florets per spike when 75% RDF and NPK (4.5:2.7:1.8 g/plant) was incorporated respectively.

Gladiolus cultivation is gaining popularity among farmers in Uttar Pradesh due to its higher returns. However, the cultivators do not have any information regarding the appropriate doses of synthetic fertilizers for the production of high-quality corms and cormels. Even people who grow flowers don't use any kind of artificial fertilizer when they're propagating their seeds. As a consequence of this, they are unable to obtain corms and cormels of the ideal size for use in flower production. Therefore, there is a good possibility of boosting the yield of robust corm and cormel production in gladiolus by using an adequate amount of N, P, and K fertilizers under the agro-ecological conditions of Uttar Pradesh. So enhancing the yield of gladiolus has gained paramount attention among the researchers. However, there have been very few studies regarding the optimization of NPK fertilizers in the agro-climatic conditions of Uttar Pradesh.

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Therefore, in light of the foregoing, the current study, named "**Effects of Nitrogen, Phosphorous and Potassium level on spike yield, bulb production and floral attributes of Gladiolus (*Gladiolus grandiflorus* L.) Cv. Nova Lux**" was carried out at Rama University, Kanpur, [Uttarand Uttar](#) Pradesh.

## 2. MATERIALS AND METHODS

The current study on Gladiolus (*Gladiolus grandiflorus* L.) Cv. Nova Lux planted at 30cm×50cm was carried out in the years 2020–21 and 2021–22. It was conducted at the main experimental station of Rama University Kanpur, Uttar Pradesh, India. The Kanpur district lies at latitudes of 25°34' and 26° 11' and longitudes of 81°S19' and 82°27' and has an altitude of 137 Mt. from mean sea level.

Randomized block design was used to set up the experiment, with 3 replications for each of the thirteen treatment combinations. Details and combinations of treatments are listed in Table 1. Each treatment received a unique combination of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. Growth attributes like Days to 50% sprouting, Plant height (cm) at harvest, Number of leaves per plant at harvest & Days to emergence of spike where-as floral attributes like Flowering duration (days), Length of spike (cm), Days taken for first floret opening (days), Length of florets (cm), Diameter of florets (cm) & Number of florets opened at a time (125 DAP) were all successfully measured to determine the best treatment combination for gladiolus cultivation.

## 3. RESULTS AND DISCUSSION

The growth and flowering attributes of Gladiolus (*Gladiolus grandiflorus* L.) Cv. Nova Lux were studied statistically. According to the findings, all the characteristics benefitted greatly from the addition of N, P<sub>2</sub>O<sub>5</sub>, and K<sub>2</sub>O. Since  $F_{Cal} > F_{Tab}$ , the evidence indicates that the variances were statistically significant.

### GROWTH ATTRIBUTES

**Days to 50% sprouting:** During both the years (2020-21 and 2021-22) of study (Table 2; Fig 1), it was observed that the treatment T<sub>11</sub>(NPK @150:100:120) recorded the minimum Days to 50% sprouting [8.65 (2020-21), 8.69 (2021-22) and 8.67 (Pooled)] days over all other treatments whereas maximum Days to 50% sprouting [9.91 (2020-21), 9.98 (2021-22) and 9.94 (Pooled)] days were recorded in T<sub>0</sub> (Control) during both the years of study as well as pooled analysis. Here, Nitrogen might have attributed for the decline in days to 50% sprouting since it can be used by plants as both a nutrient and a sprouting signal (Tiansawat & Dalling, 2013; Yan *et al.*, 2016). The ideal nitrogen

content appears to encourage germination through reducing the abscisic acid/gibberellins ratio (Song *et al.*, 2016; Yan *et al.*, 2016).

**Plant Height (cm):** During the harvest stage, it was observed that the treatment T<sub>11</sub>(NPK @150:100:120) recorded the maximum Plant height (cm) (Table 3; Fig 2) [77.87 (2020-21), 80.57 (2021-22) and 79.22 (Pooled)] cm where-as the lowest Plant height (cm) [71.94 (2020-21), 72.98 (2021-22) and 72.46 (Pooled)] cm was recorded in T<sub>0</sub> (Control) during both the years of study as well as pooled analysis. Nitrogen being an essential component of chlorophyll, proteins, and amino acids, application of treatment T<sub>11</sub>(NPK @150:100:120) could have increased the rate of photosynthesis, which ultimately could have influenced plant's height. During their research on gladiolus, Shakyaa *et al.* (2018) also discovered results that were very similar. On the other hand potassium boosts the movement of photosynthates in the phloem tissue, which may result in an increase in the meristematic activity of the plant system. Similar results were also observed by Kumar *et al.* (2017) and Regaret *et al.* (2016) on gladiolus. The application of phosphorus might also have had an influence on the height of the plants because it is necessary for the process of cell division (Dhakalet *et al.*, 2017)

**Number of leaves per plant:** The maximum Number of Leaves per plant (Table 4; Fig 3) [8.77 (2020-21), 8.95 (2021-22) and 8.86 (Pooled)] was recorded under treatment T<sub>11</sub>(NPK @150:100:120). However, the lowest Number of Leaves per plant [7.60 (2020-21), 7.54 (2021-22) and 7.57 (Pooled)] was recorded in T<sub>0</sub> (Control) during both the years of study as well as pooled analysis. As a result of the observations made above, it can be concluded that the addition of NPK in the ratio of 150:100:120 has a positive influence on the Number of Leaves per plant of gladiolus. Nitrogen being involved in all cellular enzyme activities, suggesting that it actively participates in energy metabolism, which might have aided in the increase in number of leaves per plant. Dhakalet *et al.* (2017), Chauhan (2015) and Akteret *et al.* (2017) also found similar results on gladiolus. Shah *et al.* (2014) also found that an increase in the potassium application level caused *Zinnia elegans* to generate more leaves. Similar results were found by El-Naggar and El-Nasharty (2016) on gladiolus.

**Days to emergence of spike:** [The data regarding days to the emergence of spikes is shown in Table 5 and Fig 4. From the data, it was observed that treatment T<sub>0</sub> \(Control\) recorded the maximum days to emergence of spike \[80.21 \(2020-21\), 79.95 \(2021-22\), and 80.08 \(Pooled\)\] days, whereas the lowest days to emergence of spike \[71.45 \(2020-21\), 71.21 \(2021-22\), and 71.33 \(Pooled\)\] days were recorded in T<sub>11</sub>\(NPK @150:100:120\) during both the years of study as well as pooled analysis. The number of days until spike emergence has significantly decreased, possibly](#)

due to phosphorus application. It is a part of RNA, which reads DNA's genetic code to create proteins and other substances necessary for plant structure and genetic transfer. Phosphorus bonds bind the DNA and RNA structures to one another. A crucial part of ATP, the energy unit of plants, is phosphorus. ATP is created during photosynthesis, contains phosphorus in its structure, and functions from seedling emergence through growth and maturation (Schachtman *et al.*, 1998). The minimal days to spike emergence with phosphorus applications have yielded the same findings by Mohapatra *et al.*, 2005 on gladiolus. Similar results were also found by Sabastian *et al.* (2017), Chandana and Dorajerao (2014) and Kumar (2009) on gladiolus. The data regarding Days to emergence of spike is shown in Table 5; Fig 4. From the data it was observed that treatment T<sub>0</sub> (Control) recorded the maximum Days to emergence of spike [80.21 (2020-21), 79.95 (2021-22) and 80.08 (Pooled)] days where as the lowest Days to emergence of spike [71.45 (2020-21), 71.21 (2021-22) and 71.33 (Pooled)] days was recorded in T<sub>11</sub>(NPK @150:100:120) during both the years of study as well as pooled analysis. The number of days until spike emergence has significantly decreased, possibly due to phosphorus application. it is a part of RNA, which reads DNA's genetic code to create proteins and other substances necessary for plant structure and genetic transfer. Phosphorus bonds bind the DNA and RNA structures to one another. A crucial part of ATP, the energy unit of plants, is phosphorus. ATP is created during photosynthesis, contains phosphorus in its structure, and functions from seedling emergence through growth and maturation (Schachtman *et al.*, 1998). The minimal days to spike emergence with phosphorus applications have yielded the same findings by Mohapatra *et al.*, 2005 on gladiolus. Similar results were also found by Sabastian *et al.* (2017), Chandana and Dorajerao (2014) and Kumar (2009) on gladiolus.

## FLORAL ATTRIBUTES

**Flowering duration:** Table 6 and Fig 5 display the collected data in terms of flowering duration during the years 2020-21 and 2021-22. It was observed that, treatment T<sub>11</sub>(NPK @150:100:120) recorded the maximum flowering duration (days) [16.80 (2020-21), 16.92 (2021-22), and 16.86 (Pooled)] days over all other treatments, whereas T<sub>0</sub> (Control) had the lowest recorded flowering duration (days), which was [13.95 (2020-21), 14.01 (2021-22) and 13.98 (Pooled)] days during both the years of study as well as pooled analysis. It might be attributed to the application of nitrogen to the plants. The low nitrogen content in plant tissues may reduce polyamine levels (Marschner, 1995). It has been claimed that polyamines serve either as a nitrogen source or as signal molecules that regulate abscission and bloom lifetime (Aziz, 2003). Therefore, polyamines may play a vital role in extending the period of flowering in plants. On the

other hand, P and K might not have enough effect on the flowering duration of gladiolus. **Olivariset al. (2022)** and **Woodson and Boodley (1983)** also found partially similar results. Table 6; Fig 5 displays the collected data in terms of Flowering duration during the year 2020-21 and 2021-22, it was observed that, treatment T<sub>11</sub>(NPK @150:100:120) recorded the maximum flowering duration (days) [16.80 (2020-21), 16.92 (2021-22) and 16.86 (Pooled)] days over all other treatments where as T<sub>0</sub> (Control) had the lowest recorded flowering duration (days), which was [13.95 (2020-21), 14.01 (2021-22) and 13.98 (Pooled)] days during both the years of study as well as pooled analysis. It might be attributed to the application of nitrogen to the plants. The low nitrogen content in plant tissues may reduce polyamine levels (**Marschner, 1995**). It has been claimed that polyamines serve either as a nitrogen source or as signal molecules that regulate abscission and bloom lifetime (**Aziz, 2003**). Therefore, polyamines may play a vital role in extending the period of flowering in plants. On the other hand P and K might not have enough effect on flowering duration of gladiolus. **Olivariset al. (2022)** and **Woodson and Boodley (1983)** also found partially similar results.

**Length of spike (cm):** The data regarding Length of spike (cm) is shown in Table 5; Fig 4. Treatment T<sub>11</sub>(NPK @150:100:120) recorded the maximum length of spike per plant (Table 7; Fig 6) [87.35 (2020-21), 87.79 (2021-22) and 87.57 (Pooled)] cm over all other treatments where as T<sub>0</sub> (Control) had the lowest recorded length of spikes per plant, which was [79.91 (2020-21), 79.44 (2021-22) and 79.68 (Pooled)] cm during both the years of study as well as pooled analysis. **Sharma et al. (2007)** also reported that the application of a higher dose of N and K increased the length of the spike because the higher levels resulted in the production of a greater number of leaves, which increased photosynthesis, and the higher levels of photosynthates could have been used for the production of longer spikes. Similar results were also produced by **Deshmukhet al. (2012)** in Tuberose, **Chandana and Dorajeerao (2014)** on gladiolus, **Bose and Yadav (2004)** and **Afifty (2003)** on gladiolus.

**Days taken for first floret opening:** Treatment T<sub>11</sub>(NPK @150:100:120) recorded the minimum Days taken for first floret opening (Table 8; Fig 7) [109.95 (2020-21), 110.25 (2021-22) and 110.10 (Pooled)] days over all other treatments during. However, T<sub>0</sub> (Control) had the maximum recorded Days taken for first floret opening, which was [115.02 (2020-21), 115.13 (2021-22) and 115.08 (Pooled)] days during both the years of study as well as pooled analysis. According to the observations of **Walkley and Black (1934)**, the opening of gladiolus florets was accompanied by an increase in carbohydrate concentration. Chlorophyll is an organelle needed for carbohydrate creation via photosynthesis and a chemical that gives plants their green colour. Nitrogen is a

component of Chlorophyll that contributes to the enhancement of both characteristics. Nitrogen is necessary for plant functions like photosynthesis. Therefore, plants with adequate nitrogen will experience high rates of photosynthesis and typically display a reduction in the number of days required for the first floret to open. Similarly, the outcome mirrored the findings of **Sharma and Singh, (2007)**, **Kumar and Misra, (2003)** and **Belwalet al. (2018)**.

**Length of florets (cm):** The data regarding Length of florets (cm) is shown in Table 9; Fig 8. It was observed that, treatment T<sub>11</sub>(NPK @150:100:120) recorded the maximum length of florets [9.87 (2020-21), 9.93 (2021-22) and 9.90 (Pooled)] cm over all other treatments where-as treatment T<sub>0</sub> (Control) had the lowest recorded length of florets (cm), which was [7.93 (2020-21), 8.01 (2021-22) and 7.97 (Pooled)] during both the years of study as well as pooled analysis. It is possible that increased plant development and, as a result, increased photosynthetic activity were responsible for the improvement in floral quality, as measured by the length of the florets. This improvement was brought about by appropriate fertilisation. **Yadav (2018)** and **Mahadik and Chopde (2015)** came to similarly conclusive findings as well. Similar results were also produced by **Deshmukhet al.(2012)** in Tuberose, **Chandana and Dorajeerao (2014)** on gladiolus, **Sharma et al. (2007)** while working on Tuberose.

**Diameter of florets:** According to the data mentioned at Table 10; Fig 9, it was observed that, treatment T<sub>11</sub>(NPK @150:100:120) recorded the maximum diameter of florets [7.78 (2020-21), 7.87 (2021-22) and 7.83 (Pooled)] cm over all other treatments where-as T<sub>0</sub> (Control) had the lowest recorded diameter of florets (cm), which was [5.91 (2020-21), 5.83 (2021-22) and 5.87 (Pooled)] during both the years of study as well as pooled analysis. **Sharma et al. (2007)** also found that the diameter of the florets increased when more N and K were applied. This happened as a result of the higher levels causing the formation of more leaves, which boosted photosynthesis. Additionally, higher diameter of florets might have been produced using the increased concentrations of photosynthates. Similar results were also produced by **Yadav (2018)**, **Mahadik and Chopde (2015)** and **Chandana and Dorajeerao (2014)** on gladiolus and **Deshmukhet al.(2012)** and **Sharma et al. (2007)** while working on Tuberose.

**Number of florets opened at a time (125 DAP):** The data regarding Number of florets opened at a time (125 DAP) is shown in Table 11; Fig 10. It was observed that, treatment T<sub>11</sub>(NPK @150:100:120) recorded the maximum Number of florets opened at a time (125 DAP) [5.67 (2020-21), 5.71 (2021-22) and 5.69 (Pooled)] over all other treatments. However, T<sub>0</sub> (Control) had the lowest recorded Number of florets opened at a time (125 DAP), which was [4.34 (2020-21), 4.3 (2021-22) and 4.32 (Pooled)] during both the years of study as well as pooled analysis. Floret

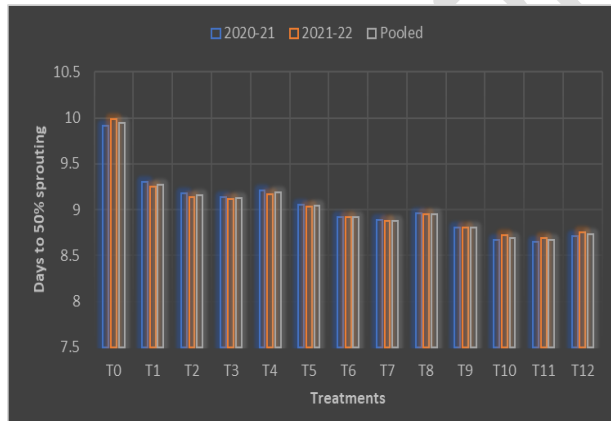
opening may be caused by a combination of sugar intake and polysaccharide breakdown. In a similar experiment performed by **Yamane *et al.*, 1991** on gladiolus florets, he discovered that in gladiolus florets, where starch is a source of soluble carbohydrate, the increase in sugar content was 7–8 times greater than the decrease in starch content, indicating sugar uptake during flower opening. Similarly, the increase in perianth sugars in freesia florets was more than 10 times greater than the decrease in starch content. Consequently, the administration of NPK to gladiolus may have increased the rate of photosynthesis, influencing the number of florets that opened simultaneously. During their investigation on gladiolus, **Shakya *et al.* (2018)** also uncovered results that were remarkably comparable to those previously discovered. **Khan and Iftikhar (2004)** and **Hila *et al.* (2001)** also found similar results while working on gladiolus.

UNDER PEER REVIEW

**Table 1:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Days to 50% sprouting of Gladiolusa-highest value, i-lowest value**

| Treatment Symbol | Days to 50% sprouting |         |        |
|------------------|-----------------------|---------|--------|
|                  | 2020-21               | 2021-22 | Pooled |
| T <sub>0</sub>   | 9.91a                 | 9.98a   | 9.94a  |
| T <sub>1</sub>   | 9.3b                  | 9.25b   | 9.27b  |
| T <sub>2</sub>   | 9.18c                 | 9.14c   | 9.16c  |
| T <sub>3</sub>   | 9.14cd                | 9.11c   | 9.12cd |
| T <sub>4</sub>   | 9.21bc                | 9.17c   | 9.19bc |
| T <sub>5</sub>   | 9.05de                | 9.03d   | 9.04de |
| T <sub>6</sub>   | 8.92f                 | 8.92e   | 8.92f  |
| T <sub>7</sub>   | 8.89fg                | 8.88e   | 8.88fg |
| T <sub>8</sub>   | 8.96ef                | 8.95e   | 8.95ef |
| T <sub>9</sub>   | 8.8gh                 | 8.8f    | 8.8gh  |
| T <sub>10</sub>  | 8.67i                 | 8.72g   | 8.69i  |
| T <sub>11</sub>  | 8.65i                 | 8.69g   | 8.67i  |
| T <sub>12</sub>  | 8.71hi                | 8.75fg  | 8.73hi |
| F-test           | **                    | **      | **     |
| S.E. (m) (±)     | 0.03                  | 0.03    | 0.02   |
| C.D. @ 5%        | 0.1                   | 0.08    | 0.06   |
| C.D. @ 1%        | 0.14                  | 0.1     | 0.08   |
| Treatment*Year   | **                    |         |        |

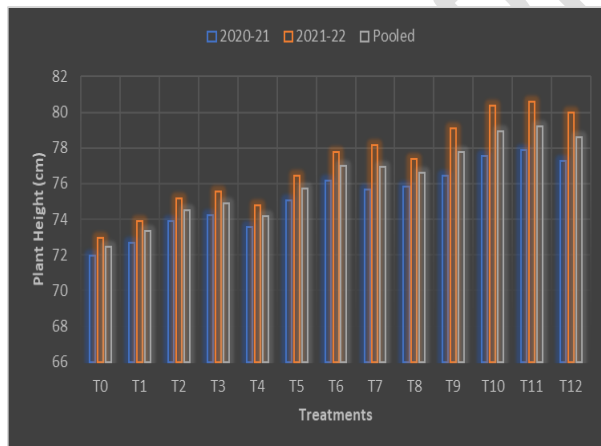
**Fig 1:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Days to 50% sprouting of Gladiolus**



**Table 2: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Plant Height (cm) of Gladiolus**

| Treatment Symbol           | Plant Height (cm) |             |             |
|----------------------------|-------------------|-------------|-------------|
|                            | 2020-21           | 2021-22     | Pooled      |
| T <sub>0</sub>             | 71.94g            | 72.98g      | 72.46g      |
| T <sub>1</sub>             | 72.78f            | 73.87f      | 73.33f      |
| T <sub>2</sub>             | 73.88e            | 75.14e      | 74.51e      |
| T <sub>3</sub>             | 74.22e            | 75.55e      | 74.89e      |
| T <sub>4</sub>             | 73.58e            | 74.76e      | 74.17e      |
| T <sub>5</sub>             | 75.03d            | 76.44d      | 75.74d      |
| T <sub>6</sub>             | 76.15bc           | 77.78c      | 76.97bc     |
| T <sub>7</sub>             | 75.65cd           | 78.17c      | 76.91c      |
| T <sub>8</sub>             | 75.82bc           | 77.37c      | 76.60c      |
| T <sub>9</sub>             | 76.44b            | 79.07b      | 77.75b      |
| T <sub>10</sub>            | 77.54a            | 80.34a      | 78.94a      |
| T <sub>11</sub>            | 77.87a            | 80.57a      | 79.22a      |
| T <sub>12</sub>            | 77.26a            | 79.97a      | 78.61a      |
| <b>F-test</b>              | <b>**</b>         | <b>**</b>   | <b>**</b>   |
| <b>S.E. (m) (±)</b>        | <b>0.25</b>       | <b>0.29</b> | <b>0.35</b> |
| <b>C.D. @ 5%</b>           | <b>0.73</b>       | <b>0.86</b> | <b>1.09</b> |
| <b>C.D. @ 1%</b>           | <b>0.99</b>       | <b>1.17</b> | <b>1.53</b> |
| <b>Treatment*<br/>Year</b> | <b>**</b>         |             |             |

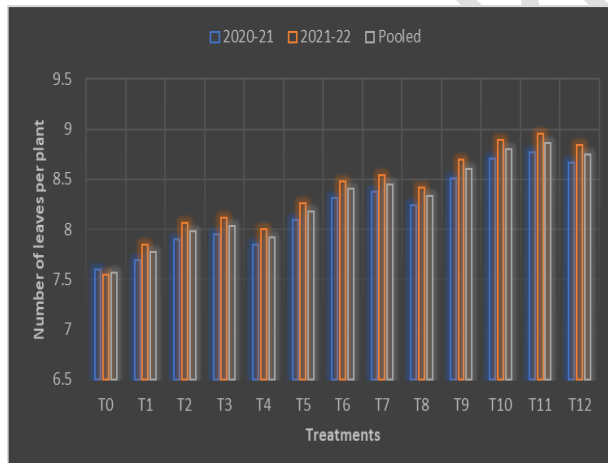
**Fig 2: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Plant Height (cm) sprouting of Gladiolus**



**Table 3: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Number of leaves per plant of Gladiolus**

| Treatment Symbol | Number of leaves per plant |         |         |
|------------------|----------------------------|---------|---------|
|                  | 2020-21                    | 2021-22 | Pooled  |
| T <sub>0</sub>   | 7.60i                      | 7.54g   | 7.57i   |
| T <sub>1</sub>   | 7.69hi                     | 7.85f   | 7.77h   |
| T <sub>2</sub>   | 7.90g                      | 8.06e   | 7.98g   |
| T <sub>3</sub>   | 7.95fg                     | 8.11e   | 8.03fg  |
| T <sub>4</sub>   | 7.84gh                     | 8.00e   | 7.92gh  |
| T <sub>5</sub>   | 8.09ef                     | 8.26d   | 8.18ef  |
| T <sub>6</sub>   | 8.31d                      | 8.48c   | 8.40d   |
| T <sub>7</sub>   | 8.37cd                     | 8.54c   | 8.45cd  |
| T <sub>8</sub>   | 8.24de                     | 8.41c   | 8.33de  |
| T <sub>9</sub>   | 8.51bc                     | 8.69b   | 8.603bc |
| T <sub>10</sub>  | 8.71a                      | 8.89a   | 8.80a   |
| T <sub>11</sub>  | 8.77a                      | 8.95a   | 8.86a   |
| T <sub>12</sub>  | 8.66ab                     | 8.84a   | 8.75ab  |
| F-test           | **                         | **      | **      |
| S.E. (m) (±)     | 0.05                       | 0.05    | 0.03    |
| C.D. @ 5%        | 0.15                       | 0.15    | 0.1     |
| C.D. @ 1%        | 0.21                       | 0.2     | 0.14    |
| Treatment*Year   | NS                         |         |         |

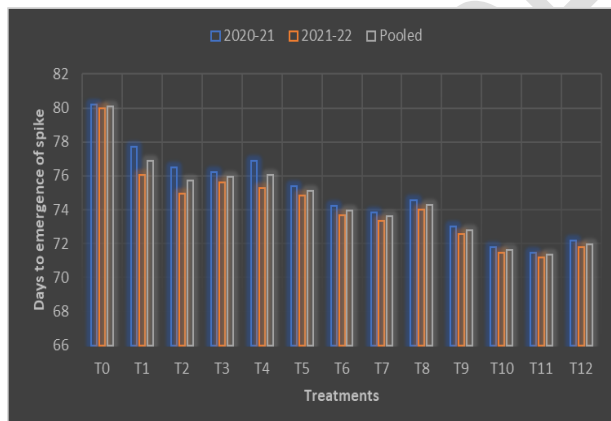
**Fig 3: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Number of leaves per plant of Gladiolus**



**Table 4:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Days to emergence of spike of Gladiolus**

| Treatment Symbol | Days to emergence of spike |         |         |
|------------------|----------------------------|---------|---------|
|                  | 2020-21                    | 2021-22 | Pooled  |
| T <sub>0</sub>   | 80.21a                     | 79.95a  | 80.08a  |
| T <sub>1</sub>   | 77.73b                     | 76.04b  | 76.89b  |
| T <sub>2</sub>   | 76.51c                     | 74.94c  | 75.73cd |
| T <sub>3</sub>   | 76.22c                     | 75.60bc | 75.91c  |
| T <sub>4</sub>   | 76.88c                     | 75.25bc | 76.07c  |
| T <sub>5</sub>   | 75.37d                     | 74.81cd | 75.09de |
| T <sub>6</sub>   | 74.21e                     | 73.65e  | 73.93f  |
| T <sub>7</sub>   | 73.85e                     | 73.35ef | 73.60f  |
| T <sub>8</sub>   | 74.54de                    | 74.02de | 74.28ef |
| T <sub>9</sub>   | 73f                        | 72.56fg | 72.78g  |
| T <sub>10</sub>  | 71.79g                     | 71.46h  | 71.63h  |
| T <sub>11</sub>  | 71.45g                     | 71.21h  | 71.33h  |
| T <sub>12</sub>  | 72.17fg                    | 71.77gh | 71.97gh |
| F-test           | **                         | **      | **      |
| S.E. (m) (±)     | 0.29                       | 0.27    | 0.19    |
| C.D. @ 5%        | 0.84                       | 0.8     | 0.56    |
| C.D. @ 1%        | 1.14                       | 1.08    | 0.75    |
| Treatment*Year   | NS                         |         |         |

**Fig 4:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Days to emergence of spike of Gladiolus**



**Table 5: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Flowering duration of Gladiolus**

| Treatment Symbol | Flowering duration (days) |         |         |
|------------------|---------------------------|---------|---------|
|                  | 2020-21                   | 2021-22 | Pooled  |
| T <sub>0</sub>   | 13.95i                    | 14.01i  | 13.98i  |
| T <sub>1</sub>   | 14.68h                    | 15.03h  | 14.86h  |
| T <sub>2</sub>   | 15.07g                    | 15.37g  | 15.22g  |
| T <sub>3</sub>   | 15.17fg                   | 15.49fg | 15.33fg |
| T <sub>4</sub>   | 14.98gh                   | 15.29gh | 15.14gh |
| T <sub>5</sub>   | 15.47ef                   | 15.75ef | 15.61ef |
| T <sub>6</sub>   | 15.89d                    | 16.10d  | 16.00d  |
| T <sub>7</sub>   | 15.97cd                   | 16.22cd | 16.10cd |
| T <sub>8</sub>   | 15.77de                   | 16.01de | 15.89de |
| T <sub>9</sub>   | 16.27bc                   | 16.48bc | 16.38bc |
| T <sub>10</sub>  | 16.66a                    | 16.84a  | 16.75a  |
| T <sub>11</sub>  | 16.80a                    | 16.92a  | 16.86a  |
| T <sub>12</sub>  | 16.57ab                   | 16.74ab | 16.66ab |
| F-test           | **                        | **      | **      |
| S.E. (m) (±)     | 0.1                       | 0.09    | 0.06    |
| C.D. @ 5%        | 0.3                       | 0.27    | 0.2     |
| C.D. @ 1%        | 0.41                      | 0.36    | 0.26    |
| Treatment*Year   | NS                        |         |         |

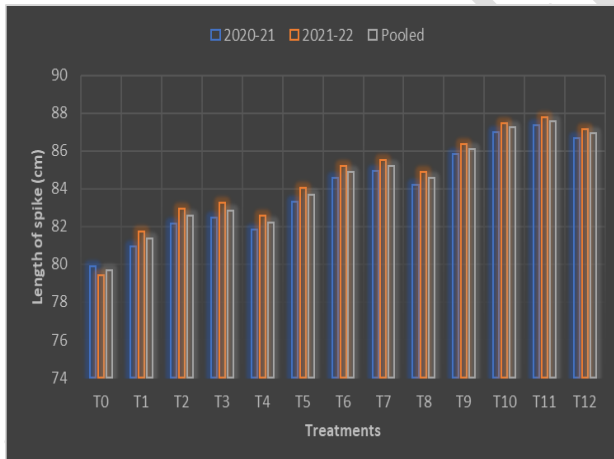
**Fig 5: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Flowering Duration (days) sprouting of Gladiolus**



**Table 6: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Length of spike (cm) of Gladiolus**

| Treatment Symbol | Length of spike (cm) |         |         |
|------------------|----------------------|---------|---------|
|                  | 2020-21              | 2021-22 | Pooled  |
| T <sub>0</sub>   | 79.91g               | 79.44i  | 79.68g  |
| T <sub>1</sub>   | 80.94f               | 81.74h  | 81.34f  |
| T <sub>2</sub>   | 82.16e               | 82.93g  | 82.55e  |
| T <sub>3</sub>   | 82.45e               | 83.24fg | 82.85de |
| T <sub>4</sub>   | 81.81e               | 82.56gh | 82.19ef |
| T <sub>5</sub>   | 83.32d               | 84.06ef | 83.69d  |
| T <sub>6</sub>   | 84.58c               | 85.22d  | 84.9c   |
| T <sub>7</sub>   | 84.93c               | 85.51cd | 85.22bc |
| T <sub>8</sub>   | 84.19c               | 84.89de | 84.54c  |
| T <sub>9</sub>   | 85.8b                | 86.33bc | 86.07b  |
| T <sub>10</sub>  | 86.98a               | 87.48a  | 87.23a  |
| T <sub>11</sub>  | 87.35a               | 87.79a  | 87.57a  |
| T <sub>12</sub>  | 86.67a               | 87.16ab | 86.92a  |
| F-test           | **                   | **      | **      |
| S.E. (m) (±)     | 0.3                  | 0.29    | 0.2     |
| C.D. @ 5%        | 0.87                 | 0.84    | 0.59    |
| C.D. @ 1%        | 1.17                 | 1.14    | 0.78    |
| Treatment*Year   | NS                   |         |         |

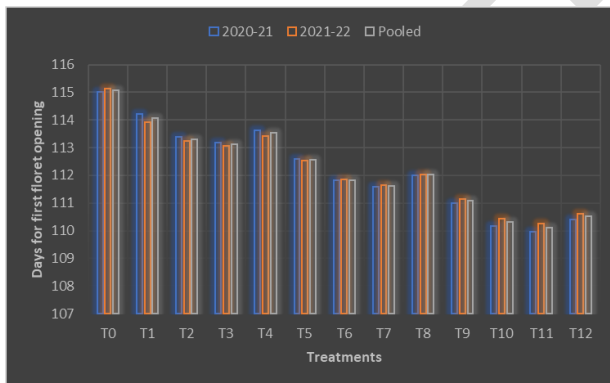
**Fig 6: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Length of spike (cm) of Gladiolus**



**Table 7: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Days taken for first floret opening of Gladiolus**

| Treatment Symbol | Days for first floret opening |          |          |
|------------------|-------------------------------|----------|----------|
|                  | 2020-21                       | 2021-22  | Pooled   |
| T <sub>0</sub>   | 115.02a                       | 115.13a  | 115.08a  |
| T <sub>1</sub>   | 114.21b                       | 113.93b  | 114.07b  |
| T <sub>2</sub>   | 113.39c                       | 113.23c  | 113.31c  |
| T <sub>3</sub>   | 113.18c                       | 113.05cd | 113.12cd |
| T <sub>4</sub>   | 113.62c                       | 113.42bc | 113.52bc |
| T <sub>5</sub>   | 112.59d                       | 112.54de | 112.57de |
| T <sub>6</sub>   | 111.81e                       | 111.85f  | 111.83f  |
| T <sub>7</sub>   | 111.59e                       | 111.64fg | 111.62fg |
| T <sub>8</sub>   | 112.00e                       | 112.03ef | 112.02ef |
| T <sub>9</sub>   | 111.00f                       | 111.13gh | 111.07gh |
| T <sub>10</sub>  | 110.17g                       | 110.44i  | 110.31i  |
| T <sub>11</sub>  | 109.95g                       | 110.25i  | 110.10i  |
| T <sub>12</sub>  | 110.41g                       | 110.62hi | 110.52hi |
| F-test           | **                            | **       | **       |
| S.E. (m) (±)     | 0.2                           | 0.18     | 0.13     |
| C.D. @ 5%        | 0.58                          | 0.53     | 0.38     |
| C.D. @ 1%        | 0.79                          | 0.71     | 0.51     |
| Treatment*Year   | NS                            |          |          |

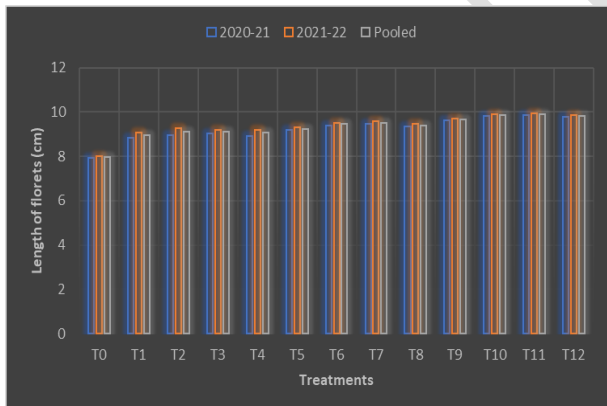
**Fig 7: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Days for first floret opening of Gladiolus**



**Table 8: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Length of florets (cm) of Gladiolus**

| Treatment Symbol | Length of florets (cm) |         |        |
|------------------|------------------------|---------|--------|
|                  | 2020-21                | 2021-22 | Pooled |
| T <sub>0</sub>   | 7.93g                  | 8.01f   | 7.97g  |
| T <sub>1</sub>   | 8.83f                  | 9.05e   | 8.94f  |
| T <sub>2</sub>   | 8.95ef                 | 9.25d   | 9.10de |
| T <sub>3</sub>   | 9.01e                  | 9.17de  | 9.09de |
| T <sub>4</sub>   | 8.90ef                 | 9.19d   | 9.05ef |
| T <sub>5</sub>   | 9.17d                  | 9.31d   | 9.24d  |
| T <sub>6</sub>   | 9.39c                  | 9.51c   | 9.45c  |
| T <sub>7</sub>   | 9.45c                  | 9.56c   | 9.51c  |
| T <sub>8</sub>   | 9.33c                  | 9.45c   | 9.39c  |
| T <sub>9</sub>   | 9.61b                  | 9.70b   | 9.66b  |
| T <sub>10</sub>  | 9.83a                  | 9.89a   | 9.86a  |
| T <sub>11</sub>  | 9.87a                  | 9.93a   | 9.90a  |
| T <sub>12</sub>  | 9.77a                  | 9.84a   | 9.81a  |
| F-test           | **                     | **      | **     |
| S.E. (m) (±)     | 0.05                   | 0.05    | 0.03   |
| C.D. @ 5%        | 0.16                   | 0.14    | 0.1    |
| C.D. @ 1%        | 0.21                   | 0.19    | 0.14   |
| Treatment*Year   | NS                     |         |        |

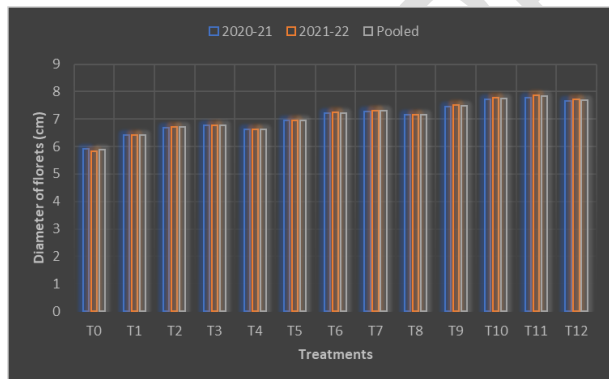
**Fig 8: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Length of florets (cm) of Gladiolus**



**Table 9:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on diameter of florets (cm) of Gladiolus**

| Treatment Symbol | Diameter of florets (cm) |         |        |
|------------------|--------------------------|---------|--------|
|                  | 2020-21                  | 2021-22 | Pooled |
| T <sub>0</sub>   | 5.91i                    | 5.83i   | 5.87i  |
| T <sub>1</sub>   | 6.42h                    | 6.42h   | 6.42h  |
| T <sub>2</sub>   | 6.68g                    | 6.71g   | 6.70g  |
| T <sub>3</sub>   | 6.76fg                   | 6.76fg  | 6.76fg |
| T <sub>4</sub>   | 6.61gh                   | 6.62gh  | 6.62gh |
| T <sub>5</sub>   | 6.95ef                   | 6.96ef  | 6.96ef |
| T <sub>6</sub>   | 7.20d                    | 7.23d   | 7.22d  |
| T <sub>7</sub>   | 7.27cd                   | 7.31cd  | 7.29cd |
| T <sub>8</sub>   | 7.14de                   | 7.16de  | 7.15de |
| T <sub>9</sub>   | 7.46bc                   | 7.51bc  | 7.49bc |
| T <sub>10</sub>  | 7.72a                    | 7.78a   | 7.75a  |
| T <sub>11</sub>  | 7.78a                    | 7.87a   | 7.83a  |
| T <sub>12</sub>  | 7.65ab                   | 7.71ab  | 7.68ab |
| F-test           | **                       | **      | **     |
| S.E. (m) (±)     | 0.07                     | 0.07    | 0.05   |
| C.D. @ 5%        | 0.2                      | 0.21    | 0.14   |
| C.D. @ 1%        | 0.27                     | 0.29    | 0.19   |
| Treatment*Year   | NS                       |         |        |

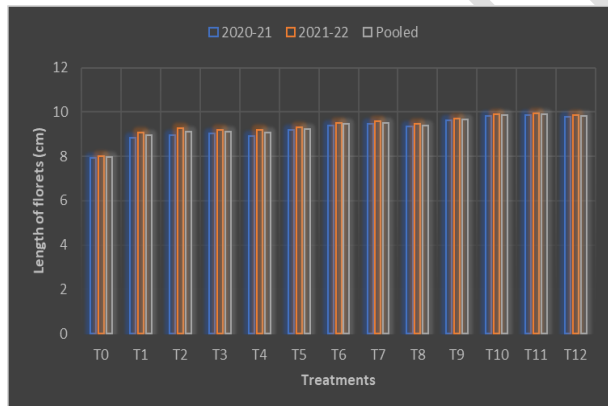
**Fig 9:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on diameter of florets (cm) of Gladiolus**



**Table 10: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Length of florets (cm) of Gladiolus**

| Treatment Symbol      | Length of florets (cm) |             |             |
|-----------------------|------------------------|-------------|-------------|
|                       | 2020-21                | 2021-22     | Pooled      |
| T <sub>0</sub>        | 7.93g                  | 8.01f       | 7.97g       |
| T <sub>1</sub>        | 8.83f                  | 9.05e       | 8.94f       |
| T <sub>2</sub>        | 8.95ef                 | 9.25d       | 9.10de      |
| T <sub>3</sub>        | 9.01e                  | 9.17de      | 9.09de      |
| T <sub>4</sub>        | 8.90ef                 | 9.19d       | 9.05ef      |
| T <sub>5</sub>        | 9.17d                  | 9.31d       | 9.24d       |
| T <sub>6</sub>        | 9.39c                  | 9.51c       | 9.45c       |
| T <sub>7</sub>        | 9.45c                  | 9.56c       | 9.51c       |
| T <sub>8</sub>        | 9.33c                  | 9.45c       | 9.39c       |
| T <sub>9</sub>        | 9.61b                  | 9.70b       | 9.66b       |
| T <sub>10</sub>       | 9.83a                  | 9.89a       | 9.86a       |
| T <sub>11</sub>       | 9.87a                  | 9.93a       | 9.90a       |
| T <sub>12</sub>       | 9.77a                  | 9.84a       | 9.81a       |
| <b>F-test</b>         | <b>**</b>              | <b>**</b>   | <b>**</b>   |
| <b>S.E. (m) (±)</b>   | <b>0.05</b>            | <b>0.05</b> | <b>0.03</b> |
| <b>C.D. @ 5%</b>      | <b>0.16</b>            | <b>0.14</b> | <b>0.1</b>  |
| <b>C.D. @ 1%</b>      | <b>0.21</b>            | <b>0.19</b> | <b>0.14</b> |
| <b>Treatment*Year</b> | <b>NS</b>              |             |             |

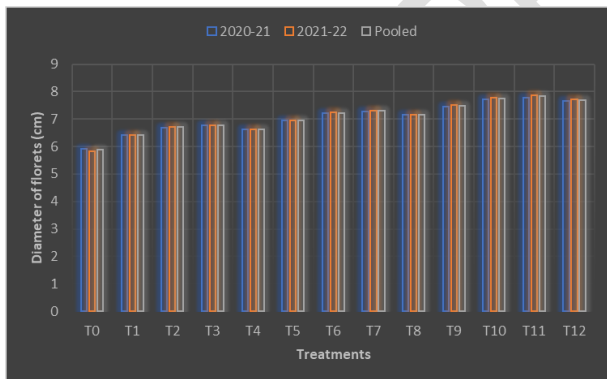
**Fig 10: Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Length of florets (cm) of Gladiolus**



**Table 11:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on diameter of florets (cm) of Gladiolus**

| Treatment Symbol | Diameter of florets (cm) |         |        |
|------------------|--------------------------|---------|--------|
|                  | 2020-21                  | 2021-22 | Pooled |
| T <sub>0</sub>   | 5.91i                    | 5.83i   | 5.87i  |
| T <sub>1</sub>   | 6.42h                    | 6.42h   | 6.42h  |
| T <sub>2</sub>   | 6.68g                    | 6.71g   | 6.70g  |
| T <sub>3</sub>   | 6.76fg                   | 6.76fg  | 6.76fg |
| T <sub>4</sub>   | 6.61gh                   | 6.62gh  | 6.62gh |
| T <sub>5</sub>   | 6.95ef                   | 6.96ef  | 6.96ef |
| T <sub>6</sub>   | 7.20d                    | 7.23d   | 7.22d  |
| T <sub>7</sub>   | 7.27cd                   | 7.31cd  | 7.29cd |
| T <sub>8</sub>   | 7.14de                   | 7.16de  | 7.15de |
| T <sub>9</sub>   | 7.46bc                   | 7.51bc  | 7.49bc |
| T <sub>10</sub>  | 7.72a                    | 7.78a   | 7.75a  |
| T <sub>11</sub>  | 7.78a                    | 7.87a   | 7.83a  |
| T <sub>12</sub>  | 7.65ab                   | 7.71ab  | 7.68ab |
| F-test           | **                       | **      | **     |
| S.E. (m) (±)     | 0.07                     | 0.07    | 0.05   |
| C.D. @ 5%        | 0.2                      | 0.21    | 0.14   |
| C.D. @ 1%        | 0.27                     | 0.29    | 0.19   |
| Treatment*Year   | NS                       |         |        |

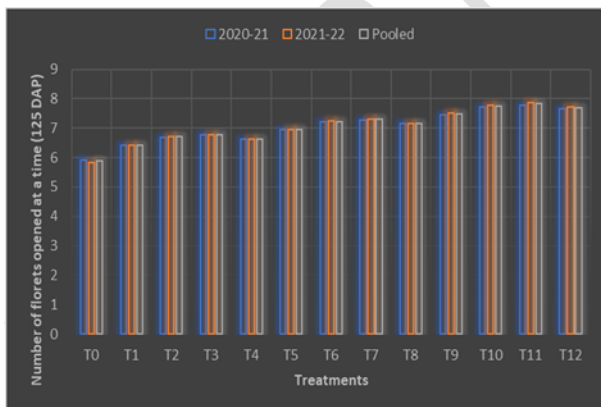
**Fig 11:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on diameter of florets (cm) of Gladiolus**



**Table 12:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Number of florets opened at a time (125 DAP)of Gladiolus**

| Treatment Symbol      | Number of florets opened at a time (125 DAP) |             |             |
|-----------------------|--|-------------|-------------|
|                       | 2020-21                                      | 2021-22     | Pooled      |
| T <sub>0</sub>        | 4.34i  | 4.3g        | 4.32i       |
| T <sub>1</sub>        | 4.59h  | 4.63f       | 4.61h       |
| T <sub>2</sub>        | 4.79g  | 4.83e       | 4.81g       |
| T <sub>3</sub>        | 4.85fg                                       | 4.89e       | 4.87fg      |
| T <sub>4</sub>        | 4.75g  | 4.79e       | 4.77g       |
| T <sub>5</sub>        | 5.00ef                                       | 5.04d       | 5.02ef      |
| T <sub>6</sub>        | 5.21d  | 5.25c       | 5.23d       |
| T <sub>7</sub>        | 5.25cd                                       | 5.29c       | 5.27cd      |
| T <sub>8</sub>        | 5.15de                                       | 5.19c       | 5.17de      |
| T <sub>9</sub>        | 5.40bc                                       | 5.44b       | 5.42bc      |
| T <sub>10</sub>       | 5.62a  | 5.66a       | 5.64a       |
| T <sub>11</sub>       | 5.67a  | 5.71a       | 5.69a       |
| T <sub>12</sub>       | 5.55ab                                       | 5.59a       | 5.57ab      |
| <b>F-test</b>         | <b>**</b>                                    | <b>**</b>   | <b>**</b>   |
| <b>S.E. (m) (±)</b>   | <b>0.05</b>                                  | <b>0.05</b> | <b>0.03</b> |
| <b>C.D. @ 5%</b>      | <b>0.15</b>                                  | <b>0.15</b> | <b>0.1</b>  |
| <b>C.D. @ 1%</b>      | <b>0.21</b>                                  | <b>0.2</b>  | <b>0.14</b> |
| <b>Treatment*Year</b> | <b>NS</b>                                    |             |             |

**Fig 12:Effect of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O on Number of florets opened at a time (125 DAP) of Gladiolus**



## CONCLUSION

From the results of the current experiment, it can be inferred that Treatment T<sub>11</sub>(NPK @150:100:120), had the best effects. It was deemed to have the best growth attributes including Days to 50% Sprouting, Plant height (cm), Number of Leaves per plant & Days to emergence of spike and floral attributes like Flowering Duration, Length of the Spike (cm), Days taken for first floret opening, Length of florets (cm), Diameter of florets (cm) & Number of florets opened at a time (125 DAP).

## FUTURE SCOPE OF STUDY

The main goals of gladioli growers are to enhance the length of spike and florets to increase its apparel. This research presents new empirical discoveries concerning the responses of different concentrations of Nitrogen, Phosphorous, and Potassium. To optimise the growth and floral characteristics of gladiolus cv. Nova Lux cultivation in the prayagraj agro-climate, it is suggested to use NPK @150:100:120. Our experiments have demonstrated that this specific combination resulted in the most significant increases. The following techniques and results are anticipated to enhance Gladiolus production while minimising the impact on cultivated land degradation. Due to the dynamic nature of cultivated Gladiolus varieties, it is recommended that the experimental design be replicated in the upcoming years to evaluate the impact of fertilisation on novel and sought-after varieties in the market.

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UNDER PEER REVIEW