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Effects of Nitrogen, Phosphorus and Potassium Level on Growth and Floral Attributes of Gladiolus (*Gladiolus grandiflorus* L.) cv. Nova Lux

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Gladiolus (*Gladiolus grandiflorus* L.) is a networthy flower crop within 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

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absence of fertiliser recommendations tailored to specific locations, among other factors. Thus, a field experiments were conducted for two consecutive seasons during 2020-2021 & 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_2O_5 and K_2O. The experiment's major goals were to assess the effects of N, P_2O_5 and K_2O on growth and floral attributes of Gladiolus (*Gladiolus grandiflorus* L.) cv. Nova Lux. According to the results of the current study, Treatment T_{11} (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 & 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 & Number of florets opened at a time (125 DAP) i.e., [5.67 (2020-21), 5.71 (2021-22) and 5.69 (Pooled)].

Keywords: Gladiolus; Gladiolus grandiflorus L.; growth; nitrogen; nova lux; phosphorous, potassium.

1. INTRODUCTION

Gladiolus is recognized as one of the most well-known and widely acceptable 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 [1]. It is a perennial geophyte and a semi-rustic herb [2]. 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 [3].

The United States (namely Florida and California), Holland, Italy, France, Bulgaria, Brazil, Australia, Israel, and India are the top gladiolus producers [4]. Though in India, It is mostly produced for commercial purposes on the northern plains of Delhi, including those in the states of Haryana, Punjab, Uttar Pradesh, as well as Maharashtra and Karnataka [5]. Gladiolus cultivation in India covers 11.16 thousand hectares (ha) and generates 102.91 thousand metric tons [6].

It is common knowledge that the aesthetic quality of plants is inextricably tied to an ideal balance of nutrients [7]. 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 [8]. 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, nuceol 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 [9]. 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 [10].

Patokar et al. [11] 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 whicj 75% RDF + 8 t Vermicompost + Azotobacter + PSB resulted in the best growth metrics.In Islamabad, Pakistan, Zamin et al. [12] 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. [13] 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. [14] 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. [15] & Preeti et al. [16] 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 of 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 the 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 of 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.

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, Uttar Pradesh.

2. MATERIALS AND METHODS

The current study on Gladiolus (*Gladiolus grandiflorus* L.) cv. Nova Lux planted at 20cm×30cm 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.

Table 1. Effect of N, P_2O_5 and K_2O on Days to 50% sprouting of Gladiolusa-highest value, i-lowest value

Treatment Symbol	Days to 50% sprouting		
	2020-21	**2021-22**	**Pooled**
T_0	9.91a	9.98a	9.94a
T_1	9.3b	9.25b	9.27b
T_2	9.18c	9.14c	9.16c
T_3	9.14cd	9.11c	9.12cd
T_4	9.21bc	9.17c	9.19bc
T_5	9.05de	9.03d	9.04de
T_6	8.92f	8.92e	8.92f
T_7	8.89fg	8.88e	8.88fg
T_8	8.96ef	8.95e	8.95ef
T_9	8.8gh	8.8f	8.8gh
T_{10}	8.67i	8.72g	8.69i
T_{11}	8.65i	8.69g	8.67i
T_{12}	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	**		

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_2O_5 and K_2O. Growth attributes like Days to 50% sprouting, Plant height (cm) at harvest, Number of leaves per plant at harvest & Days to emergence of spikewhere-as floral attributes like 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_2O_5, and K_2O. Since F Cal > F Tab, the evidence indicates that the variances were statistically significant.

3.1 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_{11}(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 where-as maximum Days to 50% sprouting [9.91 (2020-21), 9.98 (2021-22) and 9.94 (Pooled)] days were recorded in T_0 (Control) during both the years of study as well as pooled analysis. Here, Nitrogen mighthave attributed for the decline in days to 50% sprouting since it can be used by plants as both a nutrient and a sprouting signal [17,18]. The ideal nitrogen content appears to encourage germination through reducing the abscisic acid/gibberellins ratio [19,18].

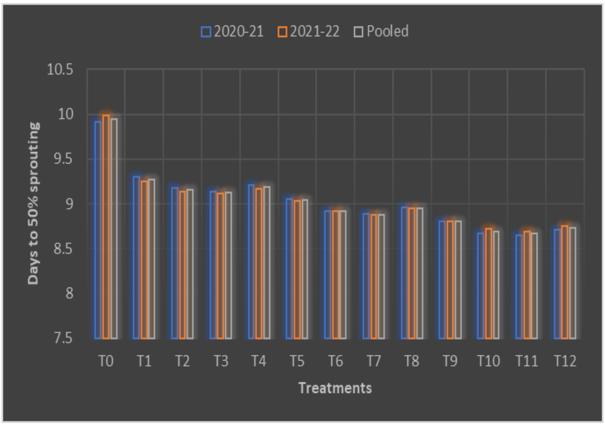

Fig. 1. Effect of N, P_2O_5 and K_2O on Days to 50% sprouting of gladiolus

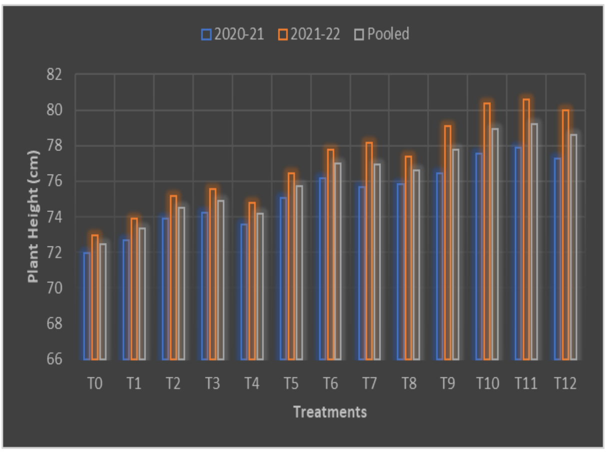

Fig. 2. Effect of N, P_2O_5 and K_2O on Plant Height (cm) sprouting of Gladiolus

Table 2. Effect of N, P_2O_5 and K_2O on Plant Height (cm) of gladiolus

Treatment Symbol	Plant Height (cm)		
	2020-21	**2021-22**	**Pooled**
T_0	71.94g	72.98g	72.46g
T_1	72.78f	73.87f	73.33f
T_2	73.88e	75.14e	74.51e
T_3	74.22e	75.55e	74.89e
T_4	73.58e	74.76e	74.17e
T_5	75.03d	76.44d	75.74d
T_6	76.15bc	77.78c	76.97bc
T_7	75.65cd	78.17c	76.91c
T_8	75.82bc	77.37c	76.60c
T_9	76.44b	79.07b	77.75b
T_{10}	77.54a	80.34a	78.94a
T_{11}	77.87a	80.57a	79.22a
T_{12}	77.26a	79.97a	78.61a
F-test	**	**	**
S.E. (m) (±)	0.25	0.29	0.35
C.D. @ 5%	0.73	0.86	1.09
C.D. @ 1%	0.99	1.17	1.53
Treatment*Year	**		

Table 3. Effect of N, P_2O_5 and K_2O on Number of leaves per plant of Gladiolus

Treatment Symbol	Number of leaves per plant		
	2020-21	**2021-22**	**Pooled**
T_0	7.60i	7.54g	7.57i
T_1	7.69hi	7.85f	7.77h
T_2	7.90g	8.06e	7.98g
T_3	7.95fg	8.11e	8.03fg
T_4	7.84gh	8.00e	7.92gh
T_5	8.09ef	8.26d	8.18ef
T_6	8.31d	8.48c	8.40d
T_7	8.37cd	8.54c	8.45cd
T_8	8.24de	8.41c	8.33de
T_9	8.51bc	8.69b	8.603bc
T_{10}	8.71a	8.89a	8.80a
T_{11}	8.77a	8.95a	8.86a
T_{12}	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		

Plant Height (cm): During the harvest stage, it was observed that the treatment T_{11}(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_0 (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_{11}(NPK @150:100:120) could have increased the rate of photosynthesis, which ultimately could have influenced plant's height. During their research on gladiolus, Shakya et al. [20] 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. [21] and Regar et al. [22] 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 [23].

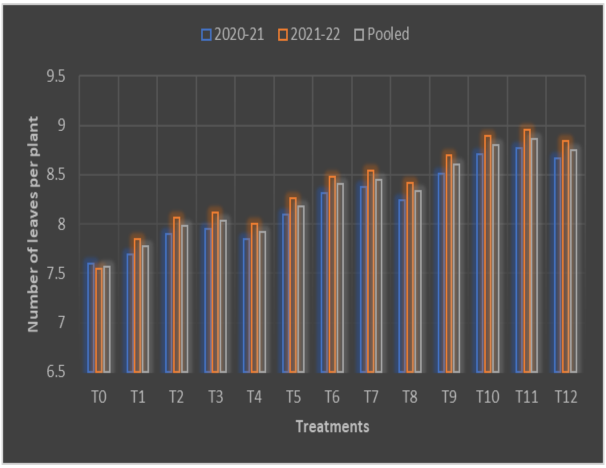

Fig. 3. Effect of N, P_2O_5 and K_2O on Number of leaves per plant of Gladiolus

Table 4. Effect of N, P_2O_5 and K_2O on Days to emergence of spike of Gladiolus

Treatment Symbol	Days to emergence of spike		
	2020-21	**2021-22**	**Pooled**
T_0	80.21a	79.95a	80.08a
T_1	77.73b	76.04b	76.89b
T_2	76.51c	74.94c	75.73cd
T_3	76.22c	75.60bc	75.91c
T_4	76.88c	75.25bc	76.07c
T_5	75.37d	74.81cd	75.09de
T_6	74.21e	73.65e	73.93f
T_7	73.85e	73.35ef	73.60f
T_8	74.54de	74.02de	74.28ef
T_9	73f	72.56fg	72.78g
T_{10}	71.79g	71.46h	71.63h
T_{11}	71.45g	71.21h	71.33h
T_{12}	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		

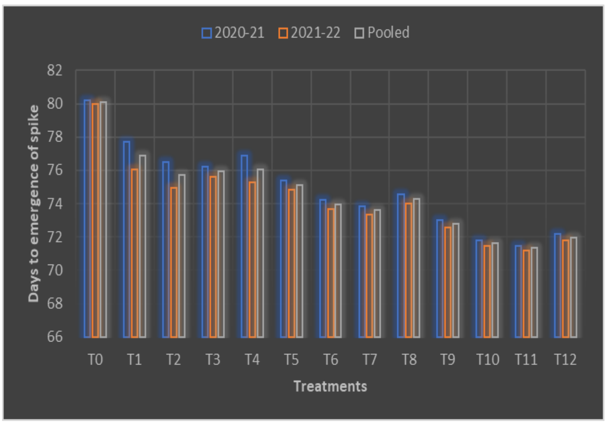

Fig. 4. Effect of N, P_2O_5 and K_2O on Days to emergence of spike of Gladiolus

Table 5. Effect of N, P_2O_5 and K_2O on Flowering duration of Gladiolus

Treatment Symbol	Flowering duration (days)		
	2020-21	2021-22	Pooled
T_0	13.95i	14.01i	13.98i
T_1	14.68h	15.03h	14.86h
T_2	15.07g	15.37g	15.22g
T_3	15.17fg	15.49fg	15.33fg
T_4	14.98gh	15.29gh	15.14gh
T_5	15.47ef	15.75ef	15.61ef
T_6	15.89d	16.10d	16.00d
T_7	15.97cd	16.22cd	16.10cd
T_8	15.77de	16.01de	15.89de
T_9	16.27bc	16.48bc	16.38bc
T_{10}	16.66a	16.84a	16.75a
T_{11}	16.80a	16.92a	16.86a
T_{12}	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_2O_5 and K_2O on Flowering Duration (days) sprouting of Gladiolus

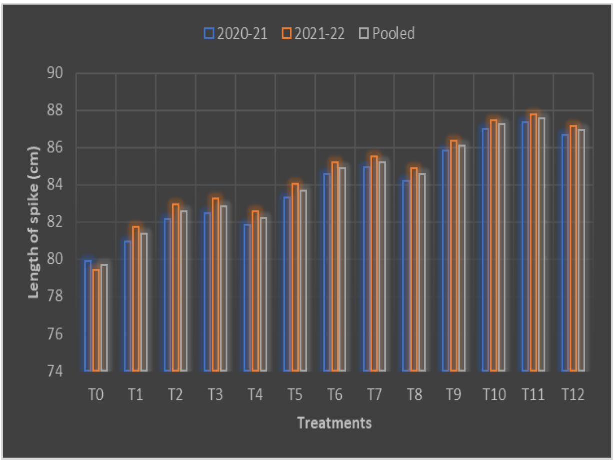

Fig. 6. Effect of N, P_2O_5 and K_2O on Length of spike (cm) of Gladiolus

Table 6. Effect of N, P_2O_5 and K_2O on Length of spike (cm) of Gladiolus

Treatment Symbol	Length of spike (cm)		
	2020-21	**2021-22**	**Pooled**
T_0	79.91g	79.44i	79.68g
T_1	80.94f	81.74h	81.34f
T_2	82.16e	82.93g	82.55e
T_3	82.45e	83.24fg	82.85de
T_4	81.81e	82.56gh	82.19ef
T_5	83.32d	84.06ef	83.69d
T_6	84.58c	85.22d	84.9c
T_7	84.93c	85.51cd	85.22bc
T_8	84.19c	84.89de	84.54c
T_9	85.8b	86.33bc	86.07b
T_{10}	86.98a	87.48a	87.23a
T_{11}	87.35a	87.79a	87.57a
T_{12}	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		

Table 7. Effect of N, P_2O_5 and K_2O on Days taken for first floret opening of Gladiolus

Treatment Symbol	Days for first floret opening		
	2020-21	**2021-22**	**Pooled**
T_0	115.02a	115.13a	115.08a
T_1	114.21b	113.93b	114.07b
T_2	113.39c	113.23c	113.31c
T_3	113.18c	113.05cd	113.12cd
T_4	113.62c	113.42bc	113.52bc
T_5	112.59d	112.54de	112.57de
T_6	111.81e	111.85f	111.83f
T_7	111.59e	111.64fg	111.62fg
T_8	112.00e	112.03ef	112.02ef
T_9	111.00f	111.13gh	111.07gh
T_{10}	110.17g	110.44i	110.31i
T_{11}	109.95g	110.25i	110.10i
T_{12}	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		

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_{11}(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_0 (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. Dhakal et al*.* [23], Chauhan [24] and Akter et al*.* [25] also found similar results on gladiolus. Shah et al*.* [26] 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 [27] on gladiolus.

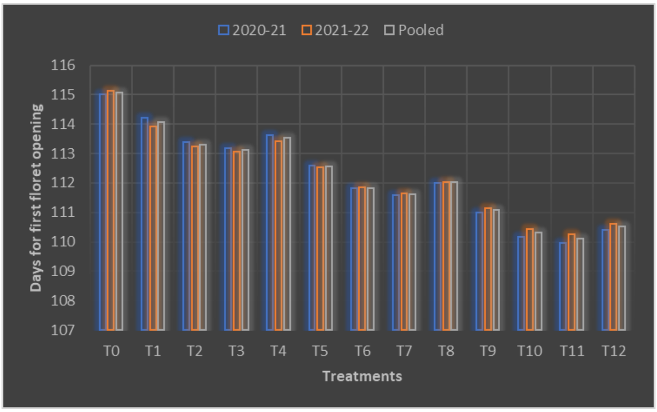

Fig. 7. Effect of N, P_2O_5 and K_2O on Days for first floret opening of Gladiolus

Table 8. Effect of N, P_2O_5 and K_2O on Length of florets (cm) of Gladiolus

Treatment Symbol	Length of florets (cm)		
	2020-21	**2021-22**	**Pooled**
T_0	7.93g	8.01f	7.97g
T_1	8.83f	9.05e	8.94f
T_2	8.95ef	9.25d	9.10de
T_3	9.01e	9.17de	9.09de
T_4	8.90ef	9.19d	9.05ef
T_5	9.17d	9.31d	9.24d
T_6	9.39c	9.51c	9.45c
T_7	9.45c	9.56c	9.51c
T_8	9.33c	9.45c	9.39c
T_9	9.61b	9.70b	9.66b
T_{10}	9.83a	9.89a	9.86a
T_{11}	9.87a	9.93a	9.90a
T_{12}	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		

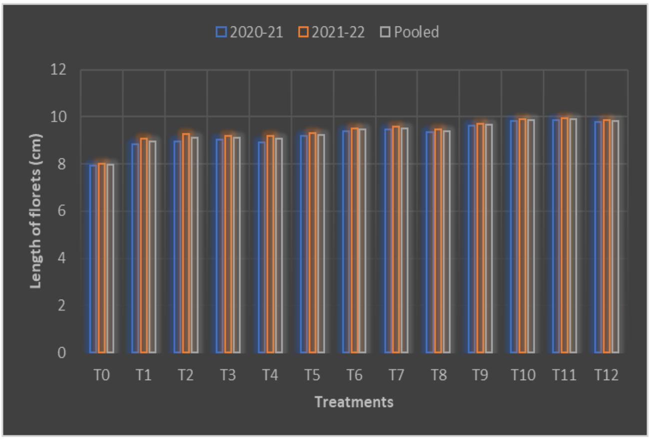

Fig. 8. Effect of N, P_2O_5 and K_2O on Length of florets (cm) of Gladiolus

Table 9. Effect of N, P_2O_5 and K_2O on diameter of florets (cm) of Gladiolus

Treatment Symbol	Diameter of florets (cm)		
	2020-21	**2021-22**	**Pooled**
T_0	5.91i	5.83i	5.87i
T_1	6.42h	6.42h	6.42h
T_2	6.68g	6.71g	6.70g
T_3	6.76fg	6.76fg	6.76fg
T_4	6.61gh	6.62gh	6.62gh
T_5	6.95ef	6.96ef	6.96ef
T_6	7.20d	7.23d	7.22d
T_7	7.27cd	7.31cd	7.29cd
T_8	7.14de	7.16de	7.15de
T_9	7.46bc	7.51bc	7.49bc
T_{10}	7.72a	7.78a	7.75a
T_{11}	7.78a	7.87a	7.83a
T_{12}	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		

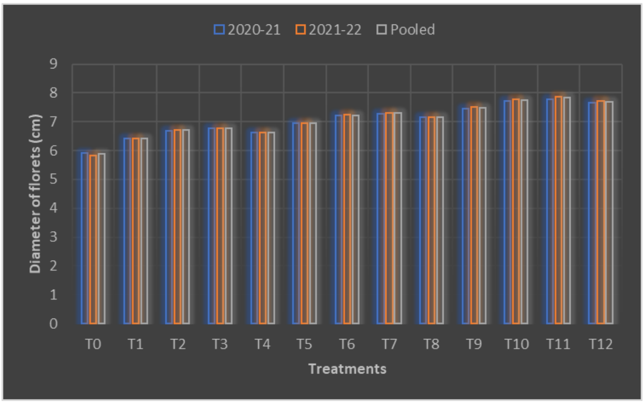

Fig. 9. Effect of N, P_2O_5 and K_2O on diameter of florets (cm) of Gladiolus

Fig. 10. Effect of N, P_2O_5 and K_2O on Number of florets opened at a time (125 DAP) of Gladiolus

Table 10. Effect of N, P_2O_5 and K_2O 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_0	4.34i	4.3g	4.32i
T_1	4.59h	4.63f	4.61h
T_2	4.79g	4.83e	4.81g
T_3	4.85fg	4.89e	4.87fg
T_4	4.75g	4.79e	4.77g
T_5	5.00ef	5.04d	5.02ef
T_6	5.21d	5.25c	5.23d
T_7	5.25cd	5.29c	5.27cd
T_8	5.15de	5.19c	5.17de
T_9	5.40bc	5.44b	5.42bc
T_{10}	5.62a	5.66a	5.64a
T_{11}	5.67a	5.71a	5.69a
T_{12}	5.55ab	5.59a	5.57ab
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		

Days to emergence of spike: The data regarding Days to emergence of spike is shown in Table 5; Fig. 4. From the data it was observed that treatment T_0 (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_{11}(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 [28]. The minimal days to spike emergence with phosphorus applications have yielded the same findings by Mohapatra et al*.,* [29] on gladiolus. Similar results were also found by Sabastian et al*.* [14], Chandana and Dorajeerao [30] and Kumar [31] on gladiolus.

3.2 Floral Attributes

Flowering duration: 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_{11}(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_0 (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 [32]. It has been claimed that polyamines serve either as a nitrogen source or as signal molecules that regulate abscission and bloom lifetime [33]. 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. Olivaris et al*.* [34] and Woodson and Boodley [35] 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_{11}(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_0 (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. [36] 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 Deshmukh et al*.* [37] in Tuberose, Chandana and Dorajeerao [30] on gladiolus, Bose and Yadav [38] and Afifty [39]on gladiolus.

Days taken for first floret opening: Treatment T_{11}(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_0 (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 [40], 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, [36], Kumar and Misra, [21] and Belwal et al*.* [41].

Length of florets (cm): The data regarding Length of florets (cm) is shown in Table 9; Fig. 8. It was observed that, treatment T_{11}(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_0 (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 [42] and Mahadik and Chopde [43] came to similarly conclusive findings as well.Similar results were also produced by Deshmukh et al*.* [37] in Tuberose, Chandana and Dorajeerao [30] on gladiolus, Sharma et al. [36] while working on Tuberose.

Diameter of florets: According to the data mentioned at Table 10; Fig. 9, it was observed that, treatment T_{11}(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_0 (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 [42], Mahadik and Chopde (2015) and Chandana and Dorajeerao [30] on gladiolus and Deshmukh et al*.* [37] and Sharma et al. [36] 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 8; Fig. 10. It was observed that, treatment T_{11}(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_0 (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*.,* [44] 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*.* [20] also uncovered results that were remarkably comparable to those previously discovered. Khan and Iftikhar [45] and Hilal et al. [46] also found similar results while working on gladiolus.

4. CONCLUSION

From the results of the current experiment, it can be inferred that Treatment T_{11}(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).

5. 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 kanpur 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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COMPETING INTERESTS

Authors have declared that no competing interests exist

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