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RD Sonone
Ph.D. Scholar, Department of
Floriculture and Landscaping,
Dr. PDKV, Akola,
Maharashtra, India

NS Gupta
Head, Department of
Floriculture and Landscaping,
Dr. PDKV, Akola,
Maharashtra, India

NG Rathod
Assistant Professor,
Department of Floriculture
and Landscaping, Dr. PDKV,
Akola, Maharashtra, India

Manisha Deshmukh
Assistant Professor,
Department of Floriculture
and Landscaping, Dr. PDKV,
Akola, Maharashtra, India

SM Bhojar
Associate Dean, College of
Agriculture, Dr. PDKV, Akola,
Maharashtra, India

MM Deshmukh
Head, Department of
Irrigation and Drainage
Engineering Dr. PDKV, Akola,
Maharashtra, India

Corresponding Author:
RD Sonone
Ph.D. Scholar, Department of
Floriculture and Landscaping,
Dr. PDKV, Akola,
Maharashtra, India

Effect of split fertigation schedules on vegetative growth of gladiolus (*Gladiolus grandiflorus* L.) cv. Dhanvantari

RD Sonone, NS Gupta, NG Rathod, Manisha Deshmukh, SM Bhojar and MM Deshmukh

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Abstract

Split fertigation is an efficient nutrient management approach that enhances fertilizer use efficiency by synchronizing nutrient supply with crop demand. A field experiment entitled "Fertigation Studies in Gladiolus cv. Dhanvantari" was conducted at the Instructional Farm, Department of Floriculture and Landscaping, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the winter seasons of 2021-22 and 2022-23 to evaluate the effect of different split fertigation schedules on vegetative growth of gladiolus. The experiment was laid out in Randomized Block Design with ten treatments and three replications. Treatments comprised conventional fertilizer application and varying split fertigation schedules using water-soluble fertilizers. The results revealed that days required for sprouting of corms and 50% sprouting were not significantly influenced by the fertigation schedules. However, significant differences were observed for vegetative growth parameters. Treatment NPK at 150:100:100 kg ha⁻¹ applied through fertigation in 8 splits at 10-day intervals starting from 20 DAP along with basal dose of NPK at 150:100:100 kg/ha through conventional fertilizers recorded the maximum plant height (61.76, 101.85 and 102.15 cm at 30, 60 and 90 DAP, respectively), number of leaves (3.58, 6.30 and 9.20), effective tillers per plant (3.11), leaf width (3.82 cm), leaf length (102.00 cm), leaf area (151.52 cm²) and leaf area per plant (1393.89 cm²), Whereas plant height at 30 DAP was at par with T₂ i.e. NPK at 300:200:200 kg/ha applied through fertigation in 13 splits at 10-day intervals starting from 10 DAP and T₃ i.e. NPK at 150:100:100 kg/ha applied through fertigation in 12 splits at 10-day intervals starting from 20 DAP. On the other hand plant height at 60 and 90 DAP was at par with T₂ i.e. NPK at 300:200:200 kg/ha applied through fertigation in 13 splits at 10-day intervals starting from 10 DAP respectively. During 2022-23 at 30 DAP the maximum number of leaves were found significant in T₇ i.e. NPK at 150:100:100 kg/ha applied through fertigation in 8 splits at 10-day intervals starting from 20 DAP. Number of leaves at 60 DAP were at par with T₂ i.e. NPK at 300:200:200 kg/ha applied through fertigation in 13 splits at 10-day intervals starting from 10 DAP and T₃ i.e. NPK at 150:100:100 kg/ha applied through fertigation in 12 splits at 10-day intervals starting from 20 DAP. Whereas number of leaves at 90 DAP were at par with T₂ i.e. NPK at 300:200:200 kg/ha applied through fertigation in 13 splits at 10-day intervals starting from 10 DAP only. The superior performance of treatment NPK at 150:100:100 kg/ha applied through fertigation in 8 splits at 10-day intervals starting from 20 DAP attributed to the continuous and balanced nutrient supply through splits fertigation, which improved nutrient availability, uptake and utilization throughout the crop growth period. The study demonstrated that application of NPK at 150:100:100 kg/ha through fertigation in eight splits initiated at 20 DAP is an effective nutrient management strategy for improving vegetative growth in gladiolus cv. Dhanvantari.

Keywords: Gladiolus, fertigation, NPK, vegetative growth, split-fertigation, Dhanvantari

Introduction

Gladiolus (*Gladiolus grandiflorus* L.), a member of the Iridaceae family, is also referred to as the "sword lily" and is also known as the "Queen of the bulbous flowers." It is one of the most important decorative flowering crops in the world.

Because of its varied hues and variants and prolonged lifespan, it is a popular cut flower. They are frequently utilized in bouquets, floral arrangements and artistic garlands. The long flower spikes make excellent cut flowers for table decoration when placed in vases.

Gladiolus is one of the most important cut flowers due to its easy cultivation and ability to adapt to a range of soils and agro climatic conditions, in addition to its appealing spikes and blossom. It has earned a place of honor in the Indian floriculture industry due to its enhanced beauty, good keeping quality and appropriateness for cut flowers.

Gladiolus can be cultivated in any kind of well-drained soil, though it works best in sandy loam soil with sufficient organic matter. The ideal pH range for gladiolus cultivation is between 6 to 7, but it can also be grown in soil with a pH between 5 to 7.

The plant's ability to absorb nutrients is intimately linked to many yield factors that determine the flower's yield. One of the most significant factors that directly affects the quality and yield of spikes is diet. According to Shankar and Dubey (2005) this crop requires a high dosage of macronutrients including nitrogen, phosphorus and potassium since it is extremely responsive to feeding.

Increasing fertilizer efficiency, increasing output and optimizing fertilizer input all depend on fertilizer management techniques that are suitable for a particular site. In order to create a fertilizer solution, water-soluble grains concentrates are dissolved in water. Benefits of water soluble fertilizers is that they are readily absorbed, retain nutrients in the root zone, where they are quickly absorbed. Fertigation is a method that uses micro-irrigation equipment to deliver nutrients straight to the active root zone. It can deliver agricultural nutrients more precisely and promptly, leading to increased yields, improved quality. By increasing fertilizer efficiency and providing flexibility in fertilizer application timing based on crop demand and physiological stages of growth, fertigation also aids in reducing nutrient waste (Papadopoulos, 1992) [7].

Material and Methods

A study entitled "Fertigation Studies in Gladiolus cv.

Dhanvantari" was carried out at the Instructional Farm of Department of Floriculture and Landscaping, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the winter seasons of 2021-2022 and 2022-2023. Akola, Maharashtra, is part of Western Vidarbha area, which borders Madhya Pradesh. Its geographic coordinates are 20°16' to 21°17' N latitude and 76°38' to 77°38' E longitude, with an elevation of 307.415 meters above mean sea level. The region's climate is subtropical and semi-arid, with scorching summers a monsoon season from June to October and mild winters. The average minimum temperature is 12.6 °C, while average maximum is 42.4 °C. Annual rainfall ranges between 740 to 860 mm.

Treatment details

The experiment was conducted in Randomized Block Design with ten treatments which were replicated thrice. The treatments comprised of ten different split fertigation schedules such as treatment T₁ i.e. RDF at 300:200:200 kg/ha in which 50% N and full dose of P and K applied at planting and remaining 50% N in three splits at the 2, 4, and 6 leaf stages respectively are applied as a straight fertilizers, treatment T₂ i.e. NPK at 300:200:200 kg/ha in 13 splits by fertigation at 10 days interval from 10 DAP. Treatment T₃ to treatment T₁₀ 50% of NPK at 150: 100: 100 kg/ha is applied through conventional fertilizers as basal dose at the time of planting and the remaining 50% of NPK 150: 100: 100 kg/ha splitting through water soluble fertilizers. Treatments T₃, T₄, T₅ and T₆ were applied by fertigation with NPK at 150:100:100 kg/ha in 12, 11, 10 and 9 splits, respectively, at 10 days interval starting from 20, 30, 40 and 50 DAP, respectively. Similarly, treatments T₇, T₈, T₉ and T₁₀ were also given NPK at 150:100:100 kg/ha through fertigation in 8, 7, 6 and 5 splits respectively at 10-day intervals starting from 20, 30, 40 and 50 DAP, respectively. The result obtained in respect of growth are summarized below.

The result obtained in respect of growth are summarized below.

Treatment	Fertilizer Dose
T ₁	RDF at 300:200:200 kg/ha in which 50% N and full dose of P and K was applied at planting and remaining 50% N applied in three splits at the 2, 4, and 6 leaf stages respectively as a straight fertilizers.
T ₂	NPK at 300:200:200 kg/ha in 13 splits by fertigation at 10 days interval from 10 DAP
T ₃	NPK at 150:100:100 kg/ha in 12 splits by fertigation at 10 days interval from 20 DAP
T ₄	NPK at 150:100:100 kg/ha in 11 splits by fertigation at 10 days interval from 30 DAP
T ₅	NPK at 150:100:100 kg/ha in 10 splits by fertigation at 10 days interval from 40 DAP
T ₆	NPK at 150:100:100 kg/ha in 9 splits by fertigation at 10 days interval from 50 DAP
T ₇	NPK at 150:100:100 kg/ha in 8 splits by fertigation at 10 days interval from 20 DAP
T ₈	NPK at 150:100:100 kg/ha in 7 splits by fertigation at 10 days interval from 30 DAP
T ₉	NPK at 150:100:100 kg/ha in 6 splits by fertigation at 10 days interval from 40 DAP
T ₁₀	NPK at 150:100:100 kg/ha in 5 splits by fertigation at 10 days interval from 50 DAP

Note: T₃ to T₁₀ 50% NPK at 150:100:100 kg/ha is applied through conventional fertilizers as basal dose at the time of planting and remaining 50% of NPK at 150:100:100 kg/ha splitting through water soluble fertilizers.

Results and Discussion

Days required for sprouting of corms and 50% sprouting

The data regarding the days required for sprouting of corms and 50% sprouting for both years of study and pooled basis is summarized in Table 1. Results pertaining to split fertigation schedules indicates that application of RDF with split fertigation have no significant effect on days required for sprouting of corms and 50% sprouting of corms. All split fertigation schedules recorded almost similar sprouting percentage of corms in both years of research and pooled analysis.

Plant height

The data with respect to plant height (Table 1) indicates that split fertigation schedules significantly influenced plant height at 30, 60 and 90 DAP. Treatment T₇ i.e. NPK at 150:100:100 kg/ha applied in 8 splits through fertigation at 10 days interval from 20 DAP recorded the highest plant height (61.76, 101.85 and 102.15 cm at 30, 60 and 90 DAP respectively) and remained statistically at par with T₂ at all stages. The lowest plant height (50.52, 79.15 and 87.30 cm respectively) was recorded under T₁ i.e. RDF at 300:200:200 kg/ha in which 50% N and full dose of P and K applied at planting and remaining 50% N in three splits at

the 2, 4, and 6 leaf stages respectively are applied as a straight fertilizers. The increased plant height under T₇ may be attributed to the continuous and balanced supply of nutrients through fertigation, which enhanced nutrient availability and uptake throughout the crop growth period. Frequent application of fertilizers in smaller doses improved

nutrient use efficiency, promoted cell division and elongation and supported steady vegetative growth. Similar findings were reported by Baladha *et al.* (2020)^[1], Pooja *et al.* (2022)^[9], Singh and Dhath (2023)^[15] and Prasad *et al.* (2023)^[10] in gladiolus.

Table 1: Effect of split fertigation schedules on days required for sprouting of corms, 50% sprouting, plant height and number of leaves in gladiolus

Treatments	Days for sprouting of corms	Days for 50% sprouting	30 DAP	Plant height 60 DAP	90 DAP	Number of leaves		
						30 DAP	60 DAP	90 DAP
T ₁	5.53	8.54	50.52	79.15	87.30	2.24	4.40	7.30
T ₂	6.19	8.55	61.06	98.15	98.52	3.28	6.09	8.57
T ₃	5.60	8.32	59.20	95.09	96.19	3.07	5.87	8.47
T ₄	5.76	8.50	55.10	91.40	94.37	2.72	5.52	8.16
T ₅	5.70	8.65	53.43	86.19	91.69	2.50	5.14	8.09
T ₆	6.67	8.75	51.01	81.93	88.38	2.29	4.71	7.96
T ₇	6.62	8.40	61.76	101.85	102.15	3.58	6.30	9.20
T ₈	6.18	8.20	56.51	93.40	95.62	2.87	5.74	8.37
T ₉	6.27	8.23	54.82	90.15	92.82	2.63	5.33	8.10
T ₁₀	6.43	8.74	52.20	83.97	90.17	2.39	4.94	7.86
'F' test	NS	NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m)±	0.31	0.34	2.09	1.90	1.39	0.07	0.16	0.20
CD at 5%	-	-	6.23	5.64	4.15	0.25	0.49	0.60

Number of leaves

Number of leaves per plant (Table 1) were significantly influenced by different split fertigations schedules. Treatment T₇ recorded the highest number of leaves at 30, 60 and 90 DAP (3.58, 6.30 and 9.20, respectively). At 60 DAP, T₇ was found to be at par with treatment T₂ (6.09) and treatment T₃ (5.87), while at 90 DAP it remained at par with treatment T₂ (8.57). The lowest number of leaves (2.24, 4.40 and 7.30 leaves at 30, 60 and 90 DAP respectively) were recorded under treatment T₁ i.e.

RDF at 300:200:200 kg/ha in which 50% N and full dose of P and K applied at planting and remaining 50% N in three splits at the 2, 4, and 6 leaf stages respectively are applied as a straight fertilizers. The increased leaf production under treatment T₇ may be attributed to the continuous supply of nutrients through fertigation, particularly nitrogen, which plays a key role in chlorophyll formation, photosynthesis and vegetative growth. Improved nutrient availability and uptake under fertigation which enhanced cell division and leaf development, resulting in a greater number of leaves per plant. Similar findings were reported by Rajesh *et al.* (2016)^[12], Prasad *et al.* (2023)^[10], Munikrishnappa *et al.* (2002)^[6] in tuberose and Qasim *et al.* (2008)^[11] in rose.

Number of effective tillers per plant

The data indicates (Table 2) number of effective tillers per plant was significantly influenced by different split fertigation schedules. Treatment T₇ i.e. NPK at 150:100:100 kg/ha applied in 8 splits through fertigation at 10 days interval from 20 DAP recorded the maximum number of effective tillers (3.11), which was statistically at par with treatment T₂ (3.02). The minimum number of effective tillers (2.41) were recorded under treatment T₁ i.e. RDF at 300:200:200 kg/ha in which 50% N and full dose of P and K applied at planting and remaining 50% N in three splits at the 2, 4, and 6 leaf stages respectively are applied as a straight fertilizer. The higher number of tillers under treatment T₇ may be attributed to the continuous and

balanced supply of nutrients through fertigation, which improved nutrient uptake and utilization throughout the crop growth period. Enhanced availability of nutrients, particularly nitrogen, promoted vegetative growth and encouraged the development of more tillers. Similar findings were reported by Munikrishnappa *et al.* (2002)^[6] in tuberose, Qasim *et al.* (2008)^[11] in rose and Rajesh *et al.* (2016)^[12] and Prasad *et al.* (2023)^[10] in gladiolus, who observed improved tillering and vegetative growth under fertigation.

Width of leaves

The data pertaining to leaf width (Table 2) indicate treatments had significantly influenced leaf width due to different split fertigation schedules. Treatment T₇ i.e. at 150:100:100 kg/ha applied in 8 splits through fertigation at 10 days interval from 20 DAP recorded the maximum leaf width (3.82 cm), which was statistically at par with treatment T₂ (3.76 cm). Both treatments produced significantly wider leaves compared to the remaining treatments. The minimum leaf width (3.33 cm) was observed in treatment T₆ i.e. NPK at 150:100:100 kg/ha in nine splits by fertigation at 10 days interval from 50 DAP. The increased leaf width under treatment T₇ may be attributed to the continuous availability of nutrients through fertigation, which enhanced nutrient uptake and promoted better vegetative growth. Adequate supply of nitrogen and phosphorus improved cell expansion and leaf development, resulting in broader leaves and greater photosynthetic surface area. Similar findings were reported by Patel *et al.* (2010)^[8], Kumar and Misra (2011)^[5], Sahu *et al.* (2020)^[13] and Khushwaha *et al.* (2024)^[4] who observed improved leaf growth and vegetative development in gladiolus under optimum nutrient management and fertigation

Length of leaf

The data in Table 2 indicates leaf length was significantly influenced by different split fertigation schedules. Treatment

T₇ i.e. at 150:100:100 kg/ha applied in 8 splits through fertigation at 10 days interval from 20 DAP recorded the maximum leaf length (102.00 cm), which was statistically at par with treatment T₂ (98.83 cm). Both treatments produced significantly longer leaves than the remaining treatments. The minimum leaf length (80.22 cm) was recorded in treatment T₆ i.e. NPK (150:100:100 kg/ha) in 9 splits by fertigation at 10 days interval from 50 DAP). The increased leaf length under treatment T₇ may be attributed to the continuous and adequate supply of nutrients through fertigation, particularly nitrogen, which plays a vital role in protein synthesis, cell division and vegetative growth. Improved nutrient availability throughout the growth period enhanced leaf expansion and elongation, resulting in longer leaves. Similar findings were reported by Patel *et al.* (2010) [8], Kumar and Misra (2011) [5], Chandana and Dorajeero (2014) [2], Khanam *et al.* (2017) [3], Pooja *et al.* (2022) [9] and Khushwaha *et al.* (2024) [4], who observed enhanced leaf growth and vegetative development in gladiolus under optimum nutrient management and fertigation practices.

Leaf area

Analysis of data obtained related to leaf area (Table 2) indicates that it was strongly affected by different split fertigation schedules. Maximum leaf area (151.52 cm²) was reported in treatment T₇ i.e. at 150:100:100 kg/ha applied in 8 splits through fertigation at 10 days interval from 20 DAP, which was statistically at par with T₂ (146.85 cm²). Treatment T₁ i.e. RDF at 300:200:200 kg/ha in which 50% N and full dose of P and K applied at planting and remaining 50% N in three splits at the 2, 4, and 6 leaf stages respectively are applied as a straight fertilizer, recorded the minimum leaf area (138.43 cm²). The higher leaf area in T₇ can be explained by constant and balanced supply of

fertigation, which increased nutrient uptake, photosynthesis and total plant growth. The timely supply of nitrogen and phosphorus stimulated cell division and leaf development, thus increasing leaf area. Similar observations were made by Kumar and Misra (2011) [5], Chandana and Dorajeero (2014) [2], Thentu *et al.* (2015) [16] and Prasad *et al.* (2023) [10] in gladiolus.

Leaf area/plant

The data pertaining to leaf area per plant (Table 2) indicates treatments of different split fertigation schedules had significant effect. Treatment T₇ i.e NPK at 150:100:100 kg/ha applied in 8 splits through fertigation at 10 days interval from 20 DAP recorded the maximum leaf area per plant (1393.89 cm²) which was statistically at par with T₂ (1274.83 cm²). The minimum leaf area per plant (1011.67 cm²) was recorded in T₁ i.e. RDF at 300:200:200 kg/ha in which 50% N and full dose of P and K applied at planting and remaining 50% N in three splits at the 2, 4, and 6 leaf stages respectively are applied as a straight fertilizers. The higher leaf area per plant observed under T₇ may be attributed to continuous and balanced supply of nutrients through fertigation, which promoted vigorous vegetative growth and enhanced leaf expansion. Improved availability and uptake of nutrients, particularly nitrogen, throughout the crop growth period resulted in increased photosynthetic surface area and overall plant growth. These findings are in agreement with the reports of Kumar and Misra (2011) [5], Chandana and Dorajeero (2014) [2], Thentu *et al.* (2015) [16], Prasad *et al.* (2023) [10] in gladiolus and Munikrishnappa *et al.* (2002) [6] in tuberose, who observed greater leaf development under efficient nutrient management and fertigation practices.

Table 2: Effect of split fertigation schedules on effective tillers, width of leaves, length of leaves, leaf area and leaf area per plant in gladiolus.

Treatments	Effective tillers/plant	Width of leaves (cm)	Length of leaf (cm)	Leaf area (cm ²)	Leaf area/plant (cm ²)
T ₁	2.41	3.59	94.01	138.43	1011.67
T ₂	3.02	3.76	98.83	146.85	1274.83
T ₃	2.92	3.43	92.81	147.70	1240.54
T ₄	2.70	3.39	89.39	144.09	1176.09
T ₅	2.53	3.35	87.08	141.23	1142.36
T ₆	2.44	3.33	80.22	139.32	1107.62
T ₇	3.11	3.82	102.00	151.52	1393.89
T ₈	2.77	3.41	90.39	145.26	1215.62
T ₉	2.65	3.37	88.72	141.92	1149.49
T ₁₀	2.49	3.34	83.88	140.08	1100.98
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m)±	0.08	0.10	2.70	1.49	34.13
CD at 5%	0.24	0.31	8.02	4.43	101.40

Conclusion

The present investigation demonstrated that split fertigation schedules had no significant influence on days required for corm sprouting and 50% sprouting in gladiolus cv. Dhanvantari. However, vegetative growth parameters were markedly improved by fertigation. Among the different treatments, treatment T₇ i.e. NPK at 150:100:100 kg/ha applied through fertigation in eight splits at 10-day intervals starting from 20 DAP along with basal application of NPK at 150:100:100 kg/ha through conventional fertilizers consistently recorded the maximum plant height, number of leaves, effective tillers, leaf width, leaf length, leaf area and leaf area per plant. Plant height at 60 and 90 DAP, number

of leaves at 90 DAP, number of effective tillers, width of leaves, length of leaves, leaf area and leaf area per plant were found to be statistically at par with treatment T₂. Plant height at 30 DAP and number of leaves at 60 DAP were recorded statistically at par with T₂ and T₃. The improved growth under treatment T₇ indicates that frequent application of nutrients in smaller doses enhances nutrient availability and uptake, resulting in better vegetative development and efficient fertilizer utilization. Therefore, fertigation with NPK at 150:100:100 kg/ha in eight equal splits at 10 days interval from 20 DAP with basal dose of NPK at 150:100:100 kg/ha through conventional fertilizers can be recommended as an effective nutrient management

practice for improving vegetative growth of gladiolus cv. Dhanvantari and other varieties.

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