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Effect of Intercropping with Leafy Vegetables on the Growth, Yield and Quality of Gladiolus Under Agro-Climatic Conditions of Prayagraj

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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

Intercropping brings diversity of species in the cropping systems and is considered to make them more resilient against environmental stresses. It can significantly enhance the efficient use of land, water and solar energy besides assuring insurance against failure of one or the other crops.

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Therefore, an attempt was made to include leafy vegetable crops as intercrops in gladiolus *cv.* Novalux, for higher productivity and profitability per unit area. The experiment consists of seven treatments with three replications. From the present investigation, it was concluded that the intercrops significantly affected the performance of gladiolus. The intercropping combination T6: Gladiolus + Fenugreek gave the best results in terms of plant height (91.40 cm), number of leaves per plant (18.53), number of shoots per corm (4.93), days to spike initiation (64.33), spike length (73.93 cm), rachis length (49.47 cm), number of florets per spike (12.93), floret size (11.27), vase life (18.53 days), weight of corms (63.67g) and cormlets (6.77g), yield of corms (2385.00kg/ha) and cormlets (225.50kg/ha). The herbage yield per plot was recorded the highest in T3: Fenugreek sole (880.00. g), and intercropping combination of Gladiolus and fenugreek (T6) gave 665.83g. Based on the recent findings, intercropping of fenugreek with gladiolus can be recommended and expanded on a larger scale for additional yield.

Keywords: Gladiolus grandiflorus; leafy vegetables; combination crop; interaction effect; yield.

1. INTRODUCTION

Intercropping is the growing of two or more crops simultaneously on the same land by utilizing resources such as soil, water, nutrients and solar radiation more effectively [1,2]. It could be a viable agronomic practice to minimize risk of crop loss, alternate and additional sources of income, improve the fertility status of soil, minimize soil erosion and helps to increase the productivity of land per unit area [3]. Willey [4] clearly and evidently proposed that intercropping gives higher yields in a given season and greater stability of yields in different seasons compared with sole crop. Yields are more stable in intercropping systems. Its relation to yield stability is the notion of risk, in terms of either productivity or income or both [5]. Intercropping of horticulture and floriculture crops can enhance profit and also ensures better returns. It increases parasitoid survivor-ship, fecundity and retention, and pest suppression in agro-ecosystems [6]. Floricultural crops should be exploited in this system, as most of them have all the potential features of an intercrop and can provide higher returns when two or more such crops are grown together in a field. In order to utilize the production potentiality of flowers, besides preserving the physico-chemical and biological health of soil, precise efforts are to be adopted for planning and execution of nutritional programs [7]. According to APEDA, gladiolus has a net production of 174.74 thousand Mt in India during 2015-16 as per the data provided by National Horticultural Board [8]. Moreover, it occupies 4th position in the global market for floricultural trade and in India, it ranks next to rose as cut flower [9,10]. Gladiolus is regarded as a viable diversification from traditional field crop due to the increase per unit return [11]. It is ideal for intercropping and due to its magnificent spikes, its demand as a cut flower in national and international markets is increasing. Whereas, intercropping is a viable agronomic practice for increasing the productivity and profitability from a unit area, vegetable crops have good marketing potential and many types of vegetable crops grown as sole crop are profitable in the region [12]. The intercropping system usually gives higher combined yield than the sole crops [13]. Among the intercrops, spinach, fenugreek and dill are considered as popular vegetables as they are short duration crops and give more monetary returns than any other agronomical crops [14]. Therefore, an attempt was made to include the vegetable crops as intercrops in gladiolus for higher productivity and profitability per unit area.

2. MATERIALS AND METHODS

The experiment was conducted at the Department of Horticulture, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, during September, 2023 to March, 2024. Geographically, Prayagraj is situated at an elevation of 78 meters from mean sea level in the South-Eastern part of Uttar Pradesh. It lies between the parallels of 24° 77' and 25° 47' north latitudes and 81° 19' and 82° 21 cast longitudes. The district experiences average maximum temperature ranges between 43°- 47°C which may go as high as 48°C during peak summers (May-June). The minimum average temperature is 2-4°C, which may fall as low as 1°C during peak winter months (December-January) The average rainfall of the district is 960 mm and the monsoon season is spread between July-September. The experiment was laid out in Randomized Block Design with 7 treatments. The treatment combinations include T1: Gladiolus sole, T2: Spinach sole, T3: Fenugreek sole, T4: Dill sole,

T5: Gladiolus + Spinach, T6: Gladiolus + Fenugreek, T7: Gladiolus + Dill. The data on growth yield and quality attributing components like plant height (cm), number of leaves per plant, number of shoots per corm, days to spike initiation, spike length (cm), rachis length (cm), number of florets per spike, floret diameter (cm), weight of corms and cormlets (g), yield of corms and cormlets (kg/ha), vase life (days) and herbage yield per plot (g). The data recorded on growth, yield and quality components were subjected to Fisher's method of analysis of variance (ANOVA) as suggested by Panse and Sukhatme [15].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Significant variation was observed among the intercropping treatments as presented in Table 1. In the case of plant height, the maximum value was observed in T6: Gladiolus + Fenugreek, whereas the minimum plant height (81.00 cm) was found in T1: Gladiolus sole. Fenugreek is a leguminous crop which fixes nitrogen as observed by Baker [16] and Anitha et al. [17] and also plant stature of fenugreek is smaller compared to other crops grown as intercrop which favours the growth of the main crop. Since nitrogen is a component of protein, it is necessary for the synthesis of protoplasm, which affects cell division and cell enlargement, leading to improved vegetative development and higher plant height. The outcomes are consistent with the conclusions of Prakash et al [18] and Sheoran et al. [19].

The highest number of leaves per plant (18.53) was recorded in T6: Gladiolus + Fenugreek whereas the minimum value (13.83) was recorded in T1: Gladiolus sole. Gladiolus, like many other plants, requires nitrogen for healthy leaf development and overall growth. Therefore, the presence of nitrogen-fixing plants in the vicinity of gladiolus can potentially have a positive effect on its leaf development. In plants with an adequate nitrogen supply, carbohydrates are converted into proteins and amino acids, which results in the production of additional leaves. Similar results were observed in the experiment conducted by Singh and Singh [20] where number of leaves of gladiolus was higher in gladiolus and fenugreek intercropping. These findings concur well with studies by Sharma and Singh [21], Bijimol and Singh [22], Kumar and Misra [23], and Prakash [24], Chandana and Dorajeerao [25] and Maddukuri [26].

The maximum number of shoots per corm (4.93) was recorded in T6: Gladiolus + Fenugreek while the minimum number of shoots per corm (2.73) was recorded in T1: Gladiolus sole. Nitrogen being a primary nutrient for faster and better vegetative growth, it may explain why application of nitrogen at optimum dosage increases plant growth. It is an enzyme and amino acid component that assisted the gladiolus plant's cell division and growth (Kumar et al.) [27]. Similar findings were also observed in gladiolus intercropping systems by Singh and Singh [20] and Maddukuri [26].

3.2 Floral Parameters

Data pertaining to the flowering parameters such as days to spike initiation, spike length (cm), rachis length (cm), number of florets per spike and floret diameter (cm) also showed significant variation among the different treatments as shown in Table 1. The minimum days to initiation of spike (64.33) were observed in T6: Gladiolus + Fenugreek while the maximum days (72.00) were observed in T1: Gladiolus sole. There is translocation of phytohormones to the plants stimulated by nitrogen, which encourages induction of early spike emergence as shown by Marschner and Romheld [28]. Plants supplied with nitrogen have delayed spike initiation probably due to the prolonged vegetative phase in Gladiolus. Complementary findings were reported by Chandana and Dorajeerao [25] and Lehri et al. [29].

The maximum spike length (73.93 cm) and rachis length (49.47 cm) were recorded in T6: Gladiolus + Fenugreek. The minimum spike length (65.13 cm) and rachis length (35.93 cm) were recorded in T1: Gladiolus sole. The presence of companion crop, fenugreek, a nitrogen-fixing plant might have resulted in increased spike and rachis length due to higher metabolites production along with efficient utilization of nutrients and minerals involved in cell division and cell elongation. Complementary findings were reported by Chandana and Dorajeerao [25] and Lehri et al. [29].

The number of florets per spike (12.93) and floret size (11.27 cm) were also recorded as highest in T6: Gladiolus + Fenugreek. Minimum number of florets per spike (10.53) and floret size (9.33 cm) were also recorded in T1: Gladiolus sole. Adequate nitrogen levels can promote healthy vegetative growth and flowering in Gladiolus, potentially resulting in larger florets. Similar

finding was observed in gladiolus and marigold paired system which was significantly superior to conventional planting practice in the production of cormels and spike. Intercropping of marigold with gladiolus paired system gave an additional yield than the pure cropping of gladiolus paired system as interpreted by Singh and Datta [30]. Similar result was reported in gladiolus and fenugreek intercropping system [20].

3.3 Quality Parameters

The maximum vase life (days) in normal tap water as presented in Table 1 was recorded in T6: Gladiolus + Fenugreek (18.53 days) followed by T7: Gladiolus + Dill (17.67) whereas the minimum vase life was found in T1: Gladiolus sole (13.00). The introduction of fenugreek in association with gladiolus could potentially influence various aspects of gladiolus growth and development, including its vase life. Nitrogen being a vital component of various proteins, therefore supply of nitrogen might have resulted in extending the vase life of gladiolus spikes [31,32]. The results are also in conformity with the findings in sandersonia flower [33], in tuberose [34,35] and in Gladiolus [36,37].

3.4 Corm Parameters

Comparison between different treatments revealed that the maximum weight of corms (63.67g) and cormlets (6.77g) were recorded in T6: Gladiolus + Fenugreek while the minimum weight of corms (41.33g) and cormlets (4.18g) were recorded in T1: Gladiolus sole as shown in Table 2 and Fig. 1. Yield of corms (2385.00kg/ha) and cormlets (225.50kg/ha) were also recorded to be highest in T6: Gladiolus + Fenugreek while the lowest corm and cormlet yield (1530.00kg/ha and 152.50kg/ha respectively) were recorded in T1: Gladiolus sole. Intercropping with fenugreek gives positive results due to phytohormones and secondary metabolites which might have indirect effects on corm formation and yield. The probable cause for enhanced weight with the optimization of nitrogen could be adequate availability of nutrients and minerals, increasing the transfer and accumulation of assimilates and carbohydrates in the daughter corms. The findings are in proximity with the corm characteristics influenced by nitrogen [38,39,40]. Similar finding was recorded in Colocasia grown with Fenugreek in 1:1 ratio with the highest cormlet weight per plant [41]. The yield of corms and cormels/cormlets per square meter with closer spacing was also recorded to be more as observed by Mukhopadhyay and Yadav [42].

3.5 Herbage Yield Per Plot (g)

The intercropping combination T6: Gladiolus+ Fenugreek reported higher yield of 665.83g, while T4: Gladiolus + Spinach (480.00g) gave the minimum herbage yield per plot (Table 3) and Fig. 2. This was due to the synergistic effect between main crop and intercrops whereas, minimum herbage yield was observed with dill and spinach intercropping system due to antagonistic effect between the crops and highly exhaustive nature of intercrops. The highest yield might be due to the nutrients present on the leafy vegetable which helps to increase the availability of additional nutrients to the main crop and also residual effect of nutrient in intercropping system as compared to sole crop of gladiolus. Similar results have been obtained in coleus + mulberry intercropping system [43] and in gladiolus grown alongside marigold [44]. Also, it was revealed that planting of *Coleus forskohlii* and *Phyllanthus amarus* registered higher tuber yield [45]. Similar findings were also reported by Maddukuri [26] and Marschner and Romheld [28].

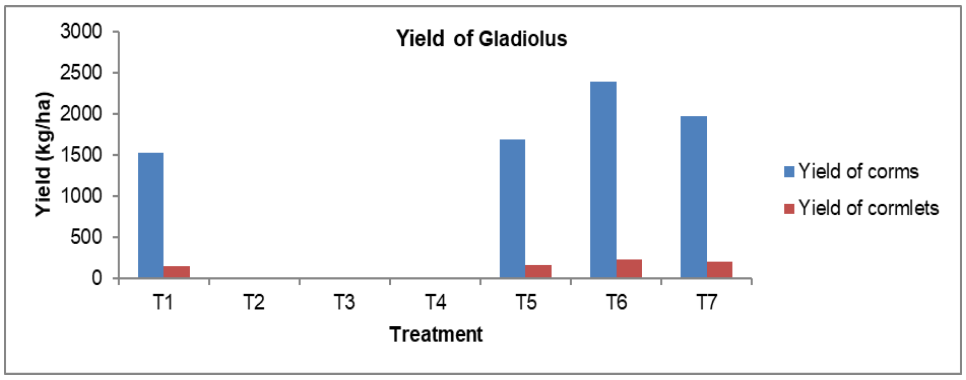

Fig. 1. Effect of intercropping on the corm yield of gladiolus

Table 1. Effect of intercropping with leafy vegetables on the growth and quality of gladiolus

Treatment	Plant height (cm)	No. of leaves/ plant	No. of shoots/plant	Days to spike initiation	Spike length (cm)	Rachis length (cm)	No. of florets per spike	Floret size (cm)	Vase life (days)
T1: Gladiolus sole	81.00	13.83	2.73	72.00	65.13	35.93	10.53	9.33	13.00
T2: Spinach sole	-	-	-	-	-	-	-	-	-
T3: Fenugreek sole	-	-	-	-	-	-	-	-	-
T4: Dill sole	-	-	-	-	-	-	-	-	-
T5:Gladiolus+ Spinach	85.80	15.20	3.67	69.73	67.47	38.47	10.87	10.27	15.60
T6:Gladiolus+ Fenugreek	91.40	18.53	4.93	64.33	73.93	49.47	12.93	11.27	18.53
T7: Gladiolus+ Dill	88.80	17.50	4.20	67.40	70.40	41.67	11.87	10.40	17.67
C.d.	3.84	0.42	0.26	2.27	2.20	1.26	0.60	0.35	0.30
Se(m)	1.23	0.14	0.08	0.73	0.71	0.40	0.19	0.11	0.10
Se(d)	1.74	0.19	0.12	1.03	0.99	0.57	0.27	0.16	0.14
C.v.	4.30	2.51	6.47	3.22	3.09	2.95	5.07	3.34	1.79

Table 2. Effect of intercropping with leafy vegetables on the corm yield of gladiolus

Treatment	Weight of corms (g)	Weight of cormlets(g)	Yield of corms (kg/ha)	Yield of cormlets (kg/ha)
T1: Gladiolus sole	41.33	4.18	1,530.00	152.50
T2: Spinach sole	-	-	-	-
T3: Fenugreek sole	-	-	-	-
T4: Dill sole	-	-	-	-
T5:Gladiolus+Spinach	45.13	5.05	1,692.50	170.08
T6:Gladiolus+ Fenugreek	63.67	6.77	2,385.00	225.50
T7: Gladiolus+ Dill	53.73	5.96	1,972.50	210.25
C.d.	0.98	0.07	48.19	19.40
Se(m)	0.32	0.02	15.47	6.23
Se(d)	0.45	0.03	21.88	8.81
C.v.	1.87	1.18	2.47	9.96

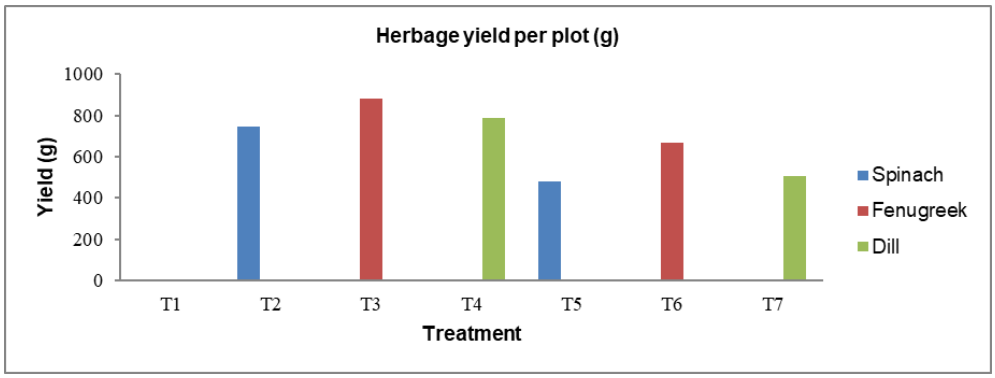

Fig. 2. Effect of intercropping on the herbage yield of spinach, fenugreek and dill

Table 3. Effect of gladiolus intercropping on the herbage yield of spinach, fenugreek and dill

Treatments	Herbage yield per plot (g)		
	Spinach	Fenugreek	Dill
T1: Gladiolus sole	-	-	-
T2: Spinach sole	746.00	-	-
T3: Fenugreek sole	-	880.00	-
T4: Dill sole	-	-	787.00
T5: Gladiolus+ Spinach	480.00	-	-
T6: Gladiolus+ Fenugreek	-	665.83	-
T7: Gladiolus+ Dill	-	-	506.00
C.d.	1.00	1.00	0.88
Se(m)	0.32	0.32	0.30
Se(d)	0.45	0.45	0.39
C.v.	0.32	0.25	0.26

4. CONCLUSION

From the present investigation, it was observed that sole cropping treatments of spinach, fenugreek and dill gave better herbage yield (g). However, it was observed that intercropping combinations *i.e.* T5 (Gladiolus + Spinach), T6 (Gladiolus+ Fenugreek) and T7 (Gladiolus+ Dill) recorded better performance in the growth, yield and quality of gladiolus in which treatment T6 (Gladiolus+ Fenugreek) gave the best results. Based on the above findings, intercropping of leafy vegetables with gladiolus has been found to increase the productivity per unit area. Fenugreek performs well as an intercrop.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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