Original Research article

Effect of Intercropping with spices on Growth, Yield and Quality of Gladiolus (*Gladiolus* spp.)

Abstract

A field experiment to study the effects the effect of Intercropping with spices on growth, yield and quality of Gladiolus (*Gladiolus* spp.)" was carried out in SHUATS, Prayagraj during rabi season (2023). The experiment was laid out in RBD, comprising eight treatment combinations where Gladiolus as main crop and fenugreek, coriander and dill as intercrops. The experimental results concluded that the treatment T_5- Gladiolus + Coriander was found higher result of plant height (107.37cm), number of leaves (7.55), number of florets per spike (17.55), rachis length (41.33 cm), spike length (85.88 cm), Floret diameter (8.76 cm), durability of spike (14.22 days), corm yield (2348.33 kg) and minimum days to spike emergence (64.78 days). Among the different treatments studied, the highest gross return (521067 Rs/ha.), net return (316857.07 Rs/ha.), benefit cost ratio (2.55) was obtained in T_8- Gladiolus + Coriander + Fenugreek + Dill crop. Cultivating coriander, fenugreek, and dill individually resulted in higher herbage yield and intercropping Gladiolus with these herbs enhanced in higher yield as compared to the sole cropping system

Keywords: Coriander, Dill, Fenugreek, Gladiolus, Intercropping

1. INTRODUCTION

Gladiolus (*Gladiolus* spp.) is an important bulbous crop belongs to family Iridaceae and native of Mediterranean region, tropical and south Africa. Gladiolus are coined from Latin word, 'Gladius' which means sword because of shape of its foliage. Gladiolus has become one of the most important commercial flower crops in India. Gladiolus grows from corms, which consist of one or more buds. Gladiolus is a popular flower crop cultivated commercially in states such as Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh, Haryana, West Bengal, Maharashtra, Tamil Nadu and Sikkim. It is one of the most important bulbous crops grown commercially for cut flower, bouquets, floral arrangements, interior decoration and garden display purposes [1].

Intercropping, a multiple cropping practice, involves cultivating two or more crops in close proximity within the same field. This agricultural technique harnesses several advantages compared to the sole culture of crops. By simultaneously growing different crops, intercropping enhances the efficient utilization of environmental factors such as light, nutrients, and soil moisture. Additionally, it optimizes labor usage while mitigating the adverse effects of various biotic and abiotic stresses on crops. Intercropping also fosters diversity in food production, leading to increased income generation and acting as insurance against crop failure. Moreover, it is associated with higher returns and total productivity per unit area. Furthermore, efficient intercropping not only improves productivity but also

sustains soil fertility. The success of intercropping hinges on the careful selection of crops, ensuring optimal resource and input utilization [2, 3].

Coriander (*Coriandrum sativum L.*) is an annual spice herb that belongs to the family Umbelliferae/Apiaceae with chromosome number 2n=22. It is one of the oldest consumed spices in India and all the plant parts are edible, but the fresh leaves and the dried seeds are the parts most traditionally used in cooking. Coriander is called as important spice crop. It consists of very small, bushy herb and consists of the alternate and compound leaves. Coriander is also a good melliferous plant and studies indicated that coriander can be used for honey bee production [4].

Fenugreek (*Trigonella foenum-graecum L.*) is annual plant in the family Fabaceae, with third largest seed spice in India after coriander and cumin. It is one of the principal odoriferous constituents of curry powder. The dried seeds, the leaves and tender shoots are all consumed and are valued as food, flavouring agent and medicine [5]. Cuboid shaped, yellow- to amber-coloured fenugreek seeds are frequently encountered in the cuisines of the Indian subcontinent, used both whole and powdered in the preparation of pickles, vegetable dishes, dal, and spice mixes such as panchphoron and sambar powder. They are often roasted to reduce inherent bitterness and to enhance flavour. In India is often cultivated as a cover crop in citrus-fruit groves to take advantage of their leguminous nature. It is a multipurpose crop grown during winter season for seed, vegetable and condiment purposes in various parts of the country.

Dill (*Anethum graveolens*) is an annual herb in the family Apiaceae, where its leaves and seeds are used as a herb or spice for flavouring food. [6] reported that intercropping between annual dill (*Anethum graveolens L.*), and perennial clary sage (*Salvia sclarea L.*) improved the efficiency of cropping systems. The study referenced as [7] demonstrated that the presence of dill residue in the soil had a notable impact on fennel seed yields in subsequent years. The goal of this experiment is realise which spices are more suitable with gladiolus for getting better economic yield and quality of gladiolus.

2. MATERIALS AND METHODS

The current field experiment was carried out at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during the rabi season of 2023. Geographically, Prayagraj is situated in the south eastern part of Uttar Pradesh, characterized by extremely hot summers and fairly cold winters. The experiment was laid out in Randomized Block Design with eight treatments having three replications. This experiment includes intercropping of Gladiolus with Coriander, Fenugreek and Dill. The details of treatments are T_1= Gladiolus sole crop, T_2= Fenugreek sole crop, T_3 = Coriander sole crop, T_4 = Dill sole crop, T_5 = Gladiolus + Coriander crop, T_6 = Gladiolus + Fenugreek crop, T_7 = Gladiolus + Dill crop, T_8 = Gladiolus + Coriander + Fenugreek + Dill crop. Data were statistically analysed by the method suggested by Fisher and Yates, 1963.

Treatment details

Symbol	Treatments
T_1	Gladiolus sole crop
T_2	Fenugreek sole crop
T_3	Coriander sole crop
T_4	Dill sole crop
T_5	Gladiolus + Coriander crop
T_6	Gladiolus + Fenugreek crop
T_7	Gladiolus + Dill crop
T_8	Gladiolus + Coriander + Fenugreek + Dill crop

(Explain statistically methods for analysis)

3. RESULT AND DISCUSSION

Data in Table 1 indicates the significant differences regarding the intercropping of coriander, fenugreek and dill with gladiolus on plant growth and yield parameters *viz.*, plant height (cm), no. of leaves, days to spike emergence (days), no. of florets, spike length (cm), rachis length (cm), floral diameter (cm), durability of spike (days), no. of cormlets per spike and corm yield (kg/ha).

A. Vegetative Parameter

Plant Height (cm) - Among all the treatments, the treatment T_5 – Gladiolus + Coriander recorded the highest plant height (107.37cm) followed by T_6 – Gladiolus + Fenugreek (103.33cm). Shortest plant height was recorded in the treatment T_1- Gladiolus sole crop (99.54cm). To increase their competitive power, plants display adaptive response, such as rapid shoot elongation to consolidate light capture [8]**.** These findings are in conformity with [9, 10] and [18] while working with tobacco based intercropping system at Pusa Bihar.

Number of leaves - The number of leaves statically varies among different treatments. The treatment T_5 – Gladiolus + Coriander recorded the highest number of leaves (7.55) followed by T_7 - Gladiolus + Dill (7.11). Minimum was recorded in the treatment T_1 – Gladiolus sole crop (6.11). The competition for growth resources among intercrops, alongside the influence of climatic factors and soil nutrients, may also play a significant role in vegetative growth. These observations align with the findings reported in references [9] and [10].

Days to spike emergence (days) - The days to spike emergence among the different treatments differed significantly. The days to spike emergence varies from 64.78 to 73.00 days. The minimum days taken for spike emergence is T5- Gladiolus + Coriander (64.78 days) followed by T7- Gladiolus + Dill (67.33 days). The maximum days taken for spike emergence is T8- Gladiolus + Coriander + Fenugreek + Dill (73.00 days) The earliness to the flowering in the best treatment might be due to the better translocation of nutrients to the aerial parts [11]. These findings are in conformity with [9].

Floral parameter

Number of florets per spike - Data for this attribute revealed that number of florets per spike showed significant difference among the treatments. Among all the treatments, the treatment T_5 – Gladiolus + Coriander was recorded the maximum number of florets per spike (17.55) followed by T_6 - Gladiolus + Fenugreek (14.89). Minimum number of florets per spike was recorded in the treatment T_1 – Gladiolus sole crop (11.89). Competition among crops arises from the growth habit of gladiolus, which capitalizes on peak resources, leading to the promotion of a higher number of florets per spike. By intercropping, it optimizes the use of light, water, and nutrients, allowing plants to access these resources more effectively, which promotes better growth and more florets.hese results are consistent with the findings reported in references [9] and [10].

Rachis length (cm) - Among all the treatments, the treatment T_5 – Gladiolus + Coriander was recorded the maximum rachis length (41.33 cm) followed by T_6 - Gladiolus + Fenugreek (40.78 cm). Minimum rachis length was recorded in the treatment T_1 – Gladiolus sole crop (36.89 cm). The competition for growth resources with intercrops facilitates the rapid vegetative growth of the main crop, thereby enhancing the efficiency of resource utilization. This ultimately results in the production of maximum rachis length and spike length in gladiolus [12]. It may be due to the optimization of resource use, enhances the microclimate, manages pests, and boosts soil health, all of which contribute to an increased number of rachis. These findings align with those reported in reference [9].

Spike length (cm) - the treatment T_5 – Gladiolus + Coriander was recorded the maximum Spike length (85.88 cm) followed by T_7 - Gladiolus + Dill (83.11 cm). Minimum spike length was recorded in the treatment T_1 – Gladiolus sole crop (70.89 cm). Competition for growth resources among intercrops accelerates the vegetative growth of the main crop, enhancing overall resource utilization efficiency. Consequently, this results in the production of maximum rachis length and spike length in gladiolus [12]. These findings are consistent with references [10] and [11].

Floret diameter (cm) - Among all the treatments, the treatment T_5 – Gladiolus + Coriander was recorded the maximum floret diameter (8.76 cm) followed by T_6 - Gladiolus + Fenugreek (8.60 cm). Minimum floret diameter was recorded in the treatment T_1 – Gladiolus sole crop (6.11 cm). The microclimate within intercrop systems could potentially benefit flower size improvement by providing shade and altering air movement. These changes in microclimate can have a significant impact on flowering size [13]. These findings align with those reported in reference [9].

Durability of spike (days) - Among all the treatments, the treatment T_5 – Gladiolus + Coriander was recorded the maximum durability of spike (14.22 days) followed by T_6 - Gladiolus + Fenugreek (13.00 days). Minimum durability of spike was recorded in the treatment T_1 – Gladiolus sole crop (10.22 days). Competition for the growth resources with intercrops, it helps for quick vegetative growth of main crop, which increases the efficiency of crops for utilization. Competition for growth resources among intercrops accelerates the rapid vegetative growth of the main crop, thereby enhancing overall resource utilization efficiency. This contributes to an increase in the number of days to blooming, while

intercropping also provides shade and helps balance the growth of the main crop. Comparable results were also found by [9].

B. Yield parameter

Number of cormlets per plant - Among all the treatments, the treatment T_1 – Gladiolus sole crop was recorded the maximum number of cormlets per plant (21.33) followed by T_5 - Gladiolus + coriander (18.55). Minimum number of cormlets per plant was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (15.89). In a sole crop system, plants may receive all the favorable environmental conditions such as solar radiation, nutrients, moisture, and space, which enhance the conversion of solar energy into biological yield. This favorable environment leads to the production of a greater number of cormlets per plant in the sole cropping system [14]. It may be due to the influence of various growth factors such as competition for resources (light, water, and nutrients), microclimate modification, and pest and disease control by which it enhanced the growth and yield of corms by improving resource use efficiency, planting density and reduced pest pressure. These findings are consistent with references [9] and [10].

Corm yield (kg/ha) - Among all the treatments, the treatment T_5 – Gladiolus + Coriander was recorded the maximum corm yield (2348.33 kg) followed by T_6 - Gladiolus + Fenugreek (2148.67 kg) Minimum corm yield was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (1458.67 kg). Cultivars of species that are compatible in this manner can be planted at higher densities, which is a significant factor contributing to the ability of intercrops to yield more than sole crops [15]. Similar results were reported by [9] and [10]. According to [18], the ratio between the base crop and the intercrop can significantly impact system productivity. It may be due to resource competition, microclimate changes, and pest control, which improve resource use efficiency and reduce pest pressure. However, the extent of this impact may depend on the nature of the produce and market demand.

Table 1. Intercropping in coriander, fenugreek and dill with gladiolus on plant growth and yield parameter of Gladiolus

Treatment	Plant Height (cm)	Number of leaves	Days to spike emergence	Number of florets per spike	Rachis length (cm)	Spike length (cm)	Floret diameter (cm)	Durability of spike	Number of cormlets per plant	Corm yield (kg/ha)
Gladiolus sole	99.54	6.11	72.66	11.89	36.89	70.89	6.11	11.44	21.33	1627.67
Fenugreek sole	-	-	-	-	-	-	-	-	-	-
Coriander sole	-	-	-	-	-	-	-	-	-	-
Dill sole	-	-	-	-	-	-	-	-	-	-
Gladiolus + Coriander	107.37	6.33	64.78	17.55	41.33	85.88	8.76	14.22	18.55	2348.33
Gladiolus + Fenugreek	103.33	7.55	69.22	14.89	40.78	77.89	8.60	13.00	17.55	2148.67
Gladiolus + Dill	101.22	7.11	67.33	13.99	39.67	83.11	8.13	12.22	17.44	1975.33
Gladiolus + Coriander + Fenugreek+ Dill	101.76	6.99	73.00	13.11	39.89	72.00	7.50	10.22	15.89	1458.67
F-test	S	S	S	S	S	S	S	S	S	S
S.Ed.(±)	1.07	0.42	1.26	0.93	0.69	2.82	0.46	0.66	0.80	1.82
CD (0.05)	2.29	0.91	2.70	2.01	1.47	6.05	0.99	1.41	1.71	3.89

C. Herbage yield of coriander, fenugreek, dill

The data regarding to herbage yield of coriander, fenugreek and dill intercropping with gladiolus is shown in the Table 2. Among all the treatments, the treatment T_3 – Coriander sole crop was recorded the maximum herbage yield per plant (424.44g) followed by T_5 - Gladiolus + Coriander (376.33g). Minimum herbage yield per plant was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (341.55g). The treatment T_3 – Coriander sole crop was recorded the maximum herbage yield (4.24 t/ha) followed by T_5 - Gladiolus + Coriander (3.76 t/ha). Minimum herbage yield was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (3.41t/ha). The treatment T_2 – Fenugreek sole crop was recorded the maximum herbage yield per plant (413.00 g) followed by T_6 - Gladiolus + Fenugreek (366.44 g). Minimum herbage yield per plant was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (331.22 g). The treatment T_2 – Fenugreek sole crop was recorded the maximum herbage yield (4.13 t/ha) followed by T_6 - Gladiolus + Fenugreek (3.66 t/ha). Minimum herbage yield was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (3.31 t/ha). The treatment T_4 – Dill sole crop was recorded the maximum herbage yield per plant (382.66g) followed by T_7 - Gladiolus + Dill (357.66 g). Minimum herbage yield per plant was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (314.66 g). The treatment T_4 – Dill sole crop was recorded the maximum herbage yield (3.82 t/ha) followed by T_7 - Gladiolus + Dill (3.57 t/ha). Minimum herbage yield was recorded in the treatment T_8 – Gladiolus + Coriander + Fenugreek + Dill (3.14 t/ha).

The higher herbage yield observed in sole cropping of coriander, fenugreek, and dill compared to intercropping can be attributed to the absence of competition from other crops. In sole cropping systems, each plant species can fully utilize available resources without competition, leading to maximized growth potential and increased biomass production. Additionally, findings from intercropping experiments, particularly when coriander was grown with safflower in different ratios, revealed consistent land-equivalent and grain-equivalent ratios of 1.25. This suggests that the combined yield of both crops in the intercropping system was comparable to or slightly higher than the yield of either crop alone in a sole cropping system. Interestingly, variations in ratios and population levels of the base crop to the intercrop did not significantly affect total returns from the system, indicating a limited influence of these factors on overall productivity. These results not only underscore the impact of resource competition on crop yield but also highlight the importance of crop composition and interaction dynamics in both sole cropping and intercropping systems. Moreover, the alignment of these findings with previous research [9] further strengthens the reliability and consistency of the observed trends in agricultural productivity.

D. Economic parameter

The economics of different treatments is depicted in Table 3. The gross return is 521067 Rs/ha, net return is 316857.07 Rs/ha, benefit cost ratio (2.55) was obtained from the treatment T_8- Gladiolus + Coriander + Fenugreek + Dill crop.

4. CONCLUSION

Based on the results of the investigation titled "Effect of intercropping with spices on growth, yield, and quality of Gladiolus (*Gladiolus spp*.)," it is evident that various intercropping treatments had notable impacts on the growth, yield, and economic returns of Gladiolus. Contrary to expectations, Gladiolus plants attained greater height when grown in sole cropping compared to intercropping, with maximum height recorded (107.37 cm) when intercropped with coriander, followed closely by fenugreek intercropping (103.33 cm). Additionally, other parameters such as the number of leaves and branches per plant were influenced by the intercropping treatments. Notably, the treatment combining Gladiolus with coriander, fenugreek, and dill (T_8) yielded the highest net return of 316857.00 Rs/ha and a benefit-cost ratio of 2.55. This enhanced economic performance can be attributed to the combined yield of three different intercrops in this treatment. However, it is noteworthy that in terms of vegetative growth, sole cropping of coriander, fenugreek, and dill produced taller plants with more leaves and branches per plant, resulting in higher herbage yield compared to intercropping. Despite this, the performance of Gladiolus was improved under intercropping conditions compared to sole cropping. These findings underscore the complexity of crop interactions and the potential economic benefits of intercropping strategies in enhancing overall agricultural productivity and profitability.

Table 2. Herbage yield of coriander, fenugreek and dill intercropping with gladiolus

Treatment	Herbage yield per plot (g)			Herbage yield per plot (t/ha)		
	1	2	3	1	2	3
Gladiolus sole	-	-	-	-	-	-
Fenugreek sole	-	413.00	-	-	4.13	-
Coriander sole	424.44	-	-	4.24	-	-
Dill sole	-	-	382.66	-	-	3.82
Gladiolus + Coriander	376.33	-	-	3.76	-	-
Gladiolus + Fenugreek	-	366.44	-	-	3.66	-
Gladiolus + Dill	-	-	357.66	-	-	3.57
Gladiolus + Coriander + Fenugreek + Dill	341.55	331.22	314.66	3.41	3.31	3.14
F- Test	S	S	S	S	S	S
S.E(d)	10.02	7.05	3.19	0.08	0.14	0.08
CD	21.50	15.13	6.84	0.18	0.29	0.18

Table 3. Effect of intercropping with gladiolus on economics of different treatments

Treatment	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
Gladiolus sole	246915.00	12346.00	1.05
Fenugreek sole	95076.00	36097.61	1.61
Coriander sole	99000.00	39000.00	1.65
Dill sole	80076.00	25203.51	1.45
Gladiolus + Coriander	345915.00	198630.5	2.34
Gladiolus + Fenugreek	341991.00	195217.31	2.33
Gladiolus + Dill	326991.00	182270.26	2.25
Gladiolus + Coriander + Fenugreek + Dill	521067.00	316857.07	2.55

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