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MANAGEMENT OF GLADIOLUS WILT BY USING LEAVES OF ALLELOPATHIC PLANTS

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ABSTRACT

The pot culture experiment was conducted to investigate the effect of different allelopathic plants leaf materials on wilt of gladiolus caused by *Fusarium oxysporum* f. sp *gladioli*. The experiment was carried out at Plant Pathology Section, College of Agriculture, Nagpur during year 2018-2019, with two main treatments viz., Levels of allelopathic M_1 (2g leaves100 g $^{-1}$ soil), M_2 (4g leaves 100 g^{-1}soil), and M_3 (6 g leaves 100 g $^{-1}$ soil) and five subtreatments allelopathic plants viz., *Allium sativum, Ipomoea carnea*, *Annona innoxia*, *Eucalyptus globulus* and *Azadirachta indica* were evaluated against *Fusarium oxysporum*. *In vivo* experiment *Azadirachta indica* treatment was found significantly superior and required minimum days to emergence of corms (15 days) and minimize the wilt incidence by 56.89% and mortality by 11.11% and also increased shoot length plant^{-1} (35.10 cm plant^{-1}), spike length plant^{-1} (50.22 cm), number of leaves plant^{-1} (5.73), number of flowers spike^{-1} (7.21), number of corms plant^{-1} (6) and weight of corm (16.04 g) over *Fusarium*. Treatment M_3 (6 g leaves 100 g $^{-1}$ soil) showed minimum wilt incidence (55.01%) and mortality (22.22%) and maximum shoot length (35.45 cm plant^{-1}), spike length plant^{-1} (49.41 cm), number of leaves plant^{-1} (5.74), number of flowers spike^{-1} (6.96), number of corms plant^{-1} (6.29) and weight of corms (15.87 g pl^{-1}) than that of M_2 treatment (4 g leaves 100 g^{-1} soil) and M_1 treatment (2 g leaves 100 g^{-1} soil). Thus, it is inferred that the incorporation of *Azadirachta indica* minimized wilt incidence, mortality and helped in increasing growth parameters of gladiolus crop.

(Key words : Allelotpathic plants, *Fusarium oxysporum*, mortality)

INTRODUCTION

Gladiolus is commonly propagated by corms and cormels. It is an important ornamental plant. Gladiolus is a tender herbaceous perennial. Flowers with brilliant colours, attractive shapes, varying sizes and excellent keeping quality. The gladiolus is ideal both for garden and floral decoration. This crop is severely affected by wilt disease caused by *Fusarium oxysporum* f. sp. *gladioli.* It is destructive one, affecting plants in the field and corms in storage. Corm rot is also called "yellows" on infected plants in the field. It caused heavy annual losses to flowers, corms and cormels production, or even destroying the plantations in Himachal Pradesh and in other states of India, resulting in huge losses to the crop (Singh, 1969 and Kaur *et al.,* 1989). The use of allelopathic plants leaves materials for control of plant diseases and which are safe for humans, animals and environment (Potdukhe *et al*., 2017b).

MATERIALS AND METHODS

Field soil and allelopathic plants leaves materials of *Allium sativum* (Garlic clove), *Ipomoea carnea* (Besharm), *Annona innoxia* (Sitaphal), *Eucalyptus globulus* (Eucalyptus) and *Azadirachta indica* (Neem) used in experiment were collected from the experimental field, College of Agriculture, Nagpur. Corms with symptoms of wilt were collected from the field of Horticulture Section, College of Agriculture, Nagpur.

Sterilization of Soil

A solution of one gallon of formalin diluted in 50 gallons of water and applied at the rate of one gallon^{-1} square foot of soil is effective in destroying many soil-borne disease producing fungi. After treatment the soil was covered with polythene and kept for four days until all odor of formaldehyde has disappeared from the soil.

Preparation of mass inoculum

Purified culture of *Fusarium oxysporum* f. sp. *gladioli* was multiplied on large scale by using sand sorghum medium. Sorghum grains 100 g + 50 g sand were filled in 500 ml conical flask and autoclaved at 15 lbs for 15 minutes. It was allowed to cool and flasks were inoculated with pure culture. The inoculated flasks were incubated at room temperature 28 ± 2 ^{o}C for eight days. The flasks were shaken every day during incubation period. Sufficient

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quantity of inoculums was prepared and used for making sick pots required for pathogenicity test and inoculums potential studies.

Incorporation of leaves of allelopathic plants

Fresh bulb of garlic clove (*Allium sativum*) and Besharam (*Ipomoea carnea*), Sitaphal *(Annona innoxia),*Eucalyptus (*Eucalyptus globulus*) and neem *(Azadirachta indica)* leaves were thoroughly washed with running tap water and were cut into one cm pieces. The plant leaves mixed in the pot soil at 2, 4 and 6 g 100 g $^{-1}$ of soil. Pots were watered and left for 15 days to allow decomposition of the plant materials. Then corm was sown in pot as per the treatments details. Four grams of *F. oxysporum* f. sp. *gladioli* inoculum was thoroughly mixed in each pot three days prior to sowing. Control treatment was without *F. oxysporum* inoculation and leaf materials incorporation. Gladiolus corms of uniform size were sown in each pot 15 days after mixing and three days after *Fusarium* inoculation. Four corms were sown in each pot. Each treatment was replicated three times. There were 21 pots in each replicate. Data regarding disease incidence and mortality were recorded as follows:

$$\text{Disease incidence (\%)} = \frac{C}{T} \times 100$$

Where,

C = No. of diseased plants

T = Total No. of plants

$$\text{Mortality (\%)} = \frac{D}{T} \times 100$$

Where,

D = No. of plants died due to disease

T = Total No. of plants

The observations on days to emergence, wilt incidence were recorded at 30, 60, 90 and 120 DAP, mortality at 90 and 120 DAP and growth parameters viz., shoot length (cm) at 30, 60, 90 and 120 DAP, length of spike (cm), number of flower spike^{-1}, number of leaves plant^{-1}, number of corms plant^{-1}, fresh weight of corms plant^{-1} were recorded.

RESULTS AND DISCUSSION

Interaction effect of levels of leaves incorporation and allelopathic plants

The data in respect to days to emergence in gladiolus as influenced by the leaves of allelopathic plants and levels of their incorporation showed in table 1.

Effect of levels of leaves incorporation

The data presented in table 1 reveals that, the effect of different concentrations of leaves incorporation on days to emergence of gladiolus variety was found to be significant. Minimum days to emergence plant^{-1} was recorded in treatment M_3 (6 g leaves 100 g $^{-1}$ soil) i.e. 15.43 days which was found to be statistically at par with the treatment M_2 (4 g leaves 100 g $^{-1}$soil) (16.43 days). Maximum days to emergence plant^{-1} were recorded with treatment M_1 (2 g leaves 100 g $^{-1}$ soil) i.e. 17 days. Similar findings were reported by Yasmin and Ali (2016), who tested various eight organic amendments and poultry manure was found better in enhancing germination in gladiolus.

Effect of allelopathic plants

The data presented in table 1 showed that, the effect of application of different allelopathic plants leaf materials on days to emergence plant^{-1} of gladiolus variety was found to be significant. The treatment A_5 (*Azadirachta indica*) was found to be significantly superior over other treatments. It was followed by A_2 (*Ipomoea carnea*), A_4 (*Eucalyptus globulus*), A_1 (*Allium sativum*), A_3 (*Annona innoxia*) recorded as 15.00, 15.33, 16.00, 16.67 and 17.67 days respectively. Whereas, maximum days of emergence plant^{-1} was recorded with the treatment A_6 *Fusarium oxysporum* (18.67 days). The potential use of various leaf materials viz., *Lantena camera*, *Ipomea carnea* and *A. indica* have been reported by Potdukhe *et al.* (2017 b) in enhancing germination of gladiolus.

Effect of levels of leaves incorporation

Interaction effect of levels of leaves incorporation and allelopathic plants on wilt incidence

Effect of leaves of allelopathic plants were tested in pot containing sick soil and observations were recorded on number of wilted plants and per cent disease incidence and the results are presented in table 2.

The effect due to incorporation of allelopathic plants leaves on wilt incidence of gladiolus plant was found to be significant at 30, 60, 90 and 120 DAP. Minimum wilt incidence was noticed in treatment M_3 (6 g leaves 100 g $^{-1}$ soil) (26.63, 30.44, 47.47, 55.01% at 30, 60, 90 and 120 DAP) followed by M_2 (4 g leaves100 g $^{-1}$soil) (27.78, 31.92, 48.20, 57.75% at 30, 60, 90 and 120 DAP). Riaz (2010) reported reduction in gladiolus wilt by the use of allelopathic plants viz., *E. citrodera*, *C. didamuus* and *Chenopodium abum.*

Effect of allelopathic plants

The data presented in table 2 revealed that, the effect of allelopathic plants on wilt incidence of gladiolus was found to be significant. Among the incorporated allelopathic plants the treatment A_5 (*Azadirachta indica)* recorded minimum wilt incidence (28.23, 31.09, 49.75 and 56.89% at 30, 60, 90 and 120 DAP) and the same treatment was found significantly superior over all other treatments. It was followed by A_2 treatment (*Ipomoea carnea)* and recorded 30.19, 33.56, 50.86 and 61.10% wilt incidence at 30, 60, 90 and 120 DAP respectively. Maximum wilt incidence was recorded in treatment A_6 (*Fusarium oxysporum)* 39.16, 44.98, 64.05 and 80.07% at 30, 60, 90 and 120 DAP respectively. This was due to arriving of resistance in the varieties. Reduction in wilt incidence due to allelopathic plants materials in gladiolus wilt caused by *Fusarium oxysporum* f. sp. *gladioli* have been reported by Riaz *et al.*

(2007), Riaz *et al.* (2010) and Pontes *et al.* (2011) and Potdukhe *et al.* (2017 b). Antifungal effect of other plant residues has been reported by Gurama *et al.* (2012).

Interaction effect

It was further revealed from the data furnished in table 2 that there were non-significant results at 30, 60, 90 and 120 DAP on wilt incidence .

Interaction effect of levels of leaves incorporation and allelopathic plants on mortality per cent

Effect of levels of leaves incorporation and allelopathic plants leaves were tested in pot containing sick soil and observations were recorded on number of plants died due to infection and results are presented in table 2 at 90 and 120 DAP.

Effect of levels of leaves incorporation

The effect due to allelopathic plants leaves on mortality per cent of gladiolus plant was found to be significant at 90 and 120 DAP. Minimum mortality per cent was noticed in treatment M_3 (9.52 and 22.22% at 90 and 120 DAP) followed by M_2 (4 g leaves100 g $^{-1}$soil), (14.28 and 28.57% at 90 and 120 DAP). Maximum wilt incidence recorded in treatment M_1 (2 g leaves100 g^{-1} soil (22.22 and 42.85 at 90 and 120 DAP). Riaz *et al.* (2010) reported the reduction in wilt incidence due to plant extracts.

Effect of allelopathic plants

The data presented in table 1 revealed that, the effect of allelopathic plants on mortality of gladiolus was found to be significant. Among the incorporated allelopathic plants the treatment A_5 (*Azadirachta indica)* recorded minimum mortality (0.00 and 11.11% at 90 and 120 DAP) and the same treatment was found significantly superior over all other treatments. It was followed by A_2 treatment (*Ipomoea carnea)* which recorded 7.41 and 18.52 per cent mortality at 90 and 120 DAP respectively.

Maximum mortality recorded in treatment A_6 (*Fusarium oxysporum)* 37.03 and 77.77 per cent at 90 and 120 DAP respectively. Reducing of mortality per cent due to allelopathic plant leaves in gladiolus wilt caused by *Fusarium oxysporum* f. sp. *gladioli* have been reported by Riaz *et a*l., (2008), Riaz *et al.,* (2010) and Pontes *et al.* (2011).

Interaction effect

It was further reveals from the data furnished in table 2 shows that there were non-significant results at 90 and 120 DAP on mortality per cent at all intervals.

Interaction effect of levels of leaves incorporation and allelopathic plants on quality parameters

It was further revealed from the data furnished in table 4 and table 5 that there were non-significant differences at 30, 60, 90 and 120 DAP on shoot length, spike length, total number of leaves, number of flowers spike^{-1}, number of corms and fresh weight of corms.

Shoot length plant^{-1}

The data in respect of shoot length plant^{-1} in gladiolus as influenced by the incorporation leaves materials and allelopathic plants at all intervals were recorded.

Effect of levels of leaves incorporation

The data presented in table 3 revealed that, the effect of different levels of leaves materials on shoot length plant^{-1} of gladiolus variety was found to be significant and enhanced shoot length plant^{-1}. The treatment M_3 (6 g leaves 100 g^{-1} soil) produced maximum shoot length 8.54, 26.38, 30.88 and 35.45 cm at 30, 60, 90 and 120 DAP was found significantly superior over other treatments and it was followed by treatment M_2 (4 leaves 100 g^{-1} soil) i.e. 7.58, 23.26, 29.44 and 32.86 cm at 30, 60, 90 and 120 DAP. The doses of 2 g 100 g^{-1} soil gave significant results while, higher doses of 4 and 6 g 100 g^{-1} soil significantly enhanced shoot length. Riaz *et al.* (2010) reported that allelopathic leaves incorporation treatments significantly reduced the disease incidence and number of lesions on corms.

Effect of allelopathic plants

The data presented in table 3 showed that, the effect of different allelopathic plants on shoot length of gladiolus variety was found to be significant. The treatment A_5 (*Azadirachta indica)* significantly enhanced shoot length 8.18, 25.00, 30.87 and 35.10 cm at 30, 60, 90 and 120 DAP and the same treatment was found significantly superior over all other treatments. It was followed by A_2 treatment *Ipomoea carnea and* recorded 8.01, 24.50, 30.23 and 34.27 cm at 30, 60, 90 and 120 DAP respectively. The variable response to shoot length production to different leaf incorporation treatments could be attributed to different nature of allelochemicals present in different allelopathic plant species. Minimum shoot length was recorded in treatment A_6 (*Fusarium oxysporum)* i.e. 4.81, 18.50, 22.83 and 24.34 cm at 30, 60, 90 and 120 DAP respectively. Enhancing shoot length due to allelopathic plant leaf materials over *Fusarium oxysporum* f. sp. *gladioli* in gladiolus have been reported by Raj and Kumar (2009) and Riaz *et al.* (2010).

Interaction effect

The data presented in table 3 revealed that, the interaction effect between levels of leaves materials X leaves of allelopathic plants on shoot length plant^{-1} of gladiolus was found to be non-significant.

Spike length plant^{-1}

The data in respect of spike length plant^{-1} in gladiolus as influenced by different treatments and levels of leaves incorporation are presented in table 4.

Effect of levels of leaves incorporation

The data presented in table 4 revealed that, the number of spikes length plant^{-1} of gladiolus was found to be significant at different concentrations. Treatment M_3 (6 g leaves 100 g $^{-1}$ soil) recorded spike length of 49.41cm plant^{-1} and found significantly superior over M_2 (4 g leaves100 g $^{-1}$soil) and M_1 (2 g leaves100 g $^{-1}$ soil) treatment i.e. 48.10 and 47.17cm plant^{-1} respectively.

Effect of allelopathic plants

The data presented in table 4 revealed that the effect of allelopathic plants on spikes length plant^{-1} of

gladiolus variety was found to be significant. The treatment A_5 (*Azadirachta indica)* recorded 50.22 cm spike length plant^{-1}. This treatment was found to be significantly superior over other treatments. Minimum spikes length plant^{-1} was recorded in the treatment A_6 (*Fusarium oxysporum)* 44.97 cm plant^{-1}. Potdukhe *et al*. (2017b) reported that incorporation of five leaf residues significantly increased spikes length of corms.

Interaction effect

The data furnished in table 4 revealed that the interaction effect between leaves of allelopathic plants with the levels of incorporation of leaves on spikes length plant^{-1} of gladiolus was found to be non-significant.

Total number of leaves plant^{-1}

The data in respect of total number of leaves plant^{-1}in gladiolus as influenced by the allelopathic plants leaves materials are presented in table 4.

Effect of levels of leaves incorporation

The data exhibited in table 4 indicates that the total number of leaves plant^{-1}of gladiolus was significantly influenced by different concentrations of leaves incorporation. Treatment M_3 (6 g leaves 100 g^{-1} soil) was found significantly superior over the treatment M_2 (4 g leaves 100 g $^{-1}$soil) and M_1 (2 g leaves100 g $^{-1}$soil). The maximum number of leaves plant^{-1} were recorded in M_3 (6 g leaves 100 g $^{-1}$ soil) 5.74 pl^{-1} followed by M_2 (4 g leaves100 g $^{-1}$soil) 5.38 pl^{-1} and M_1 (2 g leaves 100 g $^{-1}$soil) 5.02 pl^{-1}.

Effect of allelopathic plants

The data tabulated in table 4 revealed that, the effect of application of different allelopathic plants on total number of leaves plant^{-1} of gladiolus variety was found to be significant. Maximum number of leaves plant^{-1} was recorded with treatments A_5 (*Azadirachta indica)* i.e. 5.73 pl^{-1} which was found to be statistically at par with the treatment A_2 (*Ipomoea carnea)* (5.59 pl^{-1}). Whereas, minimum number of leaves plant^{-1} were recorded with the treatment A_6 (*Fusarium oxysporum*) i.e. 4.21 pl^{-1}. Pereira *et al*. (2016) and Muhammad *et al.* (2013) obtained significant effects on number of leaves and corm diameter due to varietal effects and incorporation of leaves material on different sowing dates.

Interaction effect

Perusal of data in table 4 clearly indicates significant differences due to levels of leaves incorporated with different allelopathic plants in respect of number of leaves plant $^{-1}$. The treatment A_5 (*Azadirachta indica*) recorded maximum number of leaves 5.73 plant^{-1} at different concentrations of leaves materials in treatment M_3 (6 g leaves 100 g $^{-1}$ soil), M_2 (4 g leaves 100 g $^{-1}$ soil) and M_1 (2 g leaves 100 g $^{-1}$. These might be due to accumulation of more photosynthesis during plant growth period under study. Among the three levels of incorporation M_3 (6 g leaves 100 g $^{-1}$ soil) produced highest number of leaves plant^{-1} (6.06 leaves plant^{-1}) as compared to M_1 and M_2 treatments. Treatment A_2 (*Ipomoea carnea*) was found significantly superior over M_1 (2 g leaves 100 g $^{-1}$ soil) i.e. 5.48 leaves plant^{-1}, for M_2 (4 g leaves 100 g $^{-1}$soil) and M_3 (6 g leaves 100 g $^{-1}$ soil) treatment A_5(*Azadirachta indica*) produced significantly higher number of leaves plant^{-1} i.e. 5.81 and 6.06 plant^{-1}.

Number of flowers spikes plant^{-1}

The data in respect of number of flowers spikes plant^{-1} in gladiolus as influenced by the allelopathic plants leaf materials are presented in table 4.

Effect of levels of leaves incorporation

From the data presented in table 4 it was observed that the number of flowers spikes^{-1} of gladiolus was significantly influenced at different concentrations of leaf of materials. Maximum number of flowers spikes plant^{-1} were recorded in treatment M_3 (6 g leaves 100 g $^{-1}$ soil) i.e. 6.96 which was found to be statistically at par with treatment M_2 (4 g leaves100 g $^{-1}$soil) i.e. 6.75. Whereas, minimum flowers spikes plant^{-1} was recorded with treatment M_1 (2 g leaves 100 g $^{-1}$ soil) i.e.6.58.

Effect of allelopathic plants

The data presented in table 4 revealed that, the effect of different allelopathic plant leaf incorporation on number of flower spikes plant^{-1} of gladiolus was found to be significant. The treatment A_5 (*Azadirachta indica)* produced maximum number of flowers spikes plant^{-1} (7.21) which was statistically at par with the treatment A_2 (*Ipomoea carnea)* (7.17). Whereas, minimum number of flowers spikes plant^{-1} was recorded with the treatment A_6 (*Fusarium oxysporum*) i.e. 5.52.

Interaction effect

Interaction effect due to levels of leaves incorporation × leaves of allelopathic plants were found to be non-significant.

Number of corms plant^{-1}

The data in respect of number of corms plant^{-1} in gladiolus as influenced by the concentration of leaves and allelopathic plants are presented in table 4. Treatment M_3 (6 g leaves 100 g $^{-1}$ soil) produced maximum corms 5.74 pl^{-1} followed by M_2 (4 g leaves100 g $^{-1}$soil) i.e. 5.38 pl^{-1} and M_1(2 g leaves 100 g $^{-1}$ soil) i.e. 5.02 pl^{-1}.

Effect of levels of leaves incorporation

The data presented in table 4 showed that, the effect of different concentrations of leaves materials on number of corm plant^{-1} of gladiolus was found to be significant. Treatment M_3 (6 g leaves 100 g $^{-1}$ soil) gave maximum number of corm plant^{-1} (6.29 pl^{-1}) which was found to be statistically at par with the treatment M_2 (4 g leaves 100 g $^{-1}$soil) i.e. 5.33 pl^{-1} . Whereas, minimum number of corms plant^{-1} was recorded with the M_1(2 g leaves 100 g $^{-1}$ soil) i.e. 4.76 pl^{-1}. The increase in corm in the higher concentration might be due to chemicals ingredients content in allelopathic plants. Higher concentration of allelopathic plants increased the number of corm have been reported by Riaz *et al.* (2010).

Table 1. Interaction effect of levels of leaves incorporation and allelopathic plants on days to emergence plant^{-1}and mortality at various intervals

Treatments	Mortality (%)											
	Days to emergence plant $^{-1}$				90 DAP				120 DAP			
	Levels of leaves incorporation				Levels of leaves incorporation				Levels of leaves incorporation			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
A_1 - *Allium sativum*	18.00	17.00	15.00	16.67	33.33	11.11	11.11	18.52	44.44	33.33	33.33	37.03
A_2 - *Ipomoea carnea*	16.00	15.00	15.00	15.33	11.11	11.11	0.00	7.41	33.33	11.11	11.11	18.52
A_3 - *Annona innoxia*	19.00	18.00	16.00	17.67	33.33	33.33	22.22	29.63	66.66	44.44	33.33	48.14
A_4 - *Eucalyptus globulus*	16.00	16.00	16.00	16.00	33.33	11.11	0.00	14.81	44.44	22.22	11.11	25.92
A_5 - *Azadirachtaindica*	17.00	15.00	13.00	15.00	0.00	0.00	0.00	0.00	22.22	11.11	0.00	11.11
A_6 - *Fusarium oxysporum*	19.00	19.00	18.00	18.67	44.44	33.33	33.33	37.03	88.89	77.77	66.66	77.77
A_7 - Control	14.00	15.00	15.00	14.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	17.00	16.43	15.43	--	22.22	14.28	9.52	--	42.85	28.57	22.22	--
	M	A		M x A	M	A		M x A	M	A		M x A
SE ±(m)	0.38	0.58		1.24	2.50	3.82		8.10	2.80	4.29		9.10
C D (P=0.05)	1.09	1.367		-	7.14	10.91		-	8.03	12.26		-

Table 2. Interaction effect of levels of leaves incorporation and allelopathic plants on wilt incidence of gladiolus

Treatments	Wilt incidence (%)															
	30 DAP				60 DAP				90 DAP				120 DAP			
	Levels of leaves incorporation				Levels of leaves incorporation				Levels of leaves incorporation				Levels of leaves incorporation			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
A_1 - *Allium sativum*	33.12	31.67	30.88	31.89	39.84	37.99	35.51	37.78	60.94	58.62	57.79	59.12	70.83	68.65	65.30	68.26
A_2 - *Ipomoea carnea*	31.49	30.44	28.63	30.19	35.25	33.67	31.77	33.56	53.08	49.99	49.51	50.86	63.74	61.27	58.29	61.10
A_3 - *Annona innoxia*	36.83	34.33	33.26	34.81	42.70	40.12	38.42	40.41	62.25	59.82	59.10	60.39	73.22	72.02	68.58	71.27
A_4 - *Eucalyptus globulus*	32.99	30.98	28.93	30.97	37.62	35.76	34.10	35.83	58.57	56.31	55.10	56.66	66.27	65.00	61.52	64.26
A_5 - *Azadirachtaindica*	30.41	28.16	26.11	28.23	32.14	31.02	30.11	31.09	52.03	49.25	47.96	49.75	59.58	56.78	54.32	56.89
A_6 - *Fusarium oxysporum*	40.03	38.86	38.58	39.16	46.88	44.85	43.20	44.98	65.92	63.38	62.86	64.05	82.66	80.53	77.03	80.07
A_7 - Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mean	29.27	27.78	26.63	-	33.49	31.92	30.44	-	50.40	48.20	47.47	-	59.47	57.75	55.01	-
	M		A	M×A	M		A	M×A	M		A	M×A	M		A	M×A
S E ±(m)	0.72		1.10	2.34	0.83		1.27	2.70	0.83		1.27	2.70	1.23		1.89	4.01
C D P=0.05)	2.07		3.16	-	2.38		3.64	-	2.38		3.64	-	3.53	5.40	.40	-

Table 3. Interaction effect of levels of leaves incorporation and allelopathic plants on shoot length Plant^{-1} at 30, 60, 90 and 120 DAP

Treatments	Shoot length plant^{-1}															
	30 DAP Levels of leaves incorporation				60 DAP Levels of leaves incorporation				90 DAP Levels of leaves incorporation				120 DAP Levels of leaves incorporation			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
A_1 - *Allium sativum*	6.22	6.28	5.56	7.02	22.42	24.64	27.78	23.95	24.24	28.77	32.10	28.37	28.90	33.21	36.57	32.89
A_2 - *Ipomoea carnea*	6.43	8.74	8.84	8.01	22.93	24.68	25.90	24.50	28.10	31.04	31.54	30.223	31.41	33.98	37.42	34.27
A_3 - *Annona innoxia*	5.09	6.04	6.38	5.84	18.09	21.18	22.73	20.67	23.68	28.10	29.48	27.08	26.61	31.13	34.73	30.83
A_4 - *Eucalyptus globulus*	6.44	7.84	8.84	7.71	22.01	22.96	27.37	24.11	29.58	29.81	30.66	30.2	31.67	33.43	36.83	33.98
A_5 - *Azadirachtaindica*	7.03	8.10	9.41	8.18	21.92	25.68	27.40	25.00	27.78	31.17	32.67	30.87	32.20	35.27	37.85	35.10
A_6 - *Fusarium oxysporum*	4.03	4.71	5.67	4.81	17.28	17.40	20.81	18.50	22.17	22.54	23.80	22.83	23.87	24.49	24.67	24.34
A_7 - Control	9.19	11.32	12.10	10.87	25.91	26.32	35.65	29.29	34.24	34.68	35.90	34.94	38.21	38.49	40.09	38.93
Mean	6.35	7.58	8.54	-	21.51	23.26	26.38	-	27.25	29.44	30.88	-	30.41	32.86	35.45	-
	M	A		M x A	M	A		M x A	M	A		M x A	M	A		M x A
SE ±(m)	0.17	0.27		0.57	1.00	1.53		3.25	0.90	1.38		2.94	0.62	0.94		2.01
CD (P=0.05)	0.50	0.77		-	2.87	4.38		-	2.59	3.96		-	1.77	2.741		-

Table 4. Interaction effect of levels of leaves incorporation and allelopathic plants on growth parameters and quality of gladiolus

Treatments	Spike length plant^{-1} Levels of leaves incorporation			Mean	Total number of leaves plant^{-1} Levels of leaves incorporation			Mean	Number of flowers spikes plant^{-1} Levels of leaves incorporation			Mean	Number of corms plant^{-1} Levels of leaves incorporation			Mean	Weight of corms plant^{-1} Levels of leaves incorporation			Mean
	M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3		M_1	M_2	M_3	
A_1 - *Allium sativum*	44.50	46.80	47.63	46.31	5.00	5.33	5.46	5.26	6.44	6.70	6.86	6.67	5.00	5.33	5.33	5.22	10.17	13.23	15.90	13.10
A_2 - *Ipomoea carnea*	49.33	49.40	51.80	50.18	5.48	5.57	5.72	5.59	7.07	7.17	7.28	7.17	4.33	5.33	7.00	5.56	14.57	14.97	15.07	14.87
A_3 - *Annona innoxia*	42.50	45.80	47.93	45.41	4.92	5.00	5.24	5.05	6.18	6.31	6.33	6.27	4.67	5.00	5.67	5.11	11.37	11.87	14.27	12.50
A_4 - *Eucalyptus globulus*	47.53	47.57	47.67	47.59	5.12	5.33	5.67	5.37	6.51	6.85	6.93	6.76	4.67	5.00	6.33	5.33	12.30	12.63	17.73	14.22
A_5 - *Azadirachtaindica*	49.87	50.17	50.63	50.22	5.33	5.81	6.06	5.73	7.09	7.15	7.37	7.21	5.00	5.67	7.33	6.00	14.97	16.17	17.00	16.04
A_6 - *Fusarium oxysporum*	44.23	44.50	46.17	44.97	4.00	4.30	4.33	4.21	5.28	5.32	5.98	5.52	3.33	4.33	4.67	4.11	9.98	10.11	10.32	10.14
A_7 - Control	52.20	52.43	54.07	52.90	5.31	6.33	7.67	6.44	7.52	7.73	7.97	7.74	6.33	6.67	7.67	6.89	16.27	16.33	20.80	17.80
Mean	47.17	48.10	49.41	--	5.02	5.38	5.74	--	6.58	6.75	6.96	--	4.76	5.33	6.29	--	12.80	13.62	15.87	-
	M	A	M×A		M	A	M×A		M	A	M×A		M	A	M×A		M	A	M×A	
SE ±(m)	0.48	0.74	1.57		0.09	0.14	0.31		0.08	0.13	0.28		0.36	0.55	1.17		0.31	0.47	1.01	
CD (P=0.05)	1.39	2.12	6		0.27	0.42	0.90		0.25	0.38	6		1.03	1.57	6		0.89	1.36	2.89	

plants increased the number of corms have been reported by Riaz *et al.* (2010).

Effect of allelopathic plants

The data presented in table 4 revealed that, the effect of different allelopathic plants on number of corm plant^{-1} of gladiolus variety was found to be significant. The treatment A_5 (*Azadirachta indica)* produced maximum number of corms plant^{-1} (6.00 pl^{-1}) which was statistically at par with the treatment A_2 *(Ipomoea carnea)* i.e. 5.56 pl^{-1}. Whereas, minimum number of corms plant^{-1} were recorded with the treatment A_6 (*Fusarium oxysporum*) i.e. 4.11 pl^{-1}. Raj and Kumar (2009) and Muhammad *et al.* (2013) investigated that the use of aqueous extract of seed and colves of seven plants increased corms plant^{-1} and quality parameters.

Interaction effect

The data presented in table 4 revealed that, interaction effect on number of corms plant^{-1} of gladiolus i.e. levels of leaves incorporation × allelopathic plants leaves was found to be non-significant.

Fresh weight of corms plant^{-1}

The data in respect of weight of corms plant^{-1} in gladiolus as influenced by the allelopathic plants leaf materials are presented in table 4.

Effect of levels of leaves incorporation

The data presented in table 4 showed that, the effect of different concentrations of leaf materials on weight of corms plant^{-1} of gladiolus was found to be significant. The treatment M_3 (6 g leaves 100 g^{-1} soil) gave maximum weight of corms plant^{-1} (15.87 pl^{-1}) which was found to be statistically at par with the treatment M_2 (4 g leaves 100 g^{-1} soil) i.e. 13.62 pl^{-1}. Whereas, minimum number of corms plant^{-1} were recorded with the M_1 (2 g leaves 100 g^{-1} soil) i.e. 12.80 pl^{-1}. Increase in weight of corms might be due to presence of active ingredient possess in allelopathic plants. The present findings are corroborated with the findings of Riaz *et al.* (2010), Potdukhe *et al.* (2017 b) and Raj and Kumar (2009), who reported increase in corm size and weight of corms due to application of leaf extract of *Lantana camera*, and *Ipomea carnea*.

Effect of allelopathic plants

The data presented in table 4 revealed that, the effect of incorporation of different allelopathic plants on weight of corms plant^{-1} of gladiolus varieties was found to be significant. The treatment A_5 (*Azadirachta indica)* had maximum weight of corms plant^{-1}(16.04 pl^{-1}) which was statistically at par with the treatment A_2 (*Ipomoea carnea)* i.e. 14.87 pl^{-1}). Whereas, minimum number of number of corms plant^{-1} were recorded with the treatment A_6 (*Fusarium oxysporum*) i.e. 10.14 pl^{-1}.

Interaction effect

The data presented in table 4 revealed that, interaction effect on weight of corm plant^{-1}of gladiolus was found to be significant due to concentration of leaf materials with allelopathic plants. Among the interaction effect for M_1 (2 g leaves 100 g^{-1} soil) treatment and M_2 (4 g leaves 100 g^{-1} soil) treatment A_5 (*Azadirachta indica)* was significantly superior in increasing weight of corms 14.97 and corms plant^{-1} 16.17 g respectively. However, for M_3 (6 g leaves 100 g^{-1} soil) treatment, A_4 (*Eucalyptus globulus*) registered 17.73 g corms plant^{-1} and found significantly superior over all other treatments. These effectiveness is attributed to the attainment of suitable chemical and physical properties of the allelopathic plants incorporated in the soil where might have reduced the population of the pathogen. Thus, it is inferred that the incorporation of *Azadirachta indica* minimized wilt incidence, mortality and helped in increasing growth parameters of gladiolus crop.

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