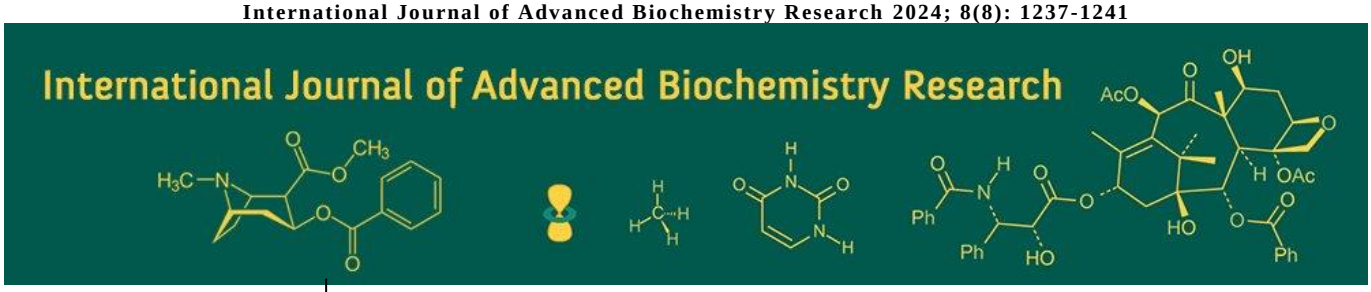

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Efficacy of medicinal plant leaves against wilt of gladiolus caused by *Fusarium oxysporum* f. sp. *gladioli*

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Abstract
An experiment entitled "Efficacy of Medicinal Plant Leaves against wilt of Gladiolus caused by *Fusarium oxysporum* f. sp. *gladioli*" was conducted at the Plant Pathology Section, College of Agriculture, Nagpur. A pot culture experiment was conducted in Factorial Completely Randomized Design (FCRD) with two main treatments (Pusa Suhagin and Punjab Dawn) and six subtreatments medicinal plant leaves, *viz*., Sitaphal, Beshram, Kaner, Marigold and (Carbendanzim + Mancozeb), and an uninoculated control in three replications during the rabi season 2023-24. The observations were recorded at 30, 60, 90, and 120 DAP. In the *in vivo* experiment, it was clearly observed that Carbendanzim + Mancozeb fungicide treatment was significantly superior, minimizing mortality (00.00%), and also increased shoot length plant^{-1} (65.45 cm at 120 DAP), higher spike length plant^{-1} (87.41 cm), maximum number of leaves plant^{-1} (8.57 at 120 DAP), number of shoots plant^{-1} (2.54), number of flower spike^{-1} (9.33), number of corm plant^{-1} (37.235) and weight of corm (37.27 g). Pusa Suhagin minimized the mortality (2.78%), as well as increased shoot length plant^{-1}, spike length plant^{-1} (75.83 cm), number of leaves plant^{-1} (7.82), number of shoots plant^{-1} (2.195), and number of flower spike^{-1} (6.95). The interaction due to varieties and medicinal plant were found to be non-significant in respect of number of shoots plant^{-1}, number of corms plant^{-1}, number of leaves plant^{-1} and fresh weight of corms plant^{-1}.

Keywords: Medicinal plant leaves, gladiolus (*Gladiolus grandiflora* L.), *Fusarium oxysporum* f.sp. *gladioli.*

1. Introduction
Gladiolus (*Gladiolus grandiflora* L.) is a herbaceous flowering plant that is widely cultivated, economically significant, and widely distributed throughout the world. Gladiolus belongs to the Iridaceae family, and many of its species can be found in South Africa, as well as Tropical Africa, Madagascar, and Eurasia. Gladiolus is an important cut flower crop. It is ideal for both garden display as well as floral arrangements. It is also commonly used for table and interior decoration by making high quality bouquet. Long and number of spikes, number of florets per spike and good corm multiplication ability are the main characters to be considered for gladiolus improvement (Nalage, 2019) [13]. Gladiolus wilt or yellows are mostly caused by four Fusarium species: *F. oxysporum* f. sp. *gladioli*, *F. solani*, *F. moniliforme*, and *F. roseum*. Among these pathogens, Fusarium corm rot and wilt caused by *Fusarium oxysporum* f. sp. *gladioli* is the most serious in India. In India gladiolus wilt, caused by *F. oxysporum* f. sp. *gladioli*, was originally reported in Uttar Pradesh (Vavre, 2021) [19]. When diseases become serious, growers who engage in ornamental cultivation in India have little knowledge of management and simply use fungicides. Chemical fungicides alone were ineffective in controlling *Fusarium oxysporum* f. sp. *gladioli* because the pathogen is protected in xylem tissue, which many chemical fungicides cannot penetrate. Scientists have diverted to find new environment friendly agents for the control of plant diseases from other sources like aromatic and medicinal plants that secrete some substances and which are safe to human and environment. Greater level of active ingredients is being obtained from leaves, flowers, seeds, roots and twigs of higher plants that are used for pathogen control in crop production. Therefore, the application of medicinal plants leaf residues is ecologically beneficial to control the pathogen.

2. Materials and Methods

2.1. Experimental site

The pot culture experiment was carried out during year 2023-24 at Plant Pathology Section, College of Agriculture, Nagpur.

2.2. Treatment details

The experiment was conducted in Factorial Completely Randomised Design (FCRD) on twelve treatment combinations in three replications.

2.2.1. Main treatments

V_1: Pusa Suhagin
V_2: Punjab Dawn

2.2.2. Sub treatments

Sub-treatment	Medicinal plants & Chemical	Rate of application
C_1	Sitaphal (*Annona innoxia*)	5 g powder of dry leaves/100 g soil
C_2	Beshram (*Ipomea carnea*)	5 g powder of dry leaves/100 g soil
C_3	Kaner (*Nerium oleander*)	5 g powder of dry leaves/100 g soil
C_4	Marigold (*Tagetes erecta*)	5 g powder of dry leaves/100 g soil
C_5	Carbendazim + Mancozeb	0.1%
C_6	Control	-

2.3. 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 500ml conical flask and autoclaved at 15 lbs psi for 15 minutes. It was allowed to cool and flasks were inoculated with pure culture. The inoculated flasks were incubated at room temperature for 15 days. The flasks were shaken every day during incubation period. Sufficient quantity of inoculums was prepared and used for preparing sick pots required for pathogenicity test and inoculums potential study.

2.4. Pathogenicity test

Pathogenicity of the test fungus *Fusarium oxysporum* f. sp. *gladioli* was conducted by soil inoculation technique (Sen and Kapoor, 1975). The inoculums of *Fusarium oxysporum* f. sp. *gladioli* were multiplied on sand sorghum medium. Soil was incubated @ 50 g/kg of sterilized soil. The inoculum was thoroughly mixed with upper layer of 5-15 cm soil, the pots (22 x 21cm) watered lightly and incubated for two days. Gladiolus corms were sown in the pots. The symptom of disease was recorded at 60 days after sowing. Re-isolation of fungus was done from diseased plants on PDA and respective selective medium by tissue isolation method. Confined the causal agent *Fusarium oxysporum* f. sp. *gladioli*.

2.5. Preparation of sick soil for pots

The pots were sterilized with the help of formalin by wiping them out with cotton plugs dipped in 1% formalin. The pots were then placed upside down to sterilize them completely for 24 hours. The soil used was also sterilized by 1% formalin solution poured in perforated PVC pipes plug on both ends and which were inserted into heaps of soil. The entire heap was then covered with polythene sheet and kept as such for four days. It was again opened and stirred to release the formaldehyde gas. The soil was then filled in pot. Full grown fungus culture was added in the earthen pots of 30 cm diameter and was filled with *Fusarium oxysporum* f. sp. *gladioli* eight days before planting.

3. Results and Discussions

3.1. Interaction effect of medicinal plant leaves and varieties on number of leaves plant^{-1}

The data exhibited in Table 1 indicates that the total number of leaves plant^{-1} of gladiolus was significantly influenced by different medicinal plant leaves treatments. It was observed from the data maximum number of leaves plant^{-1} was recorded with C_5 treatment (8.57). Among medicinal plant leaves treatments C_3 treatment recorded maximum leaves/plant (8.18). It is observed from the Table 1 that the varietal response was found significant difference on number of leaves plant^{-1}. Maximum leaves were recorded by the variety V_1 (8.21/pl) at 120 DAP and it was significantly superior over variety V_2. Interaction effect of medicinal plant leaves and varieties were found to be non-significant on number of leaves plant^{-1}.

3.2. Interaction effect of medicinal plant leaves and varieties on shoot length plant^{-1}

It is evident from the data that there were significant differences on shoot length. It is clearly observed from the data maximum shoot length was recorded with C_5 treatment observed significantly higher shoot length (65.45 cm/plant). The effects due to varieties were found to be significant. It is pertinent from the data presented in tablethat the variety V_1 (Pusa Suhagin) reported significantly higher shoot length 68.46 cm/plant at 120 DAP. It is observed from the data presented in Table 1 that the interaction effect due to medicinal plant leaves and varieties were found to be significant.

3.3. Interaction effect of medicinal plant leaves and varieties on number of shoots plant^{-1}

The data tabulated in Table 1 showed that there were significant differences over uninoculated control. Treatment C_5 recorded the highest number of shoots (2.54 plant^{-1}) and were found significantly superior over all other treatments except treatment C_4 (2.09 plant^{-1}) and treatment C_2 (2.05 plant^{-1}). It is observed from the Table 1 that the varietal effects were found to be significant on number of shoot plant^{-1}. Maximum number of shoots was recorded by the variety V_1 (2.19 shoot plant^{-1}) and it was significantly superior over variety V_2 (1.82 shoot plant^{-1}). Interaction effect of medicinal plant leaves and varieties were found to be non-significant on number of shoots plant^{-1}.

3.4. Interaction effect of medicinal plant leaves and varieties on length of spike plant^{-1}

The data tabulated in Table 2 revealed that the application of medicinal plant leaves significantly enhanced the length of spike (cm/pl). Maximum length of spike was recorded with C_5 treatment (87.41 cm/pl) and it was found significantly superior over all other treatments. The findings furnished in Table 2 indicate that the length of spike (cm/pl) was significantly improved with all the varieties. Highest length of spike was recorded with V_1 variety (75.83 cm/pl) and it was found significantly superior over V_2 variety. The interaction effect (Table 2) due to application of medicinal plant leaves and varieties were found to be significant.

3.5. Interaction effect of medicinal plant leaves and varieties on number of flowers spike^{-1}

The data regarding the number of flowers spike^{-1} were recorded at the end of harvesting (120 DAP). It was observed from the data presented in Table 2 that there was significance difference due to medicinal plant leaves on number of flowers spike^{-1} over uninoculated control. Maximum number of flowers spike^{-1} were recorded with the treatment C_5 (9.33 flowers spike^{-1}) as it was found significantly superior over all other treatments except treatment C4 (8.05 flowers spike^{-1}). Significant effects were noticed on varieties (Table 2). Variety V_1 recorded the significantly higher number of flowers spike^{-1} (6.95) followed by V_2 (3.97). The interaction effect due to medicinal plant leaves and varieties were found to be significant (Table 2). Treatment combination C_5V_1 recorded highest number of flower spike^{-1} (9.67) followed by C_5V_2 treatment.

3.6. Interaction effect of medicinal plant leaves and varieties on number of corms plant^{-1}

The data presented in Table 2 clearly showed that there was significant difference due to application of medicinal plant leaves over uninoculated control. The treatment C_5 (Carbendazim + Mancozeb) recorded significantly higher number of corms plant^{-1} (37.23 corms plant^{-1}). Minimum corms have been recorded in C_1 treatment (14.13 corms plant^{-1}). The effect of varieties due to application of medicinal plant leaves was found to be significant. Variety V_2 produced significantly higher corms plant^{-1} (25.60) followed by V_1 variety (19.45). This may be due to inherent character of the varieties and were response to medicinal plant leaves. The interaction effect due to application of medicinal plant leaves and varieties were found to be non-significant.

3.7. Interaction effect of medicinal plant leaves and varieties on fresh weight of corms plant^{-1}

The differences due to medicinal plant leaves were found to be significant (Table 2). The maximum weight of corms plant^{-1} was recorded by C_5 treatment (37.27 g plant^{-1}) and it was at par with C_4 treatment (35.21 g plant^{-1}). It would be observed from the data furnished in Table 2 clearly showed that there were significant differences on varieties. Variety V_2 produced the highest corm weight (27.33 g plant^{-1}) followed by variety V_1 (27.01 g plant^{-1}) and were at par with each other. The data tabulated in Table 2 reveals that there were found to be non-significant differences between the interaction of medicinal plant leaves and varieties.

3.8. Interaction effect of medicinal plant leaves and varieties on mortality

The data presented in Table 3 clearly showed that there was significant difference on mortality percentage over uninoculated control at 30 DAP. Minimum mortality percentage was recorded with the treatment C_4 and C_5 (0.00%) followed by C_3 Treatment (5.55%). However, at 60 DAP, the minimum mortality was recorded with C_5 treatment (0.00%) and it was found significantly superior over all the treatment. It was followed by treatment C_4 (4.16%). At 90 DAP the significant changes were noticed and there was increasing in mortality linearly from 30 to 120 DAP. At 90 and 120 DAP it is observed that the treatment C_5 recorded significantly minimum mortality percentage (0.00% each) followed by C_4 treatment (4.16% each). The data in Table 3 showed that there was significant difference due to variation in mortality percentage at various intervals. It was observed from the data that at 30 DAP variety V_1 significantly had minimum percentage of mortality (2.77%) as compared to variety V_2 (5.55%). However, from 60 DAP onwards there was increased in mortality progressively till 120 DAP. Further it was noticed that the variety V_1 recorded significantly minimum mortality percentage 6.94, 11.11 and 15.27 per cent at 60, 90, 120 DAP respectively as compared to V_2 recording 7.40, 12.96, and 16.66 per cent mortality at 60, 90, 120 DAP, respectively. It was observed that there were significant effects due to application of medicinal plant leaves and varieties. At 30 DAP, combination effect of C_3V_2 recorded minimum mortality. At 60, 90 and 120 DAP treatment combination C_4V_2 was significantly superior over all other combinations.

Table 1: Interaction effect of medicinal plant leaves and varieties on number of leaves plant^{-1}, shoot length, number of shoots plant^{-1} at 120 DAP

Treatments	Number of leaves plant^{-1} at 120 DAP			Shoot length at 120 DAP			Number of shoots plant^{-1}		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
C_1- *Annona innoxia*	8.22	7.32	7.77	69.36	53.33	61.34	2.05	1.44	1.74
C_2- *Ipomea carnea*	8.25	7.03	7.65	66.92	54.22	60.57	1.89	2.22	2.05
C_3- *Nerium oleander*	8.25	8.12	8.18	66.58	60.00	63.29	1.92	1.39	1.65
C_4- *Tagetes erecta*	8.22	7.08	7.65	67.83	61.28	64.55	2.25	1.94	2.09
C_5- Carbendazim + Mancozeb	8.35	8.80	8.57	72.25	58.66	65.45	2.42	2.66	2.54
C_6- Control	8.02	8.58	8.30	67.83	58.86	63.34	2.64	1.29	1.96
Mean	8.21	7.82	-	68.46	57.72	-	2.19	1.82	-
	V	C	V X C	V	C	V X C	V	C	V X C
'F' test	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.	Sig.	NS
SEm (±)	0.19	0.34	0.59	2.19	3.80	6.59	0.12	0.21	0.37
CD (P=0.05)	0.57	1.00	-	6.44	11.16	19.34	0.36	0.63	-

Table 2: Interaction effect of medicinal plant leaves and varieties on length of spike plant^{-1}, number of flower spike^{-1}, number of corms plant^{-1} and fresh weight of corms plant^{-1}

Treatments	Length of spike plant^{-1}			Number of flower spike^{-1}			Number of corms plant^{-1}			Fresh weight of corms plant^{-1}		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
C_1- *Annona innoxia*	0.00	0.00	0.00	0.00	0.00	0.00	15.72	12.55	14.13	25.38	26.75	26.06
C_2- *Ipomea carnea*	101.5	26.33	63.94	9.05	1.67	5.36	16.42	13.39	14.90	20.86	20.17	20.51
C_3- *Nerium oleander*	78.44	27.67	53.05	7.22	4.67	5.94	37.28	14.50	25.89	23.17	26.83	25.00
C_4- *Tagetes erecta*	87.17	76.11	81.64	7.61	8.50	8.05	21.42	41.86	31.64	29.57	40.86	35.21
C_5- Carbendazim + Mancozeb	93.50	81.33	87.41	9.67	9.00	9.33	14.14	60.33	37.23	40.50	34.04	37.27
C_6- Control	94.33	00	47.16	8.17	00	4.08	11.75	11.00	11.37	22.61	15.33	18.97
Mean	75.83	35.24	-	6.95	3.97	-	19.45	25.60	-	27.01	27.33	-
	V	C	V X C	V	C	V X C	V	C	V X C	V	C	V X C
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	Sig.	Sig.	NS
SEm (±)	5.00	8.67	15.02	0.67	1.16	2.01	4.36	7.55	13.09	1.92	3.33	5.77
CD (P=0.05)	14.68	25.43	44.05	1.96	3.41	5.90	12.79	22.16	-	5.64	9.78	-

Table 3: Interaction effect of medicinal plant leaves and varieties on mortality per cent at 30, 60, 90 and 120 days interval

Treatments	Mortality (%) at 30 DAP			Mortality (%) at 60 DAP			Mortality (%) at 90 DAP			Mortality (%) at 120 DAP		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
C_1- *Annona innoxia*	0.00	22.22	11.11	0.00	33.33	16.66	8.33	55.55	31.94	16.67	66.66	41.66
C_2- *Ipomea carnea*	16.67	0.00	8.33	25.00	0.00	12.50	33.33	11.11	22.22	41.67	22.22	31.94
C_3- *Nerium oleander*	0.00	11.11	5.55	8.33	11.11	9.72	16.67	11.11	13.89	25.00	11.11	18.05
C_4- *Tagetes erecta*	0.00	0.00	0.00	8.33	0.00	4.165	8.33	0.00	4.165	8.33	0.00	4.16
C_5- Carbendazim + Mancozeb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_6- 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
Mean	2.77	5.55	-	6.94	7.40	-	11.11	12.96	-	15.27	16.66	-
	V	C	V X C	V	C	V X C	V	C	V X C	V	C	V X C
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SEm (±)	2.16	3.75	6.50	2.48	4.29	7.44	3.42	5.93	10.27	3.15	5.46	9.47
CD (P=0.05)	6.36	11.01	19.08	7.27	12.60	21.83	10.04	17.40	30.14	9.25	16.03	27.77

4. Conclusion

It was concluded from the present investigation that application of Carbendazim + Mancozeb fungicide treatment was found to be better in growth parameters of Gladiolus. Among the medicinal plant leaves, application of Marigold was found effectively in increased number of flowers spike^{-1}, spike length, number of corms plant^{-1}, fresh weight of corms plant^{-1}, shoot length, number of shoots plant^{-1} and reduced mortality level.

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