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Effect of Weather Parameters on Wilt (*Fusarium oxysporum* f. sp. *gladioli*) of Gladiolus

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A B S T R A C T

Flower plays an important role in people's celebration and everyday lives. Among the floriculture, gladiolus is one of them. Cultivation of gladiolus flower produces huge emphasis due to less maintenance and high economic return. Even though, the diseases on gladiolus have major economic impact on quality and quantity. Moreover, weather condition is one of the major factors on disease cause and its development, which is directly proportionate to different parameters *viz*, Temperature, Rainfall and Humidity. Therefore, by considering the economic losses, an investigations and experiments were carried out during 2012-2013 at Department of Plant Pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The observations on wilt (*Fusarium oxysporum* f. sp. *gladioli*) incidence were recorded at weekly and monthly in relation to different effect of weather parameters and its correlation. During the experiment, it was observed that initiation of wilt (*Fusarium oxysporum* f. sp. *gladioli*) symptoms occurred during 26th meteorological week with an incidence 1.25 per cent. Higher disease incidence i.e. 43.12 per cent was recorded during 46th meteorological week. Maximum temperature showed positive correlation with wilt infection whereas negative and significant correlation was established by rainfall, minimum temperature and relative humidity.

Introduction

World would not have been as beautiful, charming and cherishing as it is today, without flowers. Bulbous flowering plants are one of the most wonderful creations of nature. The various bulbous flowering plants provide glamour, perfection and colour. Gladiolus (*Gladiolus grandiflorus* Hort.) easily tops the list and can rightly be called the "Queen of bulbous flower crops" grown in many parts of the world (Kaikal and Nauriyal, 1964). It is also called as 'Sword lily' on account of the shape of its leaves (Randhawa and Mukhopadhyay, 1986). In Europe it is commonly called as 'Corn flag' due to its infestation as a weed (Bose and Yadaw, 1989).

In India, gladiolus was grown more than 1270 ha with an annual production of 150 million spikes (Arora, 2002). In the last two decades,

it has become very popular flowering plant in India. The major area being Kalimpong (West Bengal), New Delhi, Srinagar (Jammu and Kashmir), Nainital (Uttaranchal), Pune and Nasik (Maharashtra), Bangalore (Karnataka), Hyderabad (Andhra Pradesh) and its cultivation is rapidly expanding in the states like Andhra Pradesh, Haryana, Karnataka, Kerala, Maharashtra, Punjab, Uttar Pradesh, Uttaranchal, Tamil Nadu and West Bengal (Naveen and Raju, 2007).

Gladiolus is a tender herbaceous perennial. It occupies fourth of worlds bulbous flower plant area (Bose *et al.*, 2003). Gladiolus plants have national and international value in respect to cut flowers. Cut flower cultivation is a sub division of ornamental plant production having the largest part in either production or economic value.

In India, it ranks second in area and production. The gladiolus crop was found infected with different fungal diseases *i.e.* wilt (*Fusarium oxysporum* f.sp. *gladioli*), corm rot (*Rhizoctonia solani*) and leaf spot (*Alternaria alternata*) during survey.

Nowadays, the wilt disease had become very severe and not much work is carried out on wilt of gladiolus.

In view of this, there is a need for systematic work in order to provide information on the fungi associated with the diseases of gladiolus and correlation of fungal diseases with weather parameters.

Materials and Methods

The present investigation was carried out during 2012-2013 at Department of Plant Pathology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) to know occurrence of wilt disease on gladiolus with effect of weather parameters on disease development. The observations on wilt (*Fusarium oxysporum* f. sp. *gladioli*) incidence were recorded at weekly and monthly in relation to different effect of weather parameters and its correlation. The disease incidence was calculated from number of infected and total number of healthy plants.

The glassware *viz*., Petri plates, test tubes, conical flasks of 250 ml, 500 ml and 1000 ml, funnel, beakers, pipettes, measuring cylinder, slides, cover slips, glass rods were used and Standard laboratory equipments *viz*., autoclave, incubator, laminar air flow, research microscope, stereoscopic binocular microscope, refrigerator, hot air oven, digital weighting balance, Bunsen burner were used and others materials *viz.*, Blotter paper, non-adsorbent cotton, muslin cloth, cork borer, inoculating needle, forceps, potato, dextrose, agar-agar, sterilized soil, pots etc. these are the following equipments were used during the course of research work.

Methods

Survey

A survey of commercially cultivated gladiolus fields in the villages i.e. Patur and Washimba, Akola district of Maharashtra and Horticulture section field, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola was conducted during June to December 2012 for the occurrence and distribution of fungal diseases on gladiolus.

While the effect of different weather parameters observed at Horticulture section field and plant parts showing typical disease symptoms were collected in separate bag and brought to the laboratory. All samples collected from field were isolated on PDA. Meanwhile, weekly and Monthly observation on disease incidence was recorded with different weather condition.

Isolation of pathogens

Isolation of fungal pathogens was done on potato dextrose agar (PDA) medium. Approximately 20 ml autoclaved PDA was poured in each sterilized Petri dish and allowed to solidify. The collected diseased sample parts were cleaned properly. The diseased portion was cut into pieces (2 mm) along with healthy portion with sterile blade and transferred into sterile Petri plate containing 0.1% mercuric chloride ($HgCl_2$) solution for surface sterilization. Then pieces were transferred to sterile water and washed with 3 changes of sterilized water to remove the traces of mercuric chloride. Pieces were then dried on sterilized filter paper to remove the excess water. Four pieces of each was aseptically transferred on to solidified PDA medium in sterile Petri dish at equal distance and kept for incubation at room temperature ($28+2^0C$). All the operations were carried out in aseptic condition. Growth of organism was observed regularly. The fungus observed around the infected bits was transferred on plates. The slides were prepared and examined under research microscope for identification and confirmation presence of disease.

Identification of the pathogens

The isolated, *Fusarium oxysporum* f. sp. *gladioli* was identified on the basis of their morphological characteristics, microscopic structures and types of spores produced and pigmentation by using different identification keys and observed its effects in relation to different weather parametric condition in the cultivation field of gladiolus.

Methodology

Record of plant diseases under natural field condition

The initiation and development of diseases on gladiolus was recorded weekly and observations were correlated with weather parameters. Incidence of diseases was recorded by selecting the plants affected due to the diseases from total number of plants in a marked area.

Method of observations

Observations on per cent disease incidence and intensity were recorded weekly. Incidence was calculated from number of infected and total number of healthy plants. The per cent disease incidence was calculated by following formula (Mayee and Datar, 1986).

$$\text{Per cent disease incidence} = \frac{\text{No. of plants showing symptoms}}{\text{Total no. of plants}} \times 100$$

Seasonal incidence and intensity of diseases in relation to weather parameters:

Meteorological data during the course of investigation for the period from June 2012 to December 2012 recorded at Meteorological Observatory along with normal values are presented in Appendix-I, the data was compiled to standard weeks and subjected to correlation equation (Panse and Sukhatme, 1967).

Results and Discussion

Seasonal incidence of wilt (*Fusarium oxysporum* f. sp. *gladioli*)

Gladiolus crop was found infected with wilt caused by *Fusarium oxysporum* f. sp. *gladioli*. The crop was planted during the second week of June 2012. Initiation of the disease symptoms occurred during 26^{th} meteorological week with an incidence 1.25 per cent, when rainfall was 20.6 mm, maximum temperature 37.7°C and minimum temperature 26.4°C along with relative humidity ranged between 71 and 37 per cent during morning and evening.

Table.1 Effect of weather parameters on wilt (*Fusarium oxysporum* f. sp. *gladioli*) of gladiolus

Meteoro-logical weeks	Observation date	Rainfall (mm)	Temperature °C		Relative humidity %		PDI %
			Maximum	Minimum	RH I	RH II	
25	18-24 June	59.4	32.7	25.1	71	51	00
26	25-1 July	20.6	37.7	26.4	71	37	1.25
27	2-8	101.0	30.7	24.0	90	72	1.87
28	9-15	20.3	31.8	24.6	87	57	3.75
29	16-22	46.1	33.1	25.0	81	58	5.62
30	23-29	91.1	26.7	23.2	87	83	7.50
31	30-5 Aug.	29.0	27.9	23.0	84	77	8.75
32	6-12	15.9	28.1	23.4	90	80	10.62
33	13-19	18.4	28.7	23.0	90	76	12.50
34	20-26	25.8	29.1	23.0	94	72	15.42
35	27-2 Sep.	44.9	30.9	23.6	94	66	16.87
36	3-9	93.8	30.1	23.4	89	68	21.25
37	10-16	10.4	30.2	23.0	85	61	23.12
38	17-23	23.8	31.7	23.0	86	54	25.62
39	24-30	9.3	32.5	22.7	85	45	28.12
40	1-7 Oct.	40.9	33.1	22.5	88	48	30.62
41	8-14	1.5	33.6	18.6	85	33	35.62
42	15-21	0.0	34.1	17.6	78	24	37.50
43	22-28	0.0	33.0	18.6	76	28	39.37
44	29-4 Nov.	0.0	31.4	17.1	75	35	40.42
45	5-11	0.0	32.1	14.9	72	23	42.50
46	12-18	0.0	31.0	11.9	73	21	43.12

PDI = Per cent Disease Incidence

Table.1a Correlation of wilt (*Fusarium oxysporum* f. sp. *gladioli*) of gladiolus with weather parameters

Disease	Per cent	Rainfall (mm)	Temperature °C		Relative humidity %	
			Maximum	Minimum	RH I	RH II
Wilt	Incidence	-0.603**	0.186	-0.87**	-0.303	-0.722**

Date of sowing – 2nd week of June 2012

'r' value at 1%: 0.537; ** significant at 1%; 'r' value at 5%: 0.423; * significant at 5%

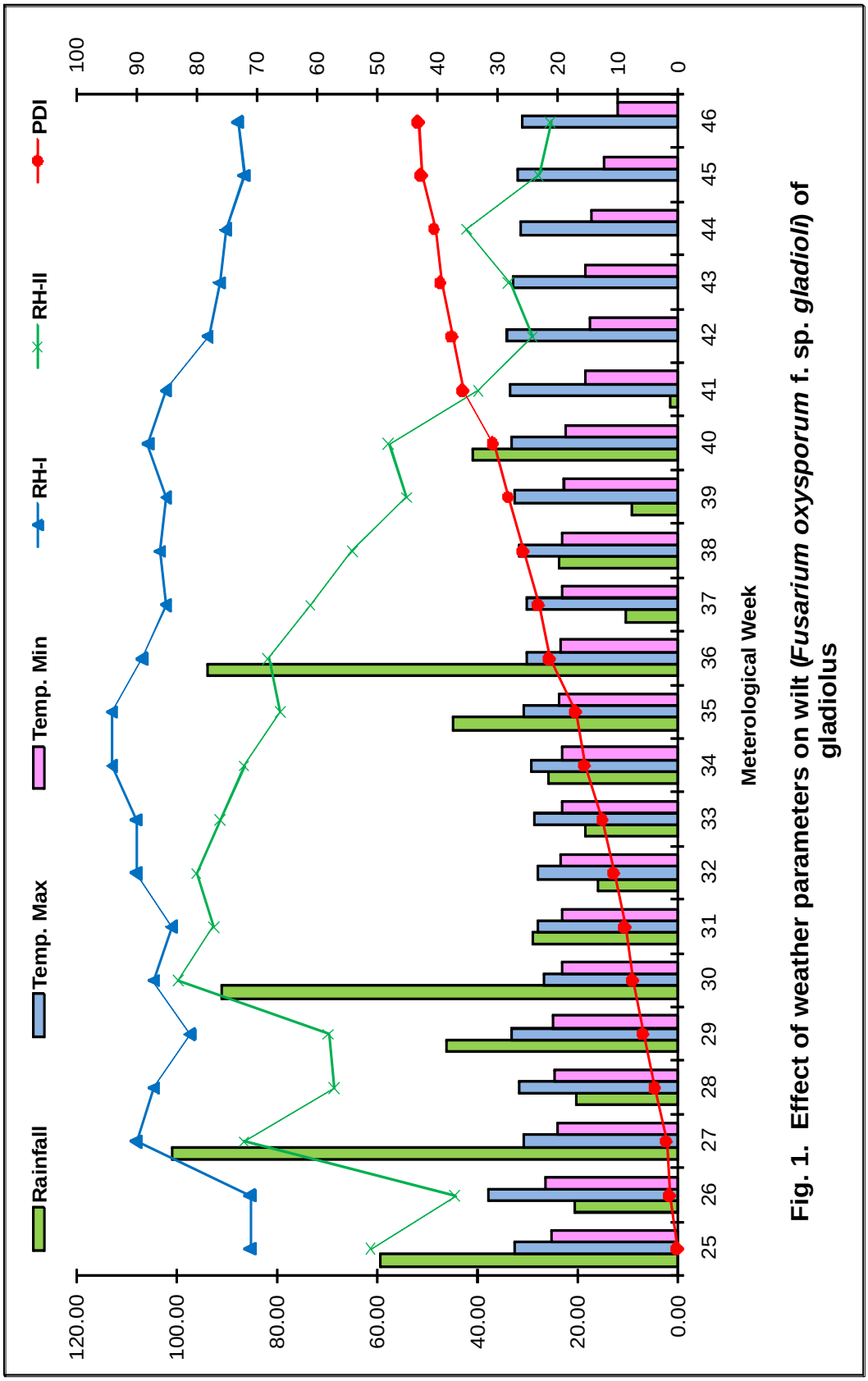

Fig. 1. Effect of weather parameters on wilt (*Fusarium oxysporum* f. sp. *gladioli*) of gladiolus

Appendix: Weekly weather Data for the Year 2012 recorded at Agro-Meteorology Observatory, Dr. PDKV, Akola

Actual - 2012 Normal: 1971-2010

Weeks	Dates	T MAX (ºC)		T MIN (ºC)		BSH (hrs)		WS (km/hr)		RH I (%)		RH II (%)		Evap (mm)		RF (mm)		CRF (mm)	Rainy Days	
		N	A	N	A	N	A	N	A	N	A	N	A	N	A	N	A		N	A
1	1-7 Jan	28.8	30.3	11.0	16.3	8.2	4.1	4.4	1.8	71.4	78	30.7	36	4.2	4.2	2.8	0.0	0.0	0.2	0.00
2	8-14	29.3	26.7	11.7	8.3	8.3	8.1	4.4	1.0	71.2	67	30.3	18	4.4	4.3	3.3	0.0	0.0	0.2	0.00
3	15-21	30.0	28.0	12.0	10.3	8.6	8.3	4.5	1.7	##	55	27.6	18	4.9	5.0	0.7	0.0	0.0	0.1	0.00
4	22-28	30.6	29.4	12.0	15.1	8.8	5.8	4.6	1.8	##	61	25.9	30	5.2	5.0	0.9	0.0	0.0	0.1	0.00
5	29-4 Feb	31.0	28.7	12.6	14.6	8.8	5.8	4.9	2.2	61.7	67	25.2	28	5.5	5.3	3.0	6.2	6.2	0.2	1.00
6	5-11	31.4	30.3	12.7	11.5	8.8	7.0	5.0	2.5	58.5	47	23.0	13	5.9	6.0	3.7	0.0	6.2	0.3	0.00
7	12-18	32.7	32.3	14.4	15.2	9.0	7.1	5.4	2.4	55.1	44	21.9	21	6.6	6.9	0.1	0.0	6.2	0.0	0.00
8	19-25	33.4	35.8	14.5	15.6	9.1	8.3	5.7	1.4	##	46	21.3	16	7.3	6.9	2.5	0.0	6.2	0.2	0.00
9	26-4 Mar*	35.0	35.5	15.7	16.4	9.5	8.4	6.1	2.7	##	47	18.4	19	8.2	8.7	4.1	0.0	6.2	0.3	0.00
10	5-11	35.9	34.6	17.3	15.9	9.2	8.4	6.1	4.0	##	40	19.6	17	8.8	9.9	5.2	0.0	6.2	0.3	0.00
11	12-18	37.0	36.9	18.1	18.1	9.1	7.9	6.3	3.1	##	35	18.1	16	9.2	9.5	2.4	0.0	6.2	0.3	0.00
12	19-25	38.4	40.0	19.3	19.2	9.2	8.4	6.4	2.8	##	27	15.0	9	10.4	12.2	0.6	0.0	6.2	0.1	0.00
13	26-1 Apr	39.0	40.7	20.4	21.9	9.2	7.7	6.9	2.1	##	25	15.0	11	11.2	11.0	2.2	0.0	6.2	0.2	0.00
14	2-8 Apr	40.0	41.4	21.7	25.9	9.4	7.8	7.3	4.0	##	38	14.3	18	11.7	12.8	1.0	0.0	6.2	0.1	0.00
15	9-15	40.8	41.9	23.1	25.9	9.5	7.9	8.4	5.4	##	36	14.3	20	12.9	13.9	0.4	0.0	6.2	0.1	0.00
16	16-22	41.6	40.8	24.1	26.9	9.7	5.0	8.6	4.5	35.7	45	14.4	26	13.9	12.2	0.5	0.7	6.9	0.1	0.00
17	23-29	42.3	40.5	25.4	26.8	9.8	8.2	9.0	4.7	##	34	14.5	20	14.7	14.4	0.5	0.0	6.9	0.1	0.00
18	30- 6 May	42.6	41.9	26.6	27.4	9.4	8.6	10.5	8.7	##	36	15.0	15	15.5	17.8	0.8	0.0	6.9	0.1	0.00
19	7-13	42.6	41.1	27.1	26.3	9.7	7.0	12.2	7.1	##	52	16.9	25	16.2	13.4	1.3	10.1	17.0	0.1	1.00
20	14-20	42.5	42.3	27.7	28.9	9.4	8.8	14.2	9.6	##	41	18.6	19	16.8	17.7	2.8	0.0	17.0	0.4	0.00
21	21-27	42.1	43.7	27.8	30.1	9.5	7.9	15.1	13.8	##	52	20.4	21	16.9	19.5	3.8	0.0	17.0	0.4	0.00
22	28-3 Jun	41.7	42.5	27.8	29.3	9.4	6.5	15.2	16.3	##	48	23.4	23	16.2	19.8	6.3	0.0	17.0	0.4	0.00
23	4-10	40.2	39.1	26.9	28.1	8.4	5.6	15.2	12.3	62.1	51	30.3	29	14.0	13.1	16.8	2.4	19.4	1.0	0.00
24	11-17	38.0	38.7	25.7	25.2	7.1	6.2	13.4	8.2	##	68	40.4	29	11.1	9.6	43.6	29.5	48.9	1.7	4.00
25	18-24	35.5	32.7	25.0	25.1	5.8	1.2	14.2	10.7	74.5	71	48.5	51	9.2	6.7	43.5	59.4	###	2.0	2.00
26	25-1Jul	33.8	37.7	24.3	26.4	4.8	6.6	12.8	10.6	##	71	55.3	37	7.4	11.1	43.4	20.6	###	2.2	1.00
27	2-8	33.2	30.7	24.0	24.0	4.8	2.2	12.0	5.8	81.5	90	57.8	72	6.5	4.1	39.4	101.0	###	2.2	5.00
28	9-15	32.3	31.8	23.8	24.6	3.8	4.0	11.2	7.4	##	87	60.4	57	5.5	5.3	42.8	20.3	###	2.5	3.00
29	16-22	31.9	33.1	23.6	25.0	4.0	2.6	10.4	8.9	##	81	63.0	58	5.2	5.8	52.8	46.1	###	2.4	4.00
30	23-29	31.3	26.7	23.3	23.2	4.0	0.0	10.8	9.1	85.5	87	64.4	83	4.8	2.6	43.4	91.1	###	2.6	5.00
31	30-5 Aug	30.9	27.9	23.3	23.0	3.5	0.2	10.6	8.0	##	84	66.7	77	4.6	3.0	49.6	29.0	###	2.4	4.00
32	6-12	29.9	28.1	23.0	23.4	3.2	1.0	10.9	9.3	##	90	70.0	80	4.1	4.1	61.0	15.9	###	2.8	2.00
33	13-19	30.4	28.7	23.0	23.0	4.0	1.2	12.4	5.6	##	90	66.8	76	4.5	3.6	35.9	18.4	###	2.0	2.00
34	20-26	30.4	29.1	22.8	23.0	4.1	3.4	11.9	4.9	##	94	67.0	72	4.3	3.9	42.5	25.8	###	1.9	3.00
35	27-2 Sep	30.5	30.9	22.7	23.6	4.2	3.5	9.3	2.1	##	94	66.1	66	4.6	3.7	42.4	44.9	521.4	2.1	3.00
36	3-9	31.0	30.1	22.5	23.4	5.3	4.3	8.6	5.5	##	89	62.1	68	5.3	4.5	33.6	93.8	615.2	1.5	5.00
37	10-16	32.1	30.2	22.4	23.0	6.6	5.0	8.0	4.2	##	85	56.8	61	5.1	3.9	22.0	10.4	###	1.1	2.00
38	17-23	32.9	31.7	22.4	23.0	6.8	5.0	6.4	2.5	##	86	54.5	54	5.2	4.2	23.7	23.8	###	1.4	1.00
39	24-30	33.5	32.5	22.1	22.7	7.3	7.1	5.1	1.2	##	85	50.4	45	5.0	4.1	24.4	9.3	###	1.4	2.00
40	1-7 Oct	33.7	33.1	21.2	22.5	7.6	5.2	4.8	2.6	81.7	88	46.9	48	5.4	5.1	23.4	40.9	###	1.1	2.00
41	8-14	34.0	33.6	19.8	18.6	8.1	7.7	4.5	0.3	##	85	40.0	33	5.3	4.7	13.1	1.5	701.1	0.7	0.00
42	15-21	33.7	34.1	18.3	17.6	8.2	7.1	4.6	1.2	##	78	36.6	24	5.3	5.3	6.1	0.0	701.1	0.4	0.00
43	22-28	33.1	33.0	16.8	18.6	8.3	4.8	4.4	1.0	##	76	34.3	28	5.3	5.6	7.6	0.0	701.1	0.4	0.00
44	29-4 Nov	32.7	31.4	16.0	17.1	8.4	5.0	4.1	1.7	##	75	31.8	35	5.3	5.1	2.3	0.0	701.1	0.2	0.00
45	5-11	32.3	32.1	15.2	14.9	8.4	7.7	3.9	1.3	71.2	72	31.7	23	5.1	5.2	3.0	0.0	701.1	0.2	0.00
46	12-18	31.6	31.0	14.6	11.9	8.3	7.6	3.9	1.2	##	73	31.6	21	4.8	4.5	5.3	0.0	701.1	0.2	0.00
47	19-25	31.0	30.7	13.3	13.0	8.4	7.6	3.7	1.3	##	73	30.5	26	4.6	4.0	7.7	0.0	701.1	0.3	0.00
48	26-2 Dec	30.5	31.8	12.8	15.5	8.4	7.0	3.6	1.2	71.3	70	31.7	28	4.4	3.9	5.5	0.0	701.1	0.3	0.00
49	3-9	30.0	31.1	11.9	15.2	8.4	7.5	3.8	1.1	##	65	30.2	21	4.3	4.5	1.0	0.0	701.1	0.1	0.00
50	10-16	29.6	31.4	10.9	15.1	8.4	7.5	3.6	0.8	71.0	76	28.1	31	4.2	3.7	0.8	0.0	701.1	0.1	0.00
51	17-23	29.5	29.2	10.8	11.9	8.5	7.1	3.8	1.0	##	79	28.5	27	4.1	4.1	0.9	0.0	701.1	0.1	0.00
52	24-31*	29.1	28.1	11.1	10.7	8.3	8.2	4.5	0.7	70.7	72	30.3	27	4.2	4.0	2.6	0.0	701.1	0.2	0.00
	Total RF received 24th to 42nd MW															**686.6**			**50**	
	Total RF 36th to 42nd MW															**146**			**12**	

The initial appearance of the disease was due to contributory effect of weather parameters of preceding meteorological week *i.e.* 59.4 mm rain was responsible for buildup of the pathogen. Higher disease incidence *i.e.* 43.12 per cent recorded during 46th meteorological week was due to weather parameter features of preceding weeks. Rainfall of 27th meteorological week *i.e.* 101.00 mm and 36th meteorological week i.e. 93.80 mm, favored the multiplication of the inoculums which resulted in gradual increase in disease incidence. The development of disease incidence was due to contributory effect of all-weather parameters prevailing during crop growing period (Table 1, 1(a) and Fig. 1).

In correlated data (Table 1a) maximum temperature showed positive correlation and negative significant with disease, while negative and significant correlation was established with rainfall, minimum temperature and relative humidity RH II and negative and non-significant correlation with RH I with wilt of gladiolus.

Yang (1998) reported post-harvest diseases of gladiolus and Lilium in Taiwan and isolated *Penicillium, Aspergillus, Mucor, Rhizopus, Alternaria, Rhizoctonia solani, Botryosphaeria* and *Fusarium.*

He also mentioned their source of infection and how to reduce incidence of post-harvest disease in storage.

Mohammad and Kashi (2005) isolated *Rhizoctonia* like mycelia from root and stem of gladiolus. Isolated fungi were identified either binucleated or multinucleated *Rhizoctonia* sp. based on hyphal tip characteristic and nuclear number. Binucleate *Rhizoctonia* isolate showed stem and corm rot and mortality symptoms on 35 days old plants, while multinucleate *Rhizoctonia* showed disease during rooting of plant.

Initiation of wilt (*Fusarium oxysporum* f. sp. *gladioli*) symptoms occurred during 26th meteorological week. Higher disease incidence i.e. 43.12 per cent was recorded during 46th meteorological week. Maximum temperature showed positive correlation with wilt infection whereas negative and significant correlation was established by rainfall, minimum temperature and relative humidity.

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