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Significance of Sowing Dates and Meteorological Parameters on Severity of Stem Gall of Coriander Caused by *Protomyces macrosporus*

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ABSTRACT

Background: Coriander (*Coriandrum sativum* L.) belongs to family *Apiaceae* is generally grown in winter season as a main crop in India. Stem gall of coriander caused by *Protomyces macrosporus* L. is a serious disease damaging all aerial plant parts. Under favourable ecological conditions, the disease may lead losses to the extent of 100 per cent therefore it is necessary to investigate the epidemiology of the disease to devise suitable remedial measures

Methods: The field experiment was conducted during *Kharif* season of 2018 with two varieties to study the effect of different meteorological parameters on stem gall of coriander at different sowing dates (1st week of November to 1st week of December). The stem gall severity was recorded at weekly intervals from the start of its incidence.

Result: The disease severity was lowest (5.42%) in the variety DH-36 sown in 3rd week of November and maximum disease severity (11.88%) was observed in variety DH-228 sown in 1st week of December. The quantitative relationship between the disease severity and weather variables at different dates of sowing for two varieties was obtained by performing correlation analysis. The temperature (maximum and minimum) and sunshine hours had positive correlation with per cent disease intensity, while relative humidity (morning and evening) and remaining weather parameters were non-significant at each dates of sowing but correlated with the disease intensity.

Key words: Coriander, Meteorological parameters, Protomyces *macrosporus*, Stem gall.

INTRODUCTION

Spices play an important role not only as condiments but in the Indian agricultural economy owing to medicinal, industrial and processing point of view. India is known as “Home of Spices” and its spices are considered to be best in quality in the world. Coriander (*Coriandrum sativum* L.) an annual herbaceous plant (2n=22), belongs to family *Apiaceae* is generally grown in winter season as a main crop in India (Singh and Verma, 2015).

In India coriander is grown mainly in Rajasthan, Madhya Pradesh, Assam, Gujarat, Andhra Pradesh, Odisha, Uttar Pradesh and Haryana (Leharwan and Gupta 2019). India occupies an area of 664 thousand ha with production of 861 thousand MT and productivity 1.3 MT per ha. In Haryana it is cultivated in 2400 ha with production of 4400 MT and productivity 1.83 MT per ha (Anonymous, 2018).

Coriander crop is prone to various fungal diseases *viz.,* powdery mildew, wilt and stem gall. Stem gall caused by *Protomyces macrosporus* L. is a serious disease of coriander damaging to all the aerial plant parts (Verma *et al.* 2019). In India, stem gall of coriander was first reported by Sydow and Butler (1911) from Bihar and later on by Gupta (1954) in other states.

The gall appears in the form of tumor like swellings on stems, leaves, peduncles and also deformed seeds, causing loss in yield as well as quality. Lakra (1999) reported about 16.1-55% seed loss due to stem gall under field conditions. Malhotra *et al.* (2016) observed that presence of excess soil moisture, low sunshine hours due to cloudy weather in winter season ameliorate the spread of stem gall and damages the crop to the extent of 100 per cent.

Among various factors, weather conditions play a predominant role in determining the course and severity of epidemics, however, information on this aspect for stem gall disease is limited. Stem gall is dreadful disease and difficult to manage by one component, therefore it needs thorough understanding of epidemiology for better disease management. The present investigation was carried out to study the effect of weather variables on stem gall of coriander at different sowing date to explore various remedial measures.

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MATERIALS AND METHODS

Effect of sowing time

Two coriander cultivars, one for seed purpose (DH-36) and one for leafy vegetable purpose (DH-228) were sown under natural conditions in Plant Pathology experimental area of CCS HAU Hisar, in randomized block design with three replications on five dates *viz.,* 1st week November, 2nd week November, 3rd week November, 4th week November and 1st week December during year 2018. The size of the plot was 4×2.4 m^2 with row to row distance of 30 cm and plant to plant distance of 20 cm. Recommended dose of fertilizers were applied (N=25kg/acre and P=25kg/acre) and along with other cultural practices optimum crop growth. Observations on disease severity were recorded at weekly interval as per the 0-4 scale Lakra, (1999).

Epidemiology of the disease

The role of environmental factors (temperature, relative humidity, rainfall and sunshine hours) on the progress of stem gall disease on two coriander varieties (DH-36 and DH-228) sown at different dates was studied. The data on the disease progress was recorded at weekly intervals starting from disease appearance. The disease severity was calculated by using 0-4 scale (Table 1) at weekly intervals up to the crop maturity (Kumar *et al*., 2016).

The disease severity (%) was calculated by using formula given by McKinney (1923).

$$\text{Disease severity (\%)} = \frac{\text{Sum of all disease ratings}}{\text{Total no. of disease rating} \times \text{Maximum disease grade}} \times 100$$

Calculation of apparent infection rate (r)

The apparent infection rate (unit per week) of the disease for two varieties was calculated by using the formula given by Vanderplank (1963) as mentioned below:

$$r = \frac{2.3}{(t_2 - t_1)} \{\log_e \frac{x_2}{1 - x_2} - \log_e \frac{x_1}{1 - x_1}\}$$

Where,

r = Apparent rate of infection at log phase of epidemic development.

t_1 and t_2 is time intervals when disease severities are x_1 and x_2 respectively.

Table 1: Severity scale of stem gall of coriander.

Plant part	Score or rating
Stem	30 points
Seed	20 points
Leaves	20 points
Pedicel	30 points
Total	100 points

The score of each unit depends on the amount of the disease (on the length for stems and pedicels, area covered for leaves and for seeds number of infected seed).

Accordingly, the data pertaining to above parameters were recorded to calculate the apparent infection rate (r).

Calculation of area under disease progress curve (AUDPC)

The area under disease progress curve was calculated for the cultivars by using the formula given by Vanderplank (1963).

$$\text{AUDPC} = \sum_{i=1}^{k} (y_i + y_{i+1}) + (t_{i+1} - t_i)$$

Where

k = Number of successive evaluation

y_i = Disease severity at time t_i

y_{i+1} = Disease severity at time t_{i+1}

t_i = Time when disease severity was y_i

t_{i+1} = Time when disease severity was y_{i+1}

Accordingly, the data relating to above parameters was recorded to calculate the AUDPC.

RESULTS AND DISCUSSION

Weather conditions play a predominant role in determining the progress and severity of disease. In present investigations, the progression and intensity of stem gall of coriander was observed on two different varieties sown on five different dates during *Rabi* 2018-2019. The data presented in Table 2 indicates that the severity of stem gall of coriander was influenced with sowing dates. The stem gall of coriander appeared during first week of March 2019 in both varieties (DH-228 and DH-36) sown on five different dates (Table 2). The temperature during this period was 24.2°C (maximum) and 8.0°C (minimum), while relative humidity (RH) was 93.0% (morning) and 53% (evening) and sunshine hours and rainfall was 5.8 and 14.8 mm, respectively. There was significant difference in disease severity between two varieties over different sowing dates. The disease severity was lowest (5.42%) in variety DH-36 sown during 3rd week of November and maximum in DH-228 (11.88%) sown in 1st week of December (Table 3). The results are similar to the observation of Tripathi (2003) who reported that early and late sowing of coriander exhibited less mean disease severity as compared to other dates and crop sown on 16 November showed comparatively low intensity of stem gall (11%). Verma *et al.* (2017) also reported best time sowing of coriander between 30 October - 15 November.

The quantitative relationship between the disease severity and weather variables for different dates of sowing for two varieties was obtained by performing correlation analysis. Significant positive correlation was observed with temperature when sown during 3rd week, 4th week of November and 1st week of December and effect of temperature was non-significant in crop sown during 1st and 2nd week of November in variety of DH-228 (Table 4). The significant positive correlation was observed with temperature on each sowing date of variety DH-36. The morning relative humidity and evening relative humidity both had negative correlation with both the varieties and other

weather parameters had non-significant correlation with each date of sowing but correlated with the disease intensity. Similarly, Saxena *et al*. (2002) observed that minimum / maximum atmospheric temperature and relative humidity play an important role in the development of stem gall. The disease appeared when the minimum and maximum temperatures were 13.2 and 30.9°C, respectively with relative humidity of 57.2 per cent however maximum disease intensity was recorded in the plants sown when the minimum and maximum temperature was 8.1 and 22.6°C, respectively with relative humidity of 65.8 per cent.

Tripathi *et al.* (2003) reported that the relationship of disease severity with minimum temperature was negative and highly significant in early sown crop whereas maximum temperature exhibited negative and significant correlation with early as well as late sown crop. The relative humidity showed significant positive association with the disease intensity revealing that disease intensity increased with corresponding increase in relative humidity. Rainfall had positive but non-significant correlation with disease intensity in various dates of sowing. Malhotra *et al.* (2016) observed that the presence of excess moisture, low sunshine hours due to cloudy weather in winter season promote the spread of stem gall and damages the crop. Gupta *et al.* (2019) reported that very low and high temperature was also not favourable for development of stem gall of coriander.

Area under disease progress curve (AUDPC)

The disease progression over a period was also computed by AUDPC as exhibited in Fig 1. Based on the disease

Table 2: Progression of stem gall of coriander on two varieties sown on five different dates.

Dates of observations	Disease Intensity (%)									
	Variety DH-228					Variety DH-36				
	1st week Nov	2nd week Nov	3rd week Nov	4th week Nov	1st week Dec	1st week Nov	2nd week Nov	3rd week Nov	4th week Nov	1st week Dec
08-03-2019	6.67	5.83	3.33	6.67	8.33	4.17	3.33	2.50	5.83	8.33
15-03-2019	10.00	8.33	6.67	10.00	10.00	5.83	5.00	4.17	8.33	9.17
22-03-2019	10.83	10.00	8.33	12.50	14.00	8.33	6.67	5.83	9.17	12.50
29-03-2019	11.67	10.83	10.00	15.00	15.17	11.67	10.83	9.17	13.33	16.67

Table 3: Effect of different dates of sowing on severity of stem gall of coriander and area under disease progress curve (AUDPC).

Date of sowing	Disease severity (%)		AUDPC	
	DH-228	DH-36	DH-228	DH-36
1st week of November	9.79 (3.27)	7.50 (2.87)	210.00	154.58
2nd week of November	8.75 (3.10)	6.46 (2.68)	186.67	131.25
3rd week of November	7.08 (2.80)	5.42 (2.48)	151.67	110.83
4th week of November	11.04 (3.44)	9.17 (3.16)	233.33	189.58
1st week of December	11.88 (3.54)	11.67 (3.53)	250.26	239.17
CD at 5%	(0.180)	(0.115)		

*Figurs in the parentheses are square root transformed values.

Table 4: Correlation matrix between weather parameters and per cent disease severity of stem gall in two coriander varieties at different dates of sowing.

Weather variables	Correlation									
	DH-228					DH-36				
	Nov 1st week	Nov 2nd week	Nov 3rd week	Nov 4th week	Dec 1st week	Nov 1st week	Nov 2nd week	Nov 3rd week	Nov 4th week	Dec 1st week
Temperature maximum (X1)	0.924	0.927	0.962*	0.971*	0.976*	0.968*	0.979*	0.983*	0.996**	0.998*
Temperature minimum (X2)	0.76	0.776	0.846	0.898	0.895	0.962*	0.984*	0.975*	0.972*	0.970*
Relative humidity morning (X3)	-0.741	-0.729	-0.789	-0.806	-0.803	-0.851	-0.903	-0.893	-0.931	-0.837
Relative humidity evening (X4)	-0.808	-0.762	-0.751	-0.692	-0.887	-0.604	-0.647	-0.657	-0.735	-0.53
Sunshine (X5)	0.677	0.624	0.628	0.577	0.782	0.521	0.586	0.587	0.677	0.457
Pan evaporation (X6)	0.847	0.844	0.893	0.909	0.881	0.934	0.963*	0.962*	0.985*	0.915
Rainfall (X7)	-0.948	-0.927	-0.882	-0.818	-0.948	-0.673	-0.653	-0.683	-0.716	-0.591

*Significance at CD 5% ** Significance at CD 1%.

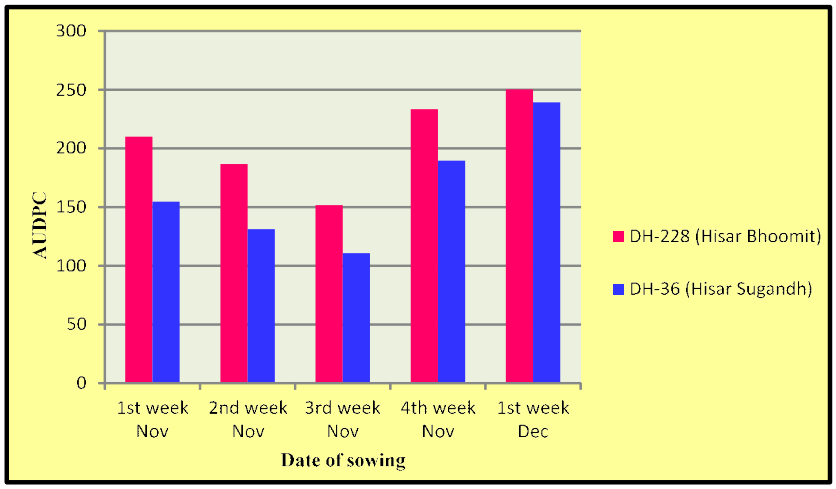

Fig 1: AUDPC of stem gall of coriander on two coriander varieties sown on five different dates.

Table 5: Effect of different sowing dates on apparent infection rate (r) of stem gall of coriander.

Dates of sowing	Infection rate							
	Variety DH 228				Variety DH36			
	8-03-19 to 15-03-19	16-03-19 to 22-03-19	23-03-19 to 29-03-19	Mean	8-03-19 to 15-03-19	16-03-19 to 22-03-19	23-03-19 to 29-03-19	Mean
1st week of November	0.131	0.141	0.141	0.138	0.130	0.133	0.136	0.133
2nd week of November	0.133	0.140	0.141	0.138	0.125	0.132	0.132	0.130
3rd week of November	0.117	0.137	0.137	0.130	0.112	0.130	0.110	0.117
4th week of November	0.134	0.139	0.142	0.138	0.133	0.140	0.137	0.137
1st week of December	0.136	0.142	0.144	0.141	0.140	0.141	0.139	0.140

progression at different intervals, AUDPC was statistically analyzed and it was found that the value of AUDPC was lowest in 3rd week of November sown crop while it was maximum when crop was sown during 1st week of December. It was observed that, AUDPC was lowest (110.83) in DH-36 which showed less disease intensity and maximum on variety DH-228 (250.26). The AUDPC increased in both varieties when sown early as well as in case of late sown. The trend of AUDPC was more in the variety DH-228 while DH-36 showed less AUDPC under all five dates of sowing.

Apparent infection rate (r)

The apparent infection rate was higher during March 16th to March 22nd on different dates of sowing however, it was less from 23rd March to 29th March in both the varieties at all dates of sowing (Table 5). The 'r' week^{-1} increased and reached its maximum at initial period of observation on five different dates of sowing.

CONCLUSION

The temperature (maximum and minimum) and sunshine hours had positive correlation with per cent disease intensity, while relative humidity (morning and evening) and remaining other weather parameters were non-significant at each dates of sowing and chances of stem gall development will be minimum if crop sown during 3rd week of November.

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