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Studies on survey and epidemiology of *Rhizoctonia solani* causing root rot of fenugreek

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Abstract

Root rot of fenugreek (*Trigonella foenum-graecum* L.), caused by *Rhizoctonia solani* has become an important constraint to the growers of fenugreek in Rajasthan. Disease incidence varied from 26.50 to 36.17 per cent in five surveyed districts of Rajasthan. To know the status of the disease in Rajasthan, survey was carried pot in five districts of Rajasthan. Maximum disease incidence was recorded in Jaipur district (36.17%) followed by Nagaur (35.55. %), Jhunjhunu (33.90%), Jodhpur (32.28%) and Sikar (26.50%). In Rajasthan, the overall average of disease incidence was 32.39 per cent in 50 fields of 10 villages of five districts. The survey of five districts revealed that none of the location was found free from the disease. Under epidemiological studies, the disease incidence was higher in last week of December to first week January in both the years i.e. 2016-17 and 2017-18. The disease first appeared during November 26-28 (i.e. 20 days after sowing), became conspicuous from fourth week of November to last week of December and declined by the first week of January. The disease was greatly favoured by maximum temperature (28.8 to 30.5^{0}C) and negative with rainfall. The coefficient of multiple determinations (R^2) was 61.02 and 75.04 per cent during 2016-17 and 2017-18.

Key words : Correlation, disease incidence, epidemiology, fenugreek, regression, root rot, *rhizoctonia solani*, survey.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) commonly known as *'Methi'* has tremendous importance in the life of human beings as a food, medicine and belongs to family *Fabaceae*. It is commercially cultivated for seeds, which are used as condiments and as a flavoring agent for relishing food preparations. Its seeds contain important steroid 'diosgenin' which is used in preparation of contraceptives. It is believed that fenugreek stimulates the digestive process as well as metabolism in general. In industry, seeds are used for extraction of alkaloids and steroids. The dried leaves and flowers are also used for flavoring vegetable curries (Arya, 2000).

This crop attacked by a number of fungal diseases *viz.,* root rot (*Rhizoctonia solani*), powdery mildew (*Erysiphe polygoni* and *Leveillula taurica*), downy mildew (*Peronospora trigonellae*), wilt (*Fusarium oxysporum*), rust (*Uromyces anthyllidis*), leaf spot (*Cercospora traversiana)* and charcoal rot (*Macrophomina phaseolina)* (Godara *et al.,* 2010). Among these, root rot of fenugreek (*Trigonella foenum-graecum* L.) caused by *Rhizoctonia solani* has become an important constraint to the growers of fenugreek in Rajasthan. In Jaipur district of Rajasthan, 20 per cent incidence of root rot of fenugreek has been reported under natural field conditions (Anonymous, 2007-08). Singh and Rao (2015) recorded 34.67 per cent incidence of root rot of fenugreek (*Rhizoctonia solani*) from Chhattisgarh caused by with yield loss of 55.26 per cent. In Karnataka, Rani and Hegde (2017) have also been recorded 48.35 per cent root rot incidence in fenugreek caused by *Rhizoctonia solani* Kuhn. Higher temperature (28.2^{0}C-35^{0}C) has a significant impact on development of damping off of fenugreek caused by *R. Solani* (Yadav, 2012 and Csondes *et al*., 2007). Singh (2009) concluded that *Rhizoctonia solani* can cause the infection in the range of 23^0-35^0 temperature but optimum temperature is 30^{0}C-32^{0}C. Yadav (2012) has also been concluded that higher relative humidity (91.5%) had a significant impact on development of damping off of fenugreek disease caused by *Rhizoctonia solani.*

Materials and methods

Survey in major fenugreek growing districts of Rajasthan *viz.,* Jaipur, Sikar, Jhunjhunu, Jodhpur and Nagaur was undertaken during last week of December to first week of January to know the incidence of root rot disease during the *Rabi* season of 2016-17 in fifty fields of ten villages of five Tehsils of five districts. The selection of two villages

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from each Tehsil was made randomly. To assess the disease incidence, five fenugreek fields were selected in each village in each Tehsil of each district and average incidence of the disease in each village was calculated. In each field, five spots of one square meter area were marked diagonally at randomly to cover entire field. Diseased and healthy plants were counted in each spot and the per cent disease incidence was calculated as per formula given below.

Per cent disease incidence =

$$\frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

In order to find out the correlation of meteorological factors with disease development, the disease incidence was recorded at weekly interval in the field, located nearby Agro Meteorology Observatory, S.K.N. College of Agriculture, Jobner. The data were recorded for two consecutive cropping seasons (2016-17 and 2017-18) in fenugreek. Inoculum multiplied on sterilized sorghum grains was added in furrows @ 20 g m^{-1} row length. Sowings were made in first week of November in the same field for both the years. Average incidence of the disease was recorded on 720 tagged plants (6 plot: 120 plants per plot) up to 90 days of sowing in the field. Per cent disease incidence (PDI) was calculated from initiation of the disease up to 90 days of sowing, where incidence was based on remaining healthy plants every time till 90 days of sowing. Weekly meteorological data on maximum and minimum temperature, relative humidity, rainfall and duration of sunshine hours were obtained for the period between two consecutive disease recordings to establish their correlation with disease development. Angular transformed values of per cent data were subjected to correlation and regression coefficients. The prediction equation used was Y = a + b1x1 +b2x2 +……+ b6x6 where, Y = Predicted disease incidence, a = Intercept, b1 to b6 = Partial regression coefficients, x_1 = Max. temp. (^{0}C), x_2 = Min. temp., x_3 = Max. RH (%), x_4 = Min. RH (%), x_5 = Rainfall (mm) and x_6= Duration of sunshine (h day^{-1}).

Results and discussion

Survey for the occurrence of root rot of fenugreek was undertaken during *Rabi* 2016-17 in fifty fields of ten villages of five districts of Rajasthan. During the survey, discussions were held with the farmers concerned, regarding occurrence and incidence of the disease. As a result of this discussion, it was revealed that disease appeared in most of the fields wherever, fenugreek crop was taken continuously on same field. Survey revealed that the disease was prevalent in varying intensities in all the districts. It is apparent from the data (Table1) that average incidence of the root rot disease was ranged from 26.50 to 36.17 per cent in five districts of Rajasthan. Mean disease incidence was highest in district Jaipur (36.17%) followed by Nagaur (35.55%), Jhunjhunu (33.90%), Jodhpur (28.32%) and it was lowest in district Sikar (26.50%). During the survey, it was observed that the incidence of root rot was more between 50-60 days after sowing. The overall mean average of disease incidence was 32.39 per cent in fifty fields of five major fenugreek growing districts of Rajasthan.

The effect of various environmental factors *viz.,* maximum and minimum temperature, morning and evening relative humidity, rainfall and sunshine hours on the disease development was studied during *Rabi* 2016-17 and 2017-18 (Table 2.1). The disease first appeared during November 25th (i.e. 20 days after sowing), become more conspicuous from first week of December to last week of December and declined by the end of January (Table2.1). Correlation coefficients of per cent disease incidence with meteorological factors were worked out and regression equation were formulated. Correlation analysis of per cent disease incidence with weather parameters indicated that higher (25.7–31.0^{O}C) temperature had significant positive correlation while minimum temperature had negative correlation during both the years (2016-17 and 2017-18), while morning (71-91%) and evening relative humidity (23-55%) had negative and non-significant correlation. However, statistically analysis between rainfall and disease incidence showed negative correlation in 2016-17 and positive in 2017-18 but it was non-significant during 2016-17 and 2017-18 (Table 2.2). Effect of sunshine hours on disease incidence during 2016-17 showed positive correlation while negative in 2017-18 but non-significant correlation in both the years. A multiple correlation between the dependent variable (disease incidence) and a group of other six independent variables (weather parameters) was responsible for the disease development in both the cropping seasons under study. The coefficient of multiple determinations (R^2) was 61.02 in 2016-17 and 75.04 per cent during 2017-18, which means that 61.02 to 75.04 per cent disease incidence was depend on the meteorological factors taken into consideration during both the cropping seasons (Table 2.3). It may be detected that temperature was the dominant weather parameter influencing the disease development. Inclusions of both maximum and minimum temperature increase the prediction value by 61.02 per cent in the year 2016-17 and 75.04 per cent in 2017-18. The analysis of all the six independent variables individually and in combinations

revealed each weather factor played an important role in disease development in addition to other unknown factors. Root rot incidence of fenugreek was severe in Jaipur district (36.17%) followed by Nagaur (35.55%), Jhunjhunu (33.90%) and Jodhpur (28.32%). Earlier this disease was considered to be a minor disease but now becoming increasingly destructive and widely damaging in recent years. Our findings are in accordance with the results of earlier research (Anonymous, 2007-08) and reported 20 per cent incidence of root rot of fenugreek under natural field conditions in Jaipur district of Rajasthan. Similar results have also been recorded by Singh and Rao (2015) who reported 34.67 per cent incidence of root rot of fenugreek (*Rhizoctonia solani*) from Chhattisgarh caused by with yield loss of 55.26 per cent. In Karnataka, Rani and Hegde (2017) have also been recorded 48.35 per cent root rot incidence in fenugreek caused by *Rhizoctonia solani* Kuhn. As per literature screened, this is the first study on systematic assessment of the disease in surveyed major fenugreek growing districts of the state which is very essential for any further study on the disease. Very little information is available in the literature on the environmental factors affecting infection and development of root rot of fenugreek in Rajasthan. In present investigation, an attempt has been made to study the effect of temperature, relative humidity, rainfall and sunshine hours for initiation and development of root rot of fenugreek. The results of two consecutive cropping seasons with respect to weather parameters revealed that root rot of fenugreek is greatly favoured by higher temperature. Significant and positive correlation was recorded with maximum temperature while negative non-significant correlation with minimum temperature during 2016-17 and 2017-18 whereas non significant and negative correlation was recorded with higher humidity. Negative correlation was observed with rainfall during 2016-17 and positive during 2017-18 whereas positive correlation was recorded with sunshine hours during 2016-17 while it was negative in 2017-18. This finding is supported with results obtained by earlier workers (Yadav, 2012 and Csondes *et al*., 2007). They reported that higher temperature (28.2^{0}C-35^{0}C) has a significant impact on development of damping off of fenugreek caused by *R. solani*. Singh (2009) concluded that *Rhizoctonia solani* can cause the infection in the range of 23^0-35^0 temperature but optimum temperature is 30^{0}C-32^{0}C. The regression equation gave close rating of disease incidence to that observed during respective years. Such attempt would help us in predicting disease incidence in given area. However, information on interaction of disease incidence and weather data of several years will be more reliable.

Table 1. Survey and incidence of root rot of fenugreek in major growing areas of Rajasthan

District	Tehsil	Village	Isolate No.	Disease incidence (%)
Jaipur	Phulera	Bobas	Rs-1	34.60
		Bamaniawas		37.75
			Mean	**36.17**
Sikar	Dhod	Kansali	Rs-2	27.80
		Purabadi		25.20
			Mean	**26.50**
Jhunjhunu	Navalgarh	Barwasi	Rs-3	32.80
		Ajeetpura		35.00
			Mean	**33.90**
Jodhpur	Phalodi	Chheela	Rs-4	29.00
		Saitan Singh Nagar		27.65
			Mean	**28.32**
Nagaur	Molasar	Dabada	Rs-5	33.50
		Dhankoli		37.60
			Mean	**35.55**
			Overall mean	**32.39**

Rs = *Rhizoctonia solani* * Average of five fields in each village

Table 2.1 Per cent root rot incidence of fenugreek in relation to environmental factors

Date of observation (Meteorological Week)	2016-17							2017-18						
	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (h day^{-1})	Weekly disease incidence (%)	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (h day^{-1})	Weekly disease incidence (%)
	Max.	Min.	Mor.	Eve.				Max.	Min.	Mor.	Eve.			
18/11(46)	30.4	08.7	72	33	0.00	9.1	0	29.6	11.6	72	30	0.00	6	0
25/11(47)	31.0	06.6	71	27	0.00	9.0	1.52	25.7	05.6	72	29	0.00	8.1	3.47
02/12(48)	30.5	08.6	73	34	0.00	9.0	11.28	28.8	05.9	73	28	0.00	9.1	14.82
09/12(49)	29.4	06.2	83	36	0.00	9.0	9.22	25.1	06.8	77	30	02.2	5.0	8.10
16/12(50)	28.1	09.4	76	42	0.00	7.2	8.93	24.5	07.2	77	37	0.00	7.1	5.88
23/12(51)	27.2	04.4	75	33	0.00	8.5	8.96	25.6	04.7	77	23	0.00	7.3	9.40
31/12(52)	27.3	06.1	82	41	0.00	7.6	9.03	25.7	03.6	81	30	0.00	8.5	9.71
07/01(01)	24.4	07.2	91	52	0.00	8.2	2.07	23.6	01.4	88	30	0.00	8.1	2.11
14/01(02)	20.4	02.8	86	40	0.00	8.6	1.42	24.4	02.2	82	23	0.00	9.0	2.16
21/01(03)	21.1	04.9	89	38	0.00	8.4	1.20	27.1	03.4	77	26	0.00	9.2	4.41
28/01(04)	23.2	10.5	89	55	21.8	5.0	0.73	24.8	04.3	73	28	0.00	8.3	1.53
04/02(05)	24.7	09.9	86	44	0.00	7.4	0.49	27.8	06.1	71	25	0.00	9.4	2.60
11/02(06)	24.4	07.8	76	33	0.00	7.3	0.24	25.0	05.7	72	24	0.00	7.3	0.80

Table 2.2 Correlation of root rot incidence of fenugreek with major meteorological factors

Variable	2016-17	2017-18
Maximum Temperature	0.668*	0.537*
Minimum Temperature	-0.039	-0.130
Morning Relative Humidity	-0.457	-0.035
Evening Relative Humidity	-0.261	0.221
Rainfall	-0.277	0.214
Sunshine	0.333	-0.083

* Correlation is significant at 5 per cent level of significance

Table 2.3 Predication equations and R2 for predicting root rot incidence in fenugreek

	Multiple regression equation (2016-17)						**R^2**
Y = -17.008	0.830 X_1						0.446
-15.891	0.895 X_1	-0.398 X_2					0.489
-29.232	1.071 X_1	-0.453 X_2	0.112 X_3				0.502
-12.719	1.087 X_1	-1.024 X_2	-0.228 X_3	0.374 X_4			0.591
-11.127	1.036 X_1	-0.947 X_2	-0.264 X_3	0.434 X_4	-0.117 X_5		0.607
-10.691	1.141 X_1	-1.061 X_2	-0.212 X_3	0.396 X_4	-0.167 X_5	-0.633 X_6	0.610
	Multiple regression equation (2017-18)						**R^2**
Y = -33.080	1.493X_1						0.289
-31.308	1.368 X_1	0.301 X_2					0.303
-127.088	2.350 X_1	1.728 X_2	0.832 X_3				0.643
-126.623	2.354 X_1	1.690 X_2	0.821 X_3	0.018 X_4			0.644
-123.991	2.370 X_1	1.546 X_2	0.781 X_3	0.039 X_4	0.341 X_5		0.645
-111.080	3.971 X_1	-0.315 X_2	0.506 X_3	0.238 X_4	-2.910 X_5	-3.611 X_6	0.750

Regression	2016-17 Y =	$+1.141x_1$	$-1.061x_2$	$-0.212\ x_3$	$+0.396x_4$	$-0.167x_5$	$-0.633x_6$	=0.610
equation:	2017-18 Y =	$+3.71x_1$	$-0.315x_2$	$+0.506x_3$	$+0.238x_4$	$-2.910x_5$	$-3.611x_6$	=0.750

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