Epidemiological Studies of Diverse Taro Genotype against Leaf Blight Caused by *Phytophthora Colocasiae* Racib.

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Abstract

The present investigations were carried out at the Main Experimental Station, Vegetable Science, NDUAT, Faizabad, Uttar Pradesh, India during *Kharif* 2006 and 2007 cropping season. Six taro genotypes were selected for studying leaf blight disease progress under field (epiphytotic) conditions. Disease showed a progressive increase and maximum terminal disease incidence in the 35th (03-09th September, 2006) standard meteorological week. The maximum disease incidence (100%) was recorded on the genotypes NDC-6 and NDC-50 while minimum on NDC-1 (42.50%) and PKS-1 (50.00%). The disease infection rate ('r') remained high at the initial stage but declined progressively due to adverse weather conditions and lack of availability of healthy tissues. All the genotypes showed more or less similar behavior in disease infection rate. The area under disease progress curve (AUDPC) pointed that disease pressure was more in year 2006 as compared to 2007. Multiple regression equation was drawn for the disease prediction based on data collected during the year 2006 and 2007 for all the six genotypes by taking the overall average of the disease incidence. In the year 2006, two weather parameters *i.e.* average relative humidity and cumulative rainfall explained maximum variability, whereas, in 2007, maximum temperature, average relative humidity and cumulative rainfall contributed in disease prediction with 100% precession. In all the genotypes, the predicted values lied in close proximity to the observed disease incidence.

1. Introduction

Taro (*Colocasia esculenta* var. *antiquorum*) is a tuber crop belonging to Araceae family. It is grown throughout India due to its wide adaptability, large scale acceptability and high return unit area^{-1} (Gurung, 2001). It is locally known as *Arvi* or *Ghuiya*. In India, it is grown in Andhra Pradesh, Bengal, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra (Konkan region), Tamil Nadu, Uttar Pradesh and West Bengal. It grows well in lowland and upland areas. The cormel and leaves of taro are eaten as fried and cooked vegetable. Various delicious dishes are prepared by using different plant parts. Cormels are rich source of calcium, phosphorus, protein, starch and vitamin C (Fageria et al., 2006). Besides, this crop also has great medicinal value and included in many Ayurvedic preparations. The juice from petioles or whole leaves is used for styptics, poultices and pulmonary congestion. It is also strongly recommended in prenatal diets as well as to nursing mothers. In addition to its nutritional and economic importance, taro also plays a significant role in cultural custom in different parts of India, and is also considered as an essential component of many traditional ceremonies (Chadha, 2003). The area and production of taro in the World was 1.49 million ha and 8.98 million tons during the year 2001, respectively, with a productivity 6.01 tons ha^{-1} (FAO, 2002). In India, area under taro is about 80,000 ha with a production is about 0.8 million tons (Swarup, 2006). Leaf blight of taro caused by soil borne fungus *Phytophthora colocasiae* (Raciborski, 1900) is the most vulnerable disease infecting all plant parts viz. leaves, petioles, corms and cormels leading to heavy yield losses which may exceed upto the tune of 60% in severe cases (Maheshwari et al., 2007). The fungus is favoured by flooding conditions in field (Gadre and Joshi, 2003). The study of relationship between disease progressions with weather parameters is of paramount importance for effective disease management. Keeping in view the above facts, the present study was undertaken to determine the epidemiological factors on leaf blight against diverse taro genotypes in sub tropics of eastern Uttar Pradesh conditions.

2. Materials and Methods

The present investigations were conducted at Main Experimental Station, Vegetable Science, NDUAT, Faizabad, Uttar Pradesh during *kharif* 2006 and 2007 cropping season. The experimental site is situated at 26.47°N latitude, 82.12°E longitude and approximately 113 meters above mean sea level. Six taro genotypes viz., NDC-1, PKS-1(moderately susceptible), NDC-4, NDC-16 (susceptible), NDC-6 and NDC-50 (highly susceptible) were selected for analysing the disease progress under field (epiphytotic) conditions. The selected taro genotypes were planted in 2×2 m^2 plots with three replications during 15th March in both the year, under randomized block design. The disease incidence was recorded at weekly intervals, from the appearance of first symptoms till the crop was harvested. Ten plants were randomly selected for recording the development of disease under natural epiphytotic conditions. Disease scoring was made on 0-5 rating scale 0=0% healthy plant (HR),1=0-1% not more than 1 spot $leaf^{-1}$, one to two spots $plant^{-1}$ (R), 2=2-5% one to two spot $leaf^{-1}$, two to five spots $plant^{-1}$ (MR), 3=6-25% two to three spots $leaf^{-1}$, five to ten spots $plant^{-1}$ (MS), 4=26-50% three to five spot $leaf^{-1}$, ten to twenty spots $plant^{-1}$, spot tend to coalesce (S) and 5=51-100% whole plant look blighted spots coalesce and leaves droop (HS) given by (Prasad, 1982) and % disease incidence (PDI) was calculated adopting following formula:

$$\text{\% disease intensity (PDI)} = \frac{\text{Sum of total numerical rating}}{\text{Total number of leaves infected} \times \text{Highest rating}} \times 100$$

The epidemiological parameters viz., minimum and maximum temperature (°C), average relative humidity (%), cumulative rainfall (mm) and sunshine (hour) were recorded from meteorological observatory located at University Campus. The average of all the epidemiological parameters during each standard meteorological week was considered while calculating their effect on disease incidence in terms of multiple regression analysis. In order to calculate the regression coefficient, minimum temperature, maximum temperature, average relative humidity, cumulative rainfall and sunshine were symbolized as X_1, X_2, X_3, X_4 and X_5 respectively.

3. Results and Discussion

The results presented in table 1 and 2 indicated that among the six taro genotypes tested, leaf blight initiated during the 27th (9-15th July) and 29th (23-29th July) standard meteorological week (SMW) in 2006 and 2007 cropping season, respectively. Disease showed a progressive increase and higher terminal incidence in the 35th (3-9th September, 2006) and 36th (10-16th September, 2007) SMW. The maximum disease incidence was observed on genotypes NDC-6 and NDC-50 during both the years, whereas, minimum disease incidence was recorded on NDC-1 and PKS-1 during both the year, respectively.

Disease infection rate ('r') in general remained high during the start of natural epiphytotic condition from 28th (16-22nd July, 2006) to 30th (30th July -5th August, 2006) SMW and later infection rate ('r') increased in NDC-6 and NDC-50 during 33rd (20-26th August, 2006) SMW. This could be attributed to weather factors *i.e.* maximum temperature (30.90°C), relative humidity (84.80%) and maximum rainfall (198.20mm), respectively. However, after 30th (July 30th-5th August, 2006) SMW there was increase in maximum (34.00°C) and minimum (26.50°C) temperature. Simultaneously, there was decrease in relative humidity (<78.10%) and a dry spell of one week resulting in the decline of infection rate ('r'). However, with the weather conditions once again becoming congenial for the disease development, the infection rate ('r'=0.617) increased during 33rd (20-26th August, 2006) SMW in NDC-1 and NDC-50 and infection rate ('r'=0.601) in NDC-16, NDC-6 and NDC-50 during 31st (6-12th August, 2007) SMW. This could be directly correlated to rise in the average relative humidity due to cumulative rainfall and sunshine in 33rd (20-26th August, 2006) and 32nd (13-19th August) SMW, which restricted the minimum and maximum temperature (24.5 °C). The results are also supported by the earlier work of Suheri and Price (2000), Razdan et al. (2008) and Shakywar et al. (2012) who reported that maximum sporangia germination, zoospores formation and penetration of taro leaves by *Phytophthora colocasiae* was recorded at 21-26°C temperature, 90-100% maximum average relative humidity, sunshine hours 5-10 and frequent cumulative rainfall. They observed strong correlation between the total numbers of sporangia and zoospores at 20-25°C, and infection increased with the increasing duration of leaf wetness at all the temperatures tested with highest being at 20-29°C. Subsequently, the infection rate declined progressively due to adverse weather conditions and lack of tissues availability during course of investigation. All the genotypes showed more or less similar behavior in disease infection rate during both the years. The fact that increasing disease levels frequently occur late in the growing season is often attributed to increasing age of the susceptibility of plant tissues (Miller, 1983; Everts and Lacy, 1990 and Shukla, 2006).

After calculating the area under disease progress curve (AUDPC) it was observed that the disease pressure was more in all the genotypes during 2006 as compared to 2007 (Table 3), which may be attributed to the fact that frequent cumulative rainfall, relative humidity and sunshine remained low during the year 2007. The present findings are also supported by earlier

Table 1: Effect of epidemiological factors on % disease incidence of taro genotypes during *kharif* 2006

SMW	Dates of SMW	Temp. °C		Average Relative humidity (%)	Cumulative rainfall (mm)	Sunshine (hours)	PDI of different genotypes						Infection rate unit^{-1}
		Min.	Max.				NDC-1	PKS-1	NDC-4	NDC-16	NDC-6	NDC-50	
27	9-15 Jul	27.10	34.40	68.10	6.20	4.60	0.00	0.00	0.00	0.00	5.72	6.24	0.000
28	16-22 Jul	25.81	30.90	84.80	198.20	1.10	0.00	0.00	0.00	8.75	12.21	10.75	0.000
29	23-29 Jul	26.50	33.20	73.20	129.50	7.20	8.25	6.13	9.25	17.81	28.1	25.12	0.519
30	30 Jul-5 Aug	26.20	32.30	80.10	36.40	7.80	25.15	21.24	24.75	32.52	43.52	40.25	0.187
31	6-12 Aug	25.90	33.10	79.90	19.20	7.30	32.2	34.56	44.62	43.8	68.1	65.12	0.162
32	13-19 Aug	26.00	32.40	77.80	6.20	7.50	39.12	38.52	53.75	62.72	89.00	85.00	0. 376
33	20-26 Aug	26.50	34.00	78.10	34.50	8.50	42.50	44.52	67.21	74.50	100.00	92.15	0. 617
34	27 Aug-2 Sep	26.20	33.00	81.80	27.00	4.40	42.50	50.00	75.00	74.50	100.00	100.00	0.516
35	3-9 Sep	25.10	31.40	82.40	95.40	4.40	42.50	50.00	75.00	74.50	100.00	100.00	0.349
Average		26.14	32.74	78.47	61.40	5.42	29.44	32.49	45.76	40.02	49.37	53.07	0.303

*SMW- Standard meteorological week

Table 2: Effect of epidemiological factors on % disease incidence of taro genotypes during *kharif* 2007

SMW	Dates of SMW	Temp. °C		Average Relative humidity (%)	Cumulative rainfall (mm)	Sunshine (hours)	PDI of Different Genotypes						Infection rate unit^{-1}
		Min.	Max.				NDC-1	PKS-1	NDC-4	NDC-16	NDC-6	NDC-50	
29	23-29 Jul	25.30	31.70	80.10	135.40	3.70	0.00	0.00	0.00	0.00	7.23	9.52	0.000
30	30 Jul-5Aug	24.50	30.20	84.90	22.20	4.47	0.00	0.00	8.75	10.25	21.45	24.72	0.439
31	6-12 Aug	26.00	32.40	81.70	49.20	2.50	7.23	6.15	17.85	21.17	42.25	38.47	0.601
32	13-19Aug	27.80	34.30	77.10	2.20	6.80	9.12	11.21	21.62	28.65	54.72	50.25	0.133
33	20-26Aug	25.90	30.90	82.70	54.70	0.08	22.45	25.15	33.43	37.12	65.75	70.10	0.221
34	27 Aug-2 Sep	26.40	31.90	79.90	15.60	3.80	31.00	38.70	48.52	52.70	82.13	79.25	0.150
35	3-9 Sep	25.80	32.80	82.90	24.60	1.90	37.25	42.15	63.72	74.00	98.25	100.00	0.528
36	10-16 Sep	25.30	32.10	85.50	20.80	3.80	42.50	48.00	73.75	74.00	98.25	100.00	0.423
Average		25.97	32.37	80.72	37.81	2.98	24.92	28.56	44.60	37.31	53.11	53.19	0.312

*SMW- Standard meteorological week

work done by Singh et al. (2004). Multiple regression equation drawn for the disease prediction on the basis of mean data collected for all the six taro genotypes by taking the overall average of the disease incidence during the year 2006 and 2007. It is indicated that in the year 2006, epidemiological factors viz., maximum temperature, relative humidity and continuous rainfall contributed in 100% disease precession in both the years. The regression equation values of a, b and coefficient of determination (R) are given in table 4. It is evident that the dependent variables (Y= Infection rate) can be predicted prior to the onset of infection on the basis of independent variable values (partial regression) obtained from equations. The highest value of coefficient of determination was recorded on highly susceptible genotype NDC-50 (89%) in the year 2006 and 91% in 2007. While, the minimum coefficient of determination was recorded on moderately susceptible genotypes NDC-1 (64%) in year 2006 and 67% in 2007. However, similar interactions with respect to few host-pathogen interactions have been reported by earlier workers (Mehrotra and Aggarwal, 2003).

Table 3: Level of moderately susceptible (MS), susceptible (S) and highly susceptible (HS) in taro genotypes expressed as area under disease progress curve during *Kharif* 2006 and 2007

Genotypes	Area under disease progress curve	
	2006	2007
NDC-1	173.36	150.00
PKS-1	198.30	171.92
NDC-4	276.60	230.00
NDC-16	236.00	218.04
NDC-6	322.65	296.67
NDC-50	327.00	320.31

Table 4: Regression of leaf blight infection rate ('r') and weather factors on taro genotypes during *Kharif* 2006 and 2007

Genotypes	Regression equation	R^2
	2006	
NDC-1	$Y = -27.25+1.27X_1+(-0.38)X_2+(0.079)X_3+(-0.012)X_4+0.103\ X_5$	0.646
PKS-1	$Y = 9.68+(0.44)X_1+(-0.17)X_2+(-0.036)X_3+(-0.016)X_4+(-0.096)X_5$	0.720
NDC-4	$Y = 6.06+(-0.31)X_1+(0.12)X_2+(-0.017)X_3+(-0.015)\ X_4+(0.057)X_5$	0.790
NDC-16	$Y = -1.68+(-0.079)X_1+(-0.43)X_2+(0.096)X_3+(-0.013)X_4+(-0.010)X_5$	0.820
NDC-6	$Y = -1.72+(-0.082)X_1+(0.51)X_2+(0.097)X_3+(-0.017)X_4+(-0.013)X_5$	0.830
NDC-50	$Y = 2.33+(-0.48)X_1+(0.34)X_2+(0.097)X_3+(-0.015)X_4+(-0.085)X_5$	0.890
	2007	
NDC-1	$Y = 8.17+(-0.148)X_1+(0.143)X_2+(-0.097)X_3+(-0.065)X_4+(-0.184)\ X_5$	0.676
PKS-1	$Y = 21.06+(-0.038)X_1+(0.075)X_2+(-0.253)X_3+(-0.080)X_4+(-0.313)X_5$	0.728
NDC-4	$Y = -2.54+0.07X_1+(0.067)X_2+(-0.135)X_3+(-0.014)X_4+(-0.090)X_5$	0.765
NDC-16	$Y = 5.852+(-0.104)X_1+0.190X_2+(-0.099)X_3+(-0.046)X_4+(-0.176)X_5$	0.881
NDC-6	$Y = 8.47+(-0.155)X_1+0.098X_2+(-0.082)X_3+(-0.067)X_4+(-0.124)\ X_5$	0.849
NDC-50	$Y=6.97+0.018X_1+(-0.049)X_2+(-0.066)X_3+(-0.016)X_4+(-0.041)\ X_5$	0.913

Y=Leaf blight intensity; a=Intercept; b=Slop; X_1= Temperature Minimum (°C); X_2=Temperature Maximum (°C); X_3=Relative humidity (%); X_4=Total Rainfall (mm); X_5=Sunshine (hours); R^2=Coefficient of multiple determination

4. Conclusion

The moderately susceptible genotypes NDC-1 and PKS-1 can be taken up for developing source of resistance against leaf blight of taro caused by soil borne fungus *Phytophthora colocasiae*. The farming community World over can take up commercial cultivation of taro using these genotypes for better yield purpose.

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