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Spatial distribution pattern of *Phytophthora* inoculum in cardamom soils

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ABSTRACT: An experiment was undertaken to study the soil inoculum build up and distribution pattern of *Phytophthora* in cardamom soils. Two different locations representing high and low disease intensity were selected. The inoculum distribution was studied at three different depths and distance from the plant base. In high disease pressure area, the *Phytophthora* propagules are present throughout the season at almost all depths and distance studied whereas in low disease pressure area the population level was comparatively low during April-June months at all the depths and distance. The inoculum build up starts during July and the level became comparatively high during December months at 0-5cm distance from the plant base. In the high disease pressure area also inoculum build up was noticed during November –December months. The inoculum distribution was noticed at all the depths irrespective of distance from the plant base. It is observed that the inoculum build up occurs only when there is sufficient moisture in the soil as evidenced from the inoculum level in the low disease pressure area. The pH of the soil was found between 5 and 6 which is a congenial condition for the growth of *Phytophthora.*

Key words: Capsule rot, *Phytophthora meadii*, distribution pattern, spatial distribution, leaf blight

Capsule rot (Azhukal) disease of cardamom occurring with the onset of south west monsoon is a serious problem in cardamom plantations of Kerala. The disease is caused by *Phytophthora meadii* Mac Rae of A2 mating type which was identified as the predominant species associated with capsule rot disease of cardamom (Suseela Bhai 1998; Suseela Bhai and Sarma 2005). During the post monsoon period another type of *Phytophthora* infection (*P.nicotianae* var. *nicotianae*) in cardamom causing leaf blight was also noticed. As both these diseases are caused by *Phytophthora* sp., it would be pertinent to study the distribution pattern of *Phytophthora* spp. in cardamom soils. Nair (1979) conducted detailed studies on the survival of the pathogen in the soil and observed that the pathogen could be recovered from the air dry field soil incubated at 25°. It retained sporangia and hyphae up to a period of four weeks and the saprophytic survival of the pathogen in the soil was for a period of six weeks in moist soils. Abundant formation of chlamydospores was noticed in *P. nicotianae* var. *nicotianae* colonizing moist soils at 60% field capacity. Soil pH between 6 and 7 was found favorable for the survival of the pathogen which in turn increased the incidence of the disease. It was also reported that pathogen survives in the form of chlamydospores in moist soils for longer periods. The fungus also survives in infected rhizomes for considerably longer periods and might act as initial source of inoculum. The surface layer of soil adhering to the rhizome of infected plants recorded the maximum count of *Phytophthora* and the number of propagules decreased with the increase in distance from the base and depth from the soil surface (Nair, 1979). Similar results were obtained in the case of black pepper also (Ramachandran *et. al.,* 1991) .With this background a detailed study was undertaken in two different locations representing high and low disease intensity and the horizontal and vertical distribution pattern of infective propagules of *Phytophthora* was studied in relation to different depths and distance from the plant base. This was also compared with the pH of the soil during the period.

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MATERIALS AND METHODS

Site selection

The spatial distribution pattern of *Phytophthora* inoculum in cardamom soils was studied in two locations/sites. The locations were selected based on the previous history of disease incidence. Site 1 represents a highly diseased area and site II a low diseased area. The cardamom plants in these sites were distributed in normal 8"x 8" spacing. From each site three plots were selected at a distance of 500m apart and from each plot three plants were marked.

Soil sample collection

Soil samples were collected from three sides of each marked plant using an augor. Pooled samples were made from each plant. There were nine treatments comprising three distance and three depths from each distance (Table-1).

Processing and analysis of soil sample

Soil samples collected from the base of each plant as detailed above was mixed thoroughly (nine samples from three locations- total 27 samples) and made into a composite sample. The pooled sample was sieved through a 2mm sieve and three replications of this sample was used for determining parameters such as inoculum density of *Phytophthora*, soil moisture and soil pH. The inoculum density of *Phytophthora* was determined using soil dilution end point method described by Tsao (1960 and 1983). Immediately after collection, the soil samples were analyzed for pH (using standard pH meter). Soil moisture was determined by the standard gravimetric method, *i.e.*, by determining the wet weight and dry weight of the sample. After measuring the wet weight, the soil samples were dried in a hot air oven at 80^0 C for three days and then determined the dry weight. The percentage soil moisture was estimated using the formula.

$$\frac{\text{Wet weight-Dry weight}}{\text{Dry weight}} \times 100$$

The rainfall data for the experimental period was also recorded.

Table 1. Treatment details

Treatments	Depth (D)	Distance (a)
D1 a1	0-5cm	5cm
D1 a2	0-5cm	20cm
D1 a3	0-5cm	40cm
D2 a1	6-15m	5cm
D2 a2	6-15m	20cm
D2 a3	6-15m	40cm
D3 a1	16-30cm	5cm
D3 a2	16-30cm	20cm
D3 a3	16-30cm	40cm

Depth (D) and Distance (a) from the plant base

RESULTS AND DISCUSSION

The spatial distribution of inoculum of *Phytophthora* in cardamom soil was studied during the year 1994. The rainfall during this period i.e., April-October was 2384.8mm with 116 rainy days (total rainfall in 1994 was 2789.2mm with 138 rainy days). Study on soil moisture at different depth and distance from the plant base showed that soil moisture during April-May was 26.64%-42.26 % at 6-15cm depth at a distance of 0-5cm from the plant base. In June-September the moisture level was more (39%-49%) at 0-5cm depth compared to 6-15cm depths. Similarly the moisture level decreased with increasing distance (Table 2) during June-September. Same trend was observed during October-December also. The cardamom soil was found to be acidic. The average soil pH in cardamom soil was 4.4-6.0. The pH decreased slightly with increasing depth and distance from the plant base. During April-May the pH was slightly high (4.85-5.59) whereas from June-September it was more acidic. Difference was not observed in pH between heavy diseased and low diseased areas.

Disease Potential Index (DPI) of *Phytophthora* showed high fluctuation during different months. Low DPI was observed in April-May months (1-12). During July-August months DPI was more at 0-5cm depth at a distance of 5cm as compared to other depths. September-October months the DPI was found higher at 6-15cm depth at a distance of 5cm from the plant base. During November-December the DPI was on the higher side (16-192) at all the three depths and distance studied. The increase in DPI level can be attributed to the low temp and

Table 2. Soil moisture (%) at different months

Depth (cm)	Soil moisture (%) at High Diseased area								
	April	May	June	July	August	September	October	November	December
0-5	37.32	25.15	40.93	48.93	43.12	39.24	39.67	29.46	21.41
6-15	40.40	31.91	39.15	44.47	41.44	37.11	39.60	31.66	22.53
16-30	38.30	26.06	39.75	45.19	41.72	37.64	42.13	30.26	23.09
Distance (cm)									
5	42.26	25.48	42.64	50.90	45.78	39.94	41.96	31.11	20.09
20	38.84	29.54	39.28	45.94	42.89	38.35	42.47	32.18	32.20
40	35.32	29.01	40.62	41.74	37.61	36.29	36.40	28.09	23.09
	Soil moisture (%) at Low Diseased area								
Depth (cm)	April	May	June	July	August	September	October	November	December
0-5	21.28	23.65	37.17	40.97	41.75	35.74	36.82	29.11	21.41
6-15	16.63	25.86	35.62	38.31	40.76	34.72	39.03	30.17	22.53
16-30	14.85	25.43	35.99	37.92	39.99	36.20	37.01	30.80	23.09
Distance (cm)									
5	19.54	26.64	40.08	44.92	44.48	38.95	40.15	32.36	20.09
20	15.64	20.64	36.13	37.64	40.08	34.88	36.0	28.34	32.20
40	17.58	27.82	32.57	34.64	38.05	32.66	36.71	29.51	23.09

high RH prevailing during the winter months with sufficient sunshine (Fig-1&2).

The pH of cardamom soil was 4.46-6.0 and it decreased slightly with increasing depth and distance from the plant base. The DPI of *Phytophthora* in the soil showed variation during different months. The DPI was very low during summer months where as it increased with the onset of south west monsoon due to soil moisture build up and was found concentrated on the upper layer of the soil i.e., 0-5cm depth and at a distance of 5cm from the plant base. But during September-October the DPI was found higher in the deeper layer. The result is in agreement with the work of Nair and Menon (1980) where a gradual and steady increase in the number of pathogens in the soil was observed with the onset of the rains. This is also supported by Sastry and Hegde (1988). Maximum recovery of colonized castor seed bait was obtained in August during which the plantation received the highest rainfall. Least recovery of colonized bait was recorded in the month of March during which the plantation

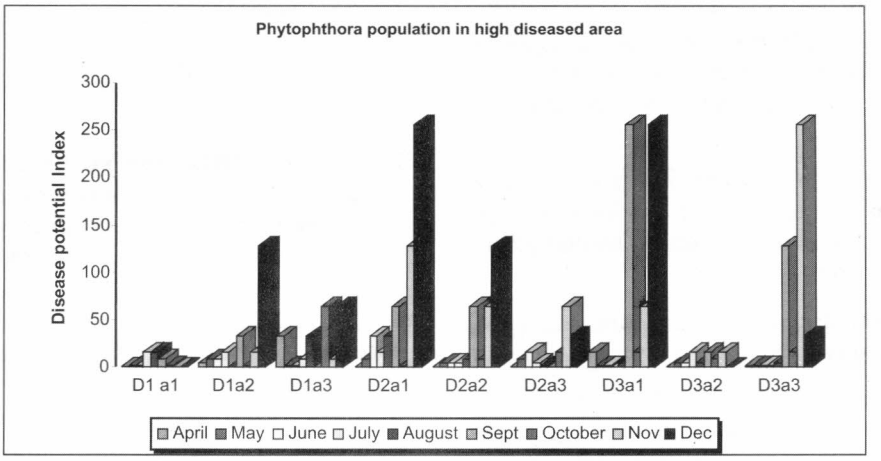

Fig. 1. Distribution pattern of *Phytophthora* in cardamom (High disease pressure area)

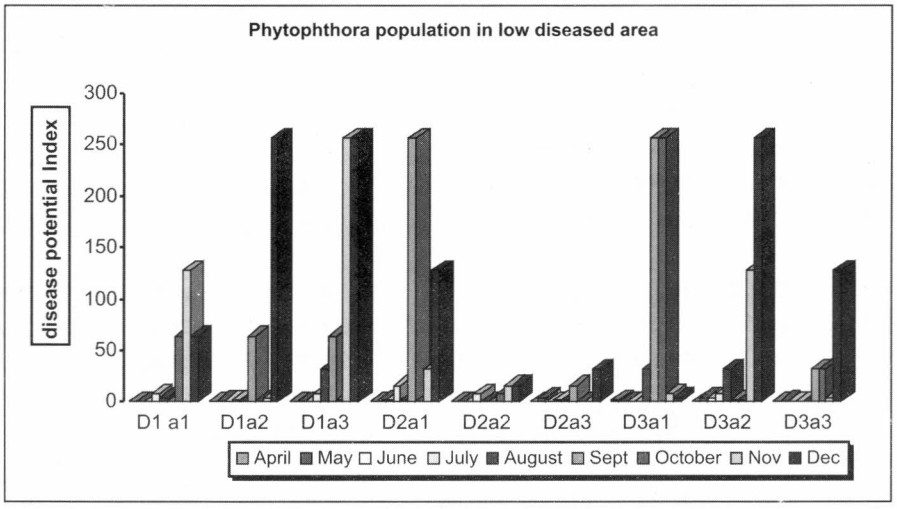

Fig. 2. Distribution pattern of *Phytophthora* in cardamom soils (Low disease pressure area)

received no rains. Similarly variation occurred in the recovery of colonized baits collected from the localities. It is evident from the study that the distribution of *Phytophthora* propagules in the soil is related to the soil moisture and Relative humidity. The inoculum distribution was noticed at all the depths irrespective of the distance from the plant base.

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REFERENCES

Nair, R.R. (1979). *Investigations on fungal diseases of cardamom* (*Elettaria cardamom* (L.) Maton. PhD. Thesis, Kerala Agricultural University Vellanikkara, Trichur, Kerala.

Nair, R.R. and **Menon, M.R.** (1980). Azhukal disease of cardamom. In: Proceedings of the workshop on *Phytophthora* diseases of tropical cultivated plants CPCRI Kasaragod, pp. 24-33.

Ramachandran, N., Sarma, Y.R. and **Anandaraj, M.** (1991). Management of *Phytophthora* infections in black pepper. In: *Diseases of Black Pepper*-Proceedings of the international pepper community workshop on Black Pepper Diseases. pp. 27-29 October, 1988 Goa, India (Eds.). Sarma, Y. R. and Premkumar, T.), NRCS, Calicut, Kerala.

Sastry, M.N.L. and **Hegde, R.K.** (1988). Survival of *P. palmivora*. *Indian Phytopath.* **41**: 118-121.

Suseela Bhai. R. (1998). *Studies on Capsule rot (Azhukal) disease of cardamom*. Ph.D Thesis, University of Calicut, Kerala, India.

Suseela Bhai, R. and **Sarma, Y.R.** (2005). Characterization of *Phytophthora* de Bary inciting Capsule Rot / Azhukal and leaf blight disease of cardamom (*Elettaria cardamomum* (L.) Maton). *J. Plantation Crops* **33**: 193-203.

Tsao, P.H. and **Garber, M.J.** (1960). Methods of soil infestation, watering and assessing degree of root infection for green house in situ ecological studies with citrus Phytophthoras. *Pl. Dis. Rep.* **44**: 710-715.

Tsao, P.H. (1983). Factors affecting isolation and quantification of *Phytophthora* from soil. In *Phytophthora*, Its *Biology, Taxonomy, Ecology and Pathology*. D.C. Erwin, S. Bartnicki-Garcia and P. H. Tsao. (Eds.) pp. 219-236.

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