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Effect of epidemiological parameters on the development of red stele of strawberry

Meenu Gupta and L.N. Bhardwaj
Department of Mycology and Plant Pathology,
Dr Y.S.Parmar Univ. of Hort. and Forestry, Nauni, Solan (H.P.)

ABSTRACT

Red stele, caused by *Phytophthora fragariae* Hickman, is one of the most destructive soil- borne diseases of strawberry wherever it is cultivated commercially in the world. While studying the effect of edaphic factors such as soil temperature, soil moisture, soil pH and soil type, it was found that high soil moisture (>75%), low temperature (15°C) and soils with slightly acidic pH (5.5) with sandy loam texture were found highly conducive for the development and spread of red stele disease causing 70.37, 66.30, 64.37 and 67.03 percent mortality of the runners 60 days after pathogen inoculation.

Keywords: Red stele, *Phytophthora fragariae*, epidemiology, soil temperature, moisture, pH, soil types

INTRODUCTION

Red stele of strawberry caused by *Phytophthora fragariae* Hickman is one of major factors limiting fruit production in most parts of the world. This disease is causing significant damage to the strawberry crop in Himachal Pradesh under favourable conditions. The fungus infects the roots and makes the plant to stunt and wilt. High soil moisture coupled with low temperature favours the development and spread of disease (Morita, 1975 and Montgomerie, 1977). However, the current knowledge on the disease with regard to weather parameters under Indian conditions is lacking. The present study was therefore, planned to determine the role of edaphic factors such as temperature, moisture, pH and soil types on the development of red stele of strawberry.

MATERIALS AND METHODS

Standardized pot-inoculation technique was used to study the influence of soil temperature, moisture, pH and soil types on the development of red stele of strawberry. Three strawberry runners of susceptible variety, 'Chandler' were planted in each pot (6" dia) containing sterilized soil. These pots were then allowed to establish for one month under polyhouse conditions. The plants were inoculated with zoospore suspension of *P. fragariae*. For the production of zoospore suspension for inoculation, 2 to 3 weeks old culture of test pathogen grown on bean agar medium was transferred to a sterile petri dish (6" dia) and were flooded in 50 ml non- sterile pond water and incubated at 24-48 hrs at 15°C. The inoculum was applied after one month of transplanting of runners. The treatments were replicated thrice.

To study the effect of soil temperature on disease development, the inoculated pots were kept at 5, 10, 15, 20, 25 and 30°C temperature in BOD incubators. To study the effect of soil moisture in disease development, different levels of moisture viz. 25, 50, 75 and 100 were maintained in pots with the help of moisture meter. The pots after inoculation were placed in laboratory conditions at temperature ranging between 15 to 20°C.

The influence of soil pH on disease development was studied by examining the progress of the disease in green house in soils artificially adjusted to different pH levels of 4.5, 5.5, 6.5, 7.5 and 8.5. The pH of the soil was adjusted with the addition of 0.1 N HCl or 0.1 N NaOH.

Similarly, the effect of different soil types namely, sandy loam, clay, loam, forest loam and sandy loam (gravelly) on disease development was studied. The soils were sterilized in an autoclave at 1 Kg/cm^2 pressure for half an hour for two consecutive days and the pots after inoculation were kept under laboratory conditions.

Sixty days after pathogen inoculation, the runner of strawberry plants were uprooted washed thoroughly and the root system was examined. Observations on disease incidence and disease severity were recorded from 25 plants selected at random from each treatment. The severity was recorded by using 0-5 scale given by Kennedy *et al.*, 1986 where 0, means roots apparently free from infection, 1, 1-10 % roots infected, 2, 10-20 % roots infected, 3, 20-50 % roots infected, 4, 50-75 % roots infected and 5 means 75 – 100 % roots infected in which the PDI (Per cent Disease Index) was calculated according to McKinney (1923).

$$\text{PDI (\%)} = \frac{\text{Sum of disease ratings}}{\text{Total Number of ratings x Maximum disease grade}} \times 100$$

RESULTS AND DISCUSSION

Effect of soil temperature

The perusal of data presented in Table 1 indicates that the red stele pathogen, *P. fragariae* was able to infect the strawberry plants at all the temperatures ranging form 5 to 30°C, however, maximum infection (incidence 70.37% and severity 56.29%) was recorded at 15°C and least at 30°C (incidence 29.68 % and severity 23.59 %). The data further reveals that temperatures <10°C and >25°C were not found congenial for development and spread of the disease. Govorova (1966) and Morita (1975) also reported 15°C temperature as optimum for the development and spread of red stele of strawberry.

Effect of soil moisture

The effect of different soil moisture levels on the development of red stele indicated that with the increase in soil moisture level from 25 to 100 per cent, the incidence was increased from 9.62 % to 66.30 % and severity from 7.70 % to 53.04 % (Table 2). However, maximum mortality of plants was recorded at 100 per cent soil moisture when 66.30 % per cent plants were found killed sixty days after pathogen inoculation while least mortality of plants (9.62 %) was observed at 25 per cent soil moisture level. Hickman and English (1951) also reported maximum infection of *P. fragariae* at high soil moisture conditions that promoted the liberation of zoospores. Similar results on the influence of soil moisture on the development of red stele were also reported by Smith (1952), Vaughan (1956), Morita (1975) and Duncan (1976).

Effect of soil pH

The data in Table 3 reveals that lower soil pH ranging between 4.5 to 6.5 was found favourable for the development of red stele of strawberry, while higher pH ranges (7.5 and 8.5) were unfavourable for its development. Maximum incidence of red stele was recorded at 5.5 pH followed by pH 4.5 and 6.5 while least incidence was observed at 8.5 pH. While studying the effect of pH on disease severity, almost similar trend was observed with maximum disease severity at pH 5.5 (51.41%) and minimum at pH 8.5 (25.71%). The data also depicts that pathogen could not proliferate and establish well in alkaline soil as both the disease incidence and severity were comparatively much less in comparison to acidic soil. Lower soil pH ranging from 4.5 to 6.5 were also reported favourable for the development of red stele by Hickman and English (1951), Montgomerie and Kennedy (1973), Maas (1976), Montgomerie (1977) and Bolay (1982).

Effect of soil types

Effect of different soil types on the incidence and severity of red stele disease of strawberry was also studied in pot culture. The data indicates (Table 4) that soil with sandy loam texture had high incidence of red stele followed by sandy loam (gravelly), forest loam and loam while least incidence was observed in clay soils. The data with regard to severity of disease also indicated high mortality of plants in sandy loam (53.63 %)

and least in clay soils (28.40 %). Similarly findings were also reported by Hickman and English (1951) and Smith (1952) who also reported lighter soils to be more conducive for the development of red stele of strawberry under favourable conditions.

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Table 1. Effect of soil temperature on the incidence and severity of red stele of strawberry

Soil temperature (°C)	**Disease Incidence (%)**	**Disease Severity (%)**
5	35.65	23.83 (30.50)
10	58.79	47.30 (43.30)
15	70.37	56.29 (48.62)
20	47.22	37.78 (37.92)
25	41.43	33.14 (35.14)
30	29.68	23.59 (29.80)
$CD_{0.05}$	5.66	(3.53)

Figures in parentheses are arc sine transformed values

Table 2. Effect of soil moisture on the incidence and severity of red stele of strawberry

Soil moisture (%)	**Disease Incidence (%)**	**Disease Severity (%)**
25	9.62 (18.06)	7.70 (16.03)
50	28.69 (32.60)	22.95 (28.60)
75	58.66 (50.42)	46.94 (43.25)
100	66.30 (55.40)	53.04 (46.74)
$CD_{0.05}$	(4.09)	(2.39)

Figures in parentheses are arc sine transformed values

Table 3. Effect of soil pH on the incidence and severity of red stele of strawberry

Soil pH	**Disease Incidence (%)**	**Disease Severity (%)**
4.5	56.37	45.09 (42.18)
5.5	64.37	51.41 (45.81)
6.5	53.20	42.56 (40.72)
7.5	38.53	30.83 (33.72)
8.5	32.13	25.71 (30.46)
$CD_{0.05}$	3.46	(1.66)

Figures in parentheses are arc sine transformed values

Table 4. Effect of soil types on the incidence and severity of red stele of strawberry

Soil Type	**Disease Incidence (%)**	**Disease Severity (%)**
Sandy loam	67.03	53.63 (47.08)
Clay	35.50	28.40 (32.20)
Loam	43.00	34.40 (35.91)
Forest loam	55.33	44.27 (41.71)
Sandy loam (gravelly)	60.10	48.08 (43.90)
$CD_{0.05}$	4.20	(1.97)

Figures in parentheses are arc sine transformed values