A simple method for indexing *Phytophthora* and nematode infections in black pepper (*Piper nigrum* L.)

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ABSTRACT

A simple method for indexing *Phytophthora* foot rot disease of black pepper (*Piper nigrum*) caused by the fungus *P. capsici* and the nematodes *Radopholus similis* and *Meloidogyne incognita* was derived. The index is based on foliar yellowing and defoliation which are the predominant aerial symptoms of the disease.

Key words : black pepper, indexing, *Phytophthora capsici, Piper nigrum,* plant parasitic nematodes.

Phytophthora capsici and plant parasitic nematodes *Radopholus similis* and *Melodogyne incognita* invade roots of black pepper (*Piper nigrum* L.), either individually or together, affecting nutrient and water uptake of affected vines leading to yellowing of leaves, defoliation and ultimately death of vines (Ramana, Sarma & Mohandas 1990; Sarma, Anandaraj & Ramachandran 1992). If the infection is confined to roots, it results in slow decline, whereas infection at the collar region leads to sudden death of vines (Anandaraj, Sarma & Ramachandran 1994). The necessity for quantifying the severity of disease based on foliar symptoms was felt in the context of monitoring field control trials involving chemicals, biocontrol agents and management practices and in field surveys for estimating crop losses due to the disease. Such indexing methods have been evolved for yellow leaf disease of arecanut (George, Jacob Mathew & Nagaraj 1980), and root (wilt) disease (George & Radha 1973), Thatipaka disease (Rama Pandu & Rajamannar 1983), Thanjavur wilt (Vijayan & Natarajan 1975) and stem bleeding disease of coconut (Jacob Mathew *et al.* 1989).

The data generated by a pot culture study under artificial inoculation with all the three pathogens, namely, *P. capsici, R. similis* and *M. incognita,* individually and in combinations (NRCS 1992), were utilized to study the relationship between symptom expression and root damage in the vines. Growth parameters like height, number of nodes, root volume, root weight and shoot weight were recorded. The vines were

grouped into four categories based on the severity of the disease as healthy, low, medium and high and scores from 0 to 3 were allocated for the visual symptoms of foliar yellowing and root rot, for each vine falling in these groups, respectively. A one-way ANOVA was carried out for these factors to study the differences in growth factors between these groups.

A sample of 1500 vines at three locations, namely, IISR Experimental Farm, Peruvannamuzhi (Calicut District, Kerala), black pepper plantations of Kerala Forest Department at Kuppady (Wynad District, Kerala) and a farmers' garden at Nedumkandam (Idukki District, Kerala) were selected and monitored for three years during 1991 to 1993. During the first year of study, the frequencies of incidence of visual symptoms such as foliar yellowing, defoliation, foliar infection, and collar infection were recorded . In this case the selected vines were grouped into five groups instead of four by assigning scores from 0 to 4 based on the percentage of foliage affected. The criteria adopted for scoring the symptoms was by assigning score 0 for apparently healthy, score 1 for those vines having 1 to 25 per cent, score 2 for 26 to 50 per cent, score 3 for 51 to 75 per cent and score 4 for more than 75 per cent of the foliage affected. The incidence of the disease in these gardens was severe and vines of all stages of the disease were available for observations.

The data from the pot culture experiment revealed that grouping of vines based on root rot index had significant impact on growth factors as indicated by the results of the ANOVA (Table 1). The results show that there is a significant and steady reduction in growth factors as the root index increases.

In order to ascertain the prominent and more frequent symptoms of the disease, the distribution of the selected vines from the three locations according to the score groups were worked out (Table 2).

While 59 and 64 per cent of vines showed mild to severe yellowing and defoliation (vines having score 1 to 4), only 2.3 and 7.4 per cent of vines showed foliar infection and collar infection, respectively. This indicates that foliar yellowing and defoliation are more prominent and persistent symptoms which could be scored for working out a disease index. Hence, scoring was done separately for yellowing and defoliation for all the selected vines based on the above criteria.

The frequencies of incidence of these scores were recorded eight times during

Table 1. Mean values of growth factors for different root rot index groups

Root index	Height (cm)	No. of nodes	Root volume	Shoot weight (g)	Root weight (g)
0	127.34[a]	24.04[a]	33.89[a]	58.56[a]	23.60[a]
1	94.55[b]	19.63[b]	24.42[b]	48.00[b]	16.31[b]
2	76.35[c]	16.46[c]	15.50[c]	38.83[c]	8.73[c]
3	53.28[d]	12.30[d]	5.69[d]	23.56[d]	3.73[d]

Means with different superscripts are significantly different

Table 2. Distribution of scores for various symptoms in *Phytophthora* foot rot/nematode affected black pepper gardens

Score	Percentage of vines having different scores for			
	Yellowing	Defoliation	Foliar infection	Collar infection
0	41.0	36.7	97.7	92.6
1	42.4	31.3	1.9	6.8
2	13.1	22.6	0.3	0.6
3	3.3	8.0	0.0	0.2
4	0.2	1.4	0.2	0.0

different seasons and the average of the frequencies of these scores were worked out to obtain the ratio of expression of these symptoms on the affected vines. The distribution of these scores were then obtained (Table 3).

Table 3. Distribution (per cent) of different scores for foliar yellowing and defoliation

Score	Foliar yellowing	Defoliation
0	48.2	51.1
1	34.6	20.4
2	10.4	13.6
3	1.7	7.1
4	5.1	7.8

Forty eight per cent of the vines had a score of 0 for yellowing and 51 per cent had a score of 0 for defoliation. This would mean that the remaining 52 and 48 per cent of vines had mild to severe symptoms of yellowing and defoliation respectively, indicating that, approximately a 1:1 ratio exists in the expression of these symptoms in the affected vines. The mean score for yellowing and defoliation was 0.81 and 1.00, respectively, which is also closer to the ratio 1:1. Thus, giving equal weightage to these symptoms for obtaining a simple index for the disease is justified. Hence, by adding these scores and converting to percentage of the total maximum possible scores for these two symptoms (4+4=8), a simple index for the disease was derived. Thus, if Y stands for the score for yellowing and D for defoliation, then the index I for the vine is given by:

$$I = \frac{Y + D}{8} \times 100$$

Phytophthora foot rot disease of black pepper, though conventionally known as quick wilt disease, the process of decline of vines is gradual if the feeder roots get infected and foliar symptoms are expressed only after a substantial portion of the feeder roots are damaged. Sudden death of the vines occur only when the collar region of the vine is infected. Remission of symptoms is also often observed depending upon the root regeneration capacity of the vines and favourable weather and soil conditions.

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