FACTORS ASSOCIATED WITH SLOW WILT OF PEPPER

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ABSTRACT

Slow wilt is one of the serious diseases of pepper, next only to quick wilt. The etiology of the disease is little understood. Investigations show that the disease is of complex origin and many agents/factors are associated with the disease. Results are presented to show that fungi, nematodes, nutritional deficiency and soil moisture stress are associated with the disease.

INTRODUCTION

The average yield of black pepper in India, its original home is far below than that in other countries. It is about 275 kg/ha in India as against 529 kg in Indonesia, 3400 kg in Brazil and 4130 kg in Malaysia (Swaminathan, 1977). Though there was a conspicuous increase in area under pepper cultivation in India, the total production remained static at less than 30,000 tonnes for a number of years. Though non-adoption of scientific cultivation practices by a majority of farmers coupled with high cost of cultivation are important contributory factors for low pepper production in this country, the role played by incidence of major diseases like wilts cannot be overlooked.

Two types of wilt diseases are recognised in India, quick wilt and slow wilt : slow wilt has been referred to as 'slow decline' Rutgers, (1915) or 'yellows' (Bregman, 1940). Menon (1949) reported mortality upto 10% of vines due to wilt disease in Wynaad. In Guyana, Bisessar (1969) found that yellows disease inflicted 30% loss to the crop, whereas in Bangka island in Indonesia, Hubert (1957) estimated the loss at 90% The etiology of this disease is not fully understood. While investigating the causative agent/agents of this disease, we observed the association of many agents/factors with the incidence of this disease. We report in this paper in brief the results of these studies.

Symptoms

Nambiar and Sarma (1977) described briefly the symptoms of slow wilt. The disease is usually obrseved after the North East monsoon. The lower leaves of affected vines show general pallor and loss of natural lustre. The yellowing gradually progiesses upwards. The affected leaves become flaccid and fall off. The leaves also exhibit necrosis at their tips. Die-back of twigs is also commonly observed. The affected shoots and roots show occassionally vascular browning. Some of the vines exhibiting foliar yellowing show root knot formations in the rootlets. In certain cases lesions and rotting were alwo observed in roots. It is also quite common to observe necrosis of both feeder and mature roots of vines in most of the gardens. The affected vines die gradually after the appearance of external visible symptoms.

Materials and Methods

The studies were undertaken in the pepper gardens in Cannanore and Calicut districts. Fungi were isolated from roots of affected plants and maintained on oat agar medium. For pathogenicity tests with fungi and root knot nematode, rooted cuttings of Panniyur-I were used. In pathogenicity tests with *Meloidogyne* sp. an inoculum dose of 4000 larvae and eggs per pot was used.

The field control trials using nematicides, were taken up in a garden at Chamakochi near Kasaragod. Panniyur-I vines trained on arecanut palms were used for the trial. There were three replications. No control plot was maintained during the year 1977—78. However in 1978—79 season a control plot was also maintained. The nematicides used were Phensulfothion (20 g), Ethoprop (10 g), Aldicarb (10 g), Phenamiphos (20 g) and Aldicarb sulfone (10 g) per standard. The plot size ranged from 10—16 plants per plot. Nematicides were applied in semi-circular trenches at the base of the vines, in June and October during 1977 and 1978. After the application, the trenches were filled with soil, and the garden irrigated. Observations were recorded on foliar yellowing of vines during pre and post-treatment periods, i.e. in May and January.

In studies on the foliar yellowing of vines during different seasons, observations were recorded at periodic intervals on yellowing and defoliation in 280 pepper vines spread over 5 pepper gardens in Alacode in Taliparamba. The vines were under observation for a period of 2 years from January, 1974 to February 1976.

For nutrient studies, soil and leaf samples were collected from healthy and slow wilt-affected vines of five gardens in Alacode and analysed for major elements. Samples were collected from healthy vines from healthy gardens and healthy and diseased vines from diseased gardens. Soil samples were taken at 0—15 cm, 15—30 cm and 30—45 cm depths.

Results and Discussion

Fungi

From the roots of affected plants *Fusarium* sp., *Diplodia* sp. and *Rhizoctonia bataticola* were isolated. Among these *Fusarium* sp. was constantly isolated. Pathogenicity tests gave positive results with one isolate of *Fusarium* sp. (Anon, 1973). We have also isolated *Pythium* sp. from tender discoloured roots of pepper vines showing foliar yellowing and the fungus was found to be pathogenic on inoculation. Menon (1949) in his studies isolated fungi like *Fusarium* sp., *Diplodia* sp., *Rhizoctonia* sp. and *Pythium* sp. Butler during his survey of wilt affected areas in Wynaad in 1904 observed perithecia of *Nectria* sp. in abundance at the base of the diseased vines and opined that the fungus was responsible for the disease (See Menon, 1949). Recently, *R. bataticola* has been reported to cause considerable loss in *Piper betle* in Karnataka. In Cambodia *Pythium complectans* and *P. splendens* were found to invade roots of pepper vines in combination with nematodes like *Heterodera marioni* (Litzemberger and Lip, 1961) and found that fungi were unable to infect the host in the absence of nematodes. However, Holliday and Mowat (1963) isolated *P. splendans* from small roots of pepper in Sarawak and reported that the fungus caused damping off in seedlings on inoculation.

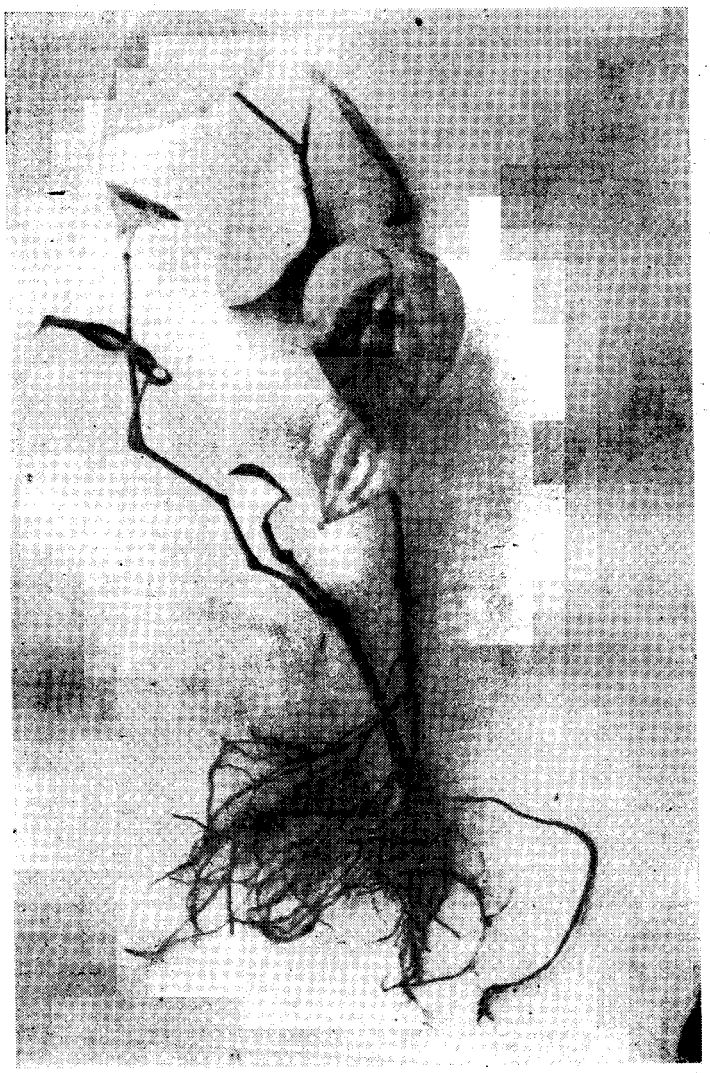

Fig. 1. Root knot affected
Pepper – Panniyur 1

Nematodes

From roots of vines exhibiting foliar yellowing and wilting the authors (Nambiar and Sarma, 1975) reported *Meloidogyne* sp. in Alacode area in Cannanore District. One year old rooted cuttings of Panniyur-I when inoculated with the nematode using an inoculum of larvae and eggs of 4000/pot developed foliar yellowing after 4—5 months. Roots of such vines showed severe gall formations (Fig. 1). Koshy *et al* (1977) identified the species as *M. incognita* from samples collected from different districts in Kerala. *Meloidogyne* sp. was first recorded in pepper by Delacroix (1902). This was followed by reports of Barat (1952), Nadakkal (1964), Sharma and Loof (1974), Ting (1975) and Koshy *et al* (1977). Ting (1975) found that *Meloidogyne* spp. were the most important groups of nematodes in Malaysia in causing the decline of pepper in that country. Venkitesan (1978) reported reduction in shoot and root growth and leaf production in rooted cuttings of Kalluvally inoculated with the nematode.

Recently (Koshy *et al*, 1975) a pepper garden crop mixed with arecanut was found to harbour high population of *Radopholus similis*. Koshy *et al* (1977) found the presence of *R. similis* in roots of wilt-affected pepper vines in Idukki and Cannanore district. The vines showed foliar yellowing and defoliation. This observation is important in that the nematode infests arecanut also (Koshy *et al*, 1975). Venkitesan (1976) established the pathogenicity of *R. similis* on pepper and described its possible role in the incidence of slow wilt. Earlier workers (Kumar *et al*, 1971; Seshadri, 1972) had also reported the occurrence of this nematode in the root zones of pepper. The finding that *R.similis* was the causative agent of pepper yellows in Indonesia (Van der Vecht, 1950; Hubert, 1957; Christie 1957, 1959; Thorne, 1960) is corroborated by these observations. In Thailand Sher *et al* (1969) reported the occurrence of *R. similis*, *Meloidogyne* spp., *Tylenehus semipenetrans* and *Rotylenchus reniformis* in the roots and soils of diseased plants.

The control trials laid out in a *R.similis* affected pepper vines trained on arecanut in Chamakuchi in Kasaragod taluk, Kerala, using different nematicides revealed that the nematicide Phenami-

phos @ 20 g per standard reduced the foliar yellowing by 28.1% as against 4.8% reduction in control (Table 1). Wahid (1976) found that nematicide application in combination with leaf mulch was effective in reducing the incidence of pepper yellows in Bargka. Venkitesan (1978) reported that in an observational trial, application of Dasanit @ 20—30 g per vine affected by the nematode helped in recovery of the vines and putting forth new flush.

Table 1 Effect of application of different nematicides on the foliar yellowing of slow wilt-affected pepper vines.

Treatment	Percentage reduction in foliar yellowing after nematicide—treatment		
	1977—78	1978—79	Mean
Fensulfothion 20g/standard	11.90	18.92	15.41
Ethoprop 10/g standard	0.00	5.71	2.85
Aldicarb 10 g/standard	14.86	13.16	14.01
Phenamiphos 20g/standard	31.03	25.10	28.06
Aldicarb sulfone 10g/standard	23.81	11.11	17.46
Control	—	4.76	4.76

No control plot was maintained in 1977—78
Mean of 3 replications.

Soil moisture

Observations on foliar yellowing in vines in slow wilt affected pepper gardens in Alacode for 1974—76 period showed that the symptom expression reached its maximum in summer months, i.e. during April—May. Where the vines were more exposed to direct sunlight the symptoms of foliar yellowing were more acute. Out of the 283 vines observed, in an average of over 50% vines, the foliar yellowing persisted throughout the year in varying intensities. But about 12% of the vines which exhibited yellowing during summer months showed remission of yellowing symptoms during the rainy season (Table 2). This probably indicates that

soil water stress may be contributory to such symptom expresion. Vines affected by acute soil water stress for 2—3 consecutive summer months seldom recover, probably due to invasion by other organisms present in the soil. Hardar and Newteboom (1936) opined that soil moisture may be involved in development of yellow disease of pepper in Bangka.

Table 2 Frequency of occurrence of foliar yellowing in five pepper gardens in Cannanore District, Kerala.

Symptoms	GARDEN NO.					
	1	2	3	4	5	Total
	Number of vines					
Foliar yellowing during summer months followed by recovery during monsoon months	9 (15.2)	7 (20.6)	10 (14.1)	4 (8.0)	5 (7.3)	35 (12.4)
Foliar yellowing throughout the year in varying intensities	18 (30.5)	20 (58.8)	35 (49.3)	26 (52.0)	44 (63.8)	143 (50.5)
Death due to collar rot, stem borer and other causes	22 (37.3)	5 (14.7)	14 (19.7)	12 (24.0)	7 (10.1)	60 (21.2)
No disease symptom (Healthyvines)	10 (16.9)	2 (5.9)	12 (16.9)	8 (16.0)	13 (18.8)	45 (15.9)

Figures in parantheses indicate percentage of vines affected.

Nutrient deficiency

Analysis of leaf and soil samples from slow wilt affected and healthy pepper gardens (Table 3) showed a lower content of P and K in both leaves of affected vines and their basin soils. The importance of nutrition in pepper in the control of pepper yellows

in Indonesia was stressed by Harper (1975). He reported that though nematodes were clearly linked with the disease, a more important contributing factor to the disease might be the nutritional imbalance in the soils in Bangka. De Waard (1969) reported that vines affected by potassium deficiency exhibited apical necrosis of mature leaves. Nambiar and Sarma (1977) also observed similar leaf symptoms in vines affected by slow wilt. The present finding of low levels of K in diseased leaves is in corroboration with the findings of Wahid (1976) who recorded similar observations in leaves of vines affected by yellow disease. Perrenond (1978) found that application of K increased yields of pepper vines affected by yellow disease.

Table 3 Nutrient status of leaves and soil from slow wilt affected and healthy pepper gardens in Cannanore District.*

Nutrients	Healthy gardens	Diseased gardens	
	Healthy vines	Healthy vines	Diseased vines
LEAVES			
Nitrogen %	2.606	2.219	1.889
Phosphorus %	0.111	0.121	0.092
Potassium %	1.110	1.280	0.700
Calcium %	2.190	2.080	2.160
Magnesium %	0.480	0.500	0.500
SOIL			
Total nitrogen %			
0—15 cm depth	0.026	0.027	0.024
Bray-1 Phosphorus ppm			
0—15 cm depth	4.60	4.00	2.00
15—45 cm depth	Traces	Traces	Traces
Available Potassium ppm			
0—15 cm depth	77	89	62
15—30 cm depth	63	58	39
30—45 cm depth	46	43	34

*Haridasan, M. Personal communication.

The foregoing results show that slow wilt is a complex disease wherein many causative agents/factors like fungi, nematodes, soil moisture and nutrient deficiency are implicated. It is observed that these factors occured either individually or in combination of one or two factors, and require a multipronged approach. The necessity for diagnosis of diseases of complex nature and elucidation of the contribution of various factors to disease incidence has been stressed by Wallace (1978). Of these the nematodes are more important because of their parasitic nature and they occur even in plantations provided with adequate fertilizer and irrigations. The foliar yellowing as a result of nematode attack can be minimised by application of proper nematicides.

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