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Integrated management of rhizome rot of ginger

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With the widening horizons of our understanding about plant diseases, their control has also assumed different dimensions. Multipronged approaches are devised to bring the disease under the grip of the scientist and farmer. For this, the accumulated knowledge on various aspects of crop genetics and crop husbandry comes to our help. In case of certain diseases like leaf spots etc., a single application of the appropriate chemical may bring in the desired amount of control, while the soil-borne diseases present a very unique situation where the soil, microbial complex, microclimate, host, etc. all interact and make the situation quite complex for any single control measure to be applied to get the desired effect. Again, the prospect of absolute control of the disease or complete annihilation of the pathogen is not economical. Reducing the dsiease severity and increasing productivity to commensurate with the expenditure involved in plant disease control is the desired way of tackling or managing a disease. In this connection the present paper discusses the problems and possibilities with regard to Rhizome rot of ginger, a scourge of cultivated ginger everywhere.

As the name implies this disease affects the rhizomes which are the economically important produce. Losses of even more than 50% have been reported to be caused by Rhizome rot. This disease is caused by a number of species of *Pythium*. When infection takes place through heavily contaminated seed, sprouts fail to grow resulting in pre-emergence damping off. When the disease strikes after sprouting, initial symptoms are manifested in the collar region as water soaking. Soft-rot sets in spreading upwards and downwards. Leaflets become pale, and the borders turn yellow. Lowermost leaflet is affected first. Soon yellowing spreads to all the leaves of the plant from bottom upwards. Simultaneously, soft tissues of the collar disintegrate and the plant topples. The lignified vescular strands are unaffected. As the rot affects the rhizome, it softens. Other fungi and bacteria follow and hasten the deterioration. Foul smell emits from the rhizomes. Rotting attracts dipteran flies like *Mimegralla* and *Eumerus* species. These flies lay eggs in the tissue and the maggots grow feeding on the rotting contents of the rhizome. Such rhizomes finally have only the jacket intact. The whole inside turns into a bag of maggots, unfit for consumption or planting. Various *Pythium* species have been reported attacking ginger and causing soft-rot. The available information has been summarised in Table 1. In most of the cases, *Pythium aphanidermatum* and *P. myriotylum* have been found responsible for the disease symptoms. *P. vexans* has a restricted geographic distribution. It is prevalent at high altitudes of 1170 meters or above in the Wynad District of Kerala, India.

This fungus grows at cooler temperatures, while *P. aphanidermatum* and *P. myriotylum* are commonly encountered in the plains where the temperatures are warm.

Table 1. *Pythium* species reported causing soft rot of ginger.

Organism	Place
Pythium sp.	Bihar
Pythium sp.	Hawaii
P. aphanidermatum	Bihar Hyderabad, Nagpur
P. butleri	Ceylon, Malabar
P. complactens	Ceylon
P. deliense Meurs	Jabalpur,
P. gracile	Bengal, Gujarat, Malabar, Assam, Fiji
P. graminicolum Subram	Ceylon
P. myriotylum Drech	Taiwan, Ceylon, Poona Bombay, Nagpur, Hongkong
P. pleroticum	Solan, H. P.
P. Vexans	South India
P. zingiberum	Osaka, Japan

The optimum temperature for growth of the fungus is 34 °C, while the maximum stands around 40 °C. The optimum for *P. vexans* is 28 °C and no further growth takes place beyond 34 °C. There are two ways in which the disease perpetuates. Firstly, through infested soil and secondly through infected seed. Oospores germinate when rain and temperature favour disease development. Infected rhizomes contain mycelia and fruiting bodies inside. Oospores are often seen in the scales of the seed rhizomes. Control of the disease has many facets, *viz.*, controlling the infection in seed, reducing the inoculum in soil, and checking the spread of disease. For seed infection control, the best method is to use disease-free rhizomes for planting. But seed material should be carefully selected before planting. Studies conducted at CPCRI showed that even when 100% apparently healthy seeds were stored, recovery of wholesome seed was only 60%. When 10% visibly rotten rhizomes were mixed with 90% apparently healthy looking seeds, the recovery was only to the tune of 18%. Seed selection and protection prior to storing and planting are desirable. It is therefore necessary to enforce programmes of seed certification for controlling this disease.

Since the disease is also internally seed-borne, seed treatments can reduce the infection only to a limited extent. Various types of seed treatments including chemical and hot water have been tried by different workers prior to storing and planting. At CPCRI, trials were conducted to compare hot water at 42 °C for 20 minutes and cowdung slurry dip followed by smoke treatment independently and in combination. The crop stand was better in the hot water treated group in comparison to the others. Various chemicals have also been tried as seed protectants prior to planting. Many workers used 0.1% mercuric chloride against *P. graminicolum*. At CPCRI, trials were conducted using pyroxychlor (1000-2000 ppm), Agallol (Methoxy ethyl mercuric chloride) 0.25%, Bavistin 0.3%, Benlate 3%, Captafol 0.36%, Dithane M-45 0.3%, Ridomil 0.2% and Terrazole 0.2%. Out of these, Bavistin, Dithane, Agallol, and Terrazole were better than other treatments. Initial moisture level of the seed material was 81.4%, whereas at the time of sowing it was as low as 56.7%. Temperature in the pits varied from 24.5 °C to 34 °C. Two varying

Table 2. Effect of application of soil amendments on the percentage incidence of soft rot.

Treatments	Year 1980-81					Year 1981-82				
	CK	FYM	PC	NC	Mean	CK	FYM	PC	NC	Mean
Check	7.5	15.8	10.0	5.5	9.7	4.6	7.5	10.2	8.7	7.7
Lime	8.6	36.3	20.9	9.5	18.8	9.7	39.3	22.5	9.6	20.3
Fertilizer	12.3	12.6	10.9	16.8	13.1	8.5	12.9	13.2	16.5	12.8
Lime + Fertz	31.5	27.1	23.8	17.4	25.0	37.3	27.5	23.2	17.1	26.3
Mean	15.0	23.0	16.4	12.3		15.0	21.8	17.3	12.9	
CD (5%)	Main plot 8.18			Sub plot 6.20		Main plot 8.94			Sub plot No	

CK – Control, FYM – Farm Yard Manure, PC – Pongamia cake, NC – Neem cake.

durations of dip were tried *viz.*, 30 minutes and 60 minutes, which were equally effective.

It is the experience of cultivators that by crop rotation and sowing the crop early in season, soft rot due to soil infection is checked to a certain extent. By the time the pathogen builds up sufficient inoculum potential, the crop is hardy and chances of infection and aggravation of symptoms are less. Another method of manipulating the situation of the standing crop is by the application of various soil amendments, which alter the soil reaction, change the spectrum of soil microflora and thus affect the population of pathogens existing in soil. Experiment was conducted at the Farm in Peruvannamuzhi, Kerala, using the following treatments: (1) lime @ 1.5 tonnes/ha; (2) Fertilizer (Nitrogen @ 75 kg/ha, Phosphorus @ 50 kg/ha and Potash @ 50 kg/ha); (3) Combination of lime and fertilizers and (4) Control. This was conducted for two years (Table 2), when the incidence of rhizome rot was lower in the organic amendment treated plots. Among these, neemcake and pongamia cake gave significantly lower incidence of rhizome rot when compared to control of FYM applied plot. Incidence of soft rot was lowest in the control plot and highest in plot receiving a combination of lime and fertilizer treatment. In addition, it was found that organic amendments had also increased the availabity of nutrients in the soil during crop growth. Often this amelioration is effected due to the alteration in microbial flora, either due to tho increase of antagonists or due to the prevention of the increase of pathogen or both.

Though field control trials have been repeatedly tried at two locations in Kerala, namely Kasaragod and Calicut, it was observed that Methoxy ethyl mercuric chloride (0.25%) drenched plots fared better in comparison to other fungicides tried at Kasaragod. At Calicut, Dithane M-45 (0.3%) drenched plots had an edge over other fungicides, *viz.*, Captafol (0.2%), Methoxy mercuric chloride (0.25%), Dexon 0.1%, Ridomil (0.2%), Bordeaux mixture (1 %), Heptane antibiotic (200 ppm), Captafol (0.2%), Meneb + Zinc (0.3%), Dithane

M - 45 (0.36%), Dexon (0.1%), Alliette (0.01%), Terrazole (0.2%), Formalin, (0.1%), Bordeaux Mixture (1%), Cheshnnt compound (1%). Soil drenching with fungicides does not give consistent resutls year after year. Hence, it is necessary to resort to other measures of control as well to reduce damage due to the disease. Once a clump becomes infected, it is difficult to eradicate the infection. The role of free flowing water has already been well established in the spread of the disease.

It has been observed that dipteran flies that are found in the ginger field help in disseminating the disease. *Pythium* had been successfully isolated from the foregut of field collected *Mimegralla* adult flies. However, the fungus could not be isolated from any other portion of the gut proving that the fungus does not colonise in the insect. Similarly, isolations were attempted from the dropings of maggots that were found within the rotting rhizomes. This was also not successful. These findings point to the adult fly as the positive disseminating agent. The peculiar scratching habit of the fly on the surface of the plant at the base of the clump must be aiding in transmission of the pathogen. Experiments were conducted on the effect of insecticides, singly and in combination with fungicides, at CPCRI. Of these, Methyl parathion (0.05%) proved the best, followed by Carbofuran 0.05%. An integrated control measure is therefore suggested to be the best.