STUDIES ON RHIZOME ROT OF GINGER AND ITS CONTROL

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ABSTRACT

In the germ plasm collection none of the types showed reasonable tolerance to diseases. Field control trials with different fungicides showed different degrees of protection, which varied from year to year. Dexon, Methoxy ethyl mercuric chloride gave better protection as compared to others. The cultural practices viz. flat bed method and ridges and furrow method VS with and without dolomite application, did'nt show significant difference in disease reduction. The results are discussed and future line of work suggested.

INTRODUCTION

In many of the ginger growing tracts in India rhizome rot (soft rot) is a serious disease problem causing heavy crop losses. Although about 60 fungi have been listed, affecting ginger crop (Sharma and Jain, 1977) *Pythium aphanidermatum* (Butler, 1907; Butler and Bisby, 1931), *P. myriotylum* Drechsler (Uppal, 1940) and *P. vexans* (Ramakrishnan, 1948) have been reported to be the major pathogens involved in rhizome rot of standing ginger crop. The authors noticed the prevalance of *P. aphanidermatum* as major pathogen in Cannanore and Calicut districts of Kerala. *Fusarium* sp. enhanced rotting of *Pythium* infected rhizomes (Sarma *et al*, 1977). Two dipteran maggots *Mimegralla* sp. and *Eumerus* sp. are noticed constantly in association with infected rhizomes and their role is yet to be critically assessed. However, there are strong indications of their positive role in the disease etiology (Sarma *et al*. 1977).

The symptomatology of this disease is described in detail (Chatopadhyay, 1967). In Kerala where the crop is rain fed, the disease appears when the crop is about 50—60 days old, coinciding with south west monsoon. High soil mositure prevailing during this period is highly conducive to the disease development. Maximum disease incidence is noticed during late July to September period. The disease gets accentuated under poor drainage. Although exact figures of crop loss are not available from different ginger growing tracts the disease incidence ranges from 20% to a total loss, in some areas. In Bengal losses of about 10—15% in low land and 5—6% in high land have been reported (Mc Rae 1908, 1911) and in wet years the losses may be as high as 80% (Butler, 1918). Kannan and Nair (1965) recorded losses upto 80—90% due to soft rot incidence in Kerala. Treatment of the seed rhizomes with 0.25% ceresan wet for 30 minutes has been reported to be effective in controlling rhizome rot in the field (Thomas, 1940). Drenching of the infected beds with cheshunt compound or with 0.1% Agallol 3 has been recommended to check the disease spread (Anonymous, 1978). McRae (1908) suggested phytosanitary measures, crop rotation, good drainage and healthy seed materials which help in reducing the disease incidence. Addition of organic amendments to the soil 15 days prior to planting has been reported to be efficacious in reducing disease incidence (Rajan and Singh, 1972).

Studies undertaken at this institute on varietal reaction of both cultivars and exotic types, and on field control trials to check the disease with fungicides under two different cultural practices are reported here.

Materials and Methods

About 33 types (including 4 exotic types) were raised in 3×1 m beds in 3 replications with a plant density of 60/bed, adopting a RBD design during 1972 — 1974. All the regular agronomic practices were adopted. Disease incidence was recorded from June to October as the number of clumps infected in each bed. Some of the available types during 1973 were raised in small beds and were used for field inoculation studies and minimum 10 plants/type were tested. *Pythium* isolate from ginger was raised in 250 ml conical flasks containing potato sucrose extract (20% peeled potato and 2% of surose) @ 40 ml/flask. Ten day old mats washed in running tap water blended with small quantity of water and the volume was made up to 500 ml. Aft.r exposing the collars of the 2 months old sprouts the inoculum was applied

@ 10 ml clump and later the collars were covered with soil. High soil inoisture was maintained throughout.

After evaluating 13 fungicides, four were selected viz. Heptane antibiotic (200 ppm) coordinated product of Menab + Zn (0.3%), Captafol (0.2%), and methoxy ethyl mercuric chloride (MEMC) (0.25%). Fungicides were used both for seed treatment and also as soil drenches. All the field control trials were laid out by 1st week of June. A split plot design with 2 methods of planting viz. Flat bed and ridges and furrows, with and without dolomite, application as main plots, and 4 fungicidal treatments as sub plots, was adopted. A plant density of 40 plant/bed (3×1m) and 39/3 ridges (3×1.5m) with 1 kg of seed material for each bed/3 ridges was maintained. Fertilizer was applied @75 kg N, 50 kg P_2O_5 and 50 kg K20 per hectare in 3 splits, and all other agronomic practices were adopted. Seed treatment was given by dipping the seed material in the respective fungicide solution for 30 minutes, later air dried under shade and planted subsequently. During 1978 Bayer 5072 (Dexon) was substituted for Heptane antibiotic in view of the non availability of the latter. Soil drenches were given thrice, @ 10 l/bed one at the time of planting and later twice at monthly intervals. A pot culture experiment with the same fungicides was set up during 1978, with 10 pots per treatment. Four seed pieces each of about 15 g were sown in each pot. Infected soil was used for this and necessary manure was also applied. Seed treatment and also 3 soil drenches @ 1 l/pot were given as above. An observational trial with neem and pongamia cakes as soil amendments, the quantity of which was adjusted to normal fertilizer dose was laid out. Three replicate beds were maintained in a R.B.D. design. Percentage of incidence was recorded in all the cases by counting the number of infected clumps.

Results and Discussion

The results of the field reaction of germ plasm types are presented in Table 1. The results clearly show high inconsistency of the disease reaction of the types in each year. Less amount of incidence during 1972 and greater incidence during 1973, and

Table 1. Incidence of Rhizome rot in germplasm of ginger.

Variety	Percentage of incidence 1972	1973	1974	Mean	% Incidence by artificial inoculation
Thodupuzha	5.00	38.89	23.75	22.21	88.89
Tura	5.55	50.00	22.50	25.01	95.00
Taiwan	—	—	26.75	26.75	90.00
Wynad Kunnamangalam	5.00	52.85	22.50	26.78	97.20
Naida	4.44	41.67	43.75	29.95	100.00
Himachal Pradesh	4.44	50.00	39.75	31.39	—
Sierra Leone	6.11	77.78	11.25	31.71	99.00
Bajpai	5.55	86.11	5.00	32.20	75.00
Poona	4.44	69.41	24.25	32.68	100.00
Assam	5.55	75.00	20.00	33.51	95.00
Jugijan	3.88	52.84	45.00	33.90	95.45
Thinladium	9.44	63.89	28.75	34.02	92.86
Ernad Chernad	3.88	70.83	27.50	34.07	83.83
Jorhat	7.78	83.33	11.25	34.12	95.83
Karakkal	4.44	61.11	39.25	34.93	90.00
Narasapattom	6.67	73.89	47.50	36.20	75.00
China	6.67	62.50	40.00	36.39	70.00
Wynad-Manantody	3.88	88.89	20.00	37.59	83.33
Uttar Pradesh	8.33	75.00	31.25	38.19	81.81
Ernad Manjeri	5.00	72.22	38.75	38.65	100.00
Vengara	10.00	70.83	37.50	39.44	87.50
Mysore	2.78	83.67	—	43.22	100.00
Valluvanad	13.34	94.44	22.50	43.40	100.00
Gujarat II	8.33	78.50	—	43.41	—
Burdwan	5.55	72.22	58.75	45.43	100.00
Wynad local	10.00	83.33	—	46.60	100.00
Thingpuri	7.76	80.56	56.75	48.19	91.67
Maran	11.67	72.22	62.50	48.70	97.14
Zaheerabad	9.44	91.67	—	50.55	—
Gujarat I	5.83	95.83	—	50.83	—
Peechi	5.55	100.00	—	52.77	—
Rio-de-Janiero	5.0	100.00	—	52.80	100.00
Kuruppampadi	—	—	82.50	82.50	—
Total rain fall (from June to December)	2757 mm	2796 mm	3188 mm		
Number of rainy days	88	101	103		
Temperature	24.5°—33.8°C	24.5°—31.8°C	26.2°—34.4°C		

Table 2. Rhizome rot incidence in field control trial (1976) (% incidence in transformed Values)

Main plot	Bed with dolomite		Bed without dolomite		Ridges with dolomite		Ridges without dolomite	
	% incidence	Yield (kg)	%incidence	Yield (kg)	% incidence	Yield (kg)	% incidence	Yield (kg)/ Plot
(Sub plot (Fungicides)								
1. Heptane antibiotic 200 ppm	18.70	1.530	24.73	0.985	24.0	0.245	14.9	1.043
2. Coordinated product of Meneb+ Zn 0.3%	15.80	3.230	23.10	2.68	20.48	2.132	21.75	2.030
3. Captafol 0.2%	28.68	0.218	26.88	0.178	23.25	0.392	22.85	0.248
4. Methoxy ethyl mercuric chloride 0.25%	20.0	3.325	13.68	2.603	21.05	3.767	17.78	2.515
5. Control	54.23	1.685	54.43	1.315	39.85	1.306	38.58	1.352

S E for Main plot 8.69

S E for Sub plot 9.94

C D for Sub plot 6.607

1974 might be due to less rain fall and also less number of rainy days in the former as compared to the latter. In either case same trend of the disease reaction was not noticed throughout and hence the difficulty in assessing the relative degree of tolerance. Under field conditions and by artificial inoculation, majority of the types were found to be highly susceptible. However, Nair (1965) reported the tolerance of Maran variety and greater susceptibility of Rio-de-Janiero variety. Balagopal *et al* (1974) reported Nadia and Narasapattom as moderately resistant and Bajpai and Sierraleone as highly susceptible types. Nybe and Nair (1979) recorded rhizome rot incidence from 16—27.5% in varieties, Himachal pradesh, Taiwan, Taffingiva, Rio-de-Janiero and 3.2—7.5% in varieties Maran, Vengara, Wynad local, Wynad Mannontody and Kuruppampady.

Results of the field control trials with fungicidal treatments and cultural practices are given in table 2. Ridges and furrow method of planting which ensures better drainage was not significantly different from that of flat bed method of planting. Response to dolomite application with regard to percentage disease incidence was also not significant. However, reduction in disease incidence with dolomite application has been reported (Gill, 1972; Garren *et al*, 1966). The fungicidal treatments were found to be significantly different and MEMC recorded maximum yield. From the table 2 and 4 it is seen that trend of protection seen in 1976 was not found in 1978.

Both in the pot culture experiment (Table 3), and also in the field trial (Table 4) the performance of Dexon appears to be good although the results are not statistically significant. Reduction of pre and post emergence damping off in solanaceous crops was recorded when treated with Dexon 0.025% (Lakshmi Ramakrishnan *et al*, 1973). Dexon has been reported to be effective in peach decline sites where *Pythium* is involved (Hendrix and Powell, 1970). Although MEMC is consistantly good in protection, the environmental pollution may pose as problem for its continued use. The inconsistency of the fungicides and their poor protective effect might be due to leaching off of the chemicals due to heavy rainfall conditions which prolong from 3—4 months. To make the fungicide more efficaceous under heavy rainfall conditions it is desirable that these fungicides be formulated as encapsulated granules to ensure slow and gradual release. Soil funigation with formaldehyde and nemagon though reduced pre-emergence rot (Sarma and Nambiar unpublished) it recorded high disease incidence probably due to the rapid multiplication of the pathogen

Table 3. Effect of seed treatment and soil drenches on the (%) incidence of rhizome rot of ginger in a pot culture experiment (1978).

S.No.	Treatment	P E R*	POER*	Yield(g)
1.	Bayer 5072 (Dexon) 0.1% ai.	12.5	0	1420
2.	Coordinated product of Maneb + Zn 0.3%	40.0	55.0	470
3.	Captafol 0.2%	27.5	40.0	580
4.	Methoxy ethyl mercuric chloride 0.25%	20.0	20.0	1035
5.	Control	20.00	80.0	70

*P E R = Pre emergence rot

*POER = Post emergence rot

in the absence of natural antagonistic microflora. Rapid multiplication of the pathogens in fumigated soils has been reported (Kreutzer, 1960). The protective effect of many of the soil fungicides is probably in part through the changes in antagonistic flora (Vaartaja *et al*, 1904) and use of high concentrations of fungicides might upset the ecological balance and may have adverse effect on the crop growth. Increased damping off incidence of pine seedlings where organomercurials were used, was attributed to the rapid multiplication of the pathogen and this might be due to suppression of native antagonistic microflora due to fungicide toxicity (Gibson, 1956). In either case fungicidal drenches alone cannot ensure protection. The poor protection by fungicides alone and also the constant association of maggots in affected rhizomes imply the complexness of the disease. The results of the preliminary field control trials conducted during 1978 at

Table 4. Rhizome rot incidence (%) in the field control trial (1978)

Sl.No.	Treatment	Beds PER	Beds POER	Beds Yield (in kg.)	Ridges & Furrows PER	Ridges & Furrows POER	Ridges & Furrows Yield (kg)
1.	Bayer 5072 (Dexon) 0.1% ai	6.8	25.00	2.968	7.5	22.50	2.918
2.	Captafol 0.2%	28.1	33.15	1.590	34.3	46.25	0.565
3.	Methoxy ethyl mercuric chloride 0.25%	25.0	29.37	2.072	19.3	41.75	1.731
4.	Control	23.75	33.75	1.763	26.8	35.93	1.283

PER = Pre emergence rot

POER = Post emerbegence rot

Calicut with phorate and solvirex in combination with MEMC were inconclusive. It was also noticed the presence of abundant maggots in ungerminated seed rhizomes and might be the reason for poor germination in certain beds. Seed and soil borne micro-organisms stimulated the oviposition of seed corn maggots which killed the seedlings (Harman and Eckernrode, 1974). As such critical studies on the role of maggots is imperative to understand the disease etiology.

The trials with organic amendments did not yield any conclusive results although Rajan and Singh (1972) reported the effectiveness of the oil cake amendments particularly with coconut and neem cakes. The lack of protection in the present trial might be due to the high population levels of the pathogen which probably could not be suppressed by the antagonistic microflora or the saprophytic competition present in this situation. However the studies on the organic amendements with different dosage and varying periods of application prior to/after sowing seed rhizomes are worth studying, in view of the nutrient advantage, the increased microflora that might suppress the pathogen and the improvement of soil texture.

Altering the dates of sowing and application of organic amendments, monitoring the rate of mineralisation and also the microbiological changes that occur in relation to pathogen populations are utmost essential, since the timing of the planting can be adjusted to skip off the disease, coinciding with optimum microbiological populations which can suppress the pathogen populations in the soil. The nature of *Pythium* as plant pathogens, the role of P^H of the soil and fertilizers on the disease has been reviewed (Hendrix and Campbell, 1973).

Crop rotation is generally adopted in Kerala for raising ginger and is necessary where it is not adopted in order to avoid population build up of the pathogen. The selection of healthy seed material is of utmost importance in view of the finding that oospores have been recorded on scales of ginger (Thomas, 1938; Sarma *et al*, 1978). Microbiological studies in the healthy areas where the disease incidence is less or absent and to simulate similar conditions by cultural manipulations are of greater relevance in view of the well established phenomenon of disease suppressive and disease conducive nature of soils (Broadbent and Baker, 1974). Basic studies on the reproduction of the organism in soil in relation to soil water potential and soil temperature are necessary in this disease problem for a better understanding of the disease etiology in relation to the microbial populations, antagonism, host exudates that affect the pathogen in the soil. The role of water in relation to the soil borne disease has been well stressed (Cook and Papendick, 1970).

Pythium and *Phytophthora* might be controlled more easily by manipulating soil moisture, than by attempting to eliminate pathogens (Schmitthenner, 1970). Disease management involving both cultural and chemical treatments ensuring optimum health of the ginger crop with minimum disease incidence is the only possible solution for this vexed problem.

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