Journal of Spices & Aromatic Crops 4 (1) : 40-48, 1995

Diseases of ginger (*Zingiber officinale* Rosc.) and their management

G N DAKE

National Research Centre for Spices
Marikunnu P.O., Calicut - 673 012, Kerala, India.

ABSTRACT

Ginger (*Zingiber officinale* Rosc.) suffers from 24 diseases of fungal, bacterial, viral and mycoplasmal origin. Of them, soft rot (*Pythium aphanidermatum*), yellows (*Fusarium oxysporum* f. sp. *zingiberi*), bacterial wilt (*Pseudomonas solanacearum*), *Phyllosticta* leaf spot (*Phyllosticta zingiberi*) and storage rot by many pathogenic, saprophytic fungi and bacteria are of economic importance because of their potential to cause great losses to ginger production. The constraints in disease management and the strategies that have been developed to manage the diseases involving cultural, chemical and biological methods combined with soil solarization are discussed. Future options for the management of ginger diseases by integration of conventional strategies with modern biotechnological means for effective control measures are also discussed.

Key words: diseases, ginger, management, *Zingiber officinale.*

Introduction

Ginger (*Zingiber officinale* Rosc.) is an important commercial crop grown in Kerala, Karnataka, Tamil Nadu, West Bengal, Bihar, Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Meghalaya, Sikkim and Orissa for its aromatic rhizomes which are used both as spice and medicine.

Ginger is affected by many diseases (Iyer 1988). Of them, rhizome rot, bacterial wilt, yellows, *Phyllosticta* leaf spot and storage rot are major diseases which cause economic loss and are dealt in this paper.

Distribution and crop losses

Rhizome rot caused by *Pythium* spp., yellows by *Fusarium* spp. and bacterial wilt by *Pseudomonas solanacearum* are serious diseases in most of the ginger growing areas and cause great losses to ginger, because once the plants are infected, they result in total loss of clumps. In Kerala, bacterial wilt and rhizome rot are prevalent in major ginger areas (Dake & Edison 1988).

Epidemiology

The pathogens responsible for soft rot, bacterial wilt and yellows are soil inhabitants invaders/ dwellers having high degree of competitive saprophytic ability. Being seed and soil borne in nature, the infection of these diseases in the field may either originate from infected seed rhizomes or soil. The spread of the disease is through soil, rain, irrigation water or rain splash to the adjacent plant within a bed as well as along the gradient of the field.

Effect of climatic factors

The ginger crop is rainfed as well as irrigated. A warm and humid climate predisposes the plant to infection at sprouting stage, because of its tender and succulent tissues. The spread is typical of soil borne diseases because of fairly heavy and well distributed showers during the crop growth period June to October

Diagnosis

The fungal (*Pythium* spp., *Fusarium* spp.) and bacterial (*P. solanacearum*) infections occur simultaneously in field (Dake & Edison 1989). Proper diagnosis of diseases is essential for their management and prevention (Dake, Ramachandran & Sarma 1988). The first conspicuous symptom of bacterial wilt (to differentiate it from fungal infection) is flaccidity and curling of leaf margins downward. The colour of leaves remain dark green in bacterial wilt whereas in case of fungal infection the infected plants turn to pale yellow. The fungal infection can also be distinguished from bacterial wilt by the absence of milky bacterial ooze when the rhizomes or pseudostems are cut transversely.

Phyllosticta leaf spot

Leaf spot of ginger caused by *Phyllosticta zingiberi* Ramkr. is observed on leaves especially when the crop is grown under exposed conditions. The disease starts as water soaked, oval to elongated spots and later turn as whitish spots surrounded by dark brown margin with an yellowish halo. The pycnidia appear on the mature lesions and remain viable for about 14 months in leaf debris. The spores ooze out into water drops on the leaves and get dispersed through rain splashes (Brahma & Nambiar 1982 & 1984)

Dohroo *et al.* (1986) reported that none of the ginger types screened was found resistant to *P.zingiberi.* However, Premanathan, Peethambaran & Abi Cheeran (1982) found that the cultivars Maran and Karakkal are comparatively resistant to *Phyllosticta* leaf spot. The disease can be managed by one or two sprays of Bordeaux mixture (1%) (Ramakrishnan 1942; Sohi, Sharma & Varma 1973).

Storage rot

Seed rhizomes of ginger have to be stored for about 5 months from harvest in December to planting in April - May. During storage, the rhizomes are subjected to moisture loss and also deterioration if colonised by microorganisms (Haware & Joshi 1974; Sarma & Nambiar 1974). To check such deterioration and moisture loss during storage, several practices have been recommended (Joshi & Sharma 1982; Dake *et al.* 1989).

Disease management

An inegrated disease management programme involving cultural, chemical and biological methods combined with disease resistance is called for, to minimise crop losses and thus increasing the yield of ginger.

Cultural

Selection of seed material

These diseases apparetly perpetuate through infected rhizomes and this serves as primary source of inoculum in the newly cultivated field of ginger. The use of rhizomes from disease free areas to prevent carry over of inoculum to subsequent ginger crops has been recommended to control soft rot caused by *Pythium* spp. (Park 1941), yellows by *Fusarium oxysporum* f. sp. *zingiberi* (Rana 1991) and bacterial wilt by *P. solanacearum* (Pordesimo & Raymundo 1963).

Crop rotation

Soil borne diseases are severe when ginger is grown every year on the same land because of the persistence of the pathogen in soil. Pordesimo & Raymundo (1963) suggested crop rotation to control bacterial wilt of ginger. Quimio and Chan (1979) found that rice and corn are reliable rotation crops with susceptible host species to minimize the incidence of bacterial wilt.

Organic amendments

The incorporation of various organic amendments was found effective in reducing the incidence of soft rot caused by *P. aphanidermatum* and increase in yield (Balagopal *et al.* 1974; Ghorpade & Ajiri, 1982). Ghorpade & Ajiri (1982) and Thakore *et al* . (1987) reported that amendments of oil cakes made from *Azadirachta indica, Calophyllum inophyllum, Pongamia glabra, Hibiscus subdariffa* and *Brassica campestris* were effective in reducing the incidence of rhizome rot caused by *F. solani,* and increasing yield of ginger crop.

Suppressive soils

Lee, Cheong & So (1990) reported that higher clay content and lower pH in soil from Eunhari is suppressive to *P. zingiberum* and *F. oxysporum* f. sp. *zingiberi* than the conducive soils in Korea. Power (1983) reported that bacterial wilt never occurs on the sea - shell ridges of the coastal plain of Surinam.

Elimination of weed hosts

Many weed hosts of *P. solanacearum* are symptomless carriers, wherein bacteria survive in the rhizospheres of these weed hosts (Quinon, Aragaki & Ishii 1964; Ishii & Aragaki 1963; Zehr 1969; Moffett & Hayward 1980). Pegg & Moffett (1971) and Indrasenan *et al.* (1981) suggested removal of weed hosts of *P. solanacearum* to check the disease spread.

Soil solarization

Soil solarization has been successfully utilized using solar heating by polythene mulching for 40 days in April - May. It was found that disease incidence was reduced and germination percentage and yield of ginger were increased in solarized plots compared to non- solarized plots (NRCS 1993).

Planting in raised beds

Poor drainage and water stagnation predispose the crop to infection. Well drained raised beds and provision of adequate drainage channels in the fields are recommended.

Phytosanitation

Phytosanitary measures are to be taken once the diseases are noticed in the field. Roguing diseased plants and destroying them will help in reducing the disease. All the tools used for earthing up of infected beds are to be disinfected to check the spread of inoculum to healthy beds.

Chemical

Soft rot

Treating seed rhizomes with Dithane M - 45 (0.3%) for 30 min and soil drenching with the same fungicide at same concentration have been recommended for the control of soft rot (NRCS 1986). In pot culture experiment, application of metalaxyl formulations, namely, Ridomil 5 G (soil application) and Apron 35 WS (Seed treatment) gave best control of rhizome rot in *Pythium* infected soil (Ramachandran, Dake & Sarma 1989).

Yellows

Haware & Joshi (1974) recommended dipping seed rhizomes in fungicidal suspension of Dithane M - 45 (0.3%) or Benelate for the control of rhizome rot caused by *F. oxysporum* f. sp. *zingiberi.* Rajkumar & Pandey (1989) found best control of rhizome rot caused by *F. oxysporum* when seed rhizomes were treated with Topsin M-70 (1%) combined with soil drench with formaldehyde (4%).

Bacterial wilt

Dake, Ramachandran & Sarma (1988) reported that treatment of seed rhizomes with streptocycline 200 ppm and soil drenching with streptocycline or application of bleaching powder was partially effective to keep the disease under check for 3 months. Ishii & Aragaki (1963) observed that soil fumigation with methyl bromide at 1.362 kg/ 1.21 sq m checked the disease.

Biological

Soft rot

In vitro antagonistic effect of *Trichoderma* spp. against *Pythium* spp. was reported by Thomas (1939). The disease incidence of *Pythium* rot was less and yields were higher in beds treated with *Trichoderma* spp. and *Gliocladium virens* compared to beds that received Dithane M - 45 and untreated control in soil solarized plots (NRCS 1993).

Yellows

The use of some strains of fluorescent Pseudomonads against *Pythium* spp. and *Fusarium* spp. is well documented (Hagedora, Gould & Bardinelli 1989; Kaiser, Hannan & Weller 1989; Howell & Stipanovic 1980). However further studies are required to test their efficacy in suppressing diseases in ginger.

Bacterial wilt

Sekhawat *et al.* (1992) showed the possibilities of biological managment of potato bacterial wilt using strains of *Bacillus* spp., *B. subtilis, Pseudomonas fluorescence* and actinomycetes. Kempe & Sequeira (1983) and McLanghlin & Sequeira (1988) used the antagonisitic avirulent mutants of *P. solanacearum* to induce resistance against *P. solanacearum* causing bacterial wilt in potato.

Storage

Seed treatment with *Trichoderma* spp. was effective in controlling rhizome rot of ginger in storage (Bhardwaj *et al.* 1988).

Resistance

None of the varieties screened against *Pythium* spp. (Nybe & Nair 1979; Sarma, Nambiar & Brahma 1980), *Fusarium* spp. (Rana & Arya 1991) and *P. solanacearum* (Indrasenan *et al.* 1982) was resistant. However the cultivars Maran, Nadiya and Narasapattom were found resistant to moderately resistant to *P.*

aphanidermatum (Indrasenan & Paily 1973; Balagopal *et al.* 1974). In artificially inoculated field conditions, China, Rio-de-Janeiro, Jorhat, Thingpui, Maran, Tura and Amadi were reported resistant to *P. solanacearum* (Sinha *et al.* 1990). Attempts are being made to select toxin resistant cells by culturing ginger cells in the presence of toxic compounds isolated from *P. solanacearum* and *P. aphanidermatum* (NRCS 1993).

Constraints

Production of disease free seed rhizomes

Non-availability of disease free planting material is a major constraint in the cultivation of ginger and there are at present no agencies involved for producing and distribution of quality seed rhizome material.

Lack of disease detection technique

At present no technique is available to detect seed borne pathogens. Farmers very often find it difficult to raise disease free planting material and rely mostly on presence or absence of symptoms to indicate whether the harvested rhizomes are pathogen free or healthy.

Resistant varieties

None of the varieties available for cultivation are resistant to soft rot, yellows and bacterial wilt. Moreover ginger is propagated exclusively by vegetative means, because of lack of seed set, and the conventional approach for breeding and selection for disease resistance is also a stumbling block in the development of varieties resistant to these diseases.

Lack of control measures

The etiology of these soil borne diseases is well understood but there is no effective control measure to save the crop in the field. Once the plants/clumps get infected it results in complete rotting. The technology in respect of management of these soil borne diseases has to be improved to increase productivity of ginger.

Future strategies

1. Production and distribution of disease free seed material is one of the best methods to promote production. Certified seed plots for this purpose have to be established in disease free locations.

2. Development of sensitive techniques such as DNA probes for the detection and differentiation of pathogens involved in rhizome rot complex.

3. Breeding for disease resistant is difficult through conventional breeding methods due to absence of seed set. Exploitation of somaclonal variation for *in vitro* selection for disease resistance has to be done to incorporate resistance in integrated disease management programmes.

4. Soil solarization, which is a new approach for disinfestation of soil has to be incorporated in disease management programmes involving resistance, biological, chemical and cultural methods of management of diseases.

5. The integration of conventional strategies with modern biotechnological means for effective management of disease is essential. The potential of *Gliocladium, Trichoderma, Bacillus* and fluorescent *Pseudomonas* spp. in combating these soil borne diseases of ginger are well documented. Manipulation of these strains for greater effectivity and field stability has to be exploited.

References

Balagopal C, Devi S B, Indrasenan G & Wilson K 1974 a Varietal reactions of ginger (*Zingiber officinale* Rosc.) towards soft rot caused by *Pythium aphanidermatum* (Edson) Fitz. Agric. Res. J. Kerala 12 : 113-116.

Balagopal C, Devi S B, Rajan K M & Menon M R 1974 b Biological control of soft rot of ginger. Arecanut & Spices Bull. 6 : 29-30.

Bhardwaj S S, Gupta P K, Dohroo NP & Shyam K R 1988 Biological control of rhizome rot of ginger in storage. Indian J. Plant Path. 6 : 56-59.

Brahma R N & Nambiar K K N 1982 Survival of *Phyllosticta zingiberi* Ramakr., causal agent of leaf spot disease of ginger. In: Nair M K, Premkumar T, Ravindran P N & Sarma YR (Eds.) National Seminar on Ginger and Turmeric, 8-9 April 1980, Calicut (pp. 123-125). Central Plantation Crops Research Institute, Kasaragod, India.

Brahma R N & Nambiar K K N 1984 Spore release and dispersal in ginger leaf spot pathogen - *Phyllosticta zingiberi.* In: Proc. PLACROSYM - V 1982 (pp. 541-554). Indian Society for Plantation Crops, Kasaragod, India.

Dake G N & Edison S 1988 Survey for disease incidence in major ginger growing areas of Kerala during 1984 and 1985. J. Plantn. Crops 16 : 55-57.

Dake G N & Edison S 1989 Association of pathogens with rhizome rot of ginger in Kerala. Indian Phytopath. 42 : 116-119.

Dake G N, Ramachandran N & Sarma Y R 1988 Strategies to control rhizome rot (*Pythium* spp.) and bacterial wilt (*Pseudomonas solanacearum*) of ginger. J. Coffee Res. 18 (Suppl.) : 68-72.

Dake GN, Anandaraj M, Raju C A & Iyer R 1989 Storage method of ginger seed rhizomes. Tech. Report, National Research Centre for Spices, Calicut.

Dohroo N P, Shyam K R, Bhardwaj S S & Korla B N 1986 Reaction of ginger germplasm to *Phyllosticta* leaf spot. Indian Phytopath. 39 : 605-606.

Ghorpade S A & Ajiri D S 1982 Effectiveness of oilseed cakes in control of rhizome rot malady of ginger. J. Maharashtra Agric. Univ. 7 : 272-273.

Hagedora C, Gould W D & Bardinelli T R 1989 Rhizobacteria of cotton and their suppression of seedling disease pathogens. Appl. & Environ. Microbiol. 55 : 2793-2797.

Haware M P & Joshi L K 1974 Efficacy of certain fungicides against seed borne infection by *Fusarium oxysporum* in ginger. Indian Phytopath. 27 : 236-237.

Howell C R & Stipanovic R D 1980 Suppression of *Pythium ultimum* induced damping off of cotton seedlings by *Pseudomonas* *fluorescensce* and its antibiotic pyoluteorin. Phytopath. 70 : 712-715.

Indrasenan G & Paily P V 1973 Studies on the soft rot of ginger (*Zingiber officinale* Rosc.) caused by *Pythium aphanidermatum* (Edson) Fitz. Agric. Res. J. Kerala 11(1) : 53-56.

Indrasenan G, Sreekumar V, Mathew J & Mammen M K 1981 The mode of survival of *Pseudomonas solanacearum* (Smith) Smith causing bacterial wilt of ginger (*Zingiber officinale* Rosc.). Agric. Res. J. Kerala 19 : 93-95.

Indrasenan G, Vasantha Kumar K, Mathew J & Mammen M K 1982 Reaction of different types of ginger to bacterial wilt caused by *Pseudomonas solanacearum* (Smith) Smith. Agric. Res. J. Kerala 20 : 73-76.

Ishii M & Aragaki M 1963 Ginger wilt caused by *Pseudomonas*. E. F. Smith Pl. Dis. Reptr. 47 : 710-713.

Iyer R 1988 Diseases of ginger. In : Raychaudhuri SP & Verma J P (Eds.) Review of Tropical Plant Pathology Volume 4. (pp. 251-288). New Delhi.

Joshi L K & Sharma N D 1982 Diseases of ginger and turmeric. In : Nair MK, Premkumar T, Ravindran P N & Sarma Y R (Eds.). National Seminar on Ginger and Turmeric, 8-9 April 1980, Calicut (pp. 104-119). Central Plantation Crops Research Institute, Kasaragod, Kerala, India.

Kaiser W J, Hannan R M & Weller D M 1989 Biological control of root rot and pre-emergence damping off of chick-pea with fluorescent Pseudomonads. Soil Biol. Biochem. 21 : 269-273.

Kempe J & Sequira L 1983 Biological control of bacterial wilt of potatoes: attempts to induce resistance by treating tubers with bacteria. Pl. Dis. 67 : 499-503.

Lee W H Cheong S S & So I Y 1990 Properties of suppressive and conducive soils to ginger rhizome rot. Korean J. Plant Path. 6 : 338-342.

McLaughlin J R & Sequira L 1988 Evaluation of an avirulent strain of *Pseudomonas solanacearum* for biological control of bacterial wilt of potato. American Potato J. 65 : 255-268.

Moffett M L & Hayward A C 1980 The role of weed species in the survival of *Pseudomonas solanacearum* in tomato cropping land. Australian Plant Path. 9 : 6-8.

National Research Centre for Spices 1986 Annual Report for 1985. National Research Centre for Spices, Calicut, Kerala, India.

National Research Centre for Spices 1993 Annual Report for 1992. National Research Centre for Spices, Calicut, Kerala, India.

Nybe E V & Nair P C S 1979 Field tolerance of ginger types of important pests and diseases. Indian Arecanut Spices & Cocoa J. 2 (4) : 109-111.

Park M 1941 Report of the Work of the Division of Plant Pathology (pp. D 20-D22). Adm. Rep. Dir. Agric., Ceylon 1939.

Pegg K G & Moffett M L 1971 Host range of the ginger strain of *Pseudomonas solanacearum* in Queensland. Australian J. Exp. Agric. Anim. Husb. 11 : 696-698.

Premanathan T, Peethambaran C K & Abi Cheeran 1982 Screening of ginger cultivars against *Phyllosticta* leaf spot. In: Nair M K, Premkumar T, Ravindran P N & Sarma Y R (Eds.) Proc. National Seminar on Ginger and Turmeric, 8-9 April 1980, Calicut (pp. 126-127). Central Plantation Crops Research Institute, Kasaragod, Kerala, India.

Pordesimo A N & Raymundo S A 1963 Rhizome rot of ginger and its control. Coff. Cocoa J. 5 : 240.

Power R H 1983 Relationships between the soil environment and tomato resistance to bacterial wilt *Pseudomonas solanacearum* 4. Control methods. Surinaamse Landbouw. 31 : 39-47.

Quimio A J & Chan H H 1979 Survival of *Pseudomonas solanacearum* E. F. Smith in the rhizosphere of some weed and economic plant species. Philippine Phytopath. 15 : 108-121.

Quinon V L, Aragaki M & Ishii M 1964 Pathogenicity and serological relationships of three strains of *Psedomonas solanacearum* in Hawaii. Phytopath. 41 : 1096-1099.

Raj Kumar & Pandey J C 1989 Chemical control of rhizome rot of ginger by seed and soil treatments. Prog. Hort. 21: 130-133.

Ramachandran N, Dake G N & Sarma Y R 1989 Evaluation of systemic fungicides for efficiency against rhizome rot of ginger. Indian Phytopath. 42 : 530-533.

Ramakrishnan T S 1942 A leaf spot disease of *Zingiber officinale* caused by *Phyllosticta zingiberi* n.sp. Proc. Indian Acad. Sci. 15 : 167-171.

Rana K S 1991 Effect of seed selection in the management of yellow disease of ginger. Indian J. Mycol. Plant Path. 21 : 183-185.

Rana K S & Arya P S 1991 Rhizome rot and yellow disease of ginger in Himachal Pradesh. Indian J. Mycol. Plant Path. 21 : 60-62.

Sarma Y R & Nambiar K K N 1974 Dry rot of ginger caused by *Macrophomina phaseolina* (Tassi) Goid. Curr. Sci. 43 : 487-488.

Sarma Y R Nambiar K K N & Brahma R N 1980 Studies on rhizome rot of ginger and its control. In Proc. PLACROSYM - II (pp. 386-397). Central Plantation Crops Research Institute, Kasaragod, Kerala, India.

Shekhawat G S, Chakrabarti S K, Kishore V, Sunaina V & Gadewar A V 1992 Possibilities of biological management of potato bacterial wilt with strains of *Bacillus* spp. *B. subtilis*, *Pseudomonas fluorescens* and actinomycetes. Intenational Bacterial Wilt Symposium, Program & Abstract, AVRDC.

Sinha S K, Mishra B, Singh D K & Jain B P 1990 Wilt resistance of ginger (*Zingiber officinale*) cultivars to *Pseudomonas solanacearum* E. F. Smith from Chotanagpur (Bihar) India. Bacterial Wilt News l. 6:6

Sohi H S, Sharma S L & Varma B R 1973 Chemical control of *Phyllosticta* leaf spot of ginger (*Zingiber officinale*). Pesticides 7 : 21-22.

Thakore B B L, Mathur S, Singh R B & Chakravarti B P 1987 Soil amendment with oil cakes in ginger field for rhizome rot control. Korean J. Plant Protection 26 : 267-268.

Thomas K M 1939 Detailed Administration Report of the Government Myologist, Madras for the Year 1939.

Zehr E I 1969 Studies of the distribution and economic importance of *Pseudomonas solanacearum* E.F. Smith in certain crops in the Philippines. Philippine Agric. 53 : 218-223.