DISEASES OF GINGER — A REVIEW

Zakaullah and Khial Badshah*

Ginger (*Zingiber officinale*), an important perennial rhizomatous herb indigenous to Southern Asia, is now widely cultivated for spices and drugs throughout the tropics. The feasibility of its introduction is being studied in Pakistan. Work on the collection of information on the diseases of the crop was initiated at the Pakistan Forest Institute, Peshawar and available ilterature on the subject was reviewed.

Ramakrishnan (1949) reported the occurrence of *Pythium vexans* on several hosts including ginger growing at elevations of over 915 m. The aerial shoots of ginger were found to turn yellow and wilt and rhizomes were rotten. The sysmptoms caused by the pathogen were similar to those of *P. aphanidermatum* and *P. myriotylum*, occurring at lower elevations, known as damaging agents to the crop. Besides, 50 to 90% of stored seed rhizomes are destroyed by the destructive pathogens if untreated.

Mehrotra (1952) observed white aerial mycelium covering the stored ginger rhizomes. It resembled in all respects to that of *Fusarium roseum* except in size and septation of the conidia. The inoculation experiments suggested that the fungus may be a secondary or wound-parasite. The rhizomes were also seen, in a local market, bearing patches of the mycelium of *Sclerotium rolfsii*, a new host record for India.

Simmonds (1957) found that treatment of seed-pieces with an organic mercurial, to control ginger rhizome rot caused by *F. oxysporum*, was more effective than with captan.

Simmonds (1958) controlled ginger rhizome rot (*F. oxysporum*) by immersing rhizomes in 2 lb/40 gallons of standard mercurials for 10 minutes. The higher concentrations, however, provoked an abnormal shooting.

Fordesimo (1963) carried out studies on rhizomes rot of ginger and its control. Bacterial rhizome rot was found to be the most serious disease in Phillippines. Crop rotation alongwith sanitary practices was recommended as a measure to minimize the risk of infection. Immersion of seed-pieces in a 0.06% suspension of a mercurial seed protectant for 1-1/2 hours was also recommended since the causal bacterium was generally found to enter through wounds. An addition of DDT or aldrin to this suspension was found desirable to protect the seed pieces from insect attack.

* The authors are Forest Pathologist and Technical Assistant respectively, at the Pakistan Forest Institute, Peshawar.

Teakle (1965) distinguished two types of rhizome rot in ginger caused by *Fusarium* spp. Dipping of artificially infected rhizome pieces in ethoxyethyl mercury chloride (EMC), diluted with water to a Hg concentration of 0.015% for not less than 30 minutes or in twice this concentration for 10 minutes, resulted in a healthy crop. The curing of infected rhizome pieces for 5 days and dipping in 0.2% captan or dusting with captan and chloranil had little beneficial effect. Dipping in EMC at a Hg concentration of 0.05% for 30 minutes produced toxic effects. Some organo-mercurials including EMC were, however, found to stimulate shooting of the rhizomes even when the pathogen was absent. Therefore, the dip treatment was recommended under all conditions.

Teakle (1965) carried out control experiments against a new strain of *F. oxysporum*. The disease was controlled in inoculated rhizomes by ethoxyethyl mercury choloride (6% Hg) dips at 1 lb/40 gallons for 30 minutes or 2 lbs/40 gallons for 10 minutes. The captan dips, captan or chloranil dust treatments and pre-inoculation curing of rhizomes for 5 days did not prove effective. Shooting of healthy rhizome pieces was stimulated by ethoxyethyl Hg chloride, methoxyethyl Hg chloride and phenyl Hg acetate.

Chanliongco (1966) found treatment with Zerlate, Vancide Z-65 and Dithane M-22 quite effective in controlling the leaf spot disease of ginger caused by *Phyllosticta zingiberi*.

Huang (1966) studied the host-parasite relationships of the root-knot nematode in edible ginger. *Meloidogyne incognita* was found to infect rhizomes as well as fibrous and fleshy roots. Major crop losses, however, were due to rhizome infection. The rhizomes were found invading through the axil of leaf sheath in the shoot apex. In fibrous roots, penetration occurred in the area of differentiation whereas fleshy roots were invaded throughout the entire length of the root. The nematode developed to maturity in approximately 24 days in both fibrous and fleshy roots whereas 43 days were required in rhizomes at 30°C soil temperature. Mature female laid eggs with in internal lesions formed in the fleshy roots and rhizomes and most of the hatched larvae were also trapped in there. Wound cork around the lesions was suberized only in ood rhizomes after harvest.

Hayward (1967) recorded bacterial wilt of ginger, for the first time, from Oueensland, Australia. Two types of wilt caused by biotypes 3 and 4 could be distinguished. Seven weeds, commonly found in ginger plantings, were found infected with biotype 3. The pathogenicity of biotype 4 to a number of hosts was determined and its reaction on ginger was compared with that of biotype 3 and biotype 2, isolated from potato.

Colbran (1968) reported observations on the occurrence of root-knot nematodes on *Zingiber officinale* and tested the effectiveness of some nematicides against nematode infestation. *Meloidogyne javanica* and *M. incognita* were found to be the important and widespread pests of ginger. They were found to occur in virgin ground, having many alternative hosts and were readily spread in planting material Treatment of infested soil with DD, before planting nematode free seed pieces increased yield by 80%. Hot water treatment was also found quite effective in killing nematodes in rhizomes and combined with soil fumigation proved to be a practical method of producing nematode-free ginger.

Colbran and Davis (1970) studied the effect of hot water treatment and soil fumigation on the incidence of root-knot disease in ginger. The root-knot nematodes: *M. javanica* and *M. incognita* in ginger seed-pieces were controlled, without adverse effects on germination, by hot water treatment at temperature between 45° and 55° C for 5 to 10 minutes. Pre-plant fumigation with DD, EDB, TBC and DBCP also reduced the incidence of root-knot disease. Pre-plant fumigation with EDB and the alone PBC in one trial and DBCP in an other were also found helpful in increasing the yield of the crop.

Rodriquez (1971) compiled information on ginger in Jamaica and also discussed its diseases.

Annonymous (1972) determined *P. zingiberi* to be the cause of numerous circular, oval or elongated leaf spots with white centres, brown margins and yellowish halos giving a general yellowing appearance to the crop.

Colbran (1972) carried out studies on the control of root-knot nematodes in ginger with some non-volatile nematicides applied at and after planting. Of the many granular nematicides applied and fumigants tried alongwith hot water treatment only nemacur at rates of 22-25 Kg/ha was found sufficiently effective against root-knot nematodes (*M. javanica*, *M. incognita*) infestation especially when applied no less than four months after planting.

Haware and Joshi (1973) recorded basal rot of ginger (*Z. officinale*) caused by *Sclerotium rolfsii* (*Corticium rolfsii*).

Pauloce (1973) described soft rot disease of ginger as one of the major enemies of the crop in India. The rot was found to be caused by a species of *Pythium*. The affected plants become pale and the tips of the leaves turn yellow followed by complete yellowing and drying-up of the leaves. The base of the shoot becomes soft and watery due to the infection of the fungus. The infection extends to the rhizomes as a result of which all the tissues inside get reduced to a soft black purefying mass. The infected plants stop producing further rhizomes. A high soil moisture content and insufficient drainage favoured the incidence of the disease. Since the infection was soil-borne, therefore, growing ginger in the same field year after year was not advisable. Selection of a well-drained site for planting and the use of disease-free seed material was also recommended as a precautionary measure.

Sohi et al (1973) studied chemical control of *Phyllosticta* leaf spot of ginger. Spraying with 0.2% Dithane Z-78, six times at fort-nightly intervals, gave good control of *Phyllosticta* (Zingiberi). Flit 406 (0.3%), Dithane M-22 (0.2%) and Bordeaux mixture (1%) were also found effective.

Haware et al (1973) studied the effect of post-harvest treatment of aureofungin on rhizome rot and viability of ginger seed rhizomes. Out of the nine fungicides used for post-harvest dip treatment against storage rot, mostly due to *F. oxysporum* var. Zingiberis, aureofungin at 0.02% and benlate at 0.2% gave the best control and did not effect viability of the rhizomes.

Lum (1973) carried out cross-inoculation studies of *Pseudomonas solanacearum* obtained from ginger. A weakly virulent form of *P. solanacearum*, isolated from ginger, did not produce symptoms on tomato, tobacco and ground-nut. It was, however, recovered from inoculation sites on these plants. Symptoms on ginger were described and methods of dispersal and control of the pathogen were discussed.

Haware and Joshi (1973) reported the occurrence of *F. oxysporum* causing yellow disease of ginger, for the first time, on *Z. officinale*.

Agrawal (1974) studied the effect of root-knot extract of ginger on *F. oxysporum* f. zingiberi, the cause of yellows disease. Linear growth and hyphal thickness of the pathogen were found greater in an extract of roots galled by *M. incognita* than in that of healthy roots indicating that some growth promoting substance is produced by interaction of the host and nematode.

Haware and Joshi (1974) tested the effectiveness of fungicides: benlate, demosan, plantwax, ceresan, agallol, brassicol and dithane against seed-borne infection by *F. oxysporum* in ginger.

Lee (1974) studied the effect of rhizome size and fungicide treatment on the sprouting and early growth of ginger. In a rhizome size X fungicide factorial experiment, conducted on peat, fungicide treatment had no significant effect on rotting of the rhizome portions.

Pegg et al (1974) described the pathogen, symptoms, survival, spread and control of bacterial wilt of ginger caused by *P. solanacearum*. Two biotypes were found to be involved. Biotype 111 caused common tomato wilt but was responsible for only an insignificant and slow wilt in ginger whereas biotype IV caused a very rapid severe wilt and heavy losses. Other diseases included: yellow and rhizome rot caused by *F. oxysporum* f.sp. Zingiberi, a rhizome, root and basal stem rot caused by an undetermined white fungus which generally fills the diseased hollowed out stem base and envelopes the rhizome, a rhizome and stem rot caused by *Armillariella mellea* and *S. rolfsii*; big bud caused by the tomato big bud mycoplasma and a bacterial soft rot (*Erwinia carotovora* var. carotovora).

Sharma and Nambiar (1974) reported a dry rot of ginger caused by *Macrophomina phaseolina*.

Indrasenan and Paily (1974) carried out studies on the soft rot of ginger (*Z. officinale*) caused by *P. aphanidermatum*. Of the 21 varieties screened for susceptibility to *P. aphanidermatum*, based on mean percentage infection of inoculated rhizomes, Maran was the most resistant.

Haware and Joshi (1975) recorded the pathogen *P. deliense* causing soft rot of ginger as a new disease from India.

Purseglove (1975) reported leaf spotting caused by *Colletotrichum zingiberis* and *P. zingiberi* from Asia; *Coniothyrium zingiberi* and *Pythium* spp. causing serious soft rot of

rhizomes and red and black rots caused by *Nectriella zingiberi* and *Rosellinia zingiberi*, respectively, from Phillippines. A bacterial wilt caused by *P. solanacearum* was also reported. Pre-plant fungicide treatment of the setts was advised.

Balagobal et al (1975) studied varietal reaction of ginger towards soft rot caused by *P. aphanidermatum*. Out of 22 varieties tested only Nadiya and Narasapattam were found moderately resistant to the disease.

Haware and Joshi (1975) tested the effectiveness of some fungicides against seed-borne infection by *F. oxysporum* in ginger. The results indicated that benlate and dithane M-45 could be recommended for ginger rhizome, a dip treatment, for the control of rhizome rot and seedling infection caused by *F. oxysporum*.

Vilsoni et al (1976) reported the occurrence, host range and histopathology of *Radopholus similis* in ginger (*Z. officinale*). Field surveys and examination of ginger, harvested for export, showed that *R. similis* was widely distributed throughout the ginger growing areas of Fiji. Nematodes were found to enter the rhizomes and penetrate tissues intracellularly causing large infestation resulting in the destruction of tissues and the formation of channels or galleries with in the rhizome. Secondary organisms eventually rotted the entire rhizome. The infected ginger plants showed stunting, chlorosis and failure to tiller profusely.

Annonymous (1976) found, during field tests, that preplant dips for only 1 minute in bensimidazole type fungicides gave effective control of seed-borne *F. oxysporum* f.sp. zingiberi on ginger.

Sharma and Joshi (1976) briefly described three new storage diseases of ginger caused by *Nectria inventa*, *Trichurus spiralis* and *Memnoniella echinata*.

Haware et al (1976) recorded some rhizomiicolous and foliicolous fungi of ginger. The new fungi, isolated from rhizomes and soil, were described. Some of the isolates, however, proved pathogenic on stored ginger.

Vock (1977) reported some pests and diseases of ginger from Queensland. Rhizome, root and basal stem rot caused by an unidentified white fungus was found responsible for serious losses on some farms. The most conspicuous sysmptom was the white fungus enveloping the rhizome. The serious out-breaks of the disease occurred in areas previously used for sugar-cane. It was also found to occur in any soil with undecomposed plant trash. Big bud was another serious disease the causal agent of which is known to spread by a leaf hopper. Root-knot caused by the nematodes: *M. javanica* and *M. incognita* was also reported as wide-spread pest of ginger. The fungus *Armillaria* sp. was found to cause a rhizome rot in the recently cleared forest areas.

Sharma and Jain (1977) studied the mycoflora of stored and freshly harvested rhizomes of *Z. officinale*. 29 fungi, found associated with ginger rhizomes, were tabulated including the pathogens: *F. oxysporum*, *P. deliense* and *P. myriotylum*.

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