CROP LOSS CAUSED BY CYST NEMATODE *Heterodera oryzicola* INFESTING RICE

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THESIS

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1989.

DECLARATION

I hereby declare that this thesis entitled "Crop loss caused by cyst nematode, Heterodera oryzicola infesting rice" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or society.

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11th April, 1989.

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Certified that this thesis, entitle "Crop loss caused by cyst nematode, Heterodera oryzicola infesting rice" is a record of research work done independently by Sri. S. Neelambaran, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to him.

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INTRODUCTION

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Rice (Oryza sativa.L), the staple food of Indian people, is economically the most important among the cereal crops of our country. It is cultivated all over India. During 1985-'86, India produced 63.82 million tonnes of rice from 41.14 million hectares of land (Anon, 1988 a). This includes 1.17 million tonnes of rice produced from 0.68 million hectares of Kerala State (Anon, 1988 b).

Rice is subjected to several diseases and pests that brings about heavy economic loss to our nation. Plant parasitic nematodes as pests of rice constitute a major threat causing significant reduction in yield. (Muniappan and Seshadri, 1964; Birat, 1965; Banerji and Banerji, 1966; Biswas and Rao, 1970). Among these nematodes, the rice cyst nematode, H.oryzicola had been reported as a severe pest in Kerala which takes a heavy toll of the crop in all seasons (Rao, 1978).

The presence of H.oryzicola was first observed by Rao and Jayaprakash (1977) in the upland areas of Palghat District. Later it was reported from Trivandrum (Anon, 1979) and Quilon Districts (Kuriyan et al., 1985) indicating the widespread distribution of this nematode throughout the State.

Due to continuous cultivation of the crop and the ability of the nematode to transform into cysts to tide over the adverse conditions, the rhizosphere usually maintains a very high population of this cyst nematode (Jayaprakash and Rao, 1984b).

Though the occurrence of H.oryzicola was reported, precise information of its distribution and extent of damage on rice crop in different tracts of Kerala is lacking. Hence the present investigations were carried out.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The available literature relevant to the different aspects of the study covered is reviewed below.

2.1. Importance of *Heterodera* spp. on rice crop

Rice plant (*Oryza sativa* L.) is infested by thirteen genera of plant parasitic nematodes of which *Hirschmaniella*, *Aphelenchoides*, *Ditylenchus*, *Tylenchorhynchus*, *Meloidogyne* and *Heterodera* are the predominent (Ichinohe, 1972). Among the above mentioned plant parasitic nematodes, the cyst forming group of *Heterodera* are of major economic importance on agricultural crops (Sheperd, 1965).

2.2. Distribution

2.2.1. In India

In India sixteen *Heterodera* spp. are found distributed, some of them being associated with economically important crops (Swarup and Gokte, 1986). This includes the new species reported from India, viz. *H. mothi* on cyperus (Khan and Hussain, 1965), *H.cajani* on pigeon pea (Koshy, 1967), *H.vigna* on cowpea (Edward and Mishra, 1968), *H.zeae* on maize(Kozhy *et al.*, 1970b), *H.chaubattia* on apple(Gupta and Edward, 1975), *H.oryzicola* on rice (Rao and Jayaprakash, 1978) and

H.delvii on ragi (Jayarajpuri, et al. 1979).

2.2.2. In Kerala

Rao and Jayaprakash (1977) reported the occurrence and habitat of H.oryzicola in the rhizosphere and roots of rice from Palghat District of the State. Extensive survey on the distribution of cyst forming nematodes in India revealed that H.oryzicola is confined to Kerala State (Sharma and Swarup, 1983). Kuriyan et al., (1985) reported its occurrence in the paddy fields of Trivandrum and Quilon Districts showing its wider distribution. Venkitesan and Charles (1985) and Charles and Venkitesan (1984) reported H.oryzicola parasitizing banana from Trichur, Ernakulam, Quilon and Calicut Districts.

2.3. Population dynamics

2.3.1. Effect of season

It was demonstrated experimentally that two successive generations of H.schachtii could develop in a single season from April to October, under climatic conditions of Kosice, Czechoslovokia (Curi and Zmoray, 1961).

Investigations on the seasonal variation of the nematode population in the roots of plants revealed that the populations were high during October-November or February-March (Khan et al., 1980).

In barley the most appropriate conditions for infestation of H.avenae occurred in April, but nematode development started in April and completed by the first half of June (Stoynov, 1982).

2.3.2. Effect of soil type

Wallace (1963) reported that plant parasitic nematodes generally thrive and multiply in light soils, though they are encountered in other types of soils as well.

Prasad et al. (1959) reported that H.avenae on wheat and barley caused severe crop loss especially on light, sandy soils. Bhatti and Malhan (1981) reported that the number of cysts and cyst content developed in different soil types showed great variations when H.avenae was inoculated in one week old wheat seedlings of the variety sonolika; loamy sand and sandy loam were the best soils for higher rates of multiplication and development.

Pot culture experiments on barley and wheat inoculated with H.avenae revealed that the number of larvae infesting was lower in poorly irrigated soils than where there was adequate irrigation, and damage was greater in well aerated loose soils (Mathur et al., 1981). Damage caused by H.avenae in barley was more

in sandy soil than in sandy loam. With the increase in initial population damage also increased where as nematode multiplication was reduced (Hande et al., 1985).

Pot culture experiments of H.zeae on different soil type mixtures revealed that maximum cyst production occurred in the sandy loam sand mixture. Both aeration and available oxygen in light soils increased nematode multiplication (Srivasthava and Sethi, 1984 b).

In cabbage seedlings infested with H.schachtii the fresh weights of aerial parts and roots decreased as initial infestation increased, particularly in lighter soils (Brzeski, 1969). Whiteney and Doney (1973) reported that high proportions of sand increased inoculum efficiency of H.schachtii and reduced variation in the number of nematode larvae per plant.

2.3.3. Effect of host plant

The actual influence of the infestation of H.elachista on paddy plant was more severe at later stages of growth (Shimuzu, 1976).

The number of H.avenae larvae invading root tips of cultivated clipper variety of barley plants increased with inoculum density, time and increasing number of root tips (Davies and Fisher, 1976). Pot culture

experiments on barley and wheat infested with H.avenae revealed that larvae invaded the roots mainly in the first four weeks indicating a relationship between penetrating nematodes and age of host roots; Wheat was a more suitable host than barley (Mathur et al., 1981). Gokte and Swarup (1984 b) reported a marked difference in the penetration percentage of larvae between susceptible and resistant cultivars, at inoculum levels of 100 and 1000 larvae of H.avenae per kg soil.

H.zeae infestation on two maize cultivars, each with an inoculum of 100 and 1000 larvae per kg soil revealed that the host infestation and nematode multiplication were density dependent with maximum cyst production and nematode reproduction (Srivasthava and Sethi, 1984 a). The more intensively sugarbeet was cultivated, the higher was the population density of H.schachtii in the infested field (Greco, 1985).

2.3.4. Effect of population density

Hague and Hesling (1971) recorded a decreasing tendency in the number of cyst and cyst content of the genus Heterodera with increase in inoculum levels.

Increase in initial inoculum level of H.oryzicola caused increase in final population of the nematode and

cysts in soil, as well as in rice plant (Ushakumari and Kuriyan, 1981).

With increase in the initial density of H.oryzae inoculum there was a corresponding significant increase in the density at 35th day in the paddy soils (Rao et al., 1984).

In the French speaking Switzerland the population of H.avenae in the roots of maize crop seldom exceeded 30 larvae per g compared with more than 300 larvae per g in other cereals (Valloton and Perrier, 1976). Inoculation of H.avenae on maize at 130 larvae plus egg per 200 ml soil resulted in final population of 276 cysts per 30 g maize roots (Maas and Brinkman, 1977 a). The number of H.avenae larvae invading a wheat root increased with increasing inoculum density until a maximum was reached (O'Brine and Fisher, 1978). A natural infestation of H.avenae at 3652 to 4463 larvae per 100 g soil in soybean plots increased to tenfold after three years (Serebrennikov, 1981).

In barley infested with H.avenae, the population reached the peak after ten years (Stoynov, 1982). In wheat, barley and oats the population of the cysts of H.avenae increased from 180 to 250-343 per g soil during

the observation period of one season's growth (Sabova et al., 1981a). Magi (1984) reported that in barley infested with H.avenae, the initial population density gradually increased over four years of monoculture reaching the equilibrium point in the fourth year.

Kort (1962) recorded that a negative density dependent factor operates for high population levels of Globodera rostochiensis. G.rostochiensis at 0.4 and 1.4 viable eggs per g soil resulted in final population of 2.2 and 0.6 viable eggs per g soil respectively. Broctie (1978) reported that the number of viable eggs and larvae of G.rostochiensis adhering to potato tubers after harvesting were directly related to population density in the soil; for 104 eggs plus larvae per g soil, an average of 1045 eggs plus larvae were recorded from 4.5 kg tubers.

Smith and Prentice (1929) reported negative correlation of nematode populations at a certain stage of growth or harvest with growth or yield and positive correlation with severity of disease in sugarbeet infested by H.schachtii. In cabbage seedlings infested with H.schachtii the greatest population increase was

with an inoculum level of 50 cysts per plant (Brzeski, 1969). In sugarbeet infested with H.schachtii the maximum rate of multiplication was 150-200 larvae per g soil and maximum density was 40 larvae per g soil (Olthof, 1978). Microplot experiment showed that there was an average annual population decline of H.schachtii by 59 per cent under fallow, 57 per cent under dwarf bean, 56 per cent under carrot and 64 per cent under spinach followed by carrot. Field studies showed that the rate of population decrease varied from 49 to 93 per cent in a year (Broeski, 1983).

2.3.5. Effect of rainfall

Increased precipitation appeared to favour the population of H.avenae in both summer and winter cereals of oats, barley, wheat and in some cases potato also (Schmidt and Grimm, 1978). William and Beame (1982) reported that rainfall can greatly modify crop response to the population levels of H.avenae.

2.3.6. Effect of nutrients

Whiteney and Doney (1973) reported that low fertility increased nematode reproduction and decreased sugarbeet yield. Jayaprakash and Rao (1984 b) reported that high levels of fertilizers increased root weight

giving an increase in H.oryzicola population.

2.3.7. Effect of pathogens

Brzeski (1983) reported that H.schachtii had an effective natural enemy causing its population decline every year in certain regions near Warsaw in the lowest upper Siberia of Poland. Jayaprakash and Rao (1984a) reported that H.oryzicola and the seedling blight fungus Sclerotium rolfsii interact to form a destructive disease complex resulting in increased seedling mortality. The disease complex was also detrimental to the nematode as the penetration and development of H.oryzicola was reduced in the presence of this fungus.

2.4. Nature of damage

2.4.1. Rice

Seven to ten weeks old rice crop cv. Aswathy, Triveni and Jaya in the upland areas of Kerala, infested by H.oryzicola were chlorotic and roots exhibited browning together with all stages of this nematode (Rao and Jayaprakash, 1977). Rao and Jayaprakash (1984b)reported the mortality of seedlings in patches, stunting of plants, reduction in number of tillers and yield when a population of 28 to 70 cysts of H.oryzicola per 250 ml soil occurred

in the area.

Under glass house studies, rice plants infested with H.sacchari exhibited chlorosis and retarded growth, significant lower reductions in tiller number and grain yields and the roots were very necrotic and blackened (Babatole, 1983 a). Babatole (1983 b) reported that the growth of upland rice selections and cultivars were affected by infestation of H.sacchari where as swamp seedlings grew normally except for chlorosis.

2.4.2. Sorghum

Sorghum infested by H.sorghii had thin leaves (Sakuja and Singh, 1985).

2.4.3. Maize

Maize plants infested by H.zeae were stunted, had retarded leaf emergence and reduced fresh and dry weights (Abdul-Eid and Ghoraba, 1981).

2.4.4. Oats

Oats inoculated with 10 to 11 cysts of H.avenae per 200 ml soil caused significant reduction of plant height and smaller grain content of ear (Kubler, 1980).

2.4.5. Barley

When barley was infested with H.avenae fodder suffered more thangrain (Hande et al., 1985).

2.4.6. Green gram

Green gram grown in H.cajani infested field exhibited stunting and yellow leaves. Plant growth at 30 days after planting, in fields having 150 larvae per 100 g soil was significantly poorer than that in the nematode free soil (Guar and Singh, 1977).

2.4.7. Cowpea, Pigeon pea and moth bean

Experiments conducted in green house with H.cajani revealed highly significant reduction in growth parameters of cowpea, pigeon pea and moth bean at 100 larvae and above per kg soil. Significant reductions in root length, fresh and dry weights of moth bean were observed at 10 inoculum levels (Zaki and Bhatti, 1986).

2.4.8. Potato

Slight and moderate infestation of potato by G.rostochiensis decreased yield much more than their adverse effect on the development of haulm. The infested plants had smaller tubers but the number of tubers was not affected (Videgard, 1967). Stelter and Rauber (1968) reported that the infestation resulted in the reduction of average tuber weight and number of tuber per plant. Heavy infestation resulted in less extensive root system than slightly infested one.(Evans et al., 1978). Continuous cropping of potatoes as monoculture

in infested field of H.rostochiensis caused rapid build up of nematode population and marked decline in yield. Reduction of yield was due to the reduced tuber size (Gonet and Gonet, 1982 b).

2.4.9. Sugarbeet

Sugarbeet infested by H.schachtii caused reduction in sugar yield and quality (Behringer, 1977). Initial population densities of H.schachtii at 36 and 108 larvae per g of fine sandy loam greatly influenced the emergence of sugarbeet seedlings variety 'Monogram CSF 1971' (Olthof, 1978). Griffin (1981) reported that H.schachtii adversely affected sugarbeet yield. Sugarbeet seeds grown in H.schachtii infested soil were damaged much more heavily than seeds inoculated with nematode immediately following sowing and seedlings transplanted into the infested soil suffered much more chlorosis than nontransplanted seedlings inoculated with the nematode (Olthof, 1983).

2.5. Effect of H.oryzicola on growth parameters of crops

2.5.1. Rice

Pot culture experiments with H.oryzicola under controlled conditions revealed a reduction of 11.08 to 20.32 per cent in plant height, 31.55 to 43.53 per cent

in tiller numbers, 19.36 to 28.27 per cent in leaf numbers, 13.77 to 31.30 per cent in ear head length, 34.05 to 52.59 per cent in shoot weight and 23.01 to 47.96 per cent in root weight per plant over the control (Ushakumari, 1980). In microplot experiment there was a reduction of 4.39 to 7.65 per cent in plant height, 19.3 to 28.5 per cent in tiller numbers, 10.07 to 28.13 per cent in leaf numbers, 7.36 to 17.10 per cent in ear head length, 11.62 to 35.36 per cent in shoot weight and 13.76 to 43.37 per cent in root weight per plant over the control. The reduction in growth characters was maximum at higher levels of inoculum showing that the more the nematode population the more the damage to the plant (Ushakumari and Kuriyan, 1981). Kuriyan et al. (1985) reported a reduction of 16.4 to 45 per cent in growth of rice in Trivandrum District of Kerala State due to infestation of H.oryzicola.

2.5.2. Wheat, oats and maize

Wheat seedlings infested by H.avenae were completely destroyed in an area of 100 ha in the Iskitim District of U.S.S.R., in 1963. In the experimental field plots 47.3 per cent of wheat, 58.6 per cent oats and 1.4 per cent of maize plants were found infested (Zhuk, 1969).

2.5.3. Pigeon pea

In green house studies of pigeon pea infested with H.cajani larvae, the intensity of stunting was directly related to inoculum density and negatively correlated with inoculum levels (Sharma and Nene, 1985).

2.4.5. Sugarbeet

Griffin (1977) reported that growth of sugarbeet appeared to be inversely related to H.schachtii population density.

2.5.5. Cabbage

In glass house trials, population levels of 100 cysts of H.schachtii in steamed sandy soil failed to reduce the growth of cabbage significantly. A second and third planting in the same soil reduced the growth by 32 and 72 per cent respectively (Rhoades, 1971).

2.6. Extent of damage on yield

2.6.1. Rice

Yield losses in paddy were estimated as 20 per cent (Rao, 1978) and 25.5 to 31.8 per cent (Kuriyan et al., 1985) due to infestation of H.oryzicola and 44.49 per cent due to H.elachista (Ohshima 1974). Reductions of 13.98 to 37.02 per cent in paddy yield and

of 12.18 to 78.41 per cent chaff weight per plant in pot culture experiments.(Ushakumari, 1980) and a reduction of 16.83 to 35.76 per cent in paddy yield and 20.65 to 41.91 per cent in grain weight per plant as well as 7.32 to 28.62 per cent in paddy yield and 7.75 to 36.28 per cent in grain weight per plot of one sq.m. over the control (Ushakumari and Kuriyan, 1981) were observed in rice crop.

Grain weight of upland paddy was found decreasing from 1951 to 1954 by infestation with H.oryzae, the yield being 2870, 3030, 1030 and 950 kg per ha respectively (Watanabe et al., 1963).

Rice grown in pots of soil under upland conditions inoculated with H.elachista at 0, 400 and 4000 larvae per pot yielded grains of 71.2, 67.2 and 59.5 g per pot respectively. Greater yield losses were observed when roots were inoculated by the nematode before tillering (Shimuzu, 1976).

In upland areas of Nigeria, yield was reduced by more than 60 per cent with an inoculum of H.sacchari at 800 eggs plus larvae per litre of soil (Babatole, 1984).

2.6.2. Other cereals

Dixon (1964), Mathur (1969) and Behringer (1973) reported positive correlation of H.avenae inoculum levels and damage of cereal crops. Tikhonova (1968) reported that crop loss varied from 41 to 62 per cent in areas which averaged 880 cysts per kg soil.

Investigation in Southern Sweden from 1965 to 1968 revealed H.avenae to be common in both clayey and sandy soils causing an average yield loss of 10 million Swedish crowns (Videgard 1969). The yield loss caused by H.avenae were reported to be 18 to 20 per cent at first year, 28 to 30 per cent at second year and 66 per cent at third year on spring wheat (Tikhanova and Smirnova, 1969); 60 per cent on wheat, oats and barley (Ishmaev, 1974); 38.9 to 55 per cent in silage maize (Luckae and Saefknow, 1978), 5 to 10 per cent on barley (Jackobson, 1978) and 8 to 58 per cent on barley and 2.4 to 22 per cent on oats (Gonet and Gonet, 1982 a). H.avenae caused yield loss of 10 and 64 per cent at 10 and 1250 cysts per kg soil on wheat and barley (Mukhopadhyaya et al., 1972); 48 and 35 per cent at 770 and 1300 eggs plus larvae per 200 ml soil on maize (Maas and Brinkman, 1977a);and avoidable loss of 91.8 per cent

fodder and 87.2 per cent grain of barley at an initial population of 22.4 eggs per g soil (Hande et al., 1985).

The effect of H.avenae on wheat, barley and oat in concrete tub experiments revealed that grain yields were reduced by 17 to 44 per cent for wheat, 32 to 44 per cent for barley and 50 per cent for oats and straw yields by 2 to 32, 20 to 26 and 62 per cent respectively (Sabova et al., 1981 a). In West Siberia, U.S.S.R., H.avenae population caused economic yield loss of 30 and 50 per cent of wheat at 10 and 20 per cent larvae per g respectively. A wet spring followed by a dry summer favoured infestation and caused severe crop loss of 50 to 70 per cent compared to 35 to 45 per cent after a dry spring and sufficiently wet summer (Shiabova, 1982).

2.6.3. Soybean

In Soybean infested with H.glycines, final population of the nematode was found positively correlated with damage (Ichnohe, 1961). Brag Soybean grown for two years in nematicide treated and untreated plots already infested with H.glycines in Georgia, U.S.A. revealed that average yield from the treated plots were 48 to 403 per cent higher than from the untreated plots (Hussey and Boerma, 1983).

2.6.4. Potato

Brown (1961) observed a positive correlation between the final population of G.rostochiensis and potato yields. Reduction in potato yield with differing population densities of G.rostochiensis were not linearly related to the initial nematode population levels (Stelter and Rauber, 1968). The average yield loss of potato due to G.rostochiensis were 1.2 tonnes per acre at a concentration of 20 eggs per g soil (Brown, 1969); and 30 per cent in sandy loam soils at 30 eggs per g soil (Kyrou, 1971). Schluter (1976) reported that considerable damage was caused by G.rostochiensis at 500 eggs and larvae per 100 ml soil in the potato growing areas of Morocco. Koliopanos (1976) reported a total annual yield loss of 1.6 to 2.4 per cent amounting to 2.3 million dollars in Greece. Gonet and Gonet (1982 b) reported that continuous cropping of potato as monoculture in G.rostochiensis infested fields caused 75 per cent yield loss in seventh year. In sandy loam soils infested with G.rostochiensis at 2.95 eggs per g, the yield of potato was decreased by 8.2 tonnes per ha with every increment of 20 eggs per g soil (Whitehead et al., 1984).

2.6.5. Sugarbeet

Jones (1956) found a linear relationship between

preplanting density of H.schachtii and sugar yield; no correlations between final population of the nematode and yield of sugarbeet. Root yields of sugarbeet in the H.schachtii infested soil were reduced by 25 to 50 per cent compared to that in uninfested soil as reported by Pawelska and Szota (1970) and by 50 per cent as observed by Kondic et al. (1978). Yield reductions of 40 per cent with 102 living cysts per 100 g soil and 20 per cent by 333 cysts per 100 g soil (Vinduska, 1971) and 13 per cent with an initial population density of 10 cysts per pot (Behringer, 1976) were observed. Slight infestation caused a reduction of 5 to 15 per cent and severe infestation caused 40 per cent or more (Behringer, 1977). Crop loss increased from 10 to 50 per cent at an infestation level from 200 to 1320 larvae per 100 sq.cm. (Guskova et al., 1982). The total annual national root yield loss was estimated to be approximately 10,000 tonnes in mineral soils and 30,000 tonnes in organic soils of U.K. (Cooke, 1984).

2.6.6. Vegetables

In vegetables like beet, spinach and turnip infested with H.schachtii the final population levels were positively correlated with the damage (Townshend and Olthof, 1967). Nesterov and Bukhar (1971) reported

that infestation due to H.schachtii on Brassica oleraceae caused 50 per cent yield loss. Yield losses by H.schachtii at population density of 18000 larvae per kg soil were 24 per cent for rutabaga and 49 per cent for spinach (Olthof et al., 1974).

MATERIALS AND METHODS

MATERIALS AND METHODS

The present study is comprised of a preliminary survey in the paddy fields of Trivandrum District of Kerala State, India to find out the locations of the incidence of H.oryzicola, a detailed survey in these infested localities to determine their population build up of this nematode in different paddy varieties and soil types during the three cropping seasons and a field experiment to estimate the loss caused by the nematode on rice crop.

3.1. Preliminary survey

Based on the number of revenue Panchayats, 94 localities were fixed for the preliminary survey. Each Panchayat was surveyed separately during the months of May - June in 1985.

In each of the surveyed area, 15 to 20 spots per hectare were located for sampling. Care was taken to avoid the locations near bunds, marshy areas, trees, compost pits and where fertilizers and plant protection chemicals had recently been applied. Soil and root samples were collected from the rhizoplain of healthy and diseased plants of the selected locations using a hand hoe. Samples from all locations of each locality

were bulked over a clean piece of plastic gunny. Composite samples of 500 ml soil and 50 g root were collected from each of the bulked sample by mixing and quartering. The samples were taken in polythene bags with proper labelling.

From each locality the observations relating to the type of soil, variety of paddy grown, stage of crop and symptoms of infestation, if any, on the shoot, leaf and root were recorded. From each composite sample, two samples each of 100 ml soil and 10 g root were taken; one sample of soil and root were used for estimating the larvae and the other two samples were used for examining the cysts of H.oryzicola as described below.

3.1.1. Estimation of larvae of H.oryzicola from soil samples

From each composite sample, 100 ml soil was measured out and processed by modified method of Cobbs' decanting and sieving technique (Christie and Perry, 1951). The nematode suspension was drawn out at the end of every 24 hours and the larvae of H.oryzicola were counted using a sterioscopic binocular microscope. This was repeated till no larvae were found in the

water drawn from the funnel.

3.1.2. Estimation of cysts of H.oryzicola from soil samples

From each composite sample, 100 ml soil was measured out, placed in a plastic container and covered with water. The soil particles were broken and stirred with hand. This suspension was passed through 20 and 60 mesh sieves. The residue in 60 mesh sieve was collected in a glass beaker. Transferring this to a counting dish and viewing under a microscope the old and empty cysts which floated on the surface of water and the newly formed yellow and brown cysts which settled down were identified and counted.

3.1.3. Estimation of larvae of H.oryzicola from root samples

Each root sample was transferred to a plastic container and cleaned off adhering soil particles in a stream of water under a tap. Ten gram of sliced roots were weighed out. These were put over a layer of tissue paper kept on a flat bottomed circular wire mesh dish. The wire mesh was placed over a petridish filled with water and left undisturbed. The nematode suspension

was drawn out at the end of every 24 hours. The larvae of H.oryzicola were identified and counted using stereoscopic binocular miscroscope. This was repeated till no more larvae of H.oryzicola were obtained in the sample.

3.1.4. Estimation of cysts of H.oryzicola from root samples

Each root sample was taken in a plastic container and cleaned off adhering soil particles in a stream of water under a tap. From this 10 g root samples were weighed out after slicing into small pieces. These roots were placed in a counting dish and examined directly under the microscope. The cysts/white females of H.oryzicola present in them were identified and counted.

3.2. Detailed survey

From the preliminary survey the localities infested by H.oryzicola in Trivandrum District were identified and in these localities the detailed surveys were carried out.

In the detailed survey, composite samples of soil and root were collected as described earlier, at monthly intervals from planting to harvest of paddy during the second and third crop seasons of 1985-'86 and first crop

season of 1986-'87. From these samples the cysts and larvae of H.oryzicola in 100 ml soil and 10 g root each were estimated as described earlier.

3.3 Field experiment to estimate loss caused by H.oryzicola on rice crop.

An experiment was laid out during the first crop season of 1986-'87 in a farmers' field at Anadu in Nedumangadu Taluk of Trivandrum District. It was ensured that the fields chosen were infested by H.oryzicola.

Design : Randomised Block Design

Replication : 12

Treatments : 2 (T_1 and T_2)

T_1 - Unprotected-untreated control.

T_2 - Protected-treatment of soil by broadcasting aldicarb @ 1 g ai per sq.m. and of the seedlings by dipping its roots for 20 minutes in 0.02 per cent solution of aldicarb before the transplanting.

Plot size : 4 sq.m.

Variety : Jaya

Spacing : 15 x 20 cm

Duration : 118 days

3.3.1. Nursery

Nematode free soil was selected for raising the nursery. This was assessed by collecting composite samples of soil and root from the paddy fields. The seedlings of variety Jaya were raised in a wet nursery according to the package of practice recommendations (KAU, 1986). Twentyone day old seedlings were used for transplanting in the experimental plots and the field around.

3.3.2. Mainfield

Twenty four plots of 4 sq.m. were prepared in pairs of two each. The initial populations of the larvae and cysts of H.oryzicola in the soils of these plots were estimated. Before planting paddy seedlings aldicarb @ 1 g ai per sq.m. was applied in half the plots (T_2). The seedlings for these plots were treated by dipping the roots in 0.02 per cent solution of aldicarb for 20 minutes. Three seedlings per hill were planted at a spacing of 15 x 20cm. The crop was given all the cultural operations and plant protection measures recommended in package of practices (KAU, 1986).

From each plot two composite samples of 100 ml soil and 10 g root were collected at 15 day intervals

from transplanting to harvest. The larvae and cysts of H.oryzicola present in the soil and root samples, were estimated as described earlier.

At harvest (105th day after transplanting) ten plants each were selected at random from each plot and the growth characters namely total number of tillers, number of productive tillers, height of plant, length and weight of panicle and weights of shoot and root were recorded. Total paddy yield, wet and dry weights of grain, straw and chaff of 10 plants and per plot of 4 sq.m. were assessed.

3.3.3. Statistical analysis

Data relating to the experiment was transformed as $\sqrt{x + 1}$ and analysed by the method of Snedecor and Cohran (1967). F-test was carried out through analysis of variance and treatment means were compared using critical differences.

RESULTS

RESULTS

4.1. Preliminary survey on the distribution of H.oryzicola on rice crop in Trivandrum District

The incidence of rice cyst nematode, H.oryzicola, was observed in the rhizoplain of rice crop in different localities of Trivandrum District viz. Ulloor, Kazhakootam, Andoorkonam, Attipra, Vakkam, Chemmaruthy, Karavaram, Mudakkal, Nellanadu, Panavoor, Anadu, Aryanadu, Karakulam, Vilappil, Ottasekharamangalam, Aryancode, Vellarada, Perumbazhuthoor, Parassala, Balaramapuram and Kalliyoor Panchayats.

The general symptoms observed on the infested rice crop at tillering, booting, flowering and milky stages were reduced tillering and stunted growth of the plant, yellowing and chlorosis of the leaf and hollow brown roots with cysts/white females of H.oryzicola (Table 1 and Fig. 1).

4.2. Detailed survey on the population build up of H. oryzicola observed in Trivandrum District

The mean of the population build up of H.oryzicola in different paddy varieties and soil types observed during different cropping seasons from the

MAP SHOWING DISTRIBUTION OF *H. oryzicola*

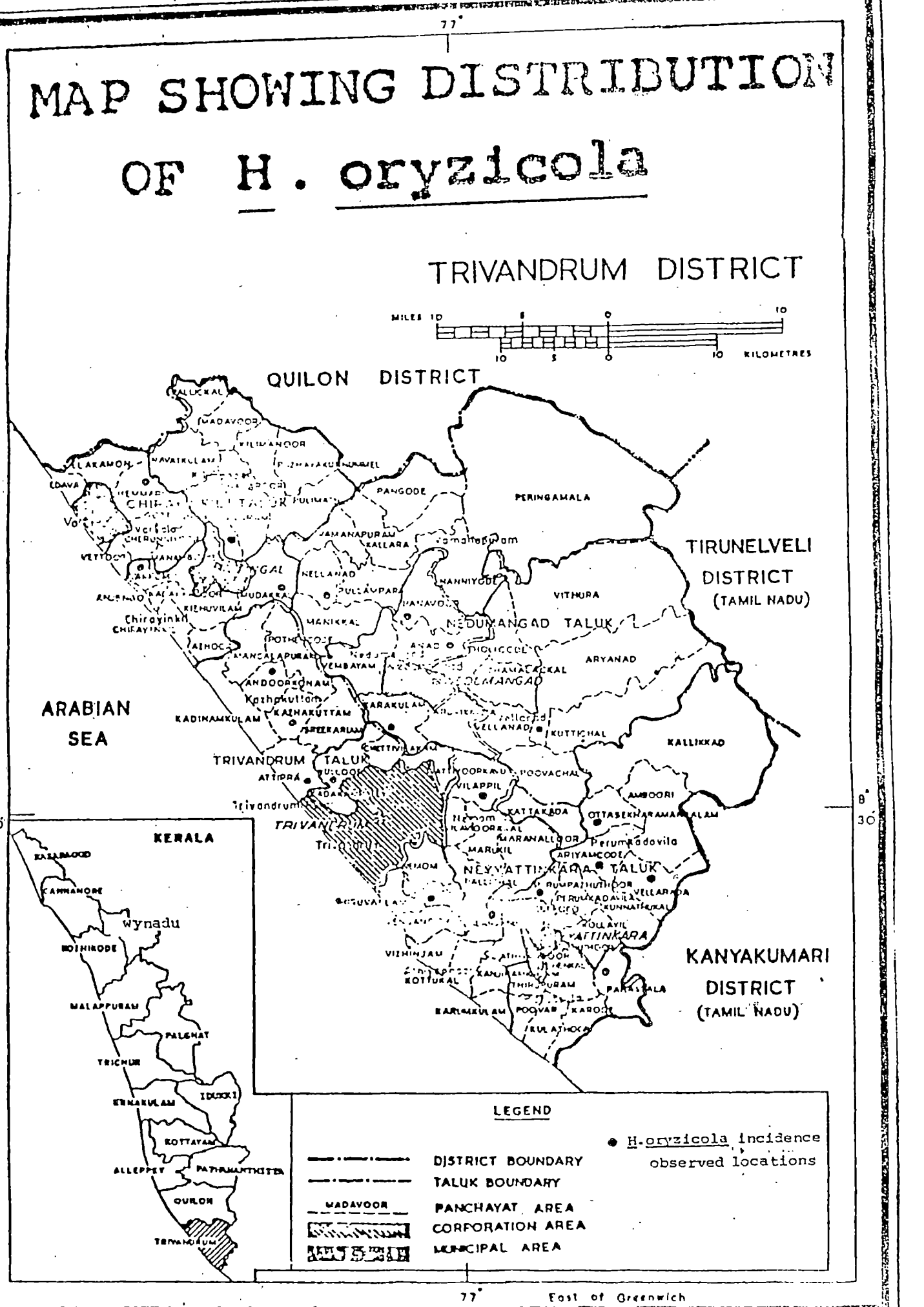

Table 1. Distribution of the rice cyst nematode, H.oryzicola in the paddy fields of Trivandrum district

Panchayat where the incidence was observed	Population in 100ml soil		Population in 10g root		soil type	variety of paddy grown	stage of the crop	symptoms observed on		
	cyst	larva	cyst	larva				shoot	leaf	root
Trivandrum thaluk										
Uloor	19	48	13	64	clayey	Sabari	flowering	stunted growth	yellowing	hollow brown roots with cysts
Attipra	5	17	9		clayey	Local	flowering		yellowing	brown roots with cysts
Kazhakootam	22	26	14	61	Sandy loam	Aswathy	milky	stunted growth	yellowing	hollow brown roots with cysts
Andoorkonam	21	46	16	86	clayey loam	Aswathy	booting		yellowing	hollow brown roots with cysts
Chirayinkil thaluk										
Vakkam		32	8	18	sandy clayey	Sabari	booting		yellowing	brown roots with cysts
Chemmaruthy	25			36	sandy clayey	Local	flowering	reduced tillering	yellowing	brown roots with cysts
Karavaram	16	34	2	4	sandy clayey	Jaya	booting		yellowing	brown roots with cysts
Mudakkal	13			26	sandy loam	Local	booting		yellowing	
Nedumangadu thaluk										
Nellanadu	11	17	6	74	clayey loam	Local	flowering	stunted growth	chlorosis	brown roots with cysts
Panavoor		11		36	clayey	Local	booting			
Anadu	16	28	24	153	sandy loam	Jaya	flowering	stunted growth, reduced tillering	chlorosis	hollow brown roots with cysts
Aryanadu	11	23		27	clayey loam	Local	flowering		chlorosis	brown roots
Karakulam	12	12	21	36	sandy loam	Local	flowering	stunted growth	chlorosis	hollow brown roots with cysts
Neyyattinkara thaluk										
Vilappil	16	16	7	28	clayey	Local	flowering	stunted growth		brown roots with cysts
Ottasekharamangalam			2	33	loamy	Local	tillering			
Aryancode	19	18	8	29	clayey	Aswathy	booting	stunted growth		brown roots with cysts
Vellarada	5	16	4	25	loamy	Jaya	booting		yellowing	roots with cysts
Perumpazhuthoor	11	29	6	41	loamy	Bharathi	tillering	stunted growth		roots with cysts
Parassala	6	31	13	43	clayey	Local	flowering	stunted growth		roots with cysts
Balaramapuram			4	22	clayey	Bharathi	tillering			
Kalliyoor	6	16	7	38	clayey	Jaya	booting	stunted growth	yellowing	brown roots with cysts

infested paddy fields of Trivandrum District were statistically analysed and the results were interpreted.

4.2.1. Population build up of H.oryzicola in different paddy varieties

Population build up of the cysts and larvae of H.oryzicola were observed in the paddy varieties namely Aswathy, Bharathy, Sabari, Jyothi, Jaya and local paddy during the second and third crop seasons of 1985-'86 and first crop season of 1986-'87.

4.2.1.1.Population build up of H.oryzicola in the paddy varieties observed during second crop of 1985-'86

The effect of paddy varieties observed during the second crop season of 1985-'86 on the population build up of H.oryzicola were statistically significant. The population build up of the cysts as well as larvae of H.oryzicola observed in the rhizoplain of paddy varieties differed significantly (Table 2).

The number of the cysts were significantly higher in the soil grown with Jaya than with Aswathy, Bharathi, Sabari, Jyothi and local which were on par. The population build up of larvae in the infested soils were significantly lower in variety Bharathi and Jyothi than in Jaya, Sabari,

Table 2. Population build up of H.oryzicola in different paddy varieties observed during second crop season of 1985-'86

eriod of bservation	Mean of cysts observed in different paddy varieties.						Mean of larvae observed in different paddy varieties.					
	Aswathy (3)	Bharathy (3)	Sabari (4)	Jyothi (2)	Jaya (2)	Local (7)	Aswathy (3)	Bharathi (3)	Sabari (4)	Jyothi (2)	Jaya (2)	Local (7)
	In 100ml soil											
planting	34.67	27.33	31.0	22.0	52.5	24.57	32.67	26.33	33.25	16.5	43.0	30.86
DAP	8.67	10.33	12.25	4.0	12.5	7.71	57.67	44.33	61.5	38.5	78.0	58.71
DAP	14.0	10.66	10.5	8.5	22.0	9.57	60.67	55.0	81.5	42.5	83.0	72.29
DAP	40.33	26.67	39.25	25.5	61.0	30.14	92.0	67.67	110.25	60.0	102.5	86.0
harvest	44.33	41.0	46.5	29.0	85.0	34.86	88.67	58.0	104.75	54.5	100.0	73.71
an	28.4	23.2	27.9	17.7	46.6	21.37	66.33	50.27	78.25	42.4	81.3	64.31
	In 10 g root											
planting	18.0	13.0	15.75	12.0	21.0	10.57	23.33	23.67	22.25	19.5	28.5	14.86
DAP	32.33	22.67	17.75	18.5	34.5	14.14	58.67	52.67	49.25	53.0	104.5	35.0
DAP	39.67	41.0	20.5	24.5	47.0	21.0	113.33	93.33	74.0	75.5	121.0	67.14
DAP	39.0	27.67	31.0	34.0	70.5	22.29	131.67	141.33	116.5	106.5	171.0	85.86
harvest	63.33	54.0	46.75	30.0	65.0	28.43	133.67	128.00	107.0	110.5	145.0	87.57
an	38.47	31.67	26.35	23.8	47.6	19.29	92.13	87.8	73.8	73.0	114.1	58.09

C.D. for comparing the effect of paddy varieties on the incidence of H. oryzicola

ddy varieties	cyst in soil					larva in soil				
athy	11.58	10.83	12.94	12.94*	9.79	25.19	23.56	28.16	28.16	21.29
rathi		10.83	12.94	12.94*	9.79		23.56*	28.16	28.16*	21.29
ari			12.28	12.28*	8.89			26.72*	26.72	19.34
thi				14.18	11.37				30.85*	24.73
a					11.37*					24.73
	cyst in root					larva in root				
athy	10.25	9.59*	11.46*	11.46	8.66*	29.73	27.81	33.24	33.24	25.13*
rathi		9.59	11.46	11.46*	8.66*		27.81	33.24	33.24	25.13*
ari			10.87	10.87*	7.87			31.54	31.54*	22.83*
thi				12.56*	10.07				36.42*	29.19
l					10.07*					29.19*

res in paranthesis are the number of samples observed
gnificant at 5% level
- days after planting

Aswathi and local which were on par and were significantly higher in variety Jaya and Sabari than in Aswathy, local, Bharathi and Jyothi which were on par.

The number of the cysts in the infested roots of Jaya and Aswathy were on par and significantly higher than all other paddy varieties; and that of local and Jyothi were on par and significantly lower than all other varieties. The number of the cysts in the infested roots were significantly higher in Jaya and lower in Sabari, Jyothi and local than in Aswathi and Bharathi varieties which were on par and that in Bharathi, Sabari and Jyothi were on par and significantly lower than in Jaya and Aswathy and higher than in the local variety.

Population build up of larvae in the infested roots were significantly lower in varieties Sabari, Jyothi and local than in Jaya, Aswathy and Bharathy which were on par. They were significantly higher in variety Jaya, Aswathy and Bharathy than in Sabari, Jyothi and local which were on par; were significantly higher in Jaya and lower in local than in Aswathy, Bharathy, Sabari and Jyothi which were on par; and were significantly higher in Jaya and Aswathy and lower in local than in Bharathy, Sabari and Jyothi which were on par.

In general the population build up of H.oryzicola observed in the infested soils was maximum with Jaya and minimum with Jyothi varieties. Similarly the population build up of H.oryzicola in the roots of paddy was maximum in Jaya and minimum in local varieties.

4.2.1.2.Population build up of H.oryzicola in the paddy varieties observed during third crop season of 1985-'86

The effect of paddy varieties during the third crop season of 1985-'86 on the number of cysts in the infested soils and roots, and larvae in the infested roots were statistically significant, but the variation in the population build up of larvae in the infested soils were not significantly different (Table 3).

The number of the cysts in the soils cultivated with paddy variety Jaya was significantly higher than with the local and Jyothi varieties which were on par. The number of cysts were significantly lower in the roots of variety Jyothi than in Jaya and local varieties which were on par. The population build up of the larvae observed in the roots of variety Jaya was on par with Jyothi and significantly higher than in local variety; and that in the local variety was on par with Jyothi

Table 3. Population build up of *H.oryzicola* in different paddy varieties observed during third crop season of 1985-'86

Period of observation	Mean of cysts observed in different paddy varieties			Mean of larvae observed in different paddy varieties		
	Jyothi (4)	Jaya (3)	Local (3)	Jyothi (4)	Jaya (3)	Local (3)
	In 100 ml soil					
At planting	16.5	34.33	21.67	16.5	28.0	25.67
30 DAP	5.5	12.0	6.67	32.0	43.67	41.67
60 DAP	7.5	13.33	8.67	39.0	55.0	53.33
At harvest	20.75	43.0	24.67	37.0	49.33	49.67
Mean	12.56	25.67	15.42	31.13	44.0	43.08
	In 10 g root					
At planting	8.5	15.33	16.67	17.5	31.67	16.0
30 DAP	19.75	30.33	24.0	60.75	85.33	38.0
60 DAP	19.75	41.67	32.0	87.5	131.33	68.0
At harvest	24.5	54.0	51.0	130.75	151.33	92.67
Mean	18.13	35.33	30.92	74.13	99.92	53.67

C.D. for comparing the effect of paddy varieties on the incidence of *H. oryzicola*

Paddy varieties	cyst in soil		larva in soil	
Jyothi	7.98 *	7.98	12.03	12.03
Jaya		8.53 *		12.86
	cyst in root		larva in root	
Jyothi	11.16 *	11.16 *	33.43	33.43
Jaya		11.93		35.73 *

Figures in paranthesis are the number of samples observed

* significant at 5% level

DAP - days after planting.

and significantly lower than in Jaya.

In general, the number of cysts in the soils and roots were maximum in variety Jaya and minimum in Jyothi and that of larvae was maximum in the soils and roots of Jaya variety and minimum in the soils grown with Jyothi and in roots of local variety.

4.2.1.3. Population build up of H.oryzicola in paddy varieties observed during the first crop season of 1986-'87

The effect of paddy varieties on the population build up of the cysts and larvae of H.oryzicola in the soils of paddy were not statistically significant, but in the roots it was found significantly varying (Table 4).

The population build up of the cysts in the roots of paddy variety Jaya was on par with that of Aswathy and significantly higher than in Sabari and local varieties. The population build up of the larvae was significantly higher in the roots of variety Jaya than in Aswathy, local and Sabari which were on par and significantly lower in Sabari than in Jaya, Aswathy and local which were on par.

In general the highest number of cysts and larvae

Table 4. Population build up of *H. oryzicola* in different Paddy varieties observed during first crop season of 1986-'87.

Period of observation	Mean of cysts observed in different paddy varieties				Mean of larvae observed in different paddy varieties.			
	Aswathi (3)	Sabari (3)	Jaya (4)	Local (8)	Aswathi (3)	Sabari (3)	Jaya (4)	Local (8)
	In 100ml soil							
At planting	17.0	16.0	19.75	20.13	18.33	11.33	23.0	19.88
30 DAP	5.0	4.33	4.0	4.63	36.33	27.33	41.75	39.13
60 DAP	7.33	5.67	6.5	8.75	33.0	26.67	44.0	40.75
90 DAP	20.33	15.0	21.75	22.63	64.33	51.33	56.25	63.88
At harvest	28.0	19.0	30.0	30.13	54.0	47.67	54.25	58.13
Mean	15.53	12.0	16.4	17.25	41.2	32.87	43.85	44.35
	In 10 g root							
At planting	9.33	8.33	11.75	8.25	22.0	16.67	29.00	21.38
30 DAP	18.67	13.67	20.75	14.63	72.0	41.67	94.0	53.63
60 DAP	21.67	22.67	31.75	18.88	114.67	71.33	120.25	109.88
90 DAP	25.67	25.0	29.5	22.88	156.67	99.67	171.5	138.25
At harvest	41.67	33.0	42.25	22.88	150.33	102.67	165.75	131.0
Mean	23.4	20.53	27.2	17.5	103.13	66.40	116.10	90.83

C.D. for comparing the effect of paddy varieties on the incidence of *H. oryzicola*

Paddy varieties	cyst in soil			larva in soil		
Aswathy	7.28	6.81	6.04	16.10	15.06	13.35
Sabari		6.81	6.04		15.06	13.35
Jaya			5.46			12.08
	cyst in root			larva in root		
Aswathy	7.06	6.60	5.85	36.88	34.50	30.58
Sabari		6.60*	5.85		34.50*	30.58
Jaya			5.30*			27.67

Figures in paranthesis are the number of samples observed

* significant at 5% level

DAP - days after planting.

of H.oryzicola was observed in the roots of paddy variety Jaya; the least number of cysts were in the roots of local variety and larvae were in the variety Sabari.

4.2.2. Population build up of H.oryzicola in different soil types

Population build up of cysts and larvae of H.oryzicola were observed in the soil types namely, sandy loam, sandy clay, loamy , clayey loam and clayey soils during the second and third crop seasons of 1985-'86 and first crop season of 1986-'87.

4.2.2.1. Population build up of H.oryzicola in the soil types observed during second crop season of 1985-'86

The effect of soil types on the population build up of H.oryzicola in both the soils and roots of paddy plant observed during the second crop of 1985-'86 were significantly varying (Table 5).

The number of cysts in sandy loam, sandy clay and clayey loam soils were on par and significantly higher than in clayey and loamy soils. It was significantly higher in sandy loam and lower in clayey and loamy soils than in sandy clay and clayey loam soils which were on par; was significantly higher in sandy loam and sandy

Table 5. Population build up of H.oryzicola in different types of soil observed during second crop season of 1985-'86

Period of observation	Mean of cysts observed in different types of soil					Mean of larvae observed in different types of soil				
	sandy loam (4)	sandy clay (3)	loamy (3)	clayey loam (4)	clayey (7)	sandy loam (4)	sandy clay (3)	loamy (3)	clayey loam (4)	clayey (7)
	In 100ml soil									
At planting	40.25	35.0	21.33	33.0	24.14	47.5	42.0	35.67	21.0	19.21
30 DAP	11.75	9.67	7.67	9.25	8.14	85.0	69.67	59.33	51.25	37.71
60 DAP	15.0	14.33	8.33	13.75	9.0	120.0	80.33	67.67	54.5	41.14
90 DAP	50.25	44.33	25.33	37.0	26.29	143.75	110.67	83.33	72.75	57.0
At harvest	56.75	52.67	37.0	50.0	32.29	124.25	105.33	66.0	71.75	55.14
Mean	34.8	31.2	19.93	28.6	19.97	104.10	81.6	62.4	54.25	42.14
	In 10 g root									
At planting	20.0	16.0	11.67	10.5	14.14	26.25	22.67	22.33	19.75	15.86
30 DAP	32.0	26.0	19.33	15.75	16.29	75.75	76.0	38.67	43.5	38.57
60 DAP	43.25	41.67	29.0	27.75	16.86	118.5	104.33	76.0	77.25	65.14
90 DAP	54.5	32.33	29.0	30.75	23.43	154.5	125.67	128.67	105.25	90.43
At harvest	68.25	57.33	52.33	34.75	27.43	142.5	116.67	124.33	104.75	89.29
Mean	43.6	34.67	28.27	23.9	19.63	103.5	89.07	79.0	70.1	59.86

C.D. for comparing the effect of the types of soil on the incidence of H. oryzicola

Types of soil	cyst in soil				larva in soil			
sandy loam	11.27	11.27*	10.43	9.25*	19.0*	19.0*	17.59*	15.59*
sandy clay		12.05	11.27	10.18*		20.31	19.0*	17.17*
loamy			11.27	10.18			19.0	17.17*
clayey loam				9.25				15.59
	cyst in root				larva in root			
sandy loam	9.51	9.51*	8.80*	7.80*	27.70	27.70	25.65*	22.73*
sandy clay		10.17	9.51*	8.59*		29.61	27.70	25.03*
loamy			9.51	8.59*			27.70	25.03
clayey loam				7.80				22.73

Figures in paranthesis are the number of samples observed
* significant at 5% level
DAP - days after planting.

clay than in clay loam, clayey and loamy soils which were on par; and was significantly lower and on par in clayey and loamy soils than in other soil types.

Population build up of larvae in the sandy clay and loamy soils were on par and significantly lower than in sandy loam and higher than in clay loam and clayey soils; that of loamy and clayey loam were on par and significantly lower than in sandy loam and sandy clay and higher than in clayey loam and cleyey soils; and that of clayey loam and clayey soils were on par and significantly lower than in all other types of soil.

The number of cysts in the roots of paddy grown in sandy loam and sandy clay soils were on par and significantly higher than these in loamy, clayey loam and clayey soils; that of sandy clay and loamy soils were on par and significantly lower than in sandy loam and higher than in clayey loam and clayey soils; that of loamy and clayey loam soils were on par and significantly lower than sandy loam, sandy clay and higher than clayey soils; and that of clayey loam and clayey soils were on par and significantly lower than all other soil types.

Population build up of larvae in the roots of paddy grown in sandy loam, sandy clay and loamy soils

were on par and significantly higher than in clayey loam and clayey soils. It was significantly higher in sandy loam and lower in clayey soils than in sandy clay, loamy and clayey loam soils, which were on par. It was also significantly higher in sandy loam and sandy clay soils than in loamy, clayey loam and clayey soils which were on par.

In general the maximum population build up of cysts and larvae of H.oryzicola was observed in the soils and roots of sandy loam. The lowest population build up of the cysts was in the soils of clayey loam and in the roots of plants in clayey soils and that of the larvae of soils and roots in clayey soils.

4.2.2.2.Population build up of H.oryzicola in the soil types observed during the third crop season of 1985-'86

The effect of soil types observed on the population build up of cysts in the soils and roots and larvae in the roots of paddy were statistically significant, but that of larvae in the roots was not significantly different (Table 6).

The number of cysts observed in the soils of sandy loam was maximum and significantly higher than in the sandy clay, loamy and clayey soils which were on par; and

Table 6. Population build up of H. oryzicola in different types of soil observed during third crop season of 1985-'86

Period of observation	Mean of cysts observed in different types of soil				Mean of larvae observed in different types of soil			
	sandy loam (2)	sandy clay (3)	loamy (2)	clayey (3)	sandy loam (2)	sandy clay (3)	loamy (2)	clayey (3)
	In 100ml soil							
At planting	34.0	25.67	22.5	14.67	36.5	21.0	16.5	19.33
30 DAP	9.5	9.67	7.0	5.33	58.0	40.0	35.0	26.0
60 DAP	14.0	9.0	9.0	7.67	72.5	56.33	43.5	28.67
At harvest	47.0	28.0	26.5	18.33	60.0	47.33	36.5	36.67
Mean	26.13	18.08	16.25	11.5	56.75	41.17	32.88	27.67
	In 10 g root							
At planting	16.5	17.0	11.0	8.0	24.0	21.33	16.5	16.0
30 DAP	33.0	26.33	24.5	16.0	77.5	67.33	54.0	49.0
60 DAP	48.0	34.33	20.0	20.33	144.0	87.33	97.0	68.0
At harvest	57.0	52.0	36.0	23.67	144.5	145.0	126.5	99.67
Mean	38.63	32.42	22.88	17.0	97.5	80.25	73.5	58.17

C.D. for comparing the effect of the types of soil on the incidence of H. oryzicola

Types of soils	cyst in soil			larva in soil		
sandy loam	9.91	10.86	9.91*	11.95*	13.09*	11.95*
sandy clay		9.91	8.86		11.95	10.69*
loamy			9.91			11.95
	cyst in root			larva in root		
sandy loam	12.91	14.15*	12.92*	41.98	45.99	41.98
sandy clay		12.92	11.55*		41.98	37.55
loamy			12.92			41.98

Figure in paranthesis are the number of samples observed

* significant at 5% level

DAP - days after planting.

that in clayey soils was minimum and significantly lower than in sandy loam, sandy clay and loamy soils which were on par.

Population build up of larvae in the soils of sandy clay and loamy were on par and significantly lower than in sandy loam and higher than in clayey soils; and that in loamy and clayey soils were on par and significantly lower than sandy loam and sandy clay soils.

Number of cysts observed in the paddy roots of sandy loam and sandy clay were on par and significantly higher than loamy and clayey soils; that in sandy clay and loamy were on par and significantly lower than in sandy loam and higher than in clayey soils; and that in loamy and clayey soils were on par and significantly lower than in sandy loam and sandy clay soils.

In general, the population build up of both cysts and larvae of H.oryzicola in the soils and roots of paddy were maximum in sandy loam and least in clayey soils.

4.2.2.3.Population build up of H.oryzicola in soil types observed during the first crop season of 1986-'87

The effect of soil types observed on the population

build up of cysts in the soils and roots and larvae in the roots of paddy were statistically significant, but that of larvae in the roots were not different significantly (Table 7).

Population build up of cysts in the soils of sandy loam was maximum and significantly higher than in sandy clay, loamy, clayey loam and clayey soils which were on par and that in sandy loam, sandy clay and loamy soils were on par and significantly higher than clayey loam and clayey soils.

Population build up of larvae in the soils of sandy loam, sandy clay and loamy were on par and significantly higher than in clayey loam and clayey soils; that in sandy clay, loamy and clayey loam soils were on par and significantly lower than in sandy loam and higher than in clayey soils; and that in clay loam and clayey soils were on par and significantly lower than all other soil types.

Population build up of the cysts in the roots of paddy plant in sandy loam soils were significantly higher than in sandy clay, loam, clayey loam and clayey soils which were on par and that in sandy loam, sandy clay and

Table 7. Population build up of H. oryzicola in different types of soil observed during first crop season of 1986-'87

Period of observation	Mean of cysts observed in different types of soil					Mean of larvae observed in different types of soil				
	sandy loam (4)	sandy clay (2)	loamy (2)	clayey loam (4)	clayey (6)	sandy loam (4)	sandy clay (2)	loamy (2)	clayey loam (4)	clayey (6)
	In 100ml soil									
At planting	25.75	22.0	21.0	14.25	15.5	26.5	26.0	25.0	17.0	10.67
30 DAP	7.0	3.0	5.0	3.75	3.67	53.25	42.0	38.0	35.25	26.17
60 DAP	9.0	6.5	7.5	8.0	6.5	57.5	50.0	42.5	30.0	24.33
90 DAP	28.25	22.5	19.0	19.5	16.67	89.5	61.0	60.0	50.75	46.67
At harvest	38.5	32.0	26.0	28.0	20.0	73.75	54.0	58.5	50.0	44.5
Mean	21.7	17.2	15.7	14.7	12.47	60.1	46.6	44.8	36.6	30.47
	In 10 g root									
At planting	11.75	6.0	8.0	9.0	9.17	28.0	24.0	22.0	20.25	19.67
30 DAP	20.75	14.5	14.5	17.0	14.67	82.5	79.0	66.0	54.5	45.0
60 DAP	31.75	26.0	22.0	18.25	19.17	116.25	114.0	108.0	106.25	101.0
90 DAP	29.5	29.5	24.0	26.0	20.67	163.75	153.0	141.5	137.5	127.83
At harvest	42.25	35.5	35.0	28.0	25.67	157.5	146.0	135.0	136.0	125.0
Mean	27.2	22.3	20.7	19.65	17.97	109.6	103.2	94.5	90.9	83.7

C.D. for comparing the effect of the types of soil on the incidence of H. oryzicola

Types of soil	cyst in soil				larva in soil			
sandy loam	7.42	7.42	6.05*	5.53*	14.94	14.94	12.20*	11.14*
sandy clay		8.56	7.42	6.99		17.25	14.94	14.09*
loamy			7.42	6.99			14.94	14.09*
clayey loam				5.53				11.14
	cyst in root				larva in root			
sandy loam	7.72	7.72	6.30*	5.75*	40.55	40.55	33.11	30.22
sandy clay		8.91	7.72	7.27		46.82	40.55	38.23
loamy			7.72	7.27			40.55	38.23
clayey loam				5.75				30.22

Figures in paranthesis are the number or samples observed

* significant at 5% level

DAP - days after planting.

loamy soils were on par and significantly higher than clayey loam and clayey soils.

In general the population build of both cysts and larvae of H.oryzicola in the soils and roots of paddy were maximum in sandy loam and least in clayey soils.

4.2.3. Population build up of H.oryzicola observed in the infested paddy fields of Trivandrum District during different cropping seasons

The effect of seasons on the population build up of H.oryzicola observed in the soils and roots of paddy during the second and third crop seasons of 1985-'86 and first crop season of 1986-'87 was significant (Table 8).

The population build up of the cysts in the soils and larvae in the soils and roots of paddy during the second crop season was significantly higher than in the third and first crop seasons which were on par. The population build up of the cysts in the roots of paddy during the second and third crop seasons were on par and significantly higher than in the first crop season.

It was also observed that planting paddy in the H.oryzicola infested fields resulted in a considerable

Table 8. Population build up of *H. oryzicola* observed during different cropping seasons

Period of observation	Mean of cysts observed in different seasons.			Mean of larvae observed in different seasons.		
	second crop of 1985-'86	third crop of 1985-'86	first crop of 1986-'87	second crop of 1985-'86	third crop of 1985-'86	first crop of 1986-'87
	(21)	(10)	(18)	(21)	(10)	(18)
	In 100ml soil					
At planting	30.05	23.4	18.83	30.71	22.7	18.89
30 DAP	9.19	7.8	4.5	56.95	38.4	37.28
60 DAP	11.71	9.6	7.5	68.10	48.7	37.83
90 DAP	35.33		20.78	87.95		60.17
At harvest	43.91	28.6	27.89	80.19	44.5	54.83
Mean	26.04	17.35	15.9	64.78	38.58	41.8
	In 10 g root					
At planting	14.48	13.0	9.22	20.48	19.3	22.39
30 DAP	21.0	24.2	16.5	51.95	61.2	61.56
60 DAP	29.24	30.0	22.83	84.76	94.8	107.78
90 DAP	32.81		25.17	115.95		142.28
At harvest	44.43	41.3	32.0	111.29	127.6	138.11
Mean	28.39	27.13	21.14	76.89	75.73	94.42

C.D. for comparing the effect of season on the incidence of *H. oryzicola* @

Season	cyst in soil		larvae in soil	
second crop	0.52*	0.40*	0.69*	0.53*
third crop		0.53		0.70
	cyst in root		larva in root	
second crop	0.48	0.37*	1.02	0.79*
third crop	0.	0.49*		1.04

Figures in paranthesis are the number of samples observed

@ Data presented are those obtained by using $\sqrt{x + 1}$ transformation

* significant at 5% level. DAP - days after planting

reduction in the soil cyst population at 30 DAP (Days after planting) than at planting and a gradual increase from 30 DAP to harvest in the soils; but in the roots the population increased as the plant grew. Similarly a gradual increase in the population of the larvae of H.oryzicola was observed both in the soils and roots at 30, 60 and 90 DAP during the second and first crop seasons than at planting and a reduction in the population at harvest than at 90 DAP during the second and first crop season and 60 DAP during third crop season.

4.3. Field trial to estimate the loss caused by H.oryzicola on rice crop

The observations recorded from the twelve replications from each of the two treatments T_1 (control) and T_2 (treated) were statistically analysed after transforming the data as $\sqrt{x + 1}$ and the results were interpreted.

4.3.1. Population build up of H.oryzicola at fortnightly intervals from planting in the soils and roots of paddy

The mean numbers of cysts and larvae of H.oryzicola observed in the soils of T_1 and T_2 at the time of

transplanting paddy seedlings were not significantly varying,but at 15, 30, 45, 60, 75, 90 DAT and at harvest time significant differences were observed (Table 9).

There was no cysts and larvae at the time of transplanting and no cysts at 15 DAT in the paddy roots of T_1 and T_2,but the population build up of cysts from 30 DAT and larvae from 15 DAT were significantly higher in the paddy roots of T_1 than T_2.

It was also observed that the effect of transplanting of paddy seedlings in the H.oryzicola infested soils resulted in a significant gradual reduction in the population of their cysts from 15 to 30 DAT than at transplanting time and a gradual increase from 45 DAT to harvest time than at 30 DAT, but in the infested roots significant gradual incfease resulted as the plant grew. Similarly the population of larvae of H.oryzicola got significantly reduced at 15 DAT than at transplanting time, increased from 30 DAT to 90 DAT and reduced at harvest than at 90 DAT, in the soils with a significant increase from transplanting to 75 DAT and a significant reduction at 90 DAT and at harvest than at 75 DAT in the roots.

Table 9. Population build up of H.oryzicola observed at fortnightly intervals from planting ●

Time of observation	soil						root					
	cysts			larvae			cysts			larvae		
	T_1	T_2	C.D	T_1	T_2	C.D	T_1	T_2	C.D	T_1	T_2	C.D
At transplanting	12.4	11.32		31.26	30.03		0	0		0	0	
	(3.66)	(3.51)	(0.57)	(5.68)	(5.57)	(0.26)	(1)	(1)		(1)	(1)	
15 DAT	7.29	1.13		19.34	0		0	0		32.64	0	
	(2.88)	(1.46)	(0.50)*	(4.51)	(1)	(0.59)*	(1)	(1)		(5.84)	(1)	(1.09)*
30 DAT	2.35	0		40.73	0		4.2	0		79.46	0	
	(1.83)	(1)	(0.18)*	(6.46)	(1)	(0.74)*	(2.29)	(1)	(0.44)*	(8.97)	(1)	(1.17)*
45 DAT	3.62	0.44		42.3	3.75		6.73	0.93		127.6	4.02	
	(2.15)	(1.02)	(0.25)*	(6.58)	(2.18)	(1.43)*	(2.78)	(1.39)	(0.49)*	(11.34)	(2.24)	(2.38)*
60 DAT	3.71	0.21		46.75	10.29		16.72	2.06		148.57	11.25	
	(2.17)	(1.10)	(0.27)*	(6.91)	(3.36)	(1.17)*	(4.21)	(1.75)	(0.41)*	(12.23)	(3.50)	(1.55)*
75 DAT	15.89	2.17		54.50	13.36		19.07	2.69		118.90	15.16	
	(4.11)	(1.78)	(0.72)*	(7.45)	(3.79)	(1.09)*	(4.48)	(1.92)	(0.73)*	(10.95)	(4.02)	(1.26)*
90 DAT	29.25	3.8		82.36	15.0		22.43	3.45		105.09	23.01	
	(5.50)	(2.19)	(0.92)*	(9.13)	(4.0)	(1.11)*	(4.84)	(2.12)	(0.56)*	(10.31)	(4.90)	(1.73)*
At harvest	33.22	4.43		81.63	3.56		28.70	2.49		92.12	18.10	
	(5.85)	(2.33)	(0.55)*	(9.09)	(4.56)	(0.96)*	(5.45)	(2.73)	(0.77)*	(9.65)	(4.37)	(1.60)*

● mean of observations from 12 replications. Figures in Paranthesis are transformed means and without paranthesis are retransformed means: * Significant at 5% level. DAT - Days after transplanting.

4.3.2. Effect of H.oryzicola infestation on the growth and yield of rice crop

The effect of H.oryzicola on the growth and yield of rice observed under field conditions were statistically significant. (Table 10).

The means of the height of plant, number of tillers, percentage of productive tillers, weights of shoot and root and length and weight of panicle per plant observed in the control (T_1) were significantly lower than those in the treated plots (T_2). The mean yield of paddy, wet and dry weights of grain and straw per ten plants as well as per plot of 4 sq.m. observed in the control (T_1) were also significantly lower than those in the plots (T_2). The mean wet and dry weights of Chaff per ten plants as well as per plot of 4 sq.m. observed in the control (T_1) were significantly higher than those in the treated plots (T_2).

Table 10. Effect of H.oryzicola infestation on the growth and yield of rice

Observations @	T_1	T_2	%increase/ decrease in T_1 than T_2	C.D.
From a plant				
Height of plant (cm)	69.90(8.42)	83.82(9.21)	-16.61	(0.15)*
Number of tillers	8.61(3.10)	11.75(3.57)	-26.72	(0.15)*
Percentage of productive tillers	69.39(8.39)	82.54(9.14)	-15.93	(0.23)*
Shoot weight (g)	52.88(7.34)	72.45(8.57)	-27.01	(0.42)*
Root weight (g)	22.72(4.87)	30.47(5.61)	-25.44	(0.30)*
Panicle length (cm)	17.40(4.29)	19.07(4.48)	-08.76	(0.09)*
Panicle weight (g)	9.82(3.29)	14.84(3.98)	-33.83	(0.35)*
From 10 plants (weight in g)				
Total yield of paddy	114.35(10.74)	150.78(12.32)	-24.16	(0.31)*
Wet weight of grain	81.63(9.09)	128.50(11.38)	-36.48	(0.40)*
Dry weight of grain	69.90(8.42)	99.80(10.04)	-29.96	(0.37)*
Wet weight of straw	147.84(12.2)	238.63(15.48)	-38.05	(0.94)*
Dry weight of straw	106.12(10.35)	180.71(13.48)	-41.28	(0.86)*
Wet weight of chaff	32.41(5.78)	22.14(4.81)	+46.39	(0.53)*
Dry weight of chaff	23.31(4.93)	16.14(4.14)	+44.42	(0.46)*
From the plot of $4m^2$ (weight in kg)				
Total yield of paddy	3.12(2.03)	3.75(2.18)	-16.80	(0.07)*
Wet weight of grain	2.5 (1.87)	3.37(2.09)	-25.82	(0.08)*
Dry weight of grain	2.13(1.77)	2.76(1.94)	-22.82	(0.07)*
Wet weight of straw	6.78(2.79)	9.56(3.25)	-29.08	(0.03)*
Dry weight of straw	2.73(1.93)	3.97(2.23)	-31.23	(0.13)*
Wet weight of chaff	0.61(1.27)	0.37(1.17)	+64.87	(0.03)*
Dry weight of chaff	0.56(1.25)	0.32(1.15)	+75.0	(0.32)*

@ Mean of observation in 12 replication

Figures in paranthesis are the means of transformed values and without paranthesis are the retransformed means

* significant at 5% level.

DISCUSSION

DISCUSSION

The rice cyst nematode, H.oryzicola, was first reported from Palghat District of Kerala State, India (Rao and Jayaprakash, 1978) and later from Trivandrum District (Anon., 1979). Extensive surveys carried out on the distribution of H.oryzicola in the country revealed not only the presence, but also its confinement to Kerala State (Sharma and Swarup, 1983).

H.oryzicola usually caused a distinct reduction in the growth and yield of the host plant without being lethal. The extent of damage is most commonly evaluated by assessing the population of cysts and larvae of H.oryzicola present in the rhizoplain of paddy (Ushakumari and Kuriyan, 1981).

Rice has been grown in our country for a very long time, but organised research on pest management for better and higher yield has only recently been started. The extent of occurrence of H.oryzicola on rice in different tracts of Trivandrum District in Kerala State and the loss caused to the crop has not been studied in detail. Hence the present investigation was undertaken in Trivandrum District.

In the preliminary survey conducted, the incidence of H.oryzicola on rice crop was observed in the paddy fields of 21 Panchayats in Trivandrum District viz. Ulloor, Kazhakootam, Andoorkonam, Attipra, Vakkom, Chemmaruthy, Karavaram, Mudakkal, Nellanad, Panavoor, Anadu, Aryanadu, Karakulam, Vilappil, Ottasekharamangalam, Aryancode, Vellarada, Perumbazhuthoor, Parassala, Balaramapuram and Kalliyoor (Table 1 and Fig. 1). Such a survey was conducted in Trivandrum District for the first time. The occurrence of this nematode on rice in the paddy fields of Trivandrum District was previously reported by Kuriyan et al. (1985).

The symptoms observed on the infested crop were reduced tillering, stunted growth of the plant, yellowing and chlorosis of the leaf and hollow brown roots with cysts/white females of H.oryzicola. This is in agreement with the symptoms reported by Rao and Jayaprakash (1977) and Jayaprakash and Rao (1984a)relating to H.oryzicola and Babatole (1983 a; 1983 b, 1984) relating to H.sacchari.

The increase in the numbers of cysts and larvae of H.oryzicola in the rhizoplain of different paddy varieties showed considerable variations as evidenced by

the results presented in Table 2,3 and 4. The population build up of H.oryzicola was found significantly higher in long duration varieties like Jaya, Aswathy, Bharathy and Sabari, with maximum population in Jaya variety and significantly lower population was observed in short duration variety Jyothi and a local paddy variety. This variation in the population build up of cysts and larvae of H.oryzicola among the paddy varieties might be due to the difference in reaction of hosts to the parasite also. Kerry and Jenkins (1976) reported that number of H.avenae larvae emerged from cysts exposed to cereal root diffusates varied with the cereal species and even cultivars. Neubert (1975) reported that among various cereals grown in rotation in soils artificially infested with H.avenae, population increase depended on the suitability of the cereal variety as host.

The population build up of H.oryzicola in different soil types showed great variations as evidenced by the results presented in Table 5, 6 and 7. The population build up of H.oryzicola was higher in sandy soils and lower in clayey soils compared to all other soil types. The difference in population build up of H.oryzicola in different types of soil might be due to

the difference in texture of soil and proportion of sand, aeration and available oxygen present in the soil. Whiteney and Doney (1973), Bhatti and Malhan (1981), Williams and Beame (1982), Srivasthava and Sethi (1984 a) in H.avenae and Jayaprakash and Rao (1984 b) in H.oryzicola had also reported that the cyst and cyst content developed in different soil types showed great variations.

It was also seen that the population build up of H.oryzicola differed during different seasons (Table 8). The population build up was higher in the second crop season and lower in the third crop season than in the first crop season. Thus the second crop season was very favourable for the build up of H.oryzicola than first and third crop seasons. This variation might be due to the difference in climatic conditions available and the cropping pattern adopted during different seasons. The season to season differences found in the nematode population trends were also reported by Ross (1962), Curi and Zmoray (1961), Schmidt and Grim (1978) and Khan et al., (1980). In West Siberia, U.S.S.R. a wet spring followed by a dry summer favoured the infestation of H.avenae (Shiabova, 1982). Thus these findings are

in agreement with the present observation.

In the experimental field the treatment of soils and roots of paddy with aldicarb was effective in controlling the population build up of H.oryzicola (Table 9). The population of cysts and larvae of H.oryzicola in the treated plots were negligible when compared to the infested control plots. Considerable reduction in the population of H.oryzicola by treating the soils and roots of paddy with aldicarb was also reported by Ushakumari (1980).

It was observed that the effect of transplanting of paddy in the H.oryzicola infested soils resulted in a gradual reduction in the population of their cysts from 15 DAT to 30 DAT than at transplanting and a gradual increase from 45 DAT to harvest than at 30 DAT. Similarly there was a significant reduction in the population of larvae of H.oryzicola in the soil at 15 DAT than at transplanting, a gradual increase from 30 to 90 DAT than at 15 DAT and a significant reduction at harvest than at 90 DAT. These reduction in the population density were significant. Similar observations were reported by Olthof (1978) that in sugarbeet infested by

H.schachtii the population densities were lower at mid season than at seedings but increased gradually upto harvest in the respective population. The reduction observed in the present findings might be due to the hatching of the cysts in the soil and penetration of larvae into the roots.

There was no cyst in the roots of paddy at transplanting and 15 DAT, but a significant increase was observed as the plant grew. Similarly there was no larva in the roots at transplanting, but a significant increase was observed from transplanting and the maximum was observed at 75 DAT and then significant reduction was noted at 90 DAT and at harvest. This was due to the hatching of the cyst and penetration of the larvae into the root system and later formation of cysts in the root tissue which got detached from the roots and fell into the soil. Bonner and Schmidt (1985) reported that the number of cysts and eggs in the soil remained low upto 100 days from planting and increased during the remaining period of the season. With a high initial nematode population, decreased at 100 days after planting and then resurged to maximum populations at harvest. Thus the present findings agree with earlier observations.

From Table 10 it can be seen that there was a reduction of 26.72 per cent in total number of tillers, 15.93 per cent in percentage of productive tillers, 16.61 per cent plant height, 27.0 per cent shoot weight, 25.41 per cent root weight, 8.76 per cent panicle length and 33.83 per cent panicle weight per plant in the control than in the treated plots. These reductions were statistically significant. Similar reductions were reported by Ushakumari (1980), Ushakumari and Kuriyan (1981) in rice infested by H.oryzicola. Brzeski (1969) in cabbage seedlings infested by H.schachtii, Guar and Singh (1977) in green gram with H.cajani, Sabova et al.(1981b) in barley and oats with H.avenae, Abdul-Eid and Ghoraba (1981) in maize plants with H.zeae and Gonet and Gonet (1982 a) in wheat and barley with H.avenae reported similar observations. Thus the earlier findings agree with present observation.

There was reduction of 24.16 and 16.8 per cent in total yield of paddy, 36.48 and 25.82 per cent in wet weights, 29.96 and 22.83 per cent in dry weights of grain; 38.05 and 29.08 per cent in wet weights and 41.28 and 31.23 per cent in dry weights of straw from 10 plants as well as per plot of 4 sq.m. respectively

in the control than in the treated plots. These reductions were statistically significant. These findings are in agreement with observations made by Ushakumari (1980) and Ushakumari and Kuriyan (1981). Loss due to H.oryzicola was estimated as 20 per cent on paddy (Rao, 1978). Kuriyan et al. (1985), Ohshima (1974) and Babatole (1984) observed similar results on rice infested by H.oryzicola, H.elachista and H.sacchari respectively. The effect of H.avenae on wheat, barley and oats in concrete tub experiments revealed that grain yields were reduced by 7.0 to 44.0 per cent for wheat, 32 to 44 per cent for barley and 50 per cent for oats and straw yields by 2 to 32 per cent, 20 to 26 per cent and 62 per cent respectively (Sabova et al., 1981a).

It can also be seen that there was an increase of 46.39 and 64.87 per cent in wet weights and 44.42 and 75.0 per cent in dry weights of chaff per 10 plants and per plot of 4 sq.m. respectively in the control over treated. These reductions were statistically significant. Similarly Ushakumari (1980) observed 26.92 and 18.53 per cent increase in chaff weight per plant and per

plot of 1 sq.m. under field condition and 30.75 per cent per plant under pot culture experiment.

Thus from the results presented it can be seen that the cyst nemetode H.oryzicola was present in the paddy fields of 21 Panchayats of Trivandrum District. It is present in all season, the highest population being in the second crop and lowest in the third crop season. The reaction of this nematode varies with paddy varieties, the population observed was highest in long duration and lowest in short duration paddy varieties. The nematode population also vary with soil types, the most suitable and ideal for multiplication and infestation of it being in the sandy loam, and that of the least being in clayey soils. The infestation of this nematode on rice crop caused considerable damage by reducing the number of tillers, percentage of productive tillers, plant height, shoot and root weights, panicle length and weight, total paddy yield, wet and dry weights of grain and straw and by increasing the wet and dry weights of chaff.

The results presented show the potency of H.oryzicola becoming a threat to cultivation of rice and

the necessity for preventing the spread of the same and to take control measures against these. The occurrence of these in other parts of the state may also be watched and sufficient quarantine measures taken against spreading the same to uninfested areas of the state as well as to the neighbouring states, as this nematode is now seen only in Kerala. Suitable measures may also be evolved to control or to prevent the infestation of these on rice crop.

SUMMARY

SUMMARY

The preliminary survey conducted in Trivandrum District of Kerala State, to study the occurrence of H.oryzicola associated with rice crop, revealed that this nematode was present in the paddy fields of 21 Panchayats viz. Ulloor, Attipra, Kazhakootam, Andoorkonam, Vakkam, Chemmaruthy, Karavaram, Mudakkal, Nellanadu, Panavoor, Anadu, Aryanadu, Karakulam, Vilappil, Ottasekharamangalam, Aryancode, Vellarada, Perumpuzhathoor, Parassala, Balaramapuram and Kalliyoor.

The visual symptoms observed on the infested rice crop were reduced tillering, stunted growth of the plant, yellowing and chlorosis of the leaves and hollow brown roots with cysts/white females of H.oryzicola.

In the detailed study of the build up of the cysts and larvae of H.oryzicola in the soils and roots of rice plant among different paddy varieties, soil types and cropping seasons showed significant influence. The population build up of H.oryzicola was found significantly higher in long duration varieties like Jaya, Aswathy, Bharathy and Sabari with the maximum in Jaya variety and significantly lower in short duration varieties like

Jyothi and local with the minimum in Jyothi variety. The population build up was higher in sandy soils and lower in clayey soils compared to the other soil types namely sandy clay, loamey and clayey loam. The build up was also higher in the second crop season and lower in the third crop season than in the first crop season..

The effect of transplanting of paddy in the H.oryzicola infested soils of the experimental field resulted in a gradual reduction in the population of their cysts from 15 DAT to 30 DAT than at transplanting and a gradual increase from 45 DAT to harvest than at 30 DAT. Similarly there was a significant reduction in the population of the larvae in the soil at 15 DAT than at transplanting, a gradual increase from 30 DAT to 90 DAT than at 15 DAT and a significant reduction at harvest than at 90 DAT. In the paddy roots the number of cysts increased gradually as the plant grew; but the number of larvae increased gradually from transplanting attaining a maximum at 75 DAT and then got reduced at harvest.

Treatment with aldicarb resulted a significant reduction in the number of the cysts as well as larvae

of H.oryzicola. With an initial population density of 12.4 cysts and 31.26 larvae of H.oryzicola per 100 ml soil there was reductions by 26.72, 15.43, 16.61, 21.07, 25.44, 8.76 and 33.83 per cent in the number of tillers, percentage of productive tillers, plant height, shoot and root weights, panicle length and weight per plant; reductions by 24.16 and 16.8, 36.48 and 25.82, 29.96 and 22.83, 38.05 and 29.08, 41.28 and 31.23 per cent per 10 plants as well as per plot of 4 sq.m. in total paddy yield, wet and dry weights of grain and straw and an increase of 46.39 and 44.42 per cent and 64.87 and 75.0 per cent in wet and dry weights of chaff per 10 plants as well as per plot of 4 sq.m. respectively.

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CROP LOSS CAUSED BY CYST NEMATODE *Heterodera oryzicola* INFESTING RICE

BY

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ABSTRACT OF THE THESIS

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ABSTRACT

The rice cyst nematode, H.oryzicola is observed to be an important pest infesting the growth and yield of rice crop in Trivandrum District of Kerala. However, detailed study on the incidence of this nematode and the extent of crop loss caused by it on rice in Trivandrum District was not carried out earlier. The present work was hence undertaken to find out the localities of incidence of H.oryzicola, the extent of its population build up and their effect of infestation on the growth and yield of rice crop in the fields of Trivandrum District.

The incidence of H.oryzicola was observed in the soils and roots of rice from the fields of 21 Panchayats of Trivandrum District Viz. Ulloor, Kazhakootam, Andoorkonam, Attipra, Vakkam, Chemmaruthy, Karavaram, Mudakkal, Nellanadu, Panavoor, Anadu, Aryanadu, Karakulam, Vilappil, Ottasekharamangalam, Aryancode, Vellarada, Perumbazhathoor, Parassala, Balaramapuram and Kalliyoor. The visual symptoms observed on the infested rice crop were reduced tillering, stunted growth of the plants, yellowing and chlorosis of the leaf and hollow brown

roots with cyst/white females of H.oryzicola. The nematoda is present throughout the season in the soils and roots of paddy, the highest population being in the second crop and lowest being in the third crop season. Their population build up between paddy varieties differ significantly, the highest population being in the long duration and lowest in the short duration paddy varieties. The nematode population also vary with soil types with a maximum in the sandy loam and minimum in the clayey soils.

The effect of transplanting of paddy in the H.oryzicola infested soils resulted in a gradual reduction in the population of their cysts from 15 DAT to 30 DAT than at transplanting and a gradual increase from 45 DAT to harvest than at 30 DAT. Similarly there was a significant reduction in the population of the larvae in the soil at 15 DAT than at transplanting, a gradual increase from 30 DAT to 90 DAT than at 15 DAT and a significant reduction at harvest than at 90 DAT. In the paddy roots the number of cysts increased gradually as the plant grew; but the number of larvae increased gradually from transplanting attaining a maximum at 75 DAT and then reduced from 90 DAT to

harvest than at 75 DAT. The infestation of H.oryzicola under field conditions on the rice crop caused considerable damage by reducing the number of tillers, percentage of productive tillers, plant height, shoot and root weights, panicle length and weight, total yield of paddy, wet and dry weights of grain and straw and by increasing the wet and dry weights of chaff.