VARIATION IN PLANT RESPONSE, GALL SIZE AND FORM INDUCED BY *MELOIDOGYNE* ON SOME MALAYSIAN CROPS

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Meloidogyne or root-knot is the most obnoxious plant parasitic nematode in the tropics. Plants attacked by the nematode manifest symptoms of root galling, retarded growth of the above-ground parts and yellowing of the leaves. This condition results in lowering of the quality and quantity of the harvest.

The worldwide distribution and ecology of *Meloidogyne* have been extensively reported. Similarly, considerable amount of information has been gathered on the histopathological and biochemical changes induced by the nematode at the cellular level. However, literature pertaining to the variability in the form and size of galls produced by *Meloidogyne* either of the same species on different host plants or of different species on the same host species or variety, is lacking. Differences in gall size on soybean variety induced by *Meloidogyne incognita* have been reported (1). Galls formed on Cv.Amsoy are larger than those found on Cv. Capitol. Likewise, small galls with multiple side roots are produced by *M. hapla* on tomato as compared to large galls with fewer side roots induced by *M. incognita.* Apparently, size and form of galls induced vary among *Meloidogyne* species as well as among plant species or variety. This paper summarises the diversity of gall form and size induced by *Meloidogyne* observed on some Malaysian crops, during the process of gathering *Meloidogyne* isolates for the IMP Project.

Rubber ***(Hevea brasiliensis).***— Rubber is the most important perennial crop in Malaysia, occupying about 2.4 million hectares of the cultivated land. Nematode problem in rubber appears to be restricted to first few years of the early part of the crop life, from planting to about 3-year-old tree. Several plant parasitic genera coexist in the soil rhizosphere of rubber root. The predominant genera are *Meloidogyne* spp., *Pratylenchus brachyurus* and *Rotylenchulus reniformis.* Less frequently present are species of *Helicotylenchus, Macroposthonia* and *Aphelenchoides. Meloidogyne* spp. and *P. brachyurus* are the two genera which could possible injure the plant by inducing respectively root galling and elliptical lesions on the root.

The size and form of galls from rubber depend on the age of the plant and density of *Meloidogyne* population in the soil. These galls are generally small and more often appear as a slight enlargement of the affected cortical tissues. Each gall appears to be elongated and discrete. Usually, only one mature female with the egg mass is present per gall. However, under heavy root-knot infestation the root may be distorted. Several galls coalesce but individual galls can still be identified. A few swollen females may be located within a few millimeters of the root.

The nematode feeds on a few cells along the periphery of the stele and the innermost cortical cells of the root. These highly enlarged cells are deeply stained in acid fuschin or cotton blue-lactophenol and can be conveniently teased out of the root. A group of hypertrophoid cells consists of six to eight individual giant cells which are elongated and more often spindle-shaped. These cells can be separated from one another. Each giant cell appears to be completely enclosed in a continuous cell wall. Possibly individual cells within the hypertrophoid tissue are interconnected with one another through their contiguous cell walls.

Tapioca ***(Manihot esculenta).***— Tapioca is more often cultivated as an intercrop in an immature rubber area. The crop produces two types of roots, the tuber and the white feeder roots. *Meloidogyne* feeds on the white roots by inducing gall formation. Depending on the population density of the nematode, the gall size may vary. Some galls are oval or elliptical bearing one, two or three mature females with their egg masses. Others, as a result of coalition of several galls under heavy nematode infestation, are elongated into finger-like structure. These galls normally bear more than five obese females. Several nematodes at different developmental stages have been located within 10 cm. of the tip

of the root. Further root elongation may be aborted, resulting in the formation of spherical galls.

Plant growth and tuber formation appear not to be affected by the nematode. More often, damage is done by coexisting *Pratylenchus brachyurus* population in the soil rhizosphere. In the presence of leguminous covercrops in the same locality, *Meloidogyne* prefers to feed on the cover's roots.

Black pepper *(Piper nigrum* L*).*— *Meloidogyne* is ubiquitous in black pepper growing area of Malaysia. Two species have been recorded, *M. incognita* and *M. javanica. M. incognita* is predominant in pepper growing area of Peninsular Malaya, while pepper grown in Sarawak, East Malaysia are invariably infested with *M. javanica.* Both species are capable of causing growth inhibition and probably lowering berry yield (2).

From afar, the affected area is manifested by symptoms of patchy, stunted, yellow bushes. Leaf yellowing spreads progressively from the lower to the upper canopy. The leaves drop prematurely with a slow decline of the vines. Affected vines wilt under dry weather condition, which is more severe when the crop is planted in a loose soil. In extreme cases, complete loss of foliage and death of vines resulted, reducing plant stand to a few erect bushes among the supporting poles.

Meloidogyne causes heavy galling on black pepper roots. The size and form of galls vary. Some galls are small, oval and discrete. Others are large, often exhibiting longitudinal cracks in the direction of the root axis. Tissues bordering the cracks undergo proliferated growth. Small, black, circular markings are present on the surface of the galls denoting the remains of dislocated egg masses. Heavily galled roots normally produce very few feeder roots. In several root systems observed, the feeder roots are completely lost.

Breadfruit *(Artocarpus communis).*— Breadfruit is very susceptible to *Meloidogyne* attack. In extreme cases, plant mortality can be very high. Early symptoms observed on affected plants are retarded growth, reduced trunk diameter, sparse branching and general yellowing of the leaves. As the disease progresses, the leaves drop prematurely, spreading progressively from the mature to the younger leaves. Finally, the canopy is reduced to a few defoliated branches. This process is accelerated by dry weather condition. New shoots tend to regenerate. Within two years of planting the plant succumbs to the nematode attack.

Affected plants are heavily galled. The nematode invades both the tap root along the soil-line, as well as the lateral roots. Galls induced on tap root are larger than those seen on the lateral and feeder roots. Some are more than 20 mm. in diameter, and they are close to one another. Rarely are these galls seen fused together. Each individual gall is quite distinct, and spherical. These galls are normally hard and reddish brown in colour. As the gall ages, it becomes friable and turns black. Galls (5-10 mm. in diameter) found on the lateral roots are few and vary in size. Galls up to 15 mm. in diameter are quite common. Some appear to be attached to one side of the root while others engulf the entire circumference of the root. If the galls are induced at the root tip further root elongation is arrested. Large galls often exhibit deep cracks on the surface. Affected plants have very poor root system devoid of feeder roots.

Vegetables.— Root-knot is a cosmopolitan genus in the vegetable soil of Peninsular Malaya. Being polyphagus in habit, almost every species of vegetables grown is a host to the nematode. It is one of the most important soil pests of vegetables. Some of the common vegetables known to be the hosts of *Meloidogyne* are cucumber, okra, eggplant, yard-long beans and *Brassica rapa.* The degree of galling on the root depends on the population density in the soil and vegetable variety grown. Cucumber, okra and eggplants appear to be most favoured hosts while yard-long bean and *Brassica* sp. are less so.

Symptoms of nematode attack are manifested by poor growth, yellowing of the leaves and slow decline. On cucumber, the leaves drop prematurely. The plant produces very few, small distorted fruits which mature early and wilt readily during hot weather. Affected okra and eggplants are short and produce small leaves. Fruit size apparently is very much reduced. These plants have shorter fruit-bearing life. Yard-long bean is susceptible to *Meloidogyne* attack. Infested plant produces few pods which are short and mature early. Plant life is shortened by the progressive defoliation of the leaves starting from the bottom. In contrast, the growth of *Brassica rapa* appears not to be affected by *Meloidogyne.*

The size and form of galls produced on the roots of these crops differ. On okra the whole root system swells into short, distorted, finger-like clumps devoid of feeder root.

Often groups of 5 to 10 mature females are found within a small area of the gall, producing what appears to be one large egg mass. In contrast, large elongated galls in cucumber are mainly confined to the tap root and adjoining lateral roots near the base of the stem. Root elongation beyond the swollen region appears not to be affected. When these roots are subsequently invaded by *Meloidogyne,* galls produced are small. They are either spindle-or oval-shaped, and about 2 to 3 mm. in diameter at the widest part. Each gall supports one to four mature females.

Root knot is not as pernicious on eggplant as on okra and cucumber. The nematode causes heavy galling on the root and retards the growth of the above-ground parts. However, plant death may be caused by subsequent fungal and bacterial infections.

Meloidogyne induces pea-size galls of about 4 mm. in diameter on both the tap-root as well as the lateral roots of eggplant. Enlargement of the gall causes deep longitudinal cracks of the tissue along the direction of the long axis of the root. The gall is accomodated in these cracks. Several fine roots are produced along the side of the gall which may be invaded by the nematode again. The cracks form an avenue for the entry of other soil-borne pathogens. On smaller roots, oval or spherical galls are produced, bearing one or two mature females. Galls induced by *Meloidogyne* at the root-tip stop further growth and elongation of the root. Affected root system produces scanty roots.

Brassica rapa is a common leafy vegetable for the Malaysians. This crop appears to be a poor host for the root-knot nematodes. Galls formed on the roots are small and few. They are spindle-shaped. When several small galls occur separately along the length of a root they appear as a string of beads. The egg masses can be easily identified by their light brownish appearance on the surface of the gall. Occasionally, several galls may fuse together into a long, knotty structure. Individual galls may be identified by the egg mass on the surface.

Conclusion

The ability of *Meloidogyne* to cause galling on the root has attracted the attention and interest of several workers throughout the world. Substantial information has been gathered on the understanding of the nematode and the host. This report on the observation of the variation in the gall size and form on some Malaysian crops would add hopefully to the sparse information available on this topic today.

Literature Cited

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DISCUSSION

Chunram: What varieties of black pepper are grown in Malaysia? What species of root-knot are present in black pepper plantations?

Razak: I do not know what varieties of black pepper are grown. The root-knot species are *Meloidogyne incognita* (West Malaysia) and *Meloidogyne javanica* (East Malaysia).

Inagaki: Have you made any experiment to analyze the relationship between root-knot nematode and *Phytophthora* fungus in disease development in black pepper?

Razak: I have just initiated the experiment in cooperation with a plant pathologist.