BREEDING VEGETABLE CROPS FOR RESISTANCE TO ROOT-KNOT NEMATODES IN BRAZIL

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Efforts for obtaining new cultivars or breeding lines with resistance to Meloidogyne species are relatively recent in Brazil. Germ plasm introductions, screening tests, hybridization experiments, etc., have been conducted. Nematology and plant breeding training programs in Brazil and abroad have been accomplished as part of these efforts.

Research on root-knot nematodes has been carried out in a few vegetable crops: carrot, potato, cowpea, and tomato.

Carrot

Carrot (Daucus carota): Results were obtained at the Brazilian Vegetable Crops Research Center of EMBRAPA (CNPH/EMBRAPA), at Brasília, by Charchar, Vieira and Huang (7). The screening program started with 249 lines in a field heavily infested with Meloidogyne incognita, and it was possible to select 51 promising lines in the first selection cycle. After four cycles of selection in the field, six highly resistant lines of M. incognita and M. javanica were selected. The susceptible cultivars (checks) used were 'Kuroda' and 'Nantes,' which had heavily galled roots. The susceptible cultivars were sown side by side with the resistant lines. At the end of the fourth selection cycle, a high frequency of commercial carrot roots consistently free of galls was found in all six experimental lines selected. These six lines originated from the cultivars 'Rio Grande,' 'Nacional' and 'Tropical,' which were collected in Rio Grande do Sul State. These three local cultivars were introduced by European immigrants many years ago.

No nematode-resistant carrot cultivar has been reported by Sasser and Kirby in their list of crop cultivars resistant to root-knot nematodes (14).

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Potato

Potato (Solanum tuberosum): Some field screening tests have been carried out to evaluate the degree of resistance to Meloidogyne spp. in potato. Charchar (personal communication) at the CNPH/EMBRAPA found among 48 cultivars (Brazilian and European cultivars), four cultivars moderately resistant to M. incognita and M. javanica: 'Delta S,' 'Edzina,' 'Sowa,' and 'Clone 70.' The important Brazilian varieties 'Santo Amor,' 'Aracy,' and 'Baroneza' were susceptible.

Cowpea

Cowpea (Vigna unguiculata): Although it has been used as a cereal, it is also prepared green as a vegetable in several Brazilian regions. It is an important source of protein in our lower income areas.

Root-knot nematodes have been limiting crop yields. Ponte, comparing infested and non-infested crops in northeastern Brazil, estimated a yield loss of 20% due to Meloidogyne spp. (12).

The selection of germ plasmaccessions and the results obtained in screening tests indicated the importance of regional tests in the selection of resistant cultivars. Among 10 cultivars grown at NE, the cultivars 'Seridó,' 'Pitiuba,' 'Quarenta-Dias,' 'CE-50,' and 'CE-212' were highly resistant to M. incognita, M. javanica, M. arenaria and M. hapla (13). Lemos & Ponte examined 15 cultivars for resistance to these four nematodes and found six to be highly resistant. Due to the use of resistant cultivars, especially 'Pitiuba,' 'Seridó' and 'Quarenta-Dias,' root-knot nematodes in the northeast are now considered a secondary disease of cowpea.

The Basic Seed Production Department (SPSB/EMBRAPA) in 1981 sold 91 tons of Basic seeds of the cultivar 'Pitiuba' and 11 tons of Basic seeds of the cultivar 'Seridó,' an amount large enough to produce about 2,260 tons of certified seed in 1982 (16).

R. D. Sharma worked in Central Brazil under greenhouse conditions with 12 cultivars inoculated simultaneously with M. javanica (30,000 eggs/larvae per pot containing 1 kg of soil) and Rhizobium japonicum. He concluded that "no cultivar was resistant to this nematode" (15). However, 'V-4 Alagoas,' 'IPEAN 69552' and 'Jaguaribe' were considered

as tolerant cultivars (high gall and egg mass indices and small growth reduction). He classified 'Pitiuba,' 'Seridó,' 'TV 1836-013J' and '4R-0267' as susceptible cultivars.

Although these results seem to contradict the ones previously mentioned (10, 13), they may suggest that the high initial inoculum level used under greenhouse conditions overloaded the biological system. This could be observed by the number of egg masses counted on roots of five cultivars 'IPEAN-V-79,' 'TUV 735-P_2,' 'Pitiuba' and 'Seridó,' which presented an average of 135 egg masses per plant representing five times fewer egg masses than the average of the remaining eight cultivars.

Tomato

Tomato (Lycopersicon esculentum): Dias et al. (9) in 1964 mentioned a tomato program to incorporate root-knot nematode resistance using the Mi gene from the Hawaiian line HES 6048 (9). Segregating population from the first backcross showed plants with roots completely free of galls. However, to our knowledge, no resistant cultivar was released.

More recently, the cultivars 'IPA-1,' 'IPA-2' and 'IPA-3,' which possess the Mi gene, were released by IPA from Pernambuco State (17). This program will be presented by Tavares during this meeting.

Camara, Araújo and Cordeiro, working with 'IPA-3' and several other cultivars in the Central Brazil, found that this dual-purpose cultivar (fresh and processing tomatoes for the NE) showed some disadvantages such as lower yield of high-graded tomato fruits, lower firmness and lower prices for the high-graded fruits when compared with the traditional Santa Cruz cultivars (6).

Charchar & Araújo at the CNPH worked in a field heavily and uniformly infested with M. incognita, in which the populations in some treatments were greatly reduced by crop rotation with Crotalaria spectabilis for 4 and 8 months (8). The results suggested that 'IPA-3' (Mi/Mi) is intolerant to M. incognita while 'Angela,' a susceptible bilocular Santa Cruz type, is tolerant to high soil populations. This finding would raise the importance in a tomato

breeding program of searching not only for resistance but also for tolerance in a given region. These experiments also indicate that in regions with night temperatures below 32 C, such as occurs in Brasília, the Mi gene could be used successfully in reducing field populations of M. incognita.

As part of their graduate course requirement, two Brazilians carried out research in California and Florida which could be useful in tomato breeding programs in our country (1, 11). Medina-Filho studied the feasibility of using starch gel electrophoresis (EP) in selecting for nematode resistance in tomato (no infection with root-knot nematode is necessary) (11). For this work, he chose the genotype of locus 1 of acid phosphatase (Aps-1) in chromosome 6. Cultivars resistant to root-knot nematodes possess $Aps\text{-}1^{+/+}$ or $Aps\text{-}1^{1/1}$ closely linked to Mi gene. $Aps\text{-}1^{1}$ was known to occur in L. peruvianum. Then, a crossing over between $Aps\text{-}1^{1}$ and Mi may have occurred in early generations of the root-knot nematode resistant cultivars derived from Hawaiian lines during the process of transferring such genes into L. esculentum. The same did not occur with 'VFN 8' and other California lines which possess $Aps\text{-}1^{1}$ (like the Hawaiian lines from which they originated, the same Smith's interspecific hybrid and Watt's first backcross of Smith's interspecific hybrid to L. esculentum).

The EP technique is useful only by using germplasm from the California Breeding Program ('VFN 8' and derivatives) or L. peruvianum with $Aps\text{-}1^{1}$.

The EP technique has several advantages over the traditional method (based on direct infection with root-knot nematodes) when transferring the Mi gene to susceptible lines or cultivars. It is time saving because no progeny test is necessary to distinguish homozygous from heterozygous resistant plants (distinct banding patterns in the zymogram), and the screening period is extended by allowing the use of several stages such as seedlings, leaflets, anthers, stored frozen leaf samples or dry anthers.

Araújo et al. (1, 2, 3, 4, 5) carried out experiments to identify new sources of resistance to root-knot nematodes effective

at high soil temperature (32.5 C). The methodology was developed to make the measurement of quantitative resistance feasible. The tomato plants were grown in controlled-temperature tanks. It was determined that the best inoculum density for screening tomato accessions at soil temperature for resistance to M. incognita and M. javanica was 200 eggs/larvae per plant. Thermoperiodism was found to play an important role in maintaining the resistance to M. incognita and explained why in many areas with high night soil temperature the Mi gene is not effective. Races may vary in aggressiveness toward tomato accessions at high soil temperature. Among 146 cultivars, PI accessions and selections of L. esculentum, L. peruvianum var. dentatum, L. peruvianum var. humifusum, L. cheesmanii var. minor, and L. esculentum x L. peruvianum, the selection 2-(Sib)-5-16 (selfed) of L. peruvianum var. dentatum 'PI 129 149' was the most resistant to M. incognita race 1 in the entire screening work at high temperature.

Now at the CNPH/EMBRAPA there is a breeding program to transfer the Mi gene into fresh and processing tomato cultivars in order to obtain isogenic lines. Another program is being carried out by the bulk population method aimed at obtaining new root-knot nematode resistant cultivars. In both programs, plant nematologists, plant breeders and other researchers are working in a multidisciplinary way.

RESUMO

Melhoramento de hortaliças no Brasil, visando resistência à meloidoginose

Trabalhos procurando fontes de resistência, de seleção e de hibridização para os nematóides das galhas Meloidogyne spp. efetuados no Brasil ou por brasileiros em cursos de pósgraduação no exterior são relatados.

Encontram-se referências nas culturas da cenoura, batata, feijão-de-corda e tomate. Novas fontes de resistência tem sido encontradas e também já foram lançadas as primeiras cultivares resistentes.

Embora promissores os programas deveriam ser dirigidos não apenas para a incorporação de resistência propriamente dita, como também para a associação de resistência com tolerância a este importante grupo de nematóides.

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