Nematol. medit. (1987), *15*: 65-70.

Division of Nematology, University of California, Davis, USA

BIOLOGICAL CRITERIA IN MANAGEMENT CONSIDERATIONS FOR *MELOIDOGYNE CHITWOODI*

by
D.R. VIGLIERCHIO

The Columbia root-knot nematode (*Meloidogyne chitwoodi*, Golden *et al.*) is a recently recognized nematode pest in the potato-growing areas of northwestern U.S.A. For years it was obscured by *Meloidogyne hapla* which also occurs in the same areas. However, with increasing incidence of nematode damage displaying characteristics different from those expected of *M. hapla*, investigators were led to the discovery of a new nematode pest, *M. chitwoodi* (Golden *et al.*, 1980). Although the early detections occurred in the potato-growing areas of the states of Washington, Oregon and Idaho (Santo *et al.*, 1980), subsequent detections have been reported from Utah, Nevada and several areas of California (Nyczepir *et al.*, 1982). *M. chitwoodi*, which is found in light and heavy soils, favours lower soil temperatures (Santo and O'Bannon, 1981). It has a wide host range including many representatives of the Gramineae, which are commonly used in rotational programmes with potatoes (Santo and O'Bannon, 1982; O'Bannon *et. al.*, 1982). Of the alternate crops used in rotation, alfalfa appears to be relatively immune to race 1 but not race 2 (Santo, personal communication). All the usual commercial cultivars of potato are susceptible to race 1 and 2. With the detection of *M. chitwoodi* in a productive potato-growing area of Northern California, it was important to characterize the problem in terms of the susceptibility of crops grown in the area and of the local biological characteristics of the nematode.

Materials and Methods

An array of cultivars of wheat, oats, barley, alfalfa, and miscellaneous crops were planted in half-litre plastic pots with infested soil from the area where *M. chitwoodi* and a root lesion nematode, tentatively identified as *Pratylenchus neglectus* (Rensch) Schuurmans Stekhoven, occurred. The young seedlings, grown in a greenhouse, were inoculated with an additional 100 juvenile *M. chitwoodi* from a stock population. After three months growth, the plants were harvested. The roots were washed free of soil with a vigorous stream of water, chopped into small pieces and placed on a mister for 1 week, after which the nematodes were collected and the numbers of each species counted. The massive root-ball of the wheat plants required vigorous manipulation and washing to remove the soil particles, so that this probably reduced available egg masses for extraction and consequently *M. chitwoodi* counts were underestimated.

The Northern California potato-growing area is at an elevation above 1,000 metres and suffers long winters, with ambient temperatures falling below freezing. In as much as *M. chitwoodi* is more active at lower temperatures than most other root-knot species, it was of interest to determine the feasibility of using freezing temperatures as a means of management. Infested soil was placed in plastic pots as before, which then were placed in plastic bags and these were tied closed. Each plastic bag lot was exposed to a specific temperature regime programme. The temperature programmes constituted a crude mimic of the regime in nature. For example, departing from a continuous 15°C regime as controls, the temperature of a soil lot was decreased by 5 degrees at weekly intervals until a desired low soil temperature and maintenance period was achieved, then raised at 5 degree intervals weekly, until control temperatures were reached, as illustrated in Fig. 1 for the lowest temperatures utilized. At the end of the soil programme, the soil-filled pots were planted with tomato cv. Columbia, a good host for *M. chitwoodi*, and after 3 months the plants were harvested for nematode counts as previously described.

Although heavy *M. chitwoodi* infestations of potato fields can decrease yields, lower population levels can also cause major crops losses because of reduced tuber quality. Nematodes penetrating the growing tuber surface establish a feeding site and develop into adult females. In the process hypertrophy of the cortical cells occurs, lesions develop, the tissue darkens and necrotic areas appear. If a female site is near the tuber surface, the hypertrophy results in a surface protrusion which is easily visible to the naked eye. Such damage may appear after several months

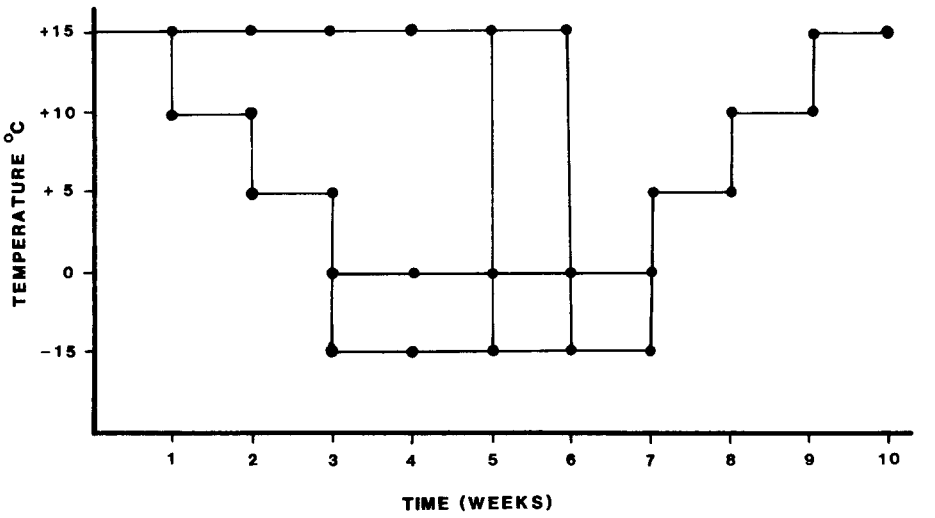

Fig. 1 - Storage temperature programme for freeze-kill trials of *Meloidogyne chitwoodi*.

in storage on tubers that were smooth-skinned at harvest. Surface and internal blemishes render tubers unmarketable and a potato lot containing 10% or more blemished potatoes is unsaleable in the fresh market (Santo and O'Bannon, 1981).

In other potato-growing areas infested with *M. incognita*, potatoes harvested early or just at maturity produce marketable potatoes. However, if harvested late, tubers are frequently blemished with symptoms similar to those caused by *M. chitwoodi*. It was of interest, therefore, to establish whether the *M. chitwoodi* blemishes were a consequence of a cultivation practice. Small Russet potato tubers were placed in 300 cm pots in which a Columbia tomato was vigorously growing and which supported a heavy infestation of *M. chitwoodi*. At 2-week intervals, the tubers were replaced by fresh tubers; the tubers that were removed were placed in storage at 10° C. Four weeks before the termination of the 12-week experiment, the tomato plants were severed at the soil surface to allow the roots to die. The potatoes from the experiment were kept in storage for an additional two months and then *M. chitwoodi* infestation was assessed in terms of bumpiness on the tuber surface and counts of embedded females in thin slices of the outer 1 cm portion of the tuber.

Results

The relative susceptibility to nematode infestation on the various cultivars tested in shown in Fig. 2. The population density of *P. neglectus* was less on alfalfa than on winter pea and the cereal cultivars, some of which supported very high populations. Except for cv. Atra 55, and perhaps Vancour, alfalfa appeared unable to support populations of *M. chitwoodi*. The results suggest that the *M. chitwoodi* population is of race 1. Although all the cereal cultivars tested supported high populations of *P. neglectus*, there were several that were relatively less susceptible to *M. chitwoodi*.

The results of the cold temperature trials indicated that *M. chitwoodi* could survide prolonged exposure at 0°C or above with little if any loss of infectivity, but were unable to survive for as little as one week at —15°C. Meteorological records for the Northern California potato-growing area show that soil temperatures at 20 cm or deeper did not fall below 0°C even in a winter that was considered to be colder than normal by the local people.

In the blemish trials, *M. chitwoodi* failed to penetrate and develop in the tubers, the surface of which thus remained smooth.

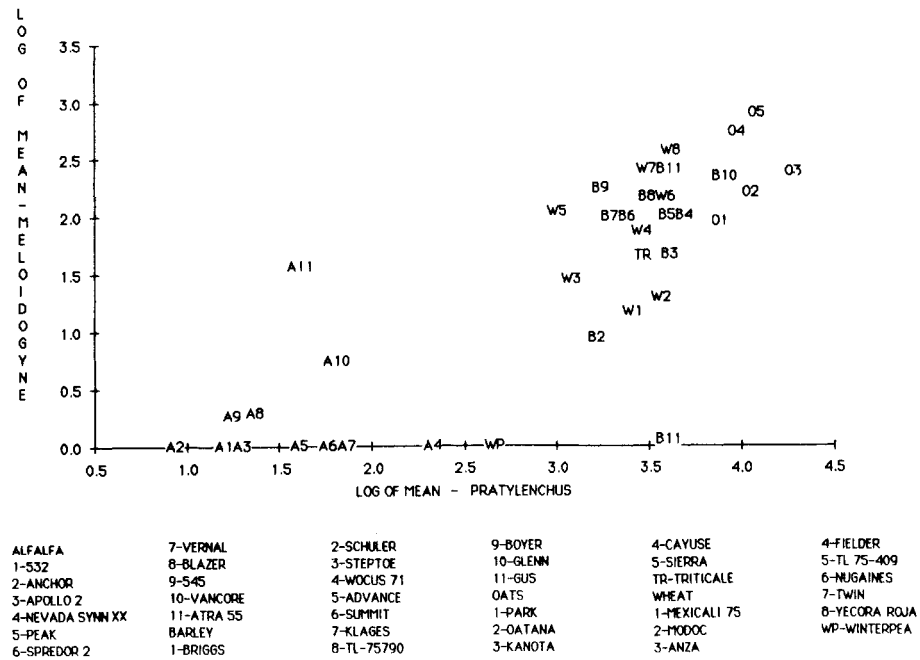

Fig. 2 - Population levels of *M. chitwoodi* and *Pratylenchus neglectus* (log-log plot) developing in 3 months on cultivars used in crop rotation with potato.

Conclusions

Notwithstanding the variability in the nematode estimates indicating cultivar susceptibility, the nematode counts are considered very conservative. The vigorous washing required to remove the heavy clay particles from the prolific root masses of the cereal cultivars resulted in the loss of *M. chitwoodi* egg masses. The real population levels were probably higher than indicated. Neverthless, the results indicate several cultivars which could support low population levels of both *M. chitwoodi* and *P. neglectus* and so for nematode management purposes would be preferable for selection in rotation programmes with potatoes.

The temperature studies indicated that the low temperatures required to kill *M. chitwoodi* were substantially below those normally experienced in this Northern California potato-growing area during a colder than normal winter season. To utilize freezing as a management control practice, substantially lower winter temperatures would be required to reduce the soil temperatures in the 20 to 40 cm depth to below —10°C.

The tuber blemish studies indicate that *M. chitwoodi* juveniles do not penetrate mature suberized tubers, thereby confirming a previous observation (Finley, 1981). Tuber blemishes appear to result from penetration of immature developing tubers by juvenile *M. chitwoodi*.

SUMMARY

In a potato-growing area of Northern California, heavily infested with *Meloidogyne chitwoodi*, cereal crops are grown in rotation with potatoes. Most cereal cultivars are highly susceptible to this nematode. In pot trials several cultivars of cereals and other crop plants supported low populations of *M. chitwoodi* and also of *Pratylenchus neglectus* which is present in this area; these could be used for the management of the nematodes in crop rotational programmes. Winter soil temperatures in the area are too high to use freeze-kill of *M. chitwoodi* as a management tool. Tuber blemish studies also showed that *M. chitwoodi* penetrate developing immature tubers but not mature suberized tubers.

LITERATURE CITED

FINLEY A.M., 1981 - Histopathology of *Meloidogyne chitwoodi* (Golden *et al.*) on Russet Burbank potato. *J. Nematol., 13*: 486-491.

GOLDEN A.M., O'BANNON J.H., SANTO G.S. and FINLEY A.M., 1980 - Description and SEM observations of *Meloidogyne chitwoodi* n. sp. (Meloidogynidae), a root-knot nematode on potato in the Pacific Northwest. *J. Nematol., 12*: 319-327.

NYCZEPIR A.P., O'BANNON J.H., SANTO G.S. and FINLEY A.M., 1982 - Incidence and distinguishing characteristics of *Meloidogyne chitwoodi* and *M. hapla* in potato from the Northwestern United States. *J. Nematol., 14*: 347-353.

O'BANNON J.H., SANTO G.S. and NYCZEPIR A.P. 1982 - Host range of the Columbia root-knot nematode. *Plant Disease, 66*: 1045-1048.

SANTO G.S., O'BANNON J.H., FINLEY A.M. and GOLDEN A.M., 1980 - Occurrence and host range of a new root-knot nematode (*Meloidogyne chitwoodi*) in the Pacific Northwest. *Plant Disease, 64*: 951-952.

SANTO G.S. and O'BANNON J.H., 1981 - Effect of soil temperature on the pathogenicity and reproduction of *Meloidogyne chitwoodi* and *M. hapla* on Russet Burbank potato. *J. Nematol., 13*: 483-486.

SANTO G.S. and O'BANNON J.H., 1982 - Reaction of tomato cultivars to *Meloidogyne chitwoodi* and *M. hapla. Plant Disease, 66*: 406-407.

Accepted for publication on 28 January 1987.