The Relationship Between Tobacco Yield and Time of Infection with Meloidogyne javanica[1]

B. B. BRODIE and P. D. DUKES[2]

Abstract: Yield of tobacco was related to the amount of infection by *Meloidogyne javanica* during the first month after transplanting. Six nematicidal treatments significantly reduced infection during this period and subsequently increased yield. However, during the second month after transplanting, infection in plots treated with O-ethyl S,S-dipropyl phosphorodithioate (V-C 9-104) and a mixture of 80% chlorinated C_3 hydrocarbons + 20% methyl isothiocyanate (DD + MENCS) was not significantly different from infection in untreated plots. After 3 months, root-knot indices in plots treated with V-C 9-104, DD + MENCS, O,O-diethyl O-[p-(methylsulfinyl) phenyl] phosphorothioate (B-25141), and 1,3-dichloropropene, 1,2-dichloropropane (DD) were not significantly different from those in untreated plots; reduced infection was present only in plots treated with ethylene dibromide (EDB) and 2-methyl-2 (methylthio) propionaldehyde O-(methylcarbamoyl) oxime (aldicarb). At the end of harvest (4 months after transplanting), root-knot indices in all plots were essentially equal. *Key words:* root-knot, chemical control.

In chemical control experiments, it is often difficult to correlate positive yield response of tobacco with reduction in root-knot indices taken at the end of the growing season. High yields are quite often associated with high root-knot indices. To better understand factors which contribute to the pathogenicity of root-knot nematodes on tobacco, we studied the progression of infection by *Meloidogyne javanica* after various nematicidal soil treatments.

Several factors contribute to the pathogenicity of *Meloidogyne* spp. to crop plants. Since *Meloidogyne* spp. attack mostly young roots of plants (3), age of host becomes a predominant factor in infection and pathogenesis. In many cases, severe plant damage occurs when root-knot nematode larvae enter roots of seedlings of "non-host" plants (2, 4). In such cases, increase in age of the plant decreases the chance of damage to a point where there is no measurable damage (2). Moreover, sensitivity of susceptible tomato to *Meloidogyne* spp. decreases rapidly with increase in age of plant (1). Inoculation of tomato seedlings in the cotyledon stage with 10,000 larvae of *M. incognita* caused 81% reduction in growth, but had no adverse effects on seedlings in the 3- to 4-petiole stage. Similarly, onion seedlings 24-48 hr old were more severely damaged by *Ditylenchus dipsaci* than were seedlings 72-96 hr old (7).

The amount of plant damage caused by a nematode is apparently related to the preplant population density of the nematode (6, 8, 10). In developing a formula for accurately predicting damage that will result from certain plant-nematode associations, Seinhorst (8) considered the portion of exposed plant not attacked to be critically important in conveying an understanding of the quantitative relation between nematode density and growth of plants. With increase in age of plant, there is a corresponding increase in exposed root system not attacked because of a temporary or permanent inaccessibility of part of the host tissue. As amount of host tissue not attacked increases, the per cent plant damage decreases. Importance of the preplant population density of *Meloidogyne* spp. in tobacco culture is exemplified in Stinson's (9) observation that tobacco planted in October and November, when nematode populations are low in Southern Rhodesia, has a better chance of developing a substantial root system than tobacco planted earlier when nematode populations are higher. Moreover, Nusbaum (5) found, in a 5-year study in the southeastern United States, that growth of tobacco was not retarded in seasons when root-knot nematode

Received for publication 27 July 1971.

[1] Cooperative investigations of Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the University of Georgia College of Agriculture Experiment Stations, Coastal Plain Station, Tifton. Journal Series Paper No. 1017.

[2] Nematologist, Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, Department of Plant Pathology, Cornell University, Ithaca, New York 14850; and former Associate Professor, Department of Plant Pathology, Coastal Plain Station, Tifton, Georgia 31794, currently Plant Pathologist, Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture, U.S. Vegetable Breeding Laboratory, Charleston, S.C. 29407. Mention of trademark name or proprietary product does not constitute a guarantee or warranty of the product by the USDA, and does not imply its approval to the exclusion of other products that may be suitable.

populations were low before planting and did not substantially increase until late in the growing season. In some cases, a low preplant population was believed to have had a favorable effect on ripening of tobacco. Also, tobacco generally did not respond to nematicide application (5) where root-knot nematode damage the previous year was rated as slight.

MATERIALS AND METHODS

Plots were established in Norfolk sandy loam which was heavily infested with *Meloidogyne javanica* Chitwood. Six nematicidal treatments were applied in a randomized complete block design replicated six times. Plots were 16.5 m long and 1.1 m apart. Three replications were selected at random each year, and plants were dug (25/treatment/replication) at monthly intervals and the roots rated for root-knot nematode galling. Individual plants were rated on a 1-5 scale where 1 = no galling and 5 = maximum galling. The remaining three replications were harvested for yield data. The experiment was repeated three times. To preclude residual effects of certain nematicides, the same test area was not used 2 years in succession. In alternate years, the test area was planted to a susceptible soybean (*Glycine max* 'Hampton') to equalize populations of *Meloidogyne javanica.*

Liquid fumigants, 1,3-dichloropropene, 1,2-dichloropropane mixture (DD), ethylene dibromide (EDB), and a mixture containing 80% DD + 20% methyl isothiocyanate (DD + MENCS) were applied 2-3 weeks before transplanting. The fumigants were injected (1 chisel/row) 20 cm below the soil surface and bedded to 30 cm above the point of injection. At planting, the top 7.5-10 cm of soil on the bed was pushed into the row middle ahead of the planter.

Nonvolatile nematicides, 2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl) oxime (aldicarb), O,O-diethyl O-[p-(methylsulfinyl) phenyl] phosphorothioate (B-25141) (Dasanit®), and O-ethyl S,S-dipropyl phosphorodithioate (V-C 9-104) (Mocap®) were applied as granular formulations just before transplanting. Each nematicide was spread on the soil surface in a 76 cm wide band and incorporated in the top 15-20 cm of soil with a power-driven rototiller.

Tobacco seedlings were transplanted into the plots with a tractor-drawn transplanter, and all plots were irrigated immediately to enhance

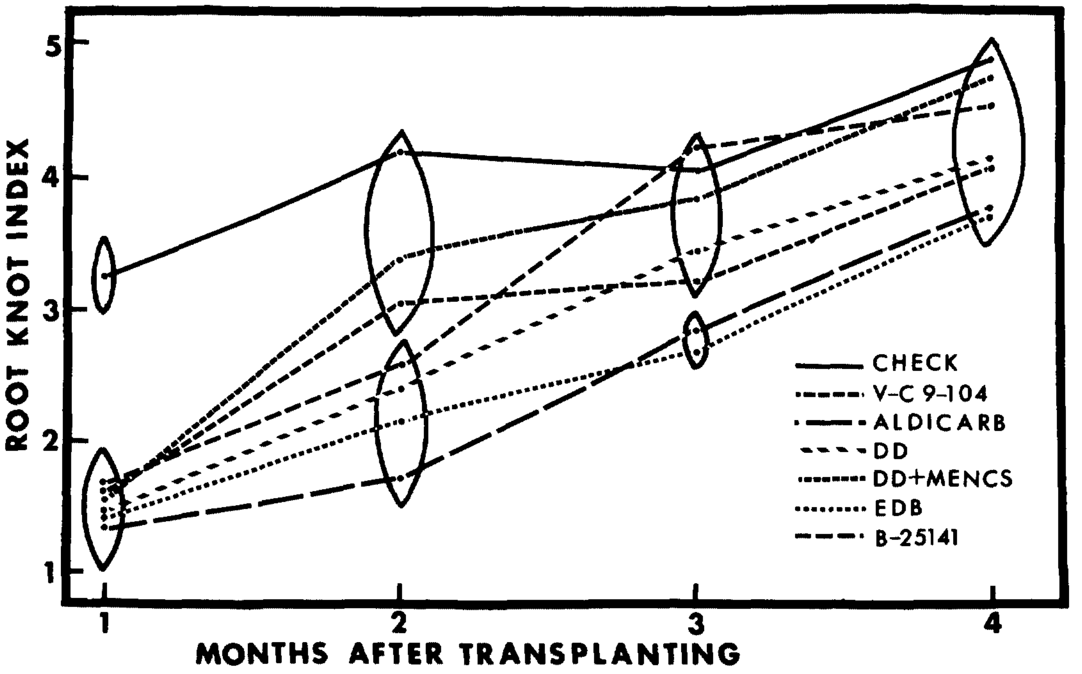

FIG. 1. Root-knot indices of tobacco at various intervals after transplanting tobacco in soil infested with *Meloidogyne javanica.* (Points within the same ellipse are not significantly different at the .05 level of probability).

transplant survival. Fertilization, cultivation, harvesting, and curing of tobacco were consistent with good farming practices of the area.

RESULTS

Statistical differences between root-knot indices of plants in treated and untreated plots varied with length of time after transplanting. Large differences were evident the first month after transplanting, but gradually decreased until no differences occurred 4 months after transplanting (Fig. 1). One month after transplanting, root-knot indices from all treated plots were significantly smaller than those from untreated plots, but no significant differences occurred among treated plots. However, 2 months after transplanting, root-knot indices of plants from plots treated with V-C 9-104 and DD + MENCS were comparable with those from untreated plots. Although root-knot nematode infection was as great in all treated plots (except for EDB and aldicarb) as it was in untreated plots 3 months after transplanting (Fig. 1), plant growth in treated plots was much superior to that in untreated plots. At harvest, 4 months after transplanting, the *M. javanica* population had increased in all plots to a level where root-indices in treated and untreated plots were not significantly different.

All nematicidal treatments significantly increased the yield of tobacco over that of the untreated control (Table 1). Also, yield from plots treated with V-C 9-104 was significantly greater than yield from plots treated with DD + MENCS. Otherwise, all nematicidal treatments were equally effective in increasing yield.

DISCUSSION

Our data indicate that the sensitivity of tobacco to damage by root-knot nematodes, as indicated by foliage yield, diminished with age of plant. Bergeson (1) found a similar relationship on tomato. Apparently, infection of tobacco by *M. javanica* 2-4 months after transplanting had little or no detrimental effect on yield. Consequently, we attributed reduction in yield to infection occurring during the first month after transplanting. This confirms the observations of Stinson (9) and Nusbaum (5) that tobacco transplanted into soil with a relatively low root-knot nematode population does not suffer appreciably from nematode attack. Furthermore, it is in agreement with Seinhorst's (8) hypothesis that the amount of damage caused by a nematode is related to the preplant population density and the amount of exposed tissue not attacked.

Several workers have observed stimulation of plant growth with a relatively low root-knot nematode population density (4). It is conceivable that part of the yield increase associated with nematicidal soil treatment results from stimulation of plant growth by low root-knot nematode population densities. Thus, it appears likely that any damage resulting from late season root-knot nematode attack could be masked by stimulation from a low initial population. Such a phenomenon agrees with Nusbaum's belief that a low initial root-knot nematode population has a favorable effect on tobacco yield (5).

Finally, our data point out the necessity of developing a clearer concept of economical control of nematodes. In the case of tobacco, it is not necessary to apply sufficient nematicidal treatment to reduce a *M. javanica* population to a low level for the entire growing season. The expense of doing so would be far greater than the benefits derived. We believe that in tobacco culture, good control of root-knot nematodes for 1 month after transplanting is sufficient for economical yield responses.

TABLE 1. Yield of tobacco as influenced by nematicidal soil treatment.

		Yield (cured leaf)[c]	
Treatment	Dosage/hectare	Kg/hectare	lb./acre
V-C 9-104	6.7 kg[a]	2059	1838
Aldicarb	6.7 kg	2016	1800
EDB	23.5 l[b]	2010	1795
B-25141	6.7 kg	1898	1695
DD	94.0 l	1892	1690
DD + MENCS	47.0 l	1669	1490
Check	–	1238	1106
LSD .05		357	319

[a]Kg of active ingredient.
[b]Liters of formulation.
[c]Average of 3 years.

LITERATURE CITED

1. BERGESON, G. B. 1968. Evaluation of factors contributing to the pathogenicity of *Meloidogyne incognita.* Phytopathology 58:49-53.
2. BRODIE, B. B., and W. E. COOPER. 1964. Pathogenicity of certain parasitic nematodes on upland cotton seedlings. Phytopathology 54:1019-1022.
3. DROPKIN, V. H. 1955. The relations between nematodes and plants. Exp. Parasitol. 4:282-322.

4. MADAMBA, C. P., J. N. SASSER, and L. A. NELSON. 1965. Some characteristics of the effects of *Meloidogyne* spp. on unsuitable host crops. North Carolina Agr. Exp. Sta. Tech. Bull. No. 169. 34 p.
5. NUSBAUM, C. J. 1960. Soil fumigation for nematode control in flue-cured tobacco. Down to Earth 16(1):15-17.
6. OOSTENBRINK, M. 1966. Major characteristics of the relation between nematodes and plants. Meded. Landbouwhogesch. Wageningen 66-4. 56 p.
7. RIEDEL, R. M. 1969. The influence of onion seedling age on the development of symptoms caused by *Ditylenchus dipsaci*. J. Nematol. 1:24-25.
8. SEINHORST, J. W. 1965. The relation between nematode density and damage to plants. Nematologica 11:137-154.
9. STINSON, F. A. 1953. Report of progress 1951-53. Tobacco Res. Bd. Southern Rhodesia Bull. No. 3.
10. SWARUP, G., and R. D. SHARMA. 1965. Root-knot of vegetables. IV. Relation between *Meloidogyne javanica* and *Meloidogyne incognita* var. *acrita* and root and shoot growth of tomato seedlings. Indian J. Exp. Biol. 3:191-198.