We found no evidence for disease resistance when plants are in the germling or very young seedling stage as previously reported (7). Rather, our study confirms earlier findings (4) that preplant infestation of soil by mycelium results in pre- and postemergence seedling disease. Although the PRR-resistant varieties Apalachee Phyto-2 and Agate were not resistant to pre- and postemergence damping-off, they were somewhat resistant when inoculated at 33 days of age. We also observed in the pathogenicity study with the Rowan isolate that the severity of PRR decreased with increasing age of PRR-susceptible DuPuits plants.

The discovery of this soilborne fungus in the Southeastern United States suggests that the disease contributes to the difficulty in maintaining persistent stands of alfalfa in this region of the country.

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SPATIAL DISTRIBUTION OF NEMATODES IN PEACH ORCHARDS

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ABSTRACT

Nematode distribution around root-knot resistant and susceptible rootstocks in peach orchards was apparently influenced by root distribution, tree age and cultural practices. Yield of individual trees was not related to numbers of plant-parasitic nematodes with either rootstock. There was considerable variation in nematode distribution among individual tree sites; *Paratylenchus hamatus* was more uniformly distributed than other genera in an orchard on 'Lovell' rootstock.

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Root-knot nematodes, Meloidogyne spp., were limiting factors in peach and nectarine orchards in California before the development of root-knot-resistant rootstocks. The nematodes reduce tree longevity and productivity (4). Root galling (4) and reproduction (6,7) of M. incognita (Kofoid & White) Chitwood and M. javanica (Treub) Chitwood has been reported on resistant rootstocks. There has been some work with postplant nematicide treatments (3) and nematicide treatment of replant sites (5). Current estimates are that about 30% of the nectarines and 20% of the peaches in the San Joaquin Valley are on the root-knot-susceptible 'Lovell' rootstock, whereas most of the others are on 'Nemaguard' and other resistant rootstocks.

The present study was similar in nature and scope, and had similar objectives, to a determination of nematode distribution in a grape vineyard by Ferris and McKenry (1). The objectives were: 1) to study the spatial distribution of nematodes in peach orchards with root-knot resistant and susceptible rootstocks and to follow seasonal changes in the distributions; and 2) to relate nematode densities to crop yield.

In a preliminary survey of the area around Fresno, California to locate suitable orchards, we had difficulty in finding an orchard on Lovell rootstock with high populations of Meloidogyne spp. We speculate that Lovell orchards have been replaced except in areas biologically or environmentally unsuited to Meloidogyne spp.

MATERIALS AND METHODS

An orchard on Nemaguard rootstock at Reedley, California, planted in 1966, and an orchard on Lovell rootstock at Parlier, California, planted in 1956, were selected for study. The Nemaguard orchard was on a deep sandy loam soil (78% sand, 10% silt, 12% clay) with pH 6.6 and electrical conductivity 0.6, averaged across depth. The Lovell orchard was on a sandy loam (57% sand, 27% silt, 16% clay) with pH 7.0 and electrical conductivity 0.6, averaged across depth.

Cultural practices within the orchards differed somewhat. The Nemaguard orchard is spaced on 5.5 x 5.5-m centers and the Lovell orchard on 7.3 x 7.3-m centers. Weed control in the Nemaguard orchard is by occasional discing between tree rows and by an annual cross discing in the row. In the Lovell orchard weeds were also controlled between rows by occasional discing. Herbicide treatments on raised beams have been used to control weeds in the tree row for the last 9 years. Both orchards are furrow-irrigated.

Sampling positions relative to each tree (1) were selected 90, 180, and 270 cm from the tree in the row and 90 and 180 cm from the tree between rows. At each position, samples were taken at 15-cm-depth intervals to 120 cm below the soil surface. Samples were taken at 56-day intervals from each orchard for a 14-month period, starting July 1973 in the Nemaguard orchard and January 1974 in the Lovell orchard. Soil handling procedures and extraction techniques were as previously reported (1).

Total fruit yield of the individual trees sampled in each orchard was measured. Yields were related to nematode densities after the nematode counts were converted to a single date using a covariance model (2).

RESULTS AND DISCUSSION

Perineal pattern identification of the Meloidogyne spp. isolated from the orchards revealed M. incognita in the Lovell orchard and M. javanica in the Nemaguard orchard. No galls were found on tree or on weed roots in the Nemaguard orchard throughout the sampling period. Nemaguard rootstock is considered resistant to M. incognita and M. javanica (4), but reproduction of Meloidogyne spp. has been reported by Sharpe and Perry (6), McElroy (4), and Wehunt (7). Other plant-parasitic nematodes in the orchards included Paratylenchus hamatus Thorne & Allen, Xiphinema americanum Cobb and Trichodorus christiei Allen.

Some of the differences in spatial distribution of nematode species and trophic groups (Figs. 1 and 2) are explicable in terms of cultural history of the orchards. The Lovell orchard is 10 years older than the Nemaguard orchard with a greater root distribution. Weed control in the Lovell orchard has been by herbicides for 8 years during which time the soil has been undisturbed in the tree row. Parasitic genera are distributed uniformly in and between rows at each depth in the Lovell orchard (Figs. 1 and 2). In the Nemaguard orchard, weeds are controlled by occasional discing between rows, resulting in root pruning and soil compaction, and by annual discing in the row. Plant-parasitic nematodes and organic material were at lower densities between rows than in the row (Figs. 1 and 2). Saprophagous nematodes (Cephalobidae and Rhabditidae) were distributed largely in the upper 15 cm of soil where aboveground litter

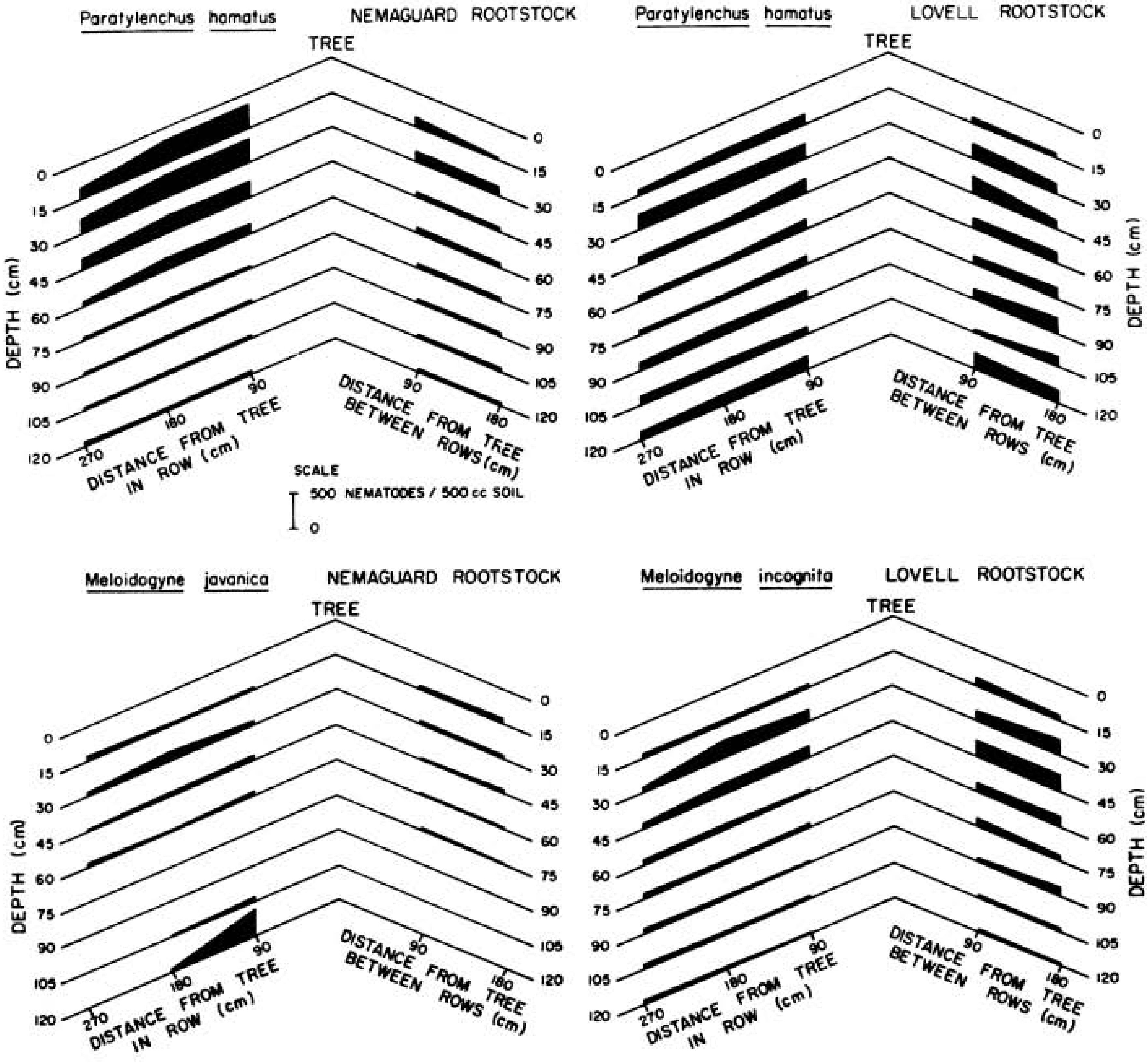

FIGURE 1. Horizontal and vertical distribution, relative to the tree trunk, of plant-parasitic nematode species in peach orchards on 'Lovell' and 'Nemaguard' rootstocks.

accumulated (Fig. 2). In both orchards distribution of plant-parasitic nematodes was highly significantly correlated with the amount of root material at each depth. In the Nemaguard orchard, a large number of Meloidogyne eggs in a single sample from the 120-cm depth resulted in a peak in the annual average at that depth (Fig. 1).

Seasonal variation in Meloidogyne spp. was similar to the pattern in grape vineyards (1) with an apparent increase in the population in August and September. The situation was confused by a relatively larger number of eggs in the Lovell orchard in the final sampling date in February. Seasonal variation in densities of P. hamatus was relatively small in both orchards and had little apparent relationship to soil moisture and temperature conditions.

Total numbers of plant-parasitic nematodes in the 40 samples of 500 cm^3 soil taken from each tree were transformed to a single date (2) and used in regressions against yield of individual trees. There was no significant relationship between tree yield and Meloidogyne or P. hamatus densities in either orchard, although P. hdmatus densities were positively related to yield as with grapevines (2).

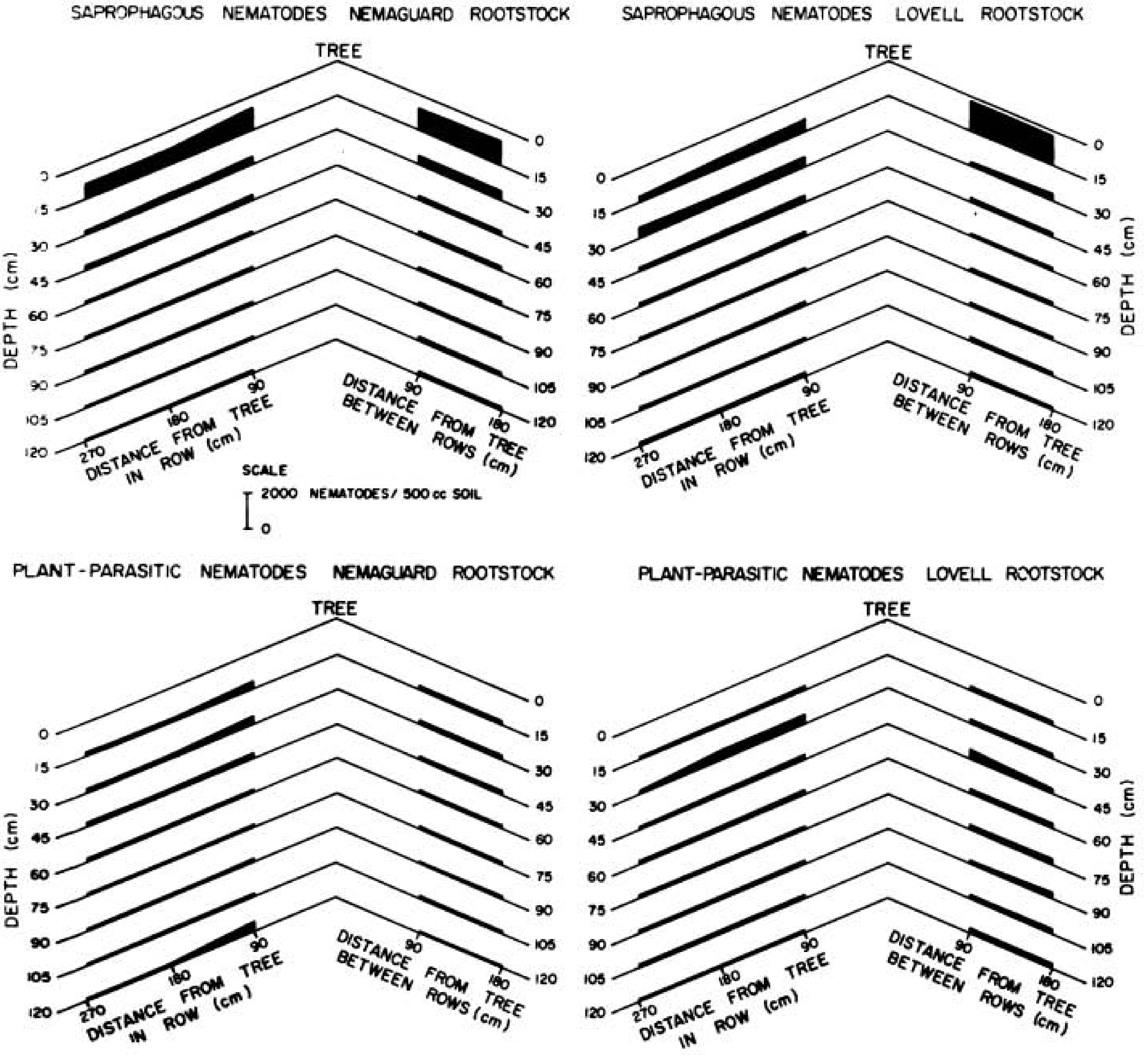

FIGURE 2. Horizontal and vertical distribution, relative to the tree trunk, of nematode trophic groups in peach orchards on 'Lovell' and 'Nemaguard' rootstocks.

Variation in distribution of nematode trophic groups and plant-parasitic species between trees was examined by analyzing the coefficients of variation among the six trees sampled on each date. Mapping of the plant-parasitic nematode distribution in the orchard revealed considerable variation between tree sites even though the orchard was selected for its apparent uniformity. Differences in coefficients of variation for the plant-parasitic species in the Nemaguard orchard were nonsignificant, although P. hamatus had the lowest mean coefficient (Table 1). In the Lovell orchard, P. hamatus was significantly more uniformly distributed than X. americanum. In a similar uniformity study in a vineyard, P. hamatus was less uniformly distributed among vines than other plant-parasitic species. Of the nematode trophic groups (Table 2), saprophagous nematodes were more uniformly distributed than the parasitic group in the Nemaguard orchard. There were no significant differences in trophic group distribution among tree sites in the Lovell orchard.

An impression gained from these studies was that densities of root-knot eggs and larvae in soil samples were not as great in Lovell orchards as in grape vineyards in our area of study.

Table 1. Mean coefficients of variation across 8 groups of 6 peach trees for total numbers of plant-parasitic nematodes in 40 soil samples from each tree.

Nematode group	Nemaguard orchard % C.V.	Lovell orchard % C.V.
Meloidogyne larvae[a]	147.8	82.5 b
Meloidogyne eggs	143.9	103.7 b
Meloidogyne eggs and larvae	133.5	65.6 bc
Xiphinema americanum	122.5	166.4 a
Paratylenchus hamatus	69.8	39.6 c
LSD .05	77.7	36.7

[a]Second stage larvae in soil samples.

Table 2. Mean coefficients of variation across 8 groups of 6 peach trees for total numbers of nematodes of various trophic groups in 40 soil samples from each tree.

Nematode trophic group	Nemaguard orchard % C.V.	Lovell orchard % C.V.
Saprophages	29.1 b	39.3
Plant parasites (-*Meloidogyne* eggs)	63.1 a	38.2
Plant parasites (+*Meloidogyne* eggs)	64.9 a	33.6
LSD .05	18.3	11.0

The Lovell orchard sampled had greater population densities than 15 others surveyed prior to this study, whereas a Thompson Seedless vineyard (1) was representative of 10 vineyards surveyed throughout California. For the 40 samples of 500 cm^3 soil taken from each tree or vine site, averaged over the total sampling period, there were 3355 *Meloidogyne* eggs and larvae in the Lovell orchard, 1169 in the Nemaguard orchard, and 36,324 in the Thompson Seedless vineyard. In terms of the amount of organic material recovered from soil samples (mainly root fragments below 30-cm depth) this represents 5.9, 2.1, and 65.2 nematodes/g, respectively.

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