Journal of Nematology 23(4):393–401. 1991.

Evaluation of Host Suitability in *Prunus* for *Criconemella xenoplax*[1]

S. W. WESTCOTT III AND E. I. ZEHR[2]

Abstract: Methods were developed for screening *Prunus* selections for host suitability to *Criconemella xenoplax*. The relative host suitability of selections was based upon a doubling accumulation value (β) that was defined as the number of degree-days (base 9 C) required for doubling of an increment of the initial nematode population. The β value characteristic for *C. xenoplax* (139 ± 8 degree-days) on suitable hosts was similar to the average β value determined for several peach rootstocks known to be suitable hosts. The β values were 144 ± 21 for Halford, 141 ± 16 for Lovell, and 138 ± 10 for Nemaguard. A higher value for β could indicate poorer host suitability or resistance of a selection to *C. xenoplax*. All of 369 *Prunus* accessions tested, including eight accessions that had survived well on a field site infested with *C. xenoplax*, were suitable hosts. Apparently, resistance to *C. xenoplax* was not a factor in survival of the accessions planted in the field. Seedlings from *P. besseyi, P. pumila* 'Mando', and two interspecific hybrids, Redcoat and Sapalta IR 549-1, failed to support nematode population increase in 44–81% of tests conducted, but all selections supported population increase in some tests. These accessions may have resistance mechanisms that are active only under specific conditions.

Key words: carrying capacity, *Criconemella xenoplax*, degree-day, host suitability, *Mesocriconema xenoplax*, modelling, nematode, peach, population increase, *Prunus*, resistance.

The search for peach (*Prunus persica* L. Batsch) rootstocks resistant to disease has received much attention in the southeastern United States since devastating losses of peach trees first began (2,4,7,9,10,12). *Criconemella xenoplax* (Raski) Luc & Raski contributes to this problem (8), and numerous selections of *Prunus* have been screened for survival on nematode-infested sites to identify those that can withstand factors that reduce tree longevity (2,10). Although differential survival was reported among selections after 6 years (10), no selections were better than Lovell or Halford, rootstocks recommended for sites infested with *C. xenoplax* in the southeastern United States. Continued observations of these plantings have identified selections with tree survival superior to that of Lovell or Halford (Reighard, pers. comm.). This type of field work requires a substantial investment of time, but ultimately it may be required for identification of worthy replacements for current peach rootstocks.

Screening programs in a greenhouse sometimes include measurements of plant growth that may be affected by injury associated with *C. xenoplax* (7,9). Although an indication of tolerance of plants to nematode feeding, such measurements on small plants in containers might not allow prediction of the effects on growth of mature trees in the field. Accurate prediction of effects on tree longevity in infested sites from such measurements is less likely than prediction of tree growth. Therefore, attempts to measure tolerance of hosts to *C. xenoplax* under greenhouse conditions may not be appropriate if improvement of tree longevity is the primary objective.

Although not proven, *Prunus* selections that are unsuitable hosts for *C. xenoplax* should sustain less injury from nematode feeding and may survive longer on infested sites than suitable hosts. Therefore, it would be worthwhile to screen for selections that limit or completely inhibit reproduction of *C. xenoplax*. Evaluation of host suitability frequently has been conducted in greenhouse tests to reduce the time and expense associated with this type of work (3,9). The most valuable information from a screening program is the

Received for publication 27 November 1990.
[1] Technical Contribution No. 3137 of the South Carolina Agricultural Experiment Station, Clemson University. Funded in part by USDA ARS Special Grants 85-CRSR-2-2573 and 87-CRSR-2-2999.
[2] Visiting Assistant Professor, and Professor, Department of Plant Pathology and Physiology, Clemson University, Clemson, SC 29634-0377.
We thank Judith White and Lynn Luszcz for technical assistance and P. M. Burrows for advice.

identity of selections that support no reproduction by *C. xenoplax* (i.e., immunity). Immune selections should be identifiable regardless of variations in the experimental system; however, useful selections may be lost if this is the only criterion included.

Quantitative comparisons of host suitability among selections may identify some with lower host suitability that will limit the damage caused by *C. xenoplax*. To predict relative host suitability in the field, the measurements must reflect the potential of the nematode to reproduce and not the limitations on population density imposed by restriction of root growth in the limited space of containers used in a greenhouse (i.e., carrying capacity). The unrestricted and more complex root system of a mature tree in the field may have a different carrying capacity.

The extractable population density at the end of incubation and its ratio to the initial population density of nematodes are common measurements for comparisons of host suitability between plants. Depending upon environmental conditions, size of plants, and density of the initial population of nematodes, these tests may reflect primarily either the carrying capacity of a root system for nematodes or the rate of reproduction by the nematode unrestricted by availability of feeding sites. The first is limited by production of feeding sites by the plant, and the latter is limited primarily by the fecundity of the nematode. If there is no distinction between these types of measurement, determinations of relative host suitability may be misleading (11).

Also, these population measurements are useful only for comparisons among results of a single experiment. When a large number of accessions are to be screened, numerous experiments must be conducted and some will occur in every season of a year. Although the temperature in a greenhouse can be moderated, it will vary with the season because of limitations of heaters and coolers. In addition, nematode population growth is highly variable, and a few plants that support no population increase will almost always occur regardless of the plant's status as a host. Repeated tests for host suitability on individual seedlings must be conducted to confirm their status as poor or unsuitable hosts. A solution to these problems would be to predict the change in nematode population density with respect to environmental factors so that results from different experiments could be compared. In a greenhouse the primary limitation on nematode activity would be temperature.

The objective of this study was to discover *Prunus* selections that are poor or unsuitable hosts for *C. xenoplax*. A model for population increase by *C. xenoplax* (11) was reformulated to allow estimation of a parameter for nematode population increase associated with each test plant in screening tests performed in the greenhouse. An additional parameter was added to the model to adjust for variation when changes in the experimental protocol were required. These modifications were tested in the experiments reported here. Results of the screening program are summarized.

Materials and Methods

Seeds and cuttings were collected from accessions grown in a *Prunus* germplasm collection at Clemson University and from the Sandhills Research and Education Center, Elgin, South Carolina. Seeds were soaked in an aqueous suspension of captan (125 mg a.i./liter) for 5 minutes and stratified at 4 C for 12–15 weeks. Cuttings from field-grown trees were treated with auxins and rooted under mist in a peat-lite mixture containing slow release fertilizer (14% N, 14% P, 14% K) (3 g/liter). Cuttings from seedlings grown in the greenhouse were rooted in a similar manner but without auxin treatment.

Seedlings were tested for host suitability to *C. xenoplax* in a series of sequential plantings in a greenhouse (15–37 C). When radicles emerged, seeds were planted in 150-cm^3 plastic cone pots (38 mm × 20 cm) filled with steamed sand (60–70 C for 30 minutes). Plants were arranged in a completely randomized design and were fertilized weekly with 5 ml of half-strength Hoagland's solution with K_2NO_3 and $CaNO_3$ as the sources of nitrogen (5). *Criconemella xenoplax* was extracted by elutriation (1) combined with centrifugal-flotation (6) from Nemaguard peach seedlings grown in a greenhouse. Approximately 100–150 adults and juveniles were added to exposed roots of each test plant and covered with sand 1 week after planting. Nematodes were separated from roots and soil by elutriation for 6.0–6.25 minutes at a flow rate of ca. 60 ml/second (1), combined with centrifugal-flotation (6), and counted 9–11 weeks after inoculation. Total plant fresh weight was recorded, and plants were stored 2–15 days at 4 C until selections were replanted.

Plants with final nematode counts (Cf) less than twice the initial population of nematodes (Pi) in the first test were tested similarly one or more additional times. Plastic pot size (0.5–2.0 liters), weekly fertilization (25–50 ml), Pi (150–300/pot), and duration of the experiments (13–43 weeks) were increased as plants became larger. Seedlings that appeared to inhibit nematode population increase in two or more trials were propagated vegetatively, and these clones were tested again for host suitability. For accessions that did not produce viable seeds, cuttings were taken from trees in the orchard, rooted, and tested as described.

A model for prediction of population increase of *C. xenoplax* (11) was reformulated to accommodate changes in the experimental protocol. The Cf were corrected for extraction efficiency to estimate final population densities (Pf) of nematodes (Pf = Cf/0.53) (11). The Pi was determined from three to six samples of the inoculum applied at the beginning of each experiment. Plants supporting Pf lower than Pi were excluded from results because they are believed to represent failures in establishment of the nematode population. The relationship between degree-days (base 9 C) and expected nematode population increase (Pf/Pi) was formulated as

$$(\mathrm{Pf/Pi}) = 1 + \alpha(2^{(d-\gamma)/\beta} - 1) \quad \text{(equation 1)}$$

where d is the degree-day accumulation (base 9 C) computed from average daily maximum and minimum air temperatures over the period during which the population increased from Pi to Pf, parameter γ is a correction factor for plants grown in pots larger than the cone pots used for germinated seeds ($\gamma = 0$ for cone pots), parameter β is the doubling constant in degree-days, and parameter α is the proportionate doubling increment. In this model α doubles and accumulates during each successive interval beyond γ degree-days in which accumulation of degree-days equals β. An average of 56 plants was included in each experiment conducted with cone pots, whereas an average of 28 plants was included in each of the experiments using larger pots. The model (equation 1) was fitted by weighted nonlinear least squares, weighting by the number of plants used to calculate average Pf/Pi values. This provided an estimate for β irrespective of host.

To measure host suitability for each plant, a β value was computed using estimates for α and γ derived from fitting equation 1 to results of all experiments. The β value for each selection was computed by solving equation 1 for β where ln is the natural logarithm:

$$\beta = (d - \gamma)(\ln 2)/\ln(1 + [\mathrm{Pf} - \mathrm{Pi}]/\alpha \mathrm{Pi}) \quad \text{(equation 2)}$$

The β value is one measure that can characterize the rate of exponential nematode population increase on a host. Under the average conditions in our experiments, the predicted β value for a suitable host is 139 degree-days (11). An increase in β value should initiate a decrease in the suitability of a given host. A ceiling value for β of 1,000 was selected as a detection limit within our experimental system. Thus, each observation for which the β value was above 1,000 was interpreted to mean that the nematode population had failed to become established as with cases in which Pf < Pi and plants were retested; plants in both categories were excluded from calculations of β values. These observations were counted to establish the percentage of tests (including multiple observations for some plants) that appeared to inhibit nematode reproduction for each selection. This proportion provided a second measure of each accession's potential for inhibiting nematode reproduction.

Where appropriate, a measure of carrying capacity (C) of a plant for the nematode was calculated. Since only plant fresh weights (W) were available, they were used as a relative measure of root size:

$$C = Pf/W \qquad \text{(equation 3)}$$

Average values for carrying capacity for each experiment maintained for longer than 2,000 degree-days were compared to degree-days accumulated during each experiment. The average C was computed for all observations made for each of 63 accessions incubated for longer than 2,000 degree-days, irrespective of the number of degree-days accumulated during each observation. These values were compared to the β value for each selection. The average C value for the nematode irrespective of host or degree-day accumulations was computed by averaging across 63 accessions.

RESULTS

About 3,300 seedlings representing 369 accessions were tested. Two important characteristics of the potential for population increase of *C. xenoplax* under these conditions were identified (Fig. 1A). First, duration of experiments beyond ca. 2,000 degree-days resulted in populations that no longer appeared to increase exponentially. No predictable change in the population variable was observed beyond 2,000 degree-days. Therefore, all observations with accumulated degree-days greater than 2,000 were excluded when fitting the model (equation 1). Second, the model previously developed (11) from experiments in cone pots failed to predict results when larger pots were used (Fig. 1A). The exponential population growth curve for experiments in larger pots is similar in shape

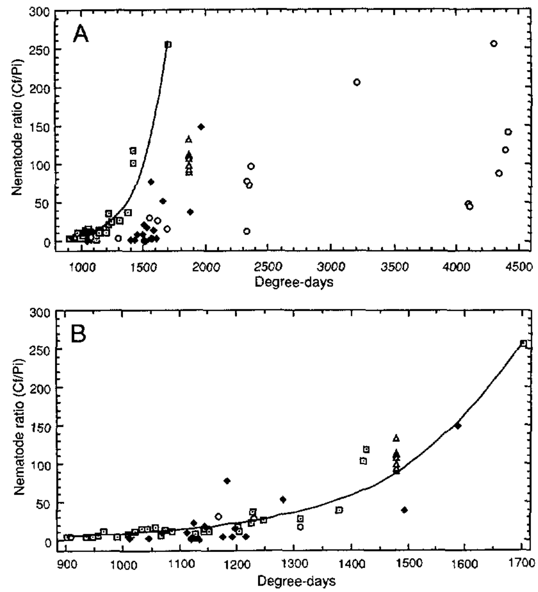

FIG. 1. Observed population increase (Cf/Pi) of *Criconemella xenoplax* on *Prunus* plants as influenced by accumulated degree-days (base 9 C) in greenhouse studies. A) Average nematode population ratio for 32, 20, 5, and 10 experiments with seedlings grown in cone pots (⧈), 0.5-liter pots (♦), 2-liter pots (○), and with cuttings in 0.5-liter pots (△), respectively. The solid line represents the predicted response from a model fitted to results from cone pots (11). B) Average nematode population ratio for experiments with accumulated degree-days ≤2,000; degree-day accumulations for all pots larger than cone pots have been shifted 386 degree-days to the left in accordance with the estimate for a delay parameter (γ). The solid line is the predicted response from the model developed in this study (equation 1).

to the original model but is offset as if initiation of nematode population increase is delayed.

Rather than fit separate models to the observations from experiments with different pot sizes, a parameter (γ) was included in the model (equation 1) to adjust for the effect of pot size. This was based on the assumption that there was a constant initial delay in nematode population increase associated with experiments using larger pots. The estimate for the apparent delay (386 ± 16 degree-days) was derived by fitting the model (equation 1) to the results of experiments with fewer than 2,000 degree-days. With this adjustment, α was estimated as 0.10 ± 0.04 every 139 ± 7 degree-days (β). The predicted re-

TABLE 1. Host suitability (β†) for *Criconemella xenoplax* on *Prunus* cultivars used for peach rootstocks in commercial orchards.

Cultivar	Seedlings tested (no.)	Average β	Tests failed (%)‡
GF 305	17	212 ± 89	18
GF 557	12	183 ± 57	0
Halford	10	144 ± 21	0
Lovell	18	141 ± 16	0
Nemaguard	41	138 ± 18	5
Rutger's Redleaf	21	223 ± 110	14
S-37	9	139 ± 7	0
Siberian C	10	187 ± 131	8

† β is the degree-day accumulation (base 9 C) required for doubling of an increment of the initial nematode population on a host. For suitable hosts β = 139.

‡ Percentage of all tests completed in which final nematode population densities were lower than initial densities.

sponse for this model has been shown along with observations for all experiments with fewer than 2,000 degree-days (Fig. 1B). In this figure the results for experiments in the larger pots have been shifted 386 degree-days to the left for comparison with the predicted response.

The β values for peach rootstocks were calculated from equation 2, assuming that α was 0.1 and the initiation of population increase was delayed by 386 degree-days (from the estimate for γ) in experiments conducted with larger pots (Table 1). The values observed for these cultivars are similar to β value from fitting equation 1 (139 ± 7 degree-days) and therefore are indicative of suitable hosts. Although statistical tests could be used to detect differences in host suitability among accessions, the lack of uniform variance makes these tests of limited value. Accessions with high values for β had high variance and probably would prove to be highly suitable hosts with additional testing. When individual seedlings were tested more than once, sometimes large differences in β values were observed. Seedlings with β values initially determined to be higher than 500 degree-days were as suitable as any other accession for *C. xenoplax* after repeated testing or after tests with clones from seedlings. All selections tested were suitable hosts for *C. xenoplax* in one or more tests.

Most tests with rooted cuttings indicated that clones were highly suitable for reproduction of the nematode. *Criconemella xenoplax* populations increased rapidly (low β) in 68% of tests with 1,120 cuttings from seedlings that appeared to inhibit nematode reproduction. These results indicate that the original plants were suitable hosts for the nematode (Table 2). Only 13 accessions had average β values above 300 and of these, selections from six accessions have been cloned and were suitable hosts. The remaining accessions have not been tested sufficiently to verify lower host suitability for *C. xenoplax*.

Tests with accessions of *P. besseyi, P. pumila* 'Mando', Redcoat, and Sapalta failed

TABLE 2. Host suitability (β†) of seedlings from *Prunus* accessions and rooted cuttings from those seedlings that appeared to inhibit reproduction of *Criconemella xenoplax*.

Accession	Seedlings tested (no.)	Average β	Tests failed (%)‡	Cuttings tested (no.)	Average β	Tests failed (%)‡
174 RL	10	305 ± 253	42	33	147 ± 24	0
French Goose	31	229 ± 62	41	51	204 ± 93	6
J. L. Budd	36	320 ± 187	47	17	191 ± 43	12
Khodjent Kostokos PI 102705	38	303 ± 190	37	42	191 ± 81	0
Manor IR 929-1	12	307 ± 205	25	37	197 ± 46	0
P 31-27 PI 430892	9	223 ± 95	56	10	199 ± 36	30
P. kansuensis	26	316 ± 170	34	14	182 ± 38	0
Prodigiosa	16	202 ± 169	35	53	179 ± 66	32
Tennessee Natural IR 281-1-9	29	305 ± 168	51	22	153 ± 27	36
Tos China #1	31	238 ± 120	20	39	153 ± 27	8

† β is the degree-day accumulation (base 9 C) required for doubling of an increment of the initial nematode population on a host. For suitable hosts β = 139; higher values apparently do not indicate resistance.

‡ Percentage of all tests completed in which final nematode population densities were lower than initial densities.

TABLE 3. Host suitability (β†) of seedlings and cuttings from *Prunus* accessions that frequently supported little or no reproduction of *Criconemella xenoplax.*

Accession	Seedlings tested (no.)	Average β	Tests failed (%)‡	Cuttings tested (no.)	Average β	Tests failed (%)‡
P. besseyi	52	200 ± 95	43	174	313 ± 73	69
P. pumila 'Mando'	33	288 ± 164	42	85	194 ± 36	81
Redcoat	28	284 ± 207	63	140	297 ± 112	44
Sapalta IR 549-1	45	183 ± 61	35	29	336 ± 227	59

† β is the degree-day accumulation (base 9 C) required for doubling of an increment of the initial nematode population on a host. For suitable hosts β = 139; higher values may indicate resistance.
‡ Percentage of all tests completed in which final nematode population densities were lower than initial densities.

frequently to detect nematode population increase on seedlings or rooted cuttings derived from these seedlings (Table 3). Although some of the β values determined for these selections are higher than those listed in Table 1, the variability in our measurements limits our confidence that reduced host suitability has been demonstrated. However, establishment of *C. xenoplax* populations on these selections was less predictable than on other selections.

Since nematode population increases in experiments with degree-day accumulations above 2,000 were not as high as predicted, the quantity of feeding sites available to the nematodes could have been limiting. With equation 3, a measure of the relative carrying capacity of each plant for the nematode was calculated. No predictable relationship occurred between C values and the accumulations of degree-days. Since there was no predictable effect of degree-day accumulations on C, the C values for individual accessions were determined by averaging across all observations in trials incubated for more than 2,000 degree-days without regard for degree-days accumulated. For individual accessions, C values exhibited large variations (Table 4). The C value mean for 63 accessions tested in this manner was 940 ± 1,050 nematodes/g fresh plant weight. No simple predictive relationship was discovered between β values and C values as different measures of host suitability.

Host suitability was determined for 17 accessions of *Prunus* where trees had been grown for 6 years in a field site that was infested with *C. xenoplax* (Table 5). These accessions were separated into two groups based on mortality associated with cold injury in the field (10). All accessions were suitable hosts for *C. xenoplax,* as indicated by the low β values. The mean β values indicate no difference between the groups.

TABLE 4. Host suitability (β†) and carrying capacities (C‡) for a selection of accessions of *Prunus.*

Accession	Plants tested (no.)	Average β	Observations for C (no.)	Average C
Chu Hun Tao	22	254 ± 95	14	536 ± 615
French Goose	31	229 ± 62	17	759 ± 880
Hui Hun Tao	24	233 ± 80	10	457 ± 545
J. L. Budd	36	320 ± 187	12	499 ± 847
Kahinta IR 552-2	24	238 ± 117	13	1,772 ± 2,481
Khodjent Kostokos PI 102705	38	303 ± 190	26	1,102 ± 2,153
P. kansuensis	26	316 ± 170	14	107 ± 133
Rubira	49	281 ± 126	29	789 ± 1,615
Tennessee Natural IR 281-1-9	29	305 ± 168	18	819 ± 1,363
Tos China #1 PI 77876	31	238 ± 120	16	592 ± 1,160

† β is the degree-day accumulation (base 9 C) required for doubling of an increment of the initial nematode population on a host. For suitable hosts β = 139.
‡ C is number of nematodes per gram total plant weight at the end of incubation.

TABLE 5. Host suitability (β†) for accessions of *Prunus* spp. rated for mortality associated with cold injury in a field infested with *Criconemella xenoplax*.

Accession	Seedlings tested (no.)	Average β	Cold injury mortality (%)‡
Accessions with high survival in the field			
520-8 B594520 op=[(Nem op)op]op	2	151 ± 2	0
520-9 B594520 op=[(Nem op)op]op	7	195 ± 90	3
Boone Co. (Byron, GA)	15	191 ± 73	4
G'aschina Novembre PI 104488	19	181 ± 82	4
Halford	10	144 ± 21	0
Lovell	18	141 ± 16	3
Nemaguard	41	138 ± 18	13
Tennessee Natural J67-34	2	151 ± 13	6
Tennessee Natural R27	13	150 ± 15	2
	Mean	160 ± 22	
Accessions with low survival in the field			
DeCoosa R27 PI 65974	6	147 ± 16	62
Harrow Blood	3	167 ± 9	68
Killiekrankie PI 106062	8	135 ± 11	73
Pi Tao PI 62602	10	207 ± 74	96
Pineapple PI 131209	9	148 ± 17	69
S37 × Yunnan (3-12)	1	163	64
Siberian C	10	187 ± 131	58
Yunnan PI 55776	23	144 ± 21	68
	Mean	162 ± 24	

† β is the degree-day accumulation (base 9 C) required for doubling of an increment of the initial nematode population on a host. For suitable hosts β = 139.

‡ Source: Reighard et al. (10).

DISCUSSION

Increase of the *C. xenoplax* population on peach rootstocks known to be good hosts was similar to that predicted by the fitted model and is evidence that the conditions for exponential growth of the nematode population were met in experiments with fewer than 2,000 degree-days accumulated. Once the nematode population began to increase in the larger pots, its characteristic exponential form appeared to be similar to that observed in cone pots. The estimates for $\alpha = 0.1$ and $\beta = 139$ from the combined results for cone pots and adjusted results for larger pots ($\gamma = 386$) were identical to those estimated from tests in development of the original model for *C. xenoplax* (11). Thus, the model appears to be a reliable predictor of the nematode population increase under these conditions up to accumulations of 2,000 degree-days. The apparent delay of 386 degree-days for nematode population increase observed in the larger pots may be a result of increased time required for appropriate feeding sites to be found on older roots. The correct explanation for this apparent delay will require further investigation.

A standard accumulation of degree-days may be selected for routine determination of β values. From experience with the extraction equipment and soil used in this study, 950–1,000 degree-days should be allowed to accumulate before harvest of experiments in cone pots and 1,450–1,500 degree-days for those in larger pots. This should provide 1,200–1,550 nematodes/plant for tests conducted in cone pots and 2,100–2,700 nematodes/plant for those in larger pots, if the Pi is ca. 100 nematodes. The greater numbers of nematodes in larger pots allow sufficient dilution of the sample to limit interference from debris when counting a sample. This adjustment may vary with extraction method and soil type.

Adjustment of the Pi allows some reduction in the duration of experiments, but the range tested in this study was small (100–300 nematodes/plant). It would be necessary to confirm that the model (equation 1) applies to situations where more than 300 nematodes are applied to each plant because competition for feeding sites among nematodes may become important. Although we have observed carryover of nematodes on roots of plants tested more than once (unpubl.), no substantial difference in β values was determined for these selections.

This evaluation system efficiently eliminates suitable hosts from further consideration. Results from initial screening in cone pots with freshly germinated seeds indicated 95% of all seedlings were suitable hosts for *C. xenoplax* after 11 weeks. Evaluation was based upon measurement of nematode population increase under conditions that allow predictable responses from suitable hosts. Since the response is predictable across experiments, average measures of host suitability can be derived from all accumulated observations rather than reporting the best Pf/Pi ratio observed. Standard cultivars for comparison are not required in every test when experimental conditions are standardized according to the requirements for the predictive model. This system reduces the number of plants required, and enables further evaluations of the same seedling that are required to identify and confirm plants as unsuitable hosts for *C. xenoplax*. Until resistant selections are identified, it will be difficult to determine expected values for β for resistant plants.

Plants on which *C. xenoplax* did not reproduce were excluded from computation of β values for individual selections. (Most of these events probably represented failures in establishment of the initial population rather than an indication of poor host suitability, but resistant plants could have been included.) Most of these plants were retested and proved to be suitable hosts for *C. xenoplax*. Approximately 50% of the small number of plants initially identified as poor hosts in cone pots ($\beta > 300$) proved to be good hosts in subsequent tests ($\beta < 300$), and only 28% of plants failed to support nematode population increase in any test. We expect that most plants in the last category will be suitable hosts for *C. xenoplax* when further tested because no resistant accessions were discovered.

There was a high frequency of tests with little or no increase in the nematode population among the seedlings of a few accessions. A resistance mechanism that allows these plants to inhibit nematode population increase under some circumstances but not others may be responsible for these results. Inhibition of nematode population increase was not consistent for any seedling that was examined repeatedly. The value of this resistance in the field is not known.

The C values based on total weights of plants grown under high accumulations of degree-days were highly variable and of little value in distinguishing levels of host suitability. Perhaps C values based on root weight would be a better measure than those based on total plant weight. However, substantial variations in rate of root growth among the different selections might make it difficult to establish standard conditions for measurement of C values.

Contrasting levels of survival among accessions planted in a field infested with *C. xenoplax* have been reported (10), but the mechanism for survival is not known. Plants that survived evidently had characteristics other than resistance to *C. xenoplax* that enabled survival in nematode-infested soil. Selections identified in this study that frequently inhibited *C. xenoplax* population increase have not been tested in the field.

Literature Cited

1. Byrd, D. W., Jr., K. R. Barker, H. Ferris, C. J. Nusbaum, W. E. Griffin, R. H. Small, and W. E. Stone. 1976. Two semi-automatic elutriators for extracting nematodes and certain fungi from soil. Journal of Nematology 8:206–212.

2. Cain, D. W., E. I. Zehr, W. R. Okie, and A. P. Nyczepir. 1988. Screening of *Prunus* germplasm for resistance to *C. xenoplax* and peach tree short life. Proceedings of the third stone tree fruit decline workshop. USDA, Agricultural Research Service, Washington, DC.

3. Culver, D. J., D. W. Ramming, and M. V. McKenry. 1989. Procedures for field and greenhouse screening of *Prunus* genotypes for resistance and tolerance to root lesion nematode. Journal of the

American Society of Horticultural Science 114:30–35.

4. Dozier, W. A., Jr., J. W. Knowles, C. C. Carlton, R. C. Rom, E. H. Arrington, E. J. Wehunt, U. L. Yadava, S. L. Doud, D. F. Ritchie, C. N. Clayton, E. I. Zehr, C. E. Gambrell, J. A. Britton, and D. W. Lockwood. 1984. Survival, growth, and yield of peach trees as affected by rootstocks. HortScience 19:26–30.

5. Hoagland, D. R., and D. I. Arnon. 1950. The water-culture method for growing plants without soil. Circular 347, California Agricultural Experiment Station, Berkeley.

6. Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.

7. Nyczepir, A. P., and W. R. Okie. 1987. Evaluating *Prunus* spp. for tolerance to *Criconemella xenoplax.* Journal of Nematology 19:548 (Abstr.).

8. Nyczepir, A. P., E. I. Zehr, S. A. Lewis, and D. C. Harshman. 1983. Short life of peach trees induced by *Criconemella xenoplax.* Plant Disease 67:507–508.

9. Okie, W. R., A. P. Nyczepir, and C. C. Reilly. 1987. Screening of peach and other *Prunus* species for resistance to ring nematode in the greenhouse. Journal of the American Society of Horticultural Science 112:67–70.

10. Reighard, G. L., W. C. Newall, Jr., and D. W. Cain. 1989. Screening *Prunus* germplasm for potential rootstocks for South Carolina, USA replant sites. Acta Horticulturae 254:287–290.

11. Westcott, S. W., III, and P. M. Burrows. 1991. Degree-day models for predicting egg hatch and population increase by *Criconemella xenoplax.* Journal of Nematology 23:386–392.

12. Zehr, E. I., R. W. Miller, and F. H. Smith. 1976. Soil fumigation and peach rootstocks for protection against peach tree short life. Phytopathology 66:689–694.