Plant Nematology in California

state's crop losses led to first department for research in plant nematology to be established by experiment stations

M. W. Allen and A. R. Maggenti

Surveys made in 1907 revealed that both root-knot nematode and sugar-beet nematode were present in several areas of California. The citrus nematode was found in the state, in 1912, and described as a new species, in 1913.

Root-knot nematodes are pests of an exceedingly large number of crops. They may have been introduced into the state with the beginning of grape culture, or with one or more of many other rooted seedlings, including ornamentals.

The sugar-beet nematode has a record of common occurrence with sugar-beet culture. Initial introduction into California may have been through the planting of imported beet seed contaminated with cysts of this nematode.

Citrus nematode is in all citrus growing areas of the world and it is probable that it was introduced into California among the first citrus stocks coming into the state. The widespread occurrence of the citrus nematode, at the time of the initial discovery, indicated it had been in California for many years. Shortly after its discovery, the citrus nematode was found in nearly every citrus grove in the state.

Problems concerning host plants, distribution and losses due to root-knot nematode in California were studied and reported prior to 1920. Also prior to 1920, nematodes were included in plant quarantine regulations.

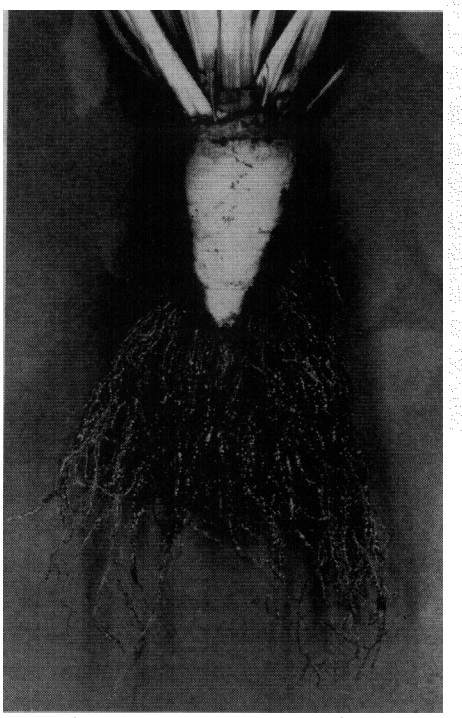
From 1920 to 1930 there was an increasing interest in nematode problems. During that period, one of the first comprehensive reports concerning citrus nematode—including experimental data on the injury it causes to citrus—was published by the California Experiment Station. In 1922 the California Department of Agriculture warned that the root-knot nematode might become a serious plant pest. The next year, the Department estimated that during the planting season—December, 1922, to April, 1923—the value of nursery stock in California rejected because of root-knot nematode was approximately $100,000.

Although no attempt was made to estimate total loss to orchards and vineyards there were many areas in the state where susceptible crops could not be grown profitably.

Investigations on sugar-beet nematode by industry, federal and state workers resulted in a general acceptance of crop rotation as a means of controlling this pest in sugar-beet fields.

The stem or bulb nematode received considerable attention because of severe losses experienced in the growing of daffodils. Control of this nematode was achieved by use of the hot water treatment developed in Europe.

Sugar-beet root heavily infected with the sugar-beet nematode. The small white bodies are mature female nematodes attached to the rootlets.



Root-lesion nematodes were first reported in California in 1927 but their importance was not fully realized until later.

Investigations conducted between 1930 and 1943 added to the knowledge of crop damage caused by nematodes within the state. Root-lesion nematode damage to walnut, fig and cherry trees was found to be widespread. Peach rootstocks and grape rootstocks resistant to root-knot nematode were developed through the cooperative efforts of state and federal investigators. Certain bean varieties with a high degree of resistance to root-knot nematode were developed and are in general use. The extent of root-knot nematode damage to the expanding cotton industry became apparent and crop rotation and summer fallow procedures were used with considerable success. Specialists located and identified nematodes as the probable cause of certain so-called declines of trees and vines.

State and local agencies charged with the inspection and certification of planting stocks became increasingly aware of nematode problems in plant nurseries. Much information was accumulated by submitting soil samples and plant parts to nematologists of the United States Department of Agriculture.

The data compiled prior to 1943 concerning the distribution, host plants and identity of the plant parasitic nematodes of California proved to be highly useful. In 1943, a report of research in Hawaii described the nematocidal properties of dichloropropene mixture. The prospect of effective nematode control by chemicals hastened the development of nematology as a science.

The relatively inexpensive and almost immediately available—in experimental quantities — dichloropropene mixture provided nematologists with a means of demonstrating in large scale field treatments the actual damage that could be caused to agricultural and horticultural crops by nematodes.

In 1944 the California Agricultural Experiment Station became the first experiment station in the United States to employ a nematologist and—in 1948—the University of California offered the

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Plant Nematodes in California

	Economic Importance		
	Recognized		Not determined
Root-knot nematodes			
Meloidogyne hapla	1		
M. incognita	1		
M. javanica javanica	1		
M. arenaria arenaria	2		
M. arenaria thamesi	2		
Cyst nematodes			
Heterodera schachtii	1	*H. trifolii*	2
H. cruciferae	2	*H. cacti*	1
H. fici	2		
Root-lesion (meadow) nematodes			
Pratylenchus brachyurus	2	*P. pratensis*	2
P. penetrans	1	*P. thornei*	1
P. vulnus	1	*P. minyus*	1
P. scribneri	2	*P. coffeae*	2
P. hexincisus	2		
Foliar and stem or bulb nematodes			
Aphelenchoides fragariae	2	*A. subtenuis*	1
A. ritzema-bosi	2		
Ditylenchus dipsaci	1*		
D. destructor	2		
Ring nematodes			
Criconemoides xenoplax	1	*Criconemoides mutabile*	1
		Cacopaurus pestis	2
		Cacopaurus epacris	2
Miscellaneous root parasites			
Hemicycliophora arenaria	2		
Paratylenchus hamatus	1		
Trichodorus christiei	1	*Trichodorus porosus*	2
		T. californicus	2
Tylenchorhynchus claytoni	3	*Tylenchorhynchus brevidens*	1
		T. cylindricus	2
		T. clarus	1
		T. capitatus	1
Xiphinema americanum	1		
X. index	2		
Rotylenchus robustus	2		
		Helicotylenchus erythrinae	1
		H. nanus	1
Radopholus similis	4	*Nacobbus dorsalis*	2
Rotylenchulus reniformis	4		

1 Generally distributed in California.

2 Limited in distribution in California.

3 Fairly common on certain ornamentals but not yet generally distributed in agricultural land in California.

4 Not now known to be present in California but previously found on certain ornamental nursery stock.

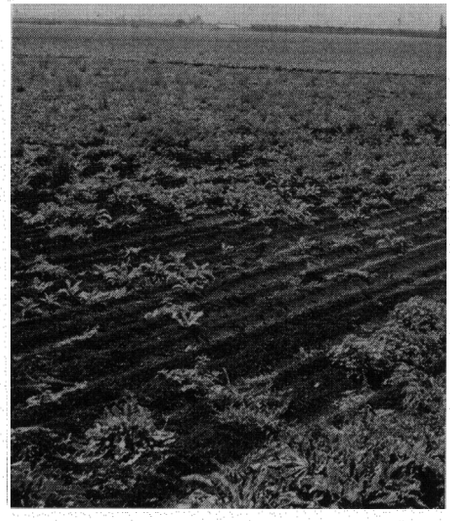
* The presence of host-specific biologic races modifies this distribution. Some (alfalfa, narcissus, onion-garlic) are generally distributed. Others (strawberry, primrose, hydrangea) apparently are not.

first formal course of instruction in plant nematology. Finally—in 1954—a statewide Department of Plant Nematology was established. In 1959, the staff in plant nematology—with 12 full time members—has 22 research projects on a wide variety of problems and engages in cooperative research with other departments on problems of mutual interest. In addition to research directly concerned with the applied control of nematodes, projects involve nematode ecology, physiology, anatomy, and taxonomy. The most recent line of investigation is a cooperative project with the Department of Plant Pathology involving nematodes as vectors of plant viruses.

The assessment of losses caused by plant parasitic nematodes has become increasingly difficult because of the discovery of many kinds of ectoparasitic nematodes that feed on roots of crops. In many cases these nematodes have been recognized only when nematocides were applied to areas where poor plant growth occurred but the cause was unknown. Many of the ectoparasitic—external parasites—species do not cause conspicuous root damage. However, root growth is restricted because of the feeding activities of these forms.

Because of the absence of symptoms, other than poor growth, each of the species of ectoparasitic nematodes must be studied thoroughly in order to determine its effect upon crop production. Investigators in some areas of the United States believe that certain ectoparasitic nematodes—once considered only as interesting soil forms—are actually responsible for more crop damage than the better known root-knot or root-lesion nematodes. Many ectoparasitic species occur in California but information concerning their distribution and the damage they do to crops is not as yet complete.

Sugar-beet field severely damaged by the sugar-beet nematode.



Recently—at the request of the Committee on Agricultural Pests, National Academy of Sciences, National Research Council—the Department of Plant Nematology prepared estimates of annual crop losses in California caused by nematodes. The estimates placed the total minimum loss at $89,442,000 and the maximum loss at $141,721,000. Such estimates are subjective but they do indicate the possible magnitude of the damage done to California crops by plant parasitic nematodes.

The science of nematology has expanded rapidly during the past 15 years in California and throughout the world. In 1940 there were fewer than 10 nematologists in the United States. In 1959 there are approximately 100 individuals in the United States devoting full time to the investigation of nematode problems. With more workers knowledge concerning nematodes has accumulated swiftly. Improved methods of control have accelerated study in the fields of nematode ecology, physiology, morphology, biology, and taxonomy.

Prior to 1949 root-knot nematodes were considered to be a single species. In that year it was established that there are a number of species of root-knot nematode, each differing morphologically as well as biologically from other species. Similarly investigations of root-lesion nematodes, stem or bulb nematodes, ring nematodes, spiral nematodes and stylet nematodes have revealed that there are many species in those groups.

The discovery of additional species in each group means that the nematologist must obtain information on the biology, ecology, distribution and pathogenicity of each species in association with plants. In many instances certain species have not been found widely distributed in California, but they are considered as parasites of potential importance to the agriculture of the state.

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D. G. Milbrath of the California Department of Agriculture prepared the estimate on the value of rejected nursery stock during the 1922–23 planting season.

Walter Carter of the Pineapple Research Institute, Hawaii, reported the nematocidal properties of dichloropropene mixture, in 1943.

B. G. Chitwood, United States Department of Agriculture, established in 1949 that there are many species of root-knot nematodes.

James Armstrong, California rancher, was very influential in calling the attention of agricultural and business interests to the importance to them of improving methods of control and reducing crop damage by nematodes. This resulted in an increase in State financial support and the establishment of the first Department of Plant Nematology in an Agricultural Experiment Station.