

# Distribution of Cyst- and Gall-Forming Nematodes of Sugar Beets in the United States<sup>1</sup>

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## Introduction

Sugar beets in the United States have grown intermittently, then continuously, for more than 120 years. Today, plant parasitic nematodes stand as one of the major problems confronting the beet-sugar industry. Since the first report of the sugar-beet nematode, *Heterodera schachtii* Schmidt, 1871, in a sugar beet field near Lehi, Utah, about 1895, known areas of infestation have increased in size and number. (2, 8, 15, 23)<sup>3</sup>.

Species of root-knot nematodes, *Meloidogyne* spp. Goeldi, 1887, are a great cause of trouble in California and are frequently encountered in other sugar-beet-growing areas.

Until recently Cobb's root-knot nematode, *Nacobbus batatiformis* Thorne and Schuster, 1956, had been mistaken for root-knot nematode, *Meloidogyne* spp., in sugar-beet-producing areas on the eastern slope of the Rocky Mountains (25).

Recent studies (1, 3) have afforded the opportunity of determining the incidence and distribution of these forms. The cooperation of interested workers and their generous sharing of information have enabled this distribution report to be as current and accurate as possible.<sup>2</sup>

## Procedure

The Beet Sugar Development Foundation conducted two studies on the incidence of plant parasitic nematodes which encompassed 86 percent of the sugar-beet-producing area.<sup>2</sup> Samples of sugar beets and contiguous soils were examined for nematodes from 14 sugar-beet-producing states as follows: California, Colorado, Idaho, Iowa, Kansas, Michigan, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Washington, and Wyoming.

Distribution and allocation of samples were based on sugar-beet acreage. Sampling was timed to collect in the selected areas at approximately the middle of the growing season. The collection of samples was delegated to sugar company fieldmen who were familiar with their particular territories. In one study conducted in California, Colorado, Kansas, and Michigan, fields

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with a known or suspected nematode infestation were selected and four samples were taken from each field. Sample A was taken from the apparent center of an infested area as determined by sugar-beet growth. Sample B was taken midway from the apparent center to the apparent edge of the infested area. Sample C was collected at the apparent edge of the infested area. The collection of Sample D was from an apparently unaffected area of the field.

In the other study, fields selected for sampling could have a known history of nematode infestation, a suspected nematode infestation or no nematode problems. Two samples were collected from each field. Sample A was taken from the center of an infested area or the center of the field if there was no evidence of a nematode infestation. Sample B was taken from a location in the field at least 50 yards distant from Sample A.

Fields selected for sampling were of a representative soil type used for growing sugar beets in the fieldman's particular area. Fields were avoided where nematode control practices by soil fumigation had been employed. If a field contained more than one infested area, only one such infestation was sampled.

The method of sampling was as follows: each sample consisted of one whole sugar beet, top included, and one quart of soil. Sugar-beet roots were dug rather than pulled to preserve the maximum number of secondary roots. Soil surrounding the beet one foot square and to the depth of the actively growing

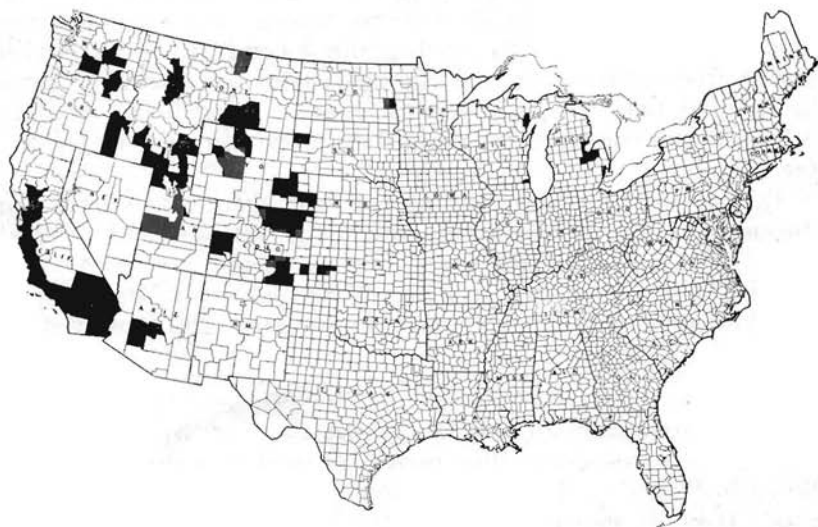


Figure 1.—Distribution of the sugar-beet nematode, *Heterodera schachtii* by counties, as observed on sugar beets in the United States.

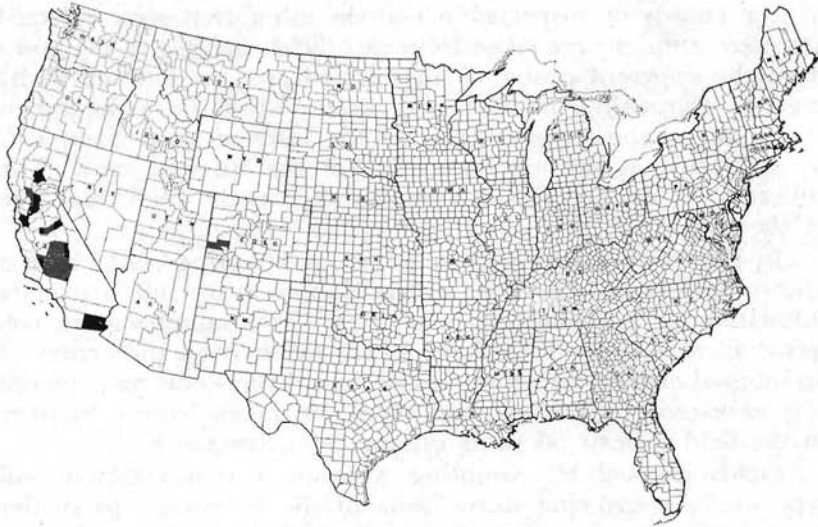


Figure 2.—Distribution of the cotton root-knot nematode, *Meloidogyne incognita acrita*, by counties, as observed on sugar beets in the United States.

fibrous roots or ten inches, whichever was greater, was thoroughly mixed on a clean surface for each sample. A one-quart aliquot of soil was then taken.

The nematodes were separated from the soil using the gravity-screening technique and preserved in 5-dram vials in five percent formaldehyde. The Baermann funnel method was combined with the screening during the second study to obtain residue free samples. Spear-form nematodes were selected from the samples that had only been screened. A medicine dropper technique was employed for rapid slide preparation of the residue free samples (3).

During the first study, samples of beet were taken from the fibrous roots, the tap root, the crown, the petioles, and the leaf blade. The beet samples were then preserved and stained in steaming acid fuchin in lacto-phenol. Second study beet samples were collected only when nematode presence was observed or suspected.

### Results and Discussion

The distribution of the nematodes is given by counties in each of the states where they occur. *H. schachtii* distribution is shown in Figure 1. The distribution of *M. incognita acrita* Chitwood, 1949, is shown in Figure 2. *M. hapla* Chitwood, 1949, distribution on sugar beets is shown in Figure 3. Reports of unidentified gall-forming nematodes is shown in Figure 4. Dis-

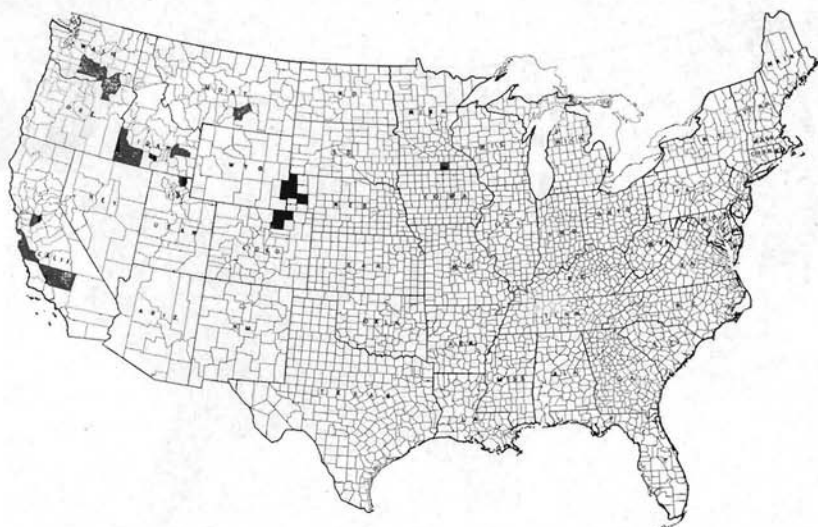


Figure 3.—Distribution of the northern root-knot nematode, *Meloidogyne hapla*, by counties, as observed on sugar beets in the United States.

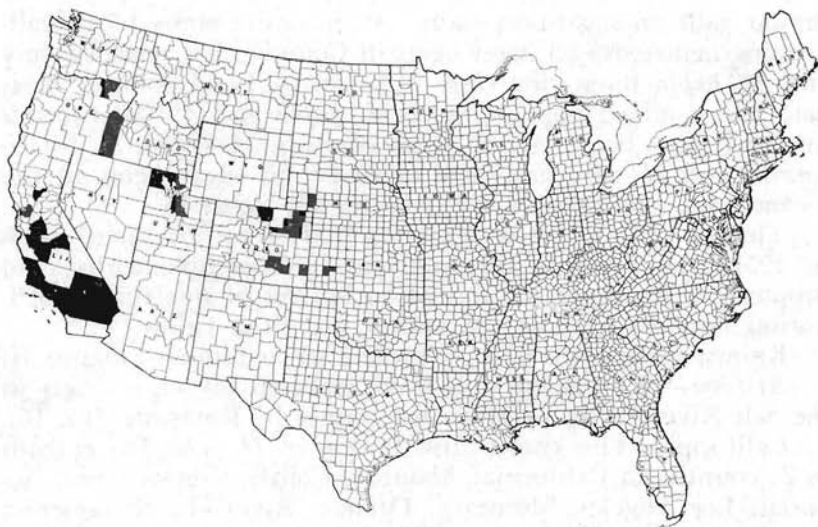


Figure 4.—Distribution of the root-knot nematode, *Meloidogyne*, spp., by counties, as reported on sugar beets in the United States. See text for explanation of other possible identification.

tribution of *N. batatiformis* as found on sugar beets is shown in Figure 5.

Reports of *Meloidogyne* species in eastern Colorado and Kansas can probably be ascribed to *N. batatiformis* which forms

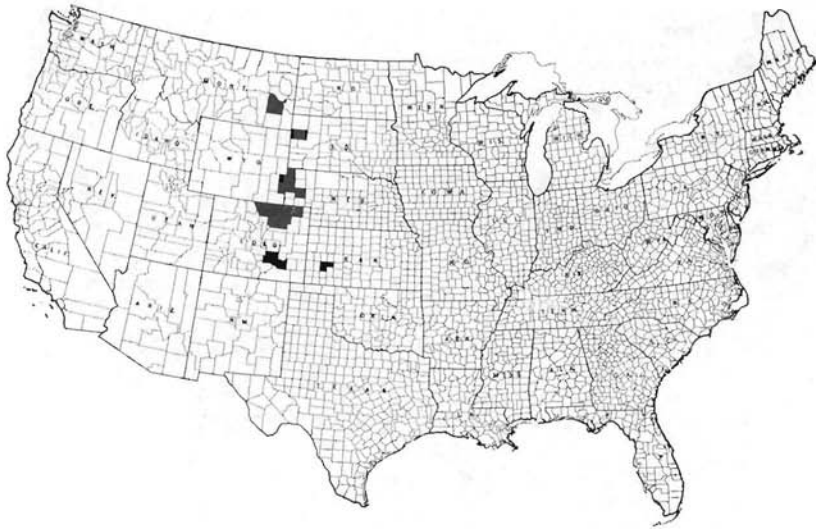


Figure 5.—Distribution of Cobb's root-knot nematode, *Nacobbus batatiformis*, by counties, as observed on sugar beets in the United States.

similar galls on sugar-beet roots. An intensive study of all gall-forming nematodes on sugar beets in Colorado has revealed only one *M. hapla* infestation near Milliken in Weld county. This field had a mixed population of *M. hapla* and *N. batatiformis* infesting sugar beets. Mixed populations of *M. hapla*, *N. batatiformis*, and *H. schachtii* were observed on sugar beets in the western sugar-beet-producing counties of Nebraska.

Thorne (23) reported the known *H. schachtii* distribution in 1952. The present investigations have complemented and supplement his report. Information sources of nematode distribution not observed by the author are cited below.

Known infestations of *H. schachtii* are as follows (Figure 1):

Arizona—*H. schachtii* has been reported on sugar beets in the Salt River Valley of Maricopa county by Reynolds (15, 16).

California—The known distribution of *H. schachtii* extends to 21 counties in California: Alameda, Colusa, Contra Costa, Imperial, Los Angeles, Monterey, Orange, Riverside, Sacramento, San Benito, San Bernardino (13, 22), San Joaquin, San Luis Obispo, Santa Barbara, Santa Clara, Santa Cruz (9), Solano, Sutter, Ventura, Yolo, and Yuba (9).

Colorado—Sixteen counties in Colorado are known to have infested sugar-beet fields: Adams, Boulder, Crowley (10, 18, 22), Delta, Larimer, Las Animas, Logan, Mesa (10, 22), Montrose, Morgan, Otero, Prowers (27), Pueblo, Sedgwick, Washington (26), and Weld.

Idaho—Sugar-beet fields in 14 Idaho counties are known to be infested: Bannock, Bingham, Bonneville, Canyon, Cassia, Elmore, Franklin (10, 22), Gooding, Jefferson, Jerome, Madison, Minidoka, Payette, and Twin Falls.

Kansas—*H. schachtii* has been observed in Finney and Kearney (27) counties.

Michigan—Six counties in Michigan contain infested sugar-beet fields: Arenac (12), Bay, Macomb (23), Menominee (23), Saginaw, and Tuscola.

Montana—Distribution of known infestations extends to nine counties in Montana: Big Horn, Blaine, Carbon, Lake, Missoula, Ravalli, Stillwater, Treasure (11), and Yellowstone.

Nebraska—In Nebraska, Garden (6), Morrill (6, 10, 22), Scotts Bluff, and Sioux counties are known to have infested sugar-beet fields.

North Dakota—One lightly infested field has been observed in Cass county.

Oregon—*H. schachtii* infestations have been observed in Malheur and Umatilla counties.

South Dakota—Several moderately to heavily infested fields have been encountered in Butte county.

Utah—Nine counties in Utah are known to have infested sugar-beet fields (23): Box Elder, Cache, Davis, Millard, Salt Lake, Sanpete, Sevier, Utah, and Weber.

Virginia—The reported presence of *H. schachtii* on Polygonum in Virginia has subsequently been diagnosed as *H. weissii* Steiner, 1953 (19, 20).

Washington—In Washington, Adams, Grant, Walla Walla, and Yakima counties have *H. schachtii* infested sugar-beet fields.

Wisconsin—Kenosha county has been reported infested (24).

Wyoming—Big Horn, Fremont, Goshen, Platte (10, 22), and Washakie counties are known to have infested sugar-beet fields.

Root-knot nematode, *Meloidogyne* species, infestations on sugar beets are as follows (Figures 2, 3, 4):

California—*M. incognita acrita* has been observed on sugar beets in Butte (14), Imperial, Kern, Madera, Sacramento, San Joaquin, Santa Clara, Tulare, and Yolo counties.

*M. hapla* has been found on sugar beets in Kern, Monterey, San Joaquin, Santa Cruz and Yolo counties.

One infestation of *M. javanica* (Treub, 1885) Chitwood, 1949, has been observed in San Joaquin county.

Infestations of *Meloidogyne* species on sugar beets have been reported from Contra Costa (24), Fresno (9), Kings (9), Los Angeles (13, 24), Merced (9), Orange (13, 24), Riverside (13),

San Benito (9), San Bernardino (13), San Luis Obispo (13), Santa Barbara (13, 24), Solano (9), Stanislaus (9), Sutter (9), Ventura (13, 24), and Yuba (9) counties.

Colorado—One field of sugar beets lightly infested by *M. incognita acrita* has been observed in Montrose county. *M. hapla* has been observed with *N. batatiformis* on sugar beets in one field in Weld county. Reports of *Meloidogyne* species in Adams (4), Larimer (21), Logan (5), Morgan (26), Otero (27), Prowers (27), Pueblo (27), and Washington (26) counties are probably mistaken observations of *N. batatiformis* on sugar beets.

Idaho—*M. hapla* has been observed on sugar beets in Bingham, Canyon, Jerome, and Owyhee counties.

Kansas—Reports of *Meloidogyne* species on sugar beets in Finney county (27) can probably be discounted as examination of sugar-beet roots has revealed only infestations of *N. batatiformis*.

Minnesota—A severe infestation of *M. hapla* has been observed on sugar beets in Freeborn county.

Montana—*M. hapla* has been observed on sugar beets from Yellowstone county.

Nebraska—*M. hapla* has been found on sugar beets in Morrill, Scotts Bluff, and Sioux counties. A species of *Meloidogyne* on sugar beets has been reported from Garden county (6).

Oregon—*M. hapla* has been observed on sugar beets in Umatilla county. A species of *Meloidogyne* has been reported on sugar beets in Malheur county (7, 17).

Utah—*M. hapla* has been observed on sugar beets in Cache and Davis counties (10). *Meloidogyne* species have been reported from Box Elder, Salt Lake, Utah, and Weber counties (24).

Washington—*M. hapla* has been observed on sugar beets in Benton, Walla Walla, and Yakima counties.

Wyoming—*M. hapla* has been observed in several sugar-beet fields in Goshen county.

Distribution on Cobb's root-knot nematode, *N. batatiformis*, on sugar beets has thus far been restricted to areas east of the Rocky Mountains (25). *N. batatiformis* has been observed on sugar beets in 14 counties and six states as follows (Figure 5):

Colorado—Infested sugar beet fields have been observed in Adams, Larimer, Logan, Morgan, Otero, Pueblo, and Weld counties.

Kansas—*N. batatiformis* has been found on sugar beets in Finney county.

Montana—Two lightly infested sugar-beet fields have been observed in Custer county.

Nebraska—Numerous infested sugar-beet fields have been observed in Morrill, Scotts Bluff, and Sioux counties.

South Dakota—A single infested field has been found near Vale in Butte county (10).

Wyoming—*N. batatiformis* has been observed in sugar beet fields in Goshen county.

### Conclusions

The rise of this formidable nematode problem is little more than half a century of intensive sugar-beet culture in the United States should cause industry and growers to reappraise their attitudes and general practices.

The return of tare dirt to sugar-beet fields should be restricted. Machinery loaned or used on several fields should be properly cleaned. Small infestations should be contained by planting with a nonhost crop, leaving the remainder of the field for sugar beets. A proper sequence of crops should be followed to maintain soil fertility and retard or limit the rate of nematode population build-up. Where practicable, soil fumigation should supplement good farming and crop rotation. An attempt should not be made to substitute it for them.

The forcing of fields into extended rotations because of nematode infestation reduces the total acreage available for sugar-beet crops in any one year. A moderate reduction in total sugar-beet tonnage could have serious consequences for a factory district. An intensive and sustained program for conservation of sugar-beet-growing acreage should be initiated.

### Summary

The known distribution of *H. schachtii* on sugar beets covers fields in 96 counties in 15 states. *M. incognita acrita* extends to ten counties in California and Colorado. *M. javaniča* has been found on sugar beets in one field in California. *M. hapla* occurred on sugar beets in 22 counties in ten states. The known distribution of *N. batatiformis* covers 14 counties in six states.

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