Project Number: 85-S2

Report to California Almond Board
December 31, 1985

TITLE: Survey of Nematodes Associated with Almond Production in California.

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1. Objective: To conduct statewide survey of nematodes associated with almond production.

2. Interpretive Summary:

Three hundred fifty soil samples from 14 of 17 almond producing counties of California were analyzed for presence of plant parasitic nematodes. The occurrence of ring nematode, Criconemalla xenoplax is associated with Bacterial Canker Complex (BCC) and sandy soils. Spiral nematode Helicotylenchus dihystera was found associated with finer textured soils. Root lesion nematode, Pratylenchus vulnus is widely distributed and present in one-fourth of the almond production region. Dagger nematode, Xiphinema americanum was most prevalent in the cooler Sacramento Valley Region. Pin nematode, Paratylenchus hamatus was most common and root knot nematode, Meloidogyne spp among the least common plant parasitic nematode. Gracilacus epacris is reported for the first time on Prunus spp. in California.

3. Experimental Procedure:

With the assistance of the almond farm advisors we visited various almond orchards in each county where there was a record of root stock and pre-plant fumigation. We sampled the poor and adjacent good areas in various production blocks to identify if nematodes were associated with the poor area. Samples were extracted by the sieve-mist method unless a single ring nematode was found and then additional soil was extracted by the sieve-centrifugation method. Nematodes were identified, counted and the results summarized.

4. Results:

In Figure 1 we show the nematode occurrence in 3 general regions of almond production. In Table 1 we indicate the average population level for each of the nematodes in the 3 regions where they occurred. In Table 2 we indicate the association of ring nematode with Bacterial Canker Complex.

5. Discussion:

Within the San Joaquin Valley the most common plant parasitic nematodes are the root knot nematodes. However, in this survey they were not detected in more than 10% of the samples. Among almond orchards root knot nematode is in low numbers because:

A. Nemaguard rootstock is in common useage in warmest production areas.

B. There are cooler and less sandy soils in the Sacramento valley region.

C. The finer-textured, non irrigated orchards of Paso Robles area were not conducive to root knot development.

Because of the associated BCC, the Ring nematode is currently the most damaging nematode of almond production. Ring nematode is commonly associated with sandiest soils and orchards with a replant history. In Table 2 the incidence of three nematodes with BCC is compared. These data indicate that where BCC was identified in an orchard the single soil samplings from good and poor trees revealed the presence of ring nematode 86% of the time. Further, the population levels of Pin nematode were not as high where BCC occurred.

An eleven-year record of county almond production was obtained from the California Almond Board. The production records of 5 counties are depicted in Fig. 2. Yield figures for San Joaquin, Merced and to a lesser extent Stanislaus county have tended to decline over the last decade, but especially since 1977 when the post-plant use of DBCP was banned. Comparable yield data from the county of Butte exhibits the impact of wet and dry years, while Kern county data exhibit the yield improvement expected from a warmer, young production region.

In association with BCC the ring nematode provides visible evidence of nematode damage including dead limbs and entire trees across irregularly shaped spots or streaks in the orchard. This survey indicates that approximately half the orchards of the San Joaquin Valley with ring nematode also exhibited BCC.

Damage caused by root lesion nematode is visibly apparent in young replant situations but in producing orchards, high population of nematodes other than ring are not easily distinguished. A soil sample is necessary to identify if a nematode problem exists and to that end we have provided indications of the average populations detected in each region.

Thirty years of experience with Nemaguard rootstock has indicated its positive and negative attributes. Since 1977 however, growers have been without the use of DBCP, a post plant nematicide which was useful for the control of root lesion and ring nematodes. Based on this survey we estimate that 100,000 Ac. of almond orchards are currently in need of some method to mitigate the effect of ring and root lesion nematodes and this need will increase as orchards are replanted.

This survey did not reveal any benefit of Lovell Seedling compared to Nemaguard as a rootstock to combat BCC. Both stocks were associated with BCC.

Much of the replanting which occurs in the Northern San Joaquin Valley is accomplished with pre-plant fumigation of individual tree sites rather than with broadcast fumigation treatments. In view of the lack of post-plant and genetic control of the two major nematode problems; we propose that the short-term nematode control provided by spot fumigation is inadequate to provide nematode protection and other methods must be explored.

6. Publications:

A full report will be submitted to "Plant Disease" for publication.

Table 1. Average population levels of selected nematodes in the 4 regions of the survey.

Region	Average Population level per 250 cc soil sample [1/]								
	Pin	Dagger	P. vulnus	Ring	Stunt	Spiral	Stubby Root	Root knot	Other
Sacramento Valley	115	15	57	4	13	36	6	9	P. thornei 280
N. San Joaquin Valley	313	19	43	325	4	131	13	21	P. neglectus 2
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[1/] All samples extracted by modified sieve-mist technique. Samples positive for ring nematode were re-extracted by sieve-centrifugation. The extraction efficiency for each life stage of each species is unknown but is between 25 to 50% for root lesion and root knot and 50% for ring nematode.

Table 2. Occurrence and average population levels of 3 nematode species in San Joaquin Valley orchards damaged with BCC.

	Nematode Incidence[1] and Average Population Levels[2]		
	Ring Nematode	Pin Nematode	Root Lesion Nematode
All sites from S.J. Valley (250 samples)	34%/295	61%/340	26%/42
All S.J. Valley sites from BCC orchards (49 samples)	86%/381	69%/95	35%/20

[1] Incidence expressed as a percentage of appropriate samples.

[2] Population levels are averaged from appropriate samples.

Figure Legend

Figure 1. Occurrence of the common plant parasitic nematodes associated with almond production in 3 separate regions.

Figure 2. Eleven-year trend of almond production from 2 counties without BCC and 3 counties with BCC in some of the orchards.

Figure 1

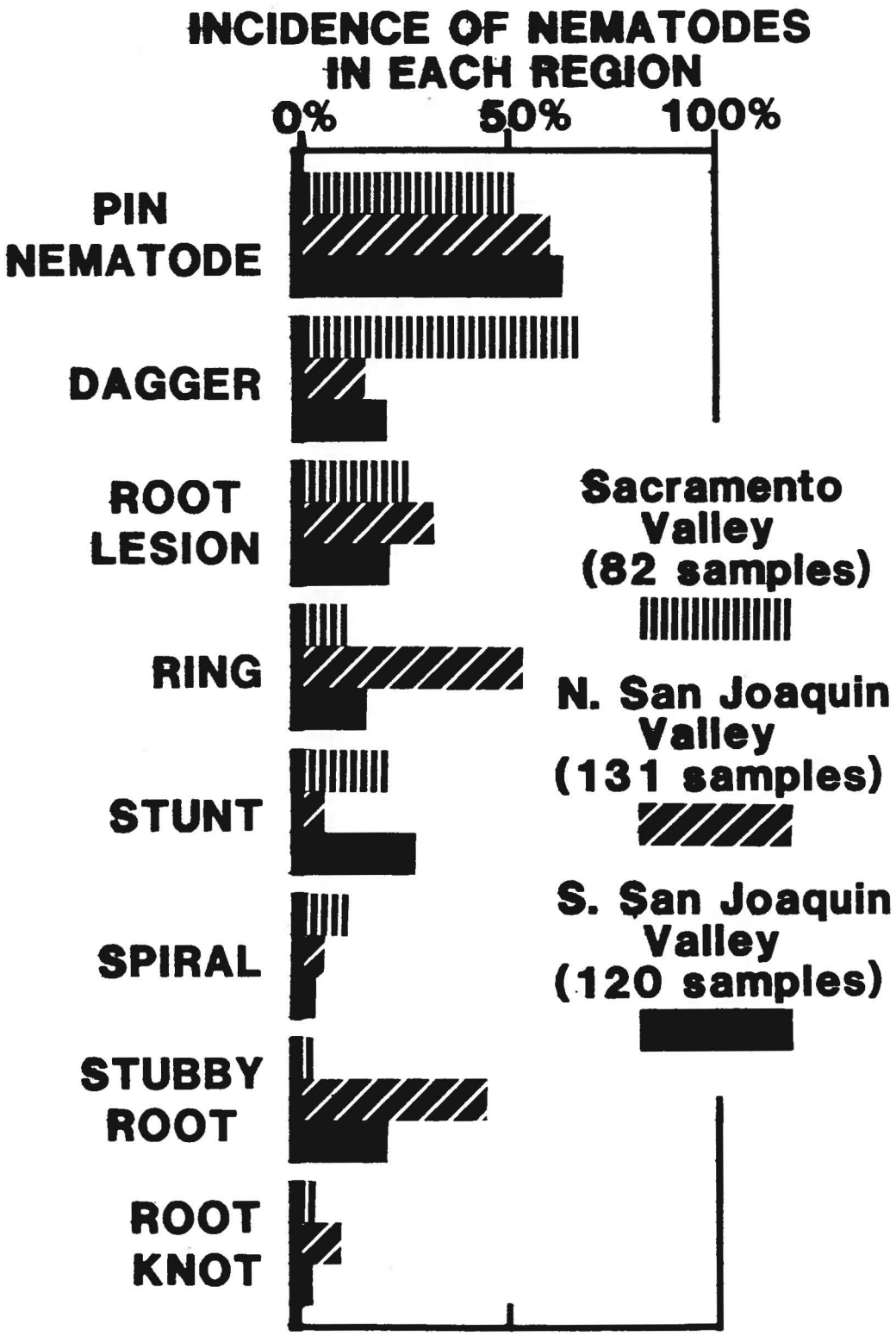
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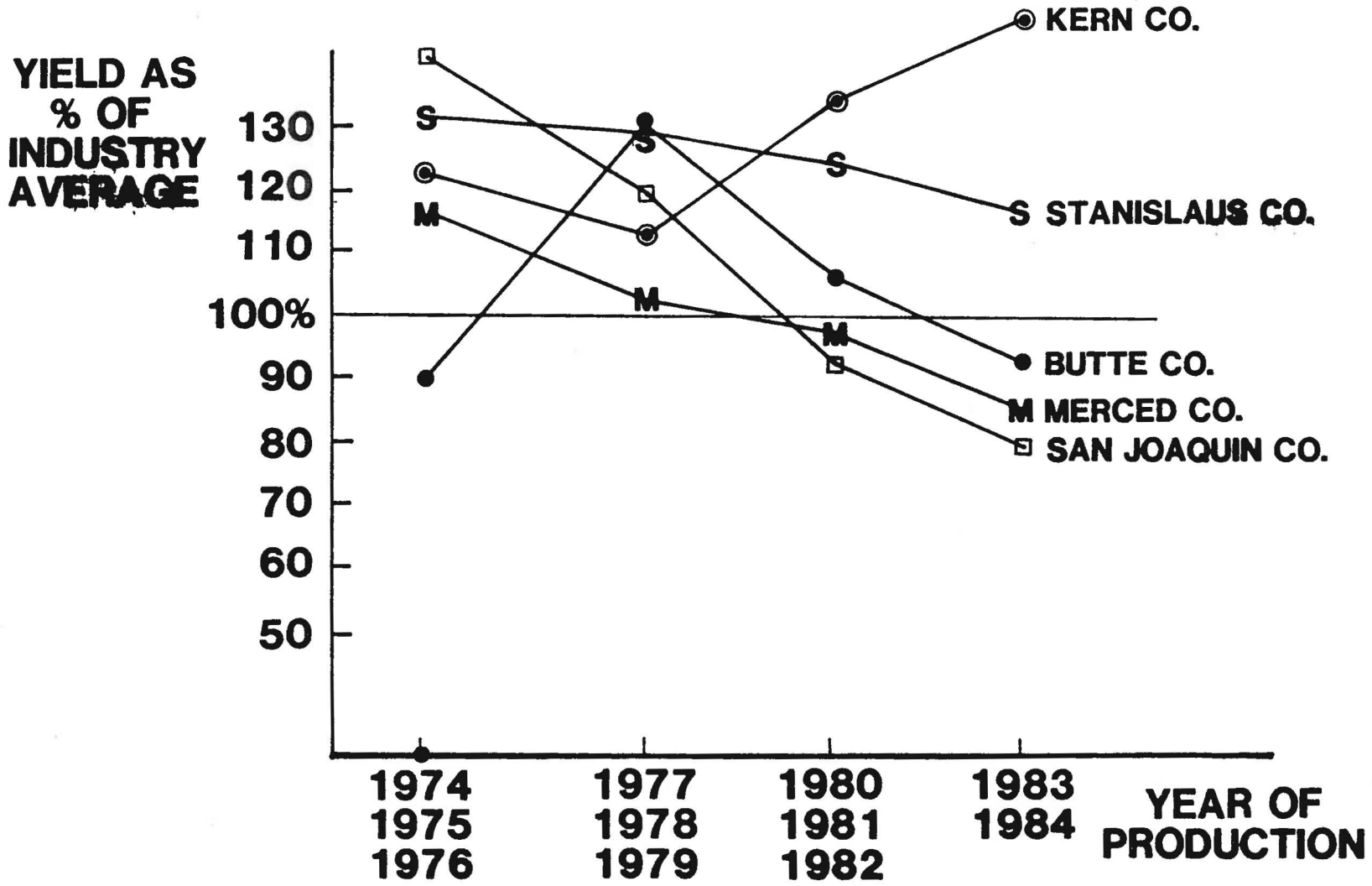
Fig. 2. ELEVEN-YEAR TRENDS OF ALMOND PRODUCTION FROM 2 COUNTIES WITHOUT BCC AND 3 COUNTIES WITH BCC IN SOME OF THE ORCHARDS. 1/



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2/ USE OF THE POST-PLANT NEMATICIDE(DBCP) WAS BANNED IN FALL 1977.

Survey of Nematodes Associated with Almond Production in California

Michael V. McKenry, Extension Nematologist and Joe Kretsch, Staff Research Associate, University of California, Kearney Agricultural Center, Parlier, CA 93648

Abstract

Three hundred fifty soil samples from 14 of 17 almond producing counties of California were analyzed for presence of plant parasitic nematodes. The occurrence of ring nematode, Criconemalla xenoplax is associated with Bacterial Canker Complex (BCC) and sandy soils. Root lesion nematode, Pratylenchus vulnus is widely distributed and present in one-fourth of the almond production region. Dagger nematode, Xiphinema americanum was most prevalent in the cooler Sacramento Valley Region. Pin nematode, Paratylenchus hamatus was most common and root knot nematode, Meloidogyne spp. among the least common plant parasitic nematode. Gracilacus epacris is reported for the first time on Prunus spp. in California.

Half the world's almond (Prunus amygdalus) crop emanates from within the Sacramento and San Joaquin Valleys of California. Production occurs along a 500 mile corridor of varied soil, temperature and rainfall gradients. Within this region a diversity of cultural practices are utilized to protect the crop from maladies of soil and weather conditions.

In 1984-85 we conducted a survey of the nematodes associated with almond production. The goal was to identify the extent of nematode problems if they existed. We also wished to identify if there were

associations of specific nematode with specific rootstocks, soils, climate or cultural practices. Of various Prunus spp. grown in California, almond is grown under the greatest diversity of conditions. There were no previous local studies of the nematodes of almond, although nematodes of other Prunus spp. including P. persica have been studied. It is well known that P. amygdalus is highly susceptible to root knot nematode Meloidogyne spp. (1) and that half the region within the Central Valley is commonly affected with Meloidogyne (5). The early recognition of root knot prevalence in California prompted a heavy reliance on the use of Prunus persica cv. Nemaguard as a favored rootstock. Much of the almond crop has been planted in the last 3 decades.

Intro

Materials and Methods

The California Crop and Livestock Reporting Service provides information on almond acreage throughout the state. Cooperative extension farm advisors in each almond producing county were asked to provide sampling sites which would be representative of the production in their area. They were asked to provide sites with a known history relative to planting dates, prior cropping history, fumigation experiences, rootstocks and disease incidence.

Selected growers or ranch managers were questioned to obtain background information on fields sampled. Totally, 350 soil samples were collected, nematodes were extracted and the plant parasitic nematode identified. Sampling sites were rated for vigor and general health on a scale from 1 to 10 with "1" being dead and "10" being the most healthy vigorous trees. Subsamples of soil were collected from the surface 60 cm at the canopy edge of each of three trees. Presence of diseases, particularly Bacterial Canker Complex (BCC) were noted at time

of sample collection. When possible, samples were collected from poor and better growing trees of each orchard in order that we could assess relative nematode damage, if any. Soil samples were protected from sunlight and stored at 10°C for no more than 20 days prior to extraction.

Nematodes were extracted using either a modified sieve-mist or sieve-centrifuge procedure (3). Samples collected from known BCC sites were processed using both techniques in order to maximize extraction of ring nematode (Criconemella xenoplax) which has been found associated with a similar malady, peach tree short life (4).

Results

Over a period of one year 14 of 17 almond producing counties were sampled (6). Eighty-two samples were from Butte, Sutter, Yuba, Colusa, Glenn and Tehama counties or the region referred to as Sacramento Valley. From the Northern San Joaquin Region of San Joaquin, Stanislaus and Merced counties, a total of 131 samples were collected. A total of 120 soil samples were collected from the Southern San Joaquin Region of Fresno, Kings, Tulare, and Kern counties. Eighteen samples were also taken from a coastal region of non-irrigated, hillside near Paso Robles, CA. The regions are referred to here for convenience, however they also provided four distinct nematode situations. The occurrence of nematodes in the three major regions is indicated in Figure 1. The average population levels are indicated in Table 1.

Sacramento Valley Region: Xiphinema sp.or spp. locally referred to as X. americanum was found to dominate this region. The second most common nematode was Paratylenchus hamatus, the pin nematode which was also the most common plant parasitic nematode of the survey. The most

common root lesion nematode, Pratylenchus vulnus, occurred in 32% of the samples but other root lesion species were not commonly found. Species of Tylenchorhynchus and Merlinius referred to as stunt nematodes were more common in this region which also has the greatest frequency of natural vegetation. Spiral nematode Helicotylenchus dihystera was found in association with the soils of finest texture which are relatively common to the region. Ring nematode Criconemella xenoplax was only occasionally found. Roughly 32% of the samples in this region which represents 30,000 ha. had no dominate nematode present. The dominate rootstock is Lovell Seedling, Prunus persica cv. Lovell. P. Amygdalus seedling, P. domestica cv. Marianna 2624 and P. persica cv. Nemaguard occurred from 23%, 12% and 11% of the sampled areas, respectively. None of the orchards we sampled had received a pre-plant fumigation. The average age of the orchards was 20 years. Where root knot (Meloidogyne incognita) galls were detected in sandiest soils, the gall frequency was relatively less than that from the San Joaquin Valley and there was no apparent tree damage even in replant situations.

Northern San Joaquin Region: Soils from this region are among the sandiest in the state. The dominant nematode was the ring nematode, C. xenoplax. The region exhibited the greatest incidence of BCC and of 31 orchards with BCC incidence, 28 had ring nematode with an average population level of 456/250 cc soil. Forty-seven percent of the orchards sampled had received pre- or post plant fumigation.

Nemaguard was the rootstock in 73% of our sampled sites with Lovell Seedling occurring in 18%. Remaining orchards are either on P. amygdalus seedling, P. domestica cv. Marianna 2624 or hybrids of nemaguard and almond. Many orchards from this region of 80,000 ha had

a cropping history of 2 or 3 generations of Prunus spp. The average age was 9.6 years. The survey provided an indication that there is antagonism between pin nematode and ring nematode. Where the Pin nematode population is 100 nematodes or less/250 cc sample; then 69% of the samples also have ring nematode (72 of 104 samples). Where the Pin nematode population is greater than 100; only 13% of the samples had Ring nematode (9 of 72 samples).

Southern San Joaquin Region: The dominant soil in this region is sandy loam but there are streaks of sand present. The newest almond plantings occurred in this region with first generation trees being most common. Pin nematode occurred throughout the area at an average population level of 367 per 250 cc soil sample. Stunt nematodes occurred in 28% of the sites. Root knot nematodes occurred in 2 sample sites near DiGiorgio, CA on Nemaguard rootstock, but galls were not apparent on the roots. Nemaguard was the dominant root with 97% incidence. Ring nematode occurred within sandy soils and was commonly associated with root lesion nematode. BCC incidence was relatively low but commonly in association with ring nematode. A single sample from the southern tip of the valley contained Gracilacus epacris at 629 per 250 cc. This nematode had previously been found on Juglans hindsii 100 miles north and from higher elevations surrounding the valley floor (2). One third of the orchards had no dominant plant parasitic nematode and only 10% had received pre-plant fumigation. This region encompasses 70,000 ha and orchards averaged 10.8 years of age in our sampling.

Paso Robles Region: Pin nematode occurred in each of the 18 soil samples from this region. Stunt and Dagger nematode also had a high incidence. The root lesion nematode Pratylenchus neglectus is common in

grasslands of the area and in this survey was commonly found with *Pratylenchus vulnus.* None of the sites had received pre plant fumigation and all the orchards were on almond rootstock which is most suitable to the dry land production conditions. The soil is medium textured and calcareous. Root knot nematode did not occur although heat accumulation throughout the year is adequate for its development. This production region only represents 2500 ha but is uniquely different from the production areas of the three Central Valley regions. The average orchard age was 30.5 years.

Discussion

Within the San Joaquin Valley the most common plant parasitic nematodes are the root knot nematodes. However, in this survey they were not detected in more than 10% of the samples. Among almond orchards root knot nematode is in low numbers because:

1. Nemaguard rootstock is in common useage in warmest production areas.
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Acknowledgements

This project was partially supported by the California Almond Board. Contacts in each county would not have been possible without the cooperation and assistance of: W. Asai, B. Beede, J. Connell, J. Edstrom, J. Foott, M. Freeman, J. Hasey, L. Hendricks, B. Krueger, J. Osgood, D. Rough, S. Sibbett, and M. Viveros.

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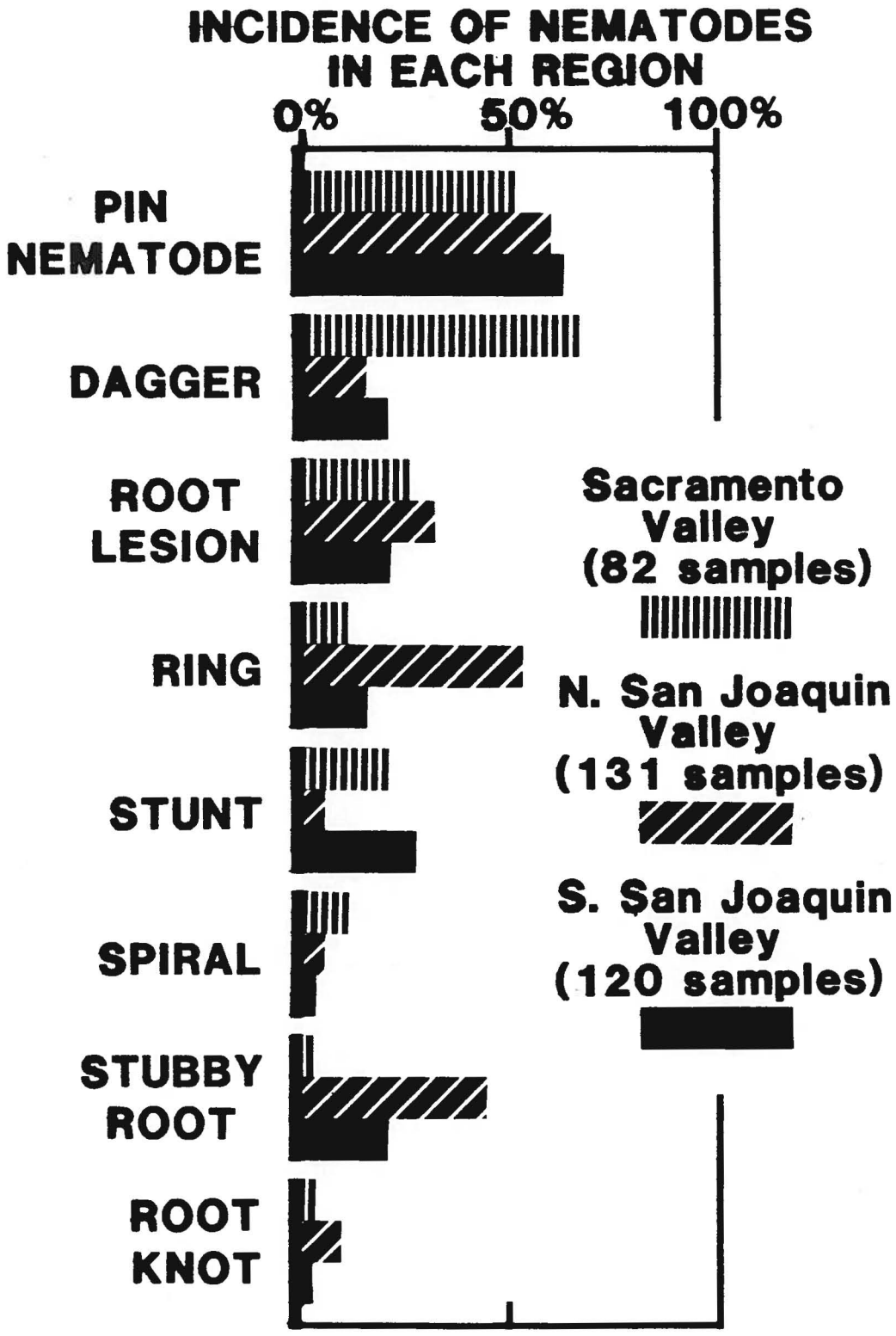
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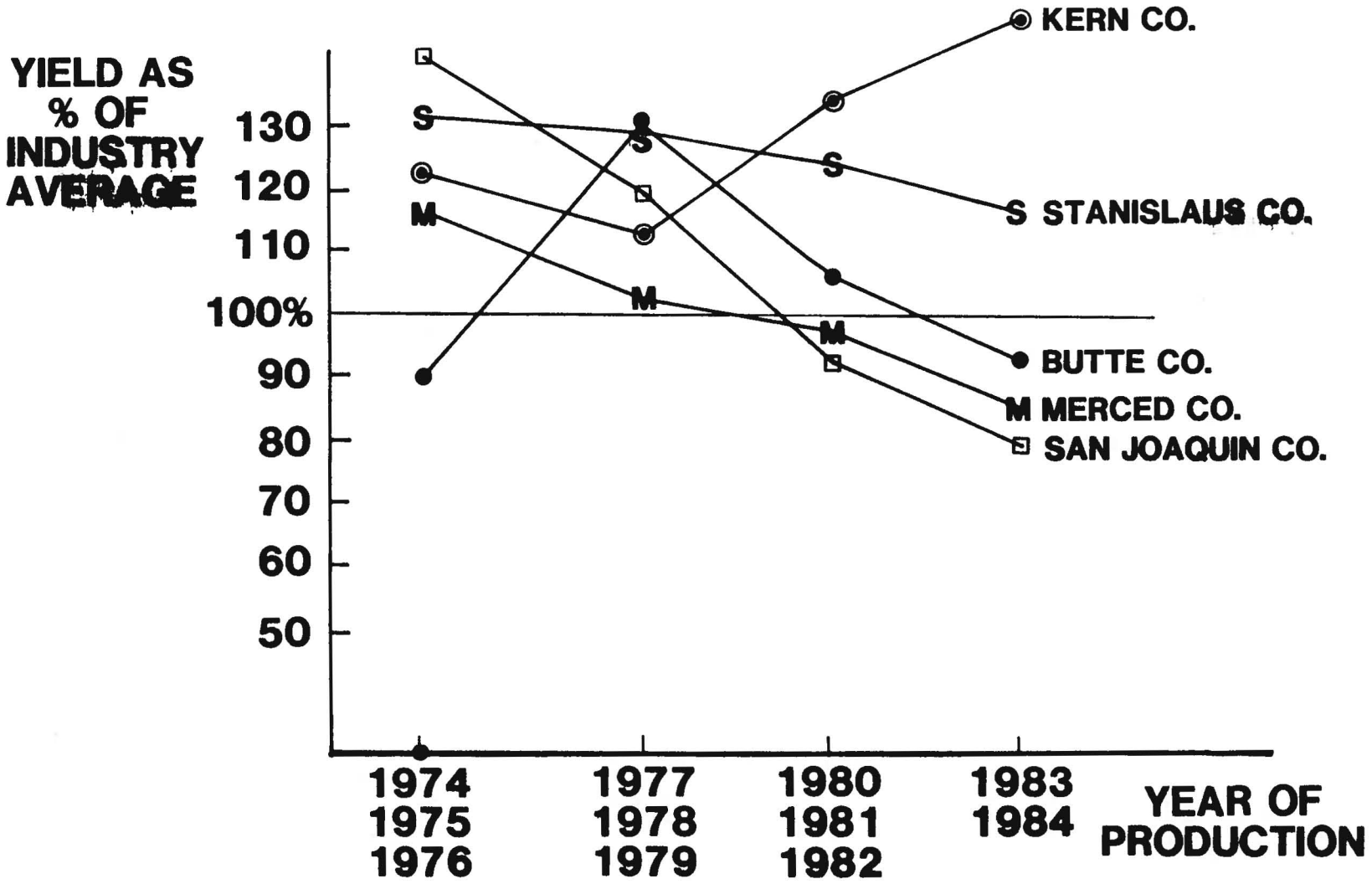

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