UNIVERSITY OF CALIFORNIA
STATEWIDE INTEGRATED PEST MANAGEMENT PROJECT

NEMABASE--A database of the host status of plants to plant-parasitic nematodes

The NEMABASE database gives fast, easy access to the host status of plants to plant-parasitic nematodes throughout the world, and helps with rotation and cover cropping decisions for nematode management. Download the entire database or order a set of disks to use NEMABASE on your PC, or do simple searches on the World Wide Web.

Developed in the UC Davis Department of Nematology, NEMABASE contains extensive lists of cover crops, native plants, crop cultivars, and their status as host for a wide range of nematodes. You'll find information on

6,100 plant taxa, including higher taxonomic information, geographic origin, growth habit, and use of each plant species.

3,900 nematodes, including details of the higher taxonomic information for 3,900 of the major plant-parasitic nematodes (to the race level).

38,000 interactions, detailing the nature of each plant and nematode interaction, the constraints of the experiment or observation, and the source and quality of the data.

This information has been extracted from nearly 5,000 articles published over the last 90 years in six journals that deal primarily with plant-parasitic nematodes, and in widespread reports assembled in earlier compilations of host records. Approximately 70% of the available data on plant and nematode interactions has been gathered into the database.

Why was NEMABASE developed?

NEMABASE collates, interprets, and evaluates available information on the host status of plants to the plant-parasitic nematodes, and makes it available as a basis for management decisions. The database

- allows selection of nonhost crops, and determination of the availability of resistant cultivars, for species and races of plant-parasitic nematodes;
- allows selection of cover crops that are nonhosts to resident plant-parasitic nematode populations; and
- provides rapid search of the available knowledge base for novel species of crops or cover crops that warrant testing in a cropping system in relation to their effect on resident nematode populations.

The Development Team

Department of Nematology faculty at the University of California, Davis, developed NEMABASE over the past several years with assistance of graduate students and staff.

Funding was provided by the UC Department of Nematology, the UC Statewide Integrated Pest Management Project, and from USDA-Extension Service Smith-Lever IPM funds.

Availability of NEMABASE

You can gain access to NEMABASE in three ways:

- Download the database and search engine directly to your PC
- Order a set of disks that contain the database and search engine for use on your PC
- Do simple searches through the World Wide Web.

See below for more information on each.

PC Version--Complete database and search engine for your PC

Hardware and software requirements. NEMABASE is distributed in a FOXPro run-time version. It does not require you to have FOXPro database software. For efficient use of NEMABASE, you'll need

- A Pentium or 486 PC
- Windows 3.1 or 95
- At least 8 Mb RAM (preferably 16)
- SVGA monitor
- approximately 20 Mb available disk space

Download NEMABASE from this site

1. Download the NEMABASE installer (5.6 Mb) to install NEMABASE on your PC under Windows.
2. When the program has been transferred successfully to your PC,
   - □ use the Windows Program Manager and select "Run...", then
   - □ specify the path of the NEMABASE.EXE file
3. The installer will decompress NEMABASE and install it under Windows.
4. To run NEMABASE, double-click the NEMABASE 1.2 icon.

Order the NEMABASE disk set

NEMABASE is available in compressed form on a set of 5 high density PC disks. To order, complete the order form and, with a check for $12.00 (payable to "Regents of UC"), send to

> Software Distribution
> Statewide IPM Project
> University of California
> One Shields Avenue
> Davis, CA 95616-8621

Getting started

The on-line help is designed to help you get started, and gives specific information about how to use the program features. Press the HELP button or press F12 at any time to access the Help Menu. (From the Help Menu, double-click in the Memo field of the desired topic.)

1. *Specify plant and nematode.* To run a database search, or "query", you must first select a Plant and a Nematode. These may be selected from higher taxon, e.g., family, to intraspecific levels (e.g., variety, cultivar, race). Refer to the Help topic "General Query Procedure" for more information.
2. *Specify criteria.* To further specify the search criteria, you may set any number of "filters" : Date Range, Host Status, Susceptibility, Tolerance, Nature of Record, Study Site, Soil Texture, Climate, Geographic Origin of record, and Data Quality. Multiple conditions may be designated for each filter.
3. *Begin the search.* After selecting the Plant, Nematode, and any desired Filters, click on the Setup box next to the nematode name to move the red arrow in preparation for processing the query. Press the Process button to begin the search.
4. *Output reports.* When the search is completed, press Print to generate a report that includes fields you designate. The report can be printed to a printer and to database or text files. The files may be imported into a database program or spreadsheet for further analysis, or into a word processor.

When searching, note that several common names for nematodes or plants may be used preferentially in different regions. Many records will be missed if a query is processed using a common name designation not listed in the nematode or plant names table of NEMABASE. **It will always be safer to use the genus and species name of the nematode, or genus and species (and variety, if appropriate) of the plant.**

World Wide Web Version of NEMABASE

The database contents have been put onto the UC Davis Department of Nematology World Wide Web server. Click on "NEMABASE Nematode-Host Association Database," and enter your search criteria according to the instructions given there.

Database design and field descriptions

NEMABASE is structured as a series of relational database tables with fields for the following features of nematodes and plants, and for their interaction:

Nematode Fields	Genus, species, authority, race, common name, order, superfamily, family, sub-family.
Plant Fields	Genus, species, authority, variety, cultivar, common name, growth habit, usage, native range, family.
Qualitative Interaction Fields	Non-host, resistant/susceptible, tolerant/intolerant; temperature, location, soil texture.
Quantitative Interaction Fields	Pf/Pi, damage thresholds, damage function.
Secondary Interactions Fields	Fungal, bacterial, virus interactions.
References, Source Fields	Author and citation.
Evaluation Comment Fields	Quality of information; association, field observation; replicated experiment.

Forty-seven variables are stored in the relational tables. The dictionary lists each field name abbreviation and provides a description.

Comments? Contact hferris@ucdavis.edu

UC IPM HOME | **HELP DESK**

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NEMABASE Database Description

NEMABASE was developed in the Department of Nematology, University of California, Davis by
-Howard Ferris, Professor
-Edward P. Caswell-Chen, Associate Professor
-Becky B. Westerdahl, Associate Professor and Extension Specialist

Programming was carried out by
-Charles B. Terry, American Fox Systems
-Michael Ransom, Department of Agronomy and Range Science, UC Davis

Data were entered by
-Rebecca Sloan, M.S. in Plant Protection and Pest Management, UC Davis
-Umesh Kodira, former graduate student in the UC Davis Dept. of Nematology
-Jeffrey Gardner, former graduate student in the UC Davis Dept. of Nematology

Funding was provided by
-Department of Nematology, University of California, Davis
-University of California Statewide Integrated Pest Management Project
-USDA-Extension Service Smith-Lever IPM Funds

About the Developers of NEMABASE

The developers are committed to nonpesticide approaches to the management of plant-parasitic nematodes in agricultural and urban situations. Ferris was one of the authors of the original grant proposal that in 1978 led to the establishment of the UC IPM Project. He has been involved with the project in various capacities during the intervening years. His research interests include the development and definition of damage threshold levels of plant parasites. Caswell-Chen is currently a member of the technical committee of the UC IPM Project. His research interests are the documentation and characterization of host-plant resistance to nematodes, and the use of cover crops that are detrimental to the survival and infectivity of plant-parasitic nematodes. Westerdahl is responsible for providing technical backup to field level advisory personnel and for adaptive research to resolve nematode problems in the wide range of crop types grown in California. She is a primary author of the UC IPM Guidelines for Nematode Management.

Jeffery Gardner and Umesh Kodira are former graduate students in the Department of Nematology at UC Davis, while Rebecca Sloan graduated from UC Davis with an MS degree in Plant Protection and Pest Management.

Why NEMABASE was Developed

The objective in developing NEMABASE is to collate, interpret and evaluate available information on the host status of plants to the plant-parasitic nematodes, and to make it available as a basis for management decisions. The database will allow selection of nonhost crops, and determination of the availability of resistant cultivars, for species and races of plant-parasitic nematodes. It will allow selection of cover crops that are nonhosts to resident plant-parasitic nematode populations. It will provide capabilities of rapid search of the available knowledge base for novel species of crops or cover crops that warrant testing in a cropping systems in relation to their effect on resident nematode populations.

Nematode management for economically-important crops in most of the world has been centered on the use of nematicides for more than 40 years. The number of nematicides available for management has declined precipitously over the past ten years. Furthermore, the use of nematicides may be incompatible with the enhancement of soil biological activity that underlies successful sustainable agricultural systems. Alternative management of plant-parasitic nematodes requires combinations of tactics. Many of those tactics involve selection, and temporal and spatial arrangement, of crop-plant or cover-crop species and cultivars to reduce nematode numbers and damage. Plant species selected for beneficial effects on soil fertility and microbiological activity should not enhance species of nematodes that are parasitic on primary economic crops in the farming system.

Alternatives management tactics for plant-parasitic nematodes include: growing nematode-resistant cultivars, growing nonhost primary crops (rotations), growing nonhost cover crops, using fallow periods, enhancing natural biological control, and implementing cultural practices. Each of these choices must be made in relation to the nematode species and environmental variables, such as soil temperature, texture, and irrigation regimes, at a given location. For example, the use of cultivars or rootstocks resistant to the predominant nematode species in a field is effective. Frequently, however, there are several damaging species present, and cultivars have not been selected for resistance to multiple nematode species. In addition, nematode species differ in their host ranges, and plants differ in their host status to various nematodes. These differences are the basis for crop rotation sequences; however, the design of successful rotations requires access to the available information on host status. There exists an abundant, although incomplete and often inaccessible, literature on the nematode-host status of many different plants.

What is not available, is easy, rapid access to the available literature on the host status of different plant species to different nematode

species. Implementation of optimization tools for nematode management requires access to data on the nematode-host interaction. An example of an attempt to unify existing host-status information is the nematode management system developed in the early 1980s for the University of California Statewide Integrated Pest Management (UC IPM) project IMPACT system (Ferris et al, 1986). Ferris and coworkers have developed crop sequence optimization algorithms, recognizing that crops differ in both their net returns and their nematode host status (Duncan and Ferris, 1983; Ferris, 1978; Ferris et al, 1986; Ferris and Greco, 1992; Ferris et al, 1994).

Crop and cultivar host status for each nematode species; the qualitative categorizations of "host", "non-host", "resistant", and of susceptibility to damage ("tolerant", "intolerant"), are immensely useful as a basis for crop-choice decisions. At a more critical level of resolution, for design of optimal cropping sequences, quantitative information is necessary. Host status of a cultivar must be expressed in terms of seasonal multiplication or decline rates of each nematode species (Ferris, 1985). Damage functions and thresholds in relation to individual nematode species, although not available for many crop-nematode combinations, allow more critical analyses. Sometimes quantitative information is available from experiment, in other cases it can be inferred or estimated from knowledge of the nematode biology.

There have been several previous efforts to collate nematode-host status information. Each of these efforts has limitations; primarily they are outdated and not readily accessible. Also, taxonomic revisions have occurred, and nematode host races and biotypes were not recognized in the earlier literature. In NEMABASE these complications have been dealt with on a case-by-case basis.

As of November 1995, there are 38,682 records from 96 countries in the database. The records include information on 6,140 plant taxa identified at the genus, species or variety level and 801 nematode taxa identified at the genus, species or race level. That information has been extracted from 4,747 articles published over the last 90 years in six journals that deal primarily with plant-parasitic nematodes and in widespread reports assembled in earlier compilations of host records. It is estimated that about 70 % of the available data on plant and nematode interactions have been compiled and entered into the database. The developers plan to continue the compilation of historical data and to keep the database updated with emerging data.

Literature Cited

Duncan, L. W. and H. Ferris. 1983. Effects of Meloidogyne incognita on cotton and cowpeas in rotation. Proc. Beltwide Cotton Prod. Res. Conf. 22-26.

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Ferris, H., H. L. Carlson, and B. B. Westerdahl. 1994. Crop rotation effects on population levels of Meloidogyne chitwoodi and Pratylenchus neglectus, and consequences for potato crops. Agronomy Journal 86:340-348.

Ferris, H. and N. Greco. 1992. Management strategies for Heterodera goettingiana in a vegetable cropping system in Italy. Fundamental and Applied Nematology 15:25-33.

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Specify plant and nematode. To run a database search, or "query", you must first select a Plant and a Nematode. These may be selected from higher taxon, e.g., family, to intraspecific levels (e.g., variety, cultivar, race). Refer to the Help topic "General Query Procedure" for more information.

Specify criteria. To further specify the search criteria, you may set any number of "filters" : Date Range, Host Status, Susceptibility, Tolerance, Nature of Record, Study Site, Soil Texture, Climate, Geographic Origin of record, and Data Quality. Multiple conditions may be designated for each filter.

Begin the search. After selecting the Plant, Nematode, and any desired Filters, click on the Setup box next to the nematode name to move the red arrow in preparation for processing the query. Press the Process button to begin the search.

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When searching, note that several common names for nematodes or plants may be used preferentially in different regions. Many records will be missed if a query is processed using a common name designation not listed in the nematode or plant names table of NEMABASE. It **will always be safer to use the genus and species name of the nematode, or genus and species (and variety, if appropriate) of the plant.**

Design of NEMABASE

NEMABASE is structured as a series of relational database tables with fields for the following features of nematodes and plants, and for their interaction:

Nematode Fields:	Genus, species, authority, race, common name, order, superfamily, family, sub-family.
Plant Fields:	Genus, species, authority, variety, cultivar, common name, growth habit, usage, native range, family.
Qualitative Interaction Fields:	Non-host, resistant/susceptible, tolerant/intolerant; temperature, location, soil texture.
Quantitative Interaction Fields:	Pf/Pi, damage thresholds, damage function.
Secondary Interactions Fields:	Fungal, bacterial, virus interactions.
References, Source Fields:	Author and citation.
Evaluation Comment Fields:	Quality of information; association, field observation; replicated experiment.

NEMABASE Field Name Abbreviations and Dictionary

Presented in the order of their appearance in the Browse and Report Screens)

Ngenus	Genus name of nematode.
Nspec	Species name of nematode. The abbreviation "sp." is used if the record refers to a single species that was not identified further; "spp." is used if the record refers to multiple unidentified species of the genus. Where an earlier species name has been split into several species, there may be no way of knowing which of the new species names applies to the nematode in the record. In that case, the general designation "spp." may be used.
Nrace	Race or biotype name of nematode (may not be designated), a designation of variation below the species level.
Pgenus	Genus name of plant.
Pspec	Species name of plant. The abbreviation "sp." is used if the record refers to a single species that was not identified further; "spp." is used if the record refers to multiple unidentified species of the genus.
Pvar	Variety name of plant (may not be designated), a designation of variation below the species level.
Cultivar	Cultivar name of plant (may not be designated), a designation of variation below the species level resulting from plant-breeding or selection.
Hstat	Host Status of this plant to this nematode. The designation "host" indicates that this species of plant is usually able to feed and reproduce on plants of this species. "Non-host" or "Immune" indicates that nematodes of this species are unable to feed or reproduce on plants of this species.
Susc	Susceptibility of this plant to this nematode. "Susceptible" implies that the nematode is able to grow and reproduce at its full genetic potential on a host species; "Resistant" (various levels) indicates that reproduction of the nematode is reduced or even nonexistent on a variant of that host species; "Immune" is the designation used for susceptibility when the plant is a Non-host.
Tol	Tolerance of the plant to damage by the nematode. "Intolerant" implies that the plant is heavily damaged by this nematode species; "Tolerant (various levels" indicates the ability of the plant to sustain normal growth despite the presence of the nematode population. In many reports there is no indication of the level of tolerance of the plant to the nematode, hence the designation "Unknown" is applied in this field to many records.
Continent	Continent from which the report of this plant/nematode interaction originated.
Country	Country from which the report of this plant/nematode interaction originated.
Location	Location within a country from which the report of this plant/nematode interaction originated. In many reports there is no indication of the location, hence the designation "Unknown" is applied in this field to many records.
Soil	Soil texture conditions for which this plant/nematode interaction is reported. In many reports there is no indication of the soil texture, hence the designation "Unknown" is applied in this field to many records.
Restemp	Temperature conditions for which this plant/nematode interaction is reported. In many reports there is no indication of the temperature, hence the designation " 0" is applied in this field to many records.
Obsorexp	Indicates whether the report originates from an observation "O" or a replicated experiment "E".

Year	Year of the report used for this record.
Source	Abbreviated list of authors of the publication from which of the report used for this record was obtained.
Reference	Formal literature citation for this record. The information is stored in a Memo field.
Norder	Order of nematodes - a higher classification designation; plant-parasitic nematodes occur in the orders Tylenchida and Dorylaimida.
Nsubord	Sub-order of nematodes - a higher classification designation; plant-parasitic nematodes occur in the sub-orders Aphelenchina and Tylenchina of the order Tylenchida, and sub-order Dorylaimina of the order Dorylaimida.
Nsuperfam	Superfamily of nematodes - a higher classification designation at a level below the sub-order.
Nfamily	Family of nematodes - a higher classification designation at a level below the superfamily.
Nsubfam	Sub-family of nematodes - a higher classification designation at a level below the family.
Ncommon	A common name for this species or race of nematodes. Note, there may be several common names that are used preferentially in different regions.
Nauthority	The taxonomic authority(ies) responsible for the description of this nematode species and for the designation of this genus and species name.
Nsyngen	A previously-used or alternate name for this Genus of nematode; in most cases, obsolete names in records have been updated with current names, but some taxonomic changes may have been missed; also, some taxonomic designations may be disputed by different authorities.
Nsynspec	A previously-used or alternate name for this Species of nematode; in most cases, obsolete names in records have been updated with current names, but some taxonomic changes may have been missed; also, some taxonomic designations may be disputed by different authorities. Where an earlier species name has been split into several species, there may be no way of knowing which of the new species names applies to the nematode in the record. In that case, the general designation "spp." may be used.
.value	An indication of the reproduction capacity of this nematode species on this plant. "R" is determined by the final population level (Pf) divided by the initial population level (Pi). Where population data are not provided, the value "-1" is used in this field.
iamthresh	Damage Threshold - An indication of the initial nematode population level (Pi) at which this plant species shows damage by this nematode. Where damage level data are not provided, the value "-1" is used in this field
athindx	A field to provide an index of the relative pathogenicity or virulence of nematodes with this mode of parasitism and feeding habit. As of December 1995, no information has been inserted in this field and the value "0" appears for each record.
ntrydate	Date on which the record was entered into the database.
amfunct	Damage Function - A formula describing the quantitative relation ship between plant damage or yield loss and the initial nematode population level (Pi) of this nematode species. Where damage level data are not provided, there is no entry in this field.
empop	Name used to designate the population of this nematode species reported in the record. In many cases no information is provided on the nematode population, so there is no entry in this field.
family	The plant family - a higher classification of plants in which this plant genus is grouped.
common	A common name for this species or variety of plant. Note, there may be several common names that are used preferentially in different regions.
native	Native area for this plant species or variety, if known.
usage	A known usage for this plant species or its products; there may be several other uses that are unknown or unlisted in NEMABASE.
eedcompan	A field to provide information on sources of seed for this plant species, variety, or cultivar. As of December 1995, no entries have been made under this field.
type	Growth habit of the plant (if known). Note the growth habit may vary under different climatic conditions.
lantauth	The taxonomic authority(ies) responsible for the description of this plant species and for the designation of this genus and species name.
ite	A designation for the Study Site of the observation or experiment that originated in this record, e.g. Cropland, Greenhouse, Forest, etc.

:limate   General description of the Climate of the country or location for
                 which this plant/nematode interaction is reported.
ual   Quality of this record - An evaluation by the individual who
                 entered the record into NEMABASE of the quality of that record,
                 based on clarity of original description, ease of interpretation,
                 whether the record originates from a report of a designed
                 experiment or is a parenthetic supplement in a description of
                 something else, whether the original report was seen or the
                 information has been derived from an earlier review, etc.
ltcode   Plant Code - A code system used internally in NEMABASE to link
                 plant information tables with the nematode/plant interaction record.
emcode   Nematode Code - A code system used internally in NEMABASE to link
                 nematode information tables with the nematode/plant interaction
                 record.
efno   Reference Number - A code system used internally in NEMABASE to
                 link literature citation tables with the nematode/plant interaction
                 record.