ROTHAMSTED RESEARCH

Report for 1955

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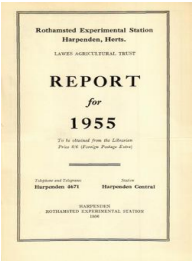

Nematology Department

D. W. Fenwick

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NEMATOLOGY DEPARTMENT

D. W. FENWICK

B. G. Peters resigned from the headship of the Nematology Department at the end of September to take up a new chair of Parasitology at Imperial College, London. D. W. Fenwick served as acting head for the rest of the year. F. G. W. Jones was appointed to succeed B. G. Peters on 1 January 1956.

Mary T. Franklin spent four months from July to October in the United States and Canada. During the first three, spent at the Connecticut Agricultural Experiment Station, New Haven, help was given with problems connected with the tobacco cyst nematode, and with ectoparasites of the roots of fruit trees. The fourth month was spent in visiting nematologists in other parts of the States and in Canada. Short visits were made to thirteen laboratories where nematological research is carried out, and a great variety of problems was seen under investigation.

B. G. Peters, D. W. Fenwick, C. C. Doncaster and J. J. Hesling attended the International Symposium on Plant Nematodes at Wageningen from 29 June to 5 July: papers were read by C. C. Doncaster on the application of electron-flash microscopy to nematology and by J. J. Hesling on his work with *Heterodera major*.

B. G. Peters attended the Easter School on " Soil Zoology " at the University of Nottingham, lecturing on soil-inhabiting nematodes and demonstrating simple techniques for handling them. D. W. Fenwick gave a course of twelve lectures on nematology for the parasitology course at Imperial College, London, on a *locum tenens* basis. J. J. Hesling and C. C. Doncaster attended a course in microscopy at the Imperial College, London.

The following visitors worked in the department during the year: Mr. J. W. Meagher from the Plant Research Laboratories, Victoria, Australia (10 October onwards), Mr. G. Macdougal Mackintosh, Marischal College, Aberdeen (8–19 August), Mr. P. Holliday, from the Commonwealth Mycological Institute (19–24 September), Mr. J. W. Coles, from the Natural History Museum, London (19–24 September), Miss E. C. Mason and Miss A. Lyell from the National Agricultural Advisory Service Laboratories, Kirton (5–10 December). Mr. A. G. Whitehead is at present holding a Colonial Agricultural Studentship in the department.

J. B. Goodey and Mary T. Franklin have completed the revision of T. Goodey's *Nematode Parasites of Plants Catalogued under their Hosts* (1940). The revised publication is now in the hands of the printers.

The technical bulletin *Laboratory Methods for Work with Plant and Soil Nematodes* (T. Goodey, 1951) is being rewritten by J. B. Goodey, and much new material is being incorporated.

A stream of specimens have been received for identification, and many enquiries from all parts of the world have been answered. Time has been devoted to the teaching of basic concepts of nematology to the several visitors. This is necessitated by the fact that this is the only department of Nematology in the country.

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Tylenchidae, Aphelenchidae and other Soil Nematodes

J. B. Goodey has continued investigations into the relationship between *Ditylenchus dipsaci*, at various levels of infestation, and susceptible and resistant varieties of oats. Other cereals have also been tested. The host ranges of several other biologic races of this eelworm have been further explored.

The relationship of mushroom to the attacks by various eelworms; *Ditylenchus destructor*, *Aphelenchoides* sp., *Panagrolaimus* sp. and *Hexatylus* sp. has received further attention. *Aphelenchoides* sp. proved to be a very active parasite. Pots of mushroom compost inoculated with 15 specimens soon stopped cropping. The mycelium was largely destroyed and the *Aphelenchoides* population had risen to about 3,000,000 within 6 weeks. A letter to *Nature*, jointly with members of the National Agricultural Advisory Service, has been written. The *Aphelenchoides* appears to be an undescribed species.

Single seedlings of Sitka spruce have been grown in glass tubes and inoculated with varying numbers of *Hoplolaimus uniformis* in an attempt to obtain direct evidence of the effects of this eelworm on Sitka. This work is part of the investigations being done by the Chemistry Department on nutritional problems in forest nurseries.

A paper, resulting from a critical study of specimens of some new species of *Iotonchium*, has been prepared and will appear in the first volume of a new periodical *Nematologica* (Leiden).

Mary T. Franklin, having established the specific characters of *Aphelenchoides parietinus*, has collected other species of doubtful standing in this genus in order to study them.

In conjunction with A. R. Forster she has carried out work on several species of *Meloidogyne* in the greenhouse and in the laboratory. This work has had two aims :

(1) In the heated greenhouse beds five known species and varieties of root-knot have been cultured. Additional information on their host ranges has been collected and fresh material obtained from which microscope slides have been made for morphological studies.

(2) A number of unidentified populations of root-knot nematodes has been studied in pot tests by means of prolonged host-range trials. The results of these have lent support to identifications based on microscopic observations of the nematodes concerned. In some cases it has become evident that more than one species is present. Several new populations have been received for identification and, when the material has been suitable, cultures have been started for host-range trials to help with the identification.

Nematodes Parasitic in Insects

H. E. Welch carried out studies on the parasitism by nematodes of the *Drosophila* (Diptera) population in the woods near Rothamsted Manor. Two new species of nematodes, both members of the Allantonematidae, were found to be parasitic in six of the twelve *Drosophila* species found in the woods. The taxonomy and life history of these worms has been worked out and observations made on their host–parasite relations. A collection and review of the

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literature of the Mermithidae, an important group of insect nematodes, has been commenced and is now well advanced. In addition, a number of small investigations have been made of material sent to this department for identification.

Cyst-Forming Species of *Heterodera*

Heterodera rostochiensis

B. G. Peters has concluded his analysis of the results of the 1953 pot experiment on the pathogenicity of *H. rostochiensis* to potatoes. This experiment, in which potatoes were exposed to a geometric series of inoculum-densities of *Heterodera rostochiensis*, revealed, on further analysis, a number of relationships between original and final densities. Thus, with increasing inoculum the density of new cysts rose to a maximum and then declined, as also did the number of larvae hatching per cyst at the end of the experiment. However, the hatching curve expressed as a proportion of all larvae *rose* with increasing inoculum density.

Pot tests carried out with two halogenated-hydrocarbon fumigants have given interesting results in tests in glazed pots each holding 20 lb. of soil infested with *Heterodera rostochiensis*. Soil samples taken 4 weeks after injection showed that both fumigants have poor kills in comparison with " DD mixture " or allyl bromide. While one was phytotoxic, reducing plant height and yield of tubers significantly, the other stimulated yield. But the end-of-season soil samples showed that both fumigants had greatly reduced hatchable larvae per cyst and per g. of soil, the improvement over " DD mixture " and allyl bromide at this stage being highly significant.

Following B. G. Peters' departure, C. C. Doncaster and J. J. Hesling took soil samples and assisted with the final injections in the 6-year experiment at Wisbech, conducted in co-operation with the West Norfolk Farmer's Manure and Chemical Co-operative and Shell Chemicals Ltd. C. C. Doncaster has undertaken the processing of these and future samples. Next year's test crop of potatoes, along with soil samples, should show the effects (if any) of year/time of injection on populations of *Heterodera rostochiensis*.

D. W. Fenwick has now succeeded in obtaining sterile viable larvae of *Heterodera rostochiensis*. Treatment of larvae with commercial H_2O_2 for 8 hours rendered them sterile but destroyed their viability. Similar treatment of the eggs resulted in sterilization, and subsequent treatment of these with sterile potato-root diffusate resulted in the production of sterile larvae. Infestation experiments have shown that there is little, if any, loss of viability from this treatment. It is now hoped that it will be possible to infest tomato roots grown in sterile media with these larvae and also investigate the production of root diffusate under plant-tissue culture conditions.

Work on the respiration of *Heterodera rostochiensis* has commenced. Preliminary investigations indicated that the respiration rate of cysts was proportional to their egg content, the oxygen consumption being about 0·05 μl./hour per 1,000 contained eggs.

Liberation of the eggs from the cysts increased the oxygen consumption by a factor of $\times 4$, while the larvae themselves used about 8 times as much oxygen as did eggs within the cyst.

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Experiments conducted in collaboration with E. Widdowson on the hatching of eggs of *Heterodera rostochiensis* have continued. Efficient sampling techniques have been evolved, and comparison of the hatching of larvae from eggs and from cysts has been made. In general, the same relationships have been found to be valid for hatching both from cysts and from eggs, but the latter was capable of greater precision for a given outlay of work and material.

The joint Agricultural Research Council project, with Professor R. H. Stoughton (Reading) and Professor Sir A. R. Todd (Cambridge), to investigate the chemistry of the hatching factor in potato-root diffusate has entered its last year; it is hoped that an analysis of the data from the assay tests will yield valuable information for the guidance of future workers.

E. Widdowson has continued her work on the production and storage of potato-root diffusate and has found the variety Arran Banner to be very suitable for this purpose. If grown in soil or in sand with or without nutrients in 6-inch pots, this variety proved capable of producing daily up to 200 ml. of diffusate of L.A. = 3·5 approximately for a period of up to 6 weeks. Storage of this at 3–4° C. resulted in an initial fall in activity of 0·4–0·5 L.A. units over the first 3 months; thereafter the activity remained constant for up to 1 year.

A. R. Forster has continued her investigations on the possible effects on resistance of a graft on its root-stock; plants of Tomato (host) and *Solanum nigrum* (non-host) were cross-grafted, grown in uninfested soil and inoculated with larvae of *Heterodera rostochiensis* after the grafts had become established. Cyst production on these plants was estimated. Side-shoots growing below the established grafts were removed, rooted in uninfested soil and *H. rostochiensis* larvae added. These plants were lifted at the end of the growing season and the cysts counted.

A similar experiment has been conducted using *Meloidogyne incognita*: plants of Tomato (host) and *Lycopersicon peruvianum* (non-host) were cross-grafted and inoculated with larvae of *M. incognita*. The plants were later lifted and the egg-masses and female nematodes counted. The analyses of these three experiments are not yet completed.

Heterodera cruciferae

C. C. Doncaster has completed a preliminary investigation into the life history and pathogenicity of *Heterodera cruciferae*. Cabbage seedlings grown in heavily infested soil for 2 days were transplanted to clean sand, 2 or 4 plants being removed daily for fixing and staining. The development of all stages of the parasite from invasion of the root by the second-stage larvae through the second, third and fourth ecdyses to sexual maturity was followed.

Sections of root containing adult worms showed considerable giant-cell formation. Heavily infested roots were badly stunted, the development of lateral roots having been arrested at an early stage; some swelling was apparent about the points of infestation. Leaves of heavily infested plants showed intervenal chlorotic marbling similar to that produced on plants grown in nutrient-deficient soil.

Observations have been made on the hatching responses of

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Heterodera cruciferae in root diffusates from sprouts, swedes, rape and mustard. Leachings from all four species stimulated larval emergence to a comparable degree; mixing mustard diffusate with that from sprouts, swedes and rape had no apparent effect on larval emergence. A study of the hatching curve showed that it was a sigmoid. Dilution curves for mustard and sprouts diffusate were linear and parallel, and it was therefore considered reasonable to suppose that these diffusates could be assayed by the methods applicable to potato-root diffusate. An account of this work has been prepared and accepted for publication in the *Ann. appl. Biol.*

The use of low-power electronic-flash apparatus for photomicrography of nematodes has been investigated. The results obtained indicated that it could usefully be employed for recording many interesting occurrences observed under the microscope and for obtaining accurate records of the structure of living nematodes. A record of this work has been accepted for publication in the first volume of a new publication *Nematologica*.

Heterodera major

J. J. Hesling carried out a survey of the classical experimental fields of Broadbalk and Hoosfield for the presence of *Heterodera major*; on Broadbalk few cysts were present, and on many plots none were detected; on Hoosfield all plots appeared to be infested: on both fields few cysts had contents.

In the long-term experiment on build-up of *Heterodera major* at Stoke-on-Tern (carried out in conjunction with Mr. H. C. F. Newton) greatest increases occurred on the oat plots; the level of infestation remained constant in barley and decreased on rye. The experiment is just entering its third year, and further results are desirable to clarify the true nature of the population changes.

Population studies on cereal-root eelworm on commercial fields in Shropshire have shown that the eelworm populations have fallen during 3 years without host crops; when cereals were introduced into the rotation the fall in population was less marked. Similar observations on other fields indicated that eelworm populations were doubled with barley and halved with rape and black mustard.

A number of varieties of oats, barley and wheat have been tested for resistance to cereal-root eelworm without any marked resistance being detected in any.

Pot tests with oats, wheat and barley showed that slight damage occurred at such low levels of infestation that they might have been missed by routine soil sampling. Twenty-eight larvae per g. of soil caused severe damage to oats, wheat and barley, and was most marked in oats towards the end of the season. Population build-up is under investigation, both in this experiment and in another involving grasses.

Cysts of different species of *Heterodera* have been studied with a view to their identification, and a collection of slides has been prepared.

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