STRAWBERRY ROOT-KNOT NEMATODE INVESTIGATIONS IN QUEENSLAND.

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SUMMARY.

Studies on the root-knot nematode Meloidogyne hapla **Chitwood, a common pest of strawberries in south-eastern Queensland, are reported.**

The use of nematode-infested planting material results in later cropping, reduced plant size and lower yield. Mean berry size is not reduced.

Treatment of nematode-infested runners in hot water at 47 deg. C. for 6, 10 and 14 min. controls the strawberry root-knot nematode but delays fruiting and does not increase overall yields.

The use of dips containing chlorophenyl mercury choroglucine, phenyl mercury dinaphthylmethane disulphonate, phenyl mercury salicylate or mercuric chloride on nematode-infested runners prior to planting controls nematodes but subsequent plant growth is unsatisfactory.

Vigorous runners relatively free of nematodes can be produced in infested fields by allowing rooting to proceed in a 6 in. mulch of sawdust spread between the parent rows.

I. INTRODUCTION.

Commercial strawberry growing in Queensland is restricted to the south-eastern portion of the State. Runners are planted in March and harvesting extends from June to December, when the plants are removed or thinned for the production of runners.

The strawberry root-knot nematode, *Meloidogyne hapla* Chitwood, is to be found in most plantings (Colbran 1958). Two types of galls occur on the roots, viz., small galls with lateral rootlets on the fibrous roots and larger terminal galls on the main roots. Reproduction of the nematode proceeds throughout the winter and considerable root breakdown is in evidence towards the end of the season.

During 1956-57 field trials were set out to determine the status of *M. hapla* as a pest, and laboratory and field work concerning control was undertaken.

II. EFFECT OF RUNNER INFESTATION ON SUBSEQUENT PERFORMANCE.

In 1956 a field trial was carried out at Ormiston to determine whether root-knot nematode infestations on planting material affected the yielding ability of the plants. The soil was a latersol.

The planting material was dug from an infested runner bed and graded into the following classes on the basis of galling :—

Heavy.—Galls on more than half the fibrous roots.

Moderate.—A light scattering of galls throughout the root system.

Nematode-free runners were produced from the same area by allowing the runners to root in a 6 in. mulch of sawdust spread between the parent plants before runnering commenced.

The layout was a 6 x 4 randomised block with 2 double rows and 30 datum plants per plot. Soil fumigation was carried out on Mar. 5, 1956, by injecting ethylene dibromide (12½ per cent. v/v formulated from a concentrate with S.G. $\frac{25}{25}$ 2·170) in holes 6 in. deep and 1 ft. apart under the intended planting lines two weeks prior to planting at a rate of 2 ml. per hole.

Berries were graded as follows:—

Punnet berries.—6 or fewer across a punnet 4 in. wide.

Factory berries.—More than 6 across a punnet 4 in. wide.

After harvesting, the plants in one row of each double row were dug and the roots rated as 0, 1, 2, 3, or 4 corresponding to increasing severity of root-knot nematode infestation.

Results and treatments are presented in Tables 1 and 2.

Table 1.

EFFECT OF RELATIVE NEMATODE INFESTATION OF PLANTING MATERIAL ON YIELDS.

Fumigation Treatment.	Relative Nematode Infestation.	Yields per Plot (g.).		
		June–July.	Oct.–Nov.	Total.
Nil ..	Heavy	226	2,212	4,511
Nil ..	Moderate	600	3,405	7,948
Nil ..	Nil	938	3,478	8,099
EDB ..	Heavy	364	2,655	6,091
EDB ..	Moderate	566	3,435	8,296
EDB ..	Nil	1,053	3,925	9,071
Differences necessary for significance	5%	234	623	1,691
	1%	324	861	2,338

Table 2.

EFFECT OF RELATIVE NEMATODE INFESTATION OF PLANTING MATERIAL ON BERRY SIZE AND GALL DEVELOPMENT.

Fumigation Treatment.	Relative Nematode Infestation.	Mean Root-knot Rating.	Number of Punnet Berries per 100 Factory Berries.
Nil	Heavy	4·0	174
Nil	Moderate	3·9	151
Nil	Nil	2·2	154
EDB	Heavy	4·0	174
EDB	Moderate	3·8	171
EDB	Nil	1·5	174
Differences necessary for significance	5%	0·57	No significant differences
	1%	0·79	

III. CONTROL IN RUNNERS BY HOT WATER TREATMENT.

Hot water treatment of strawberry propagation stock has been recommended overseas as a method of controlling stem and bulb eelworm, *Ditylenchus dipsaci* (Kühn), the foliar nematodes *Aphelenchoides ritzema-bosi* (Schwartz) and *A. fragariae* (Ritzema-bos), the root-knot nematode *Meloidogyne hapla* Chitwood, and the root-lesion nematode, *Pratylenchus penetrans* (Cobb) (Staniland 1953; Goheen and McGrew 1954; Goheen, McGrew and Smith, 1956). A number of different temperature-time combinations have been suggested for the treatment of dormant plants.

This project involved the determination of lethal temperature-time combinations for egg masses of *M. hapla* attached to strawberry roots, and a study of the effect of such combinations on treated runners.

Table 3.

Effect of Hot Water Treatment on Plant Survival and Nematode Development.

Temperature (°C.).	Immersion Time (min.).	No. of Plants Surviving.	No. of Plants with Galls.	Mean Root-knot Rating.
46	8	40	28	1·5
	10	37	25	1·7
	12	36	15	0·6
	14	37	16	0·7
	16	38	12	0·5
47	8	36	20	1·1
	10	39	20	1·1
	12	37	15	0·7
	14	38	16	0·9
	16	37	16	0·7
48	6	40	21	0·7
	8	38	11	0·4
	10	40	6	0·2
	12	39	3	0·1
	14	38	6	0·2
49	4	39	11	0·6
	6	38	8	0·4
	8	38	11	0·5
	10	39	5	0·2
	12	31	2	0·1
50	2	40	12	0·4
	4	38	12	0·5
	6	38	12	0·7
	8	36	15	0·8
	10	32	8	0·5
Untreated		40	40	3·75

Lethal temperature-time combinations for egg-masses of *M. hapla* were determined by treating infested roots in a 3 gal. container of water over a heating source. The roots were suspended in a wire basket and the water was agitated during treatment. Immediately after treatment the roots were plunged into water at room temperature. Five large egg masses were removed from each lot of treated roots, placed in 4 ml. of distilled water and incubated for 2 weeks at room temperature.

The effect of hot water treatment on the runners was determined by treating infested runners in a similar manner and planting in field plots. The plants were entirely immersed during treatment. There were four replicates of each 10-plant treatment. Runners were treated in March 1956 and examined for nematode infestation in October 1956.

The results are presented in Table 3.

IV. EFFECT OF HOT WATER TREATMENT OF RUNNERS ON YIELD.

During 1957 runners were dug from an infested plot and graded in the field for the purpose of the experiment. One series "field selected" had few, if any, galls. Runners with galls on at least half the fibrous roots were considered as "heavily infested" and used for hot water treatments. The treatments were applied in a manner similar to that mentioned previously.

A 7 x 4 randomised block layout was used with 2 double rows containing 40 datum plants per plot. The site, which was adjacent to that used for the 1956 trial, was treated on Mar. 4, 1957, with EDB (12½ per cent. v/v) at the rate of 20 gal. per acre. The trial was planted on Mar. 18, 1957.

After harvesting, the plants in one of each of the double rows were dug and rated for nematode infestation. As an indication of plant size, the number of plantlets in each crown was recorded.

The results are presented in Table 4.

Table 4.

EFFECTS OF HOT WATER TREATMENT OF RUNNERS ON GROWTH, YIELD AND NEMATODE DEVELOPMENT.

Treatment.	No. of Plants per Plot.	Weight of Berries per Plot (g.).	Mean Root-knot Rating.	No. of Plantlets per Crown.
Heavily infested runners	35·75	6,858	3·6	3·30
Field selected runners	37·25	9,507	2·9	3·85
Runners from sawdust mulch ..	37·50	11,861	2·1	4·88
Hot water 47°C. 2 min.	36·75	8,178	3·6	3·75
Hot water 47°C. 6 min.	35·25	8,622	2·7	4·28
Hot water 47°C. 10 min.	33·0	8,242	2·1	4·20
Hot water 47°C. 14 min.	31·25	6,707	1·7	4·12
Differences necessary for significance 5%	2·78	1,895	0·42	0·62
Differences necessary for significance 1%	3·81	2,597	0·58	0·84

V. CONTROL IN PLANTING MATERIAL WITH CHEMICALS.

Preliminary tests of ovicides were carried out in the laboratory by immersing egg masses for one hour in concentrations of each chemical ranging from 0·0125 per cent. to 4·0 per cent. After washing the egg masses in distilled water and incubating for four days at room temperature, the minimum concentrations for complete inhibition of hatching were determined. The following five ovicides were then selected for further investigations:—chloroplenyl mercury chloroglucine (''Aaventa''), phenyl mercury dinapthylmethane disulphonate (''Phenyl mercury fixtan''), phenyl mercury salicylate, iodine and mercuric chloride.

Nematode-infested runners were held with crowns and roots in solutions of these materials for one hour. The concentrations were based on the results of the preliminary laboratory screening, and 4 ml. of detergent (''Teepol'') were added to each litre of solution to assist in penetration of the egg masses protruding from the roots. After removal from the chemical, excess liquid was

Table 5.

SURVIVAL AND ROOT-KNOT RATINGS OF RUNNERS TREATED IN CHEMICAL DIPS.

Treatment.	Dip Conc. (%).	No. of Plants Surviving (40 per treatment).	Mean Root-knot Rating.
"Aaventa" (chlorophenyl mercury chloroglucine)* ..	1·0	25	0·5
	0·5	23	1·0
	0·25	24	1·0
	0·125	34	1·7
"Phenyl mercury fixtan" (phenyl mercury dinaphthyl-methane disulphonate)*	1·0	4	0·2
	0·5	14	0·4
	0·25	21	1·1
	0·125	26	1·4
Phenyl mercury salicylate	0·1	3	0
	0·05	16	1·0
	0·025	25	1·5
	0·0125	26	1·3
Iodine	0·5	3	2·7
	0·25	9	2·8
	0·125	15	2·5
	0·06	27	2·9
Mercuric chloride	0·25	4	0
	0·125	16	0·2
	0·06	33	0·4
	0·03	31	0·5
Control—No treatment means of 4 replicates ..		32	2·9

* Concentrations of dip refer to formulation, not active ingredient.

drained off and the runners were planted in field plots which had been fumigated with methyl bromide at the rate of 1 lb. per 80 sq. ft. There were 10 plants per treatment and 4 replications. Treatments were applied in April 1957 and data on survival and gall development were collected in August 1957.

Results are presented in Table 5.

VI. DISCUSSION.

The deleterious effect of nematode infestation of strawberry runners on subsequent growth and yield is evident from the results of the two field trials (Tables 1, 2 and 4). In the first trial an interesting feature is the much heavier June-July crop from nematode-free runners than from the moderately infested runners. This early crop commands a higher market price than later fruit. It is obvious from these figures that selection of planting material can be expected to increase strawberry yields.

Numerous temperature-time combinations for hot water treatment will control *M. hapla* on infested runners. Treatment at 47 deg. C. for 6, 10 and 14 min. did not increase yield following nematode control and this is apparently due to the early setback caused by root injury. At the end of the season the treated plants were larger than the untreated runners.

Chlorophenyl mercury chloroglucine, phenyl mercury dinaphthylmethane disulphonate, phenyl mercury salicylate and mercuric chloride dips controlled *M. hapla* but killed many of the infested roots.

The highest yields were produced by strawberry runners which had rooted in 6 in. of sawdust spread around the parent plants. In addition to relative freedom from nematodes, these plants were less etiolated than normally rooted runners.

No plant death was attributable to heavy nematode infestation.

REFERENCES.

COLBRAN, R. C. 1958. Studies of plant and soil nematodes. 2. Queensland host records of root-knot nematodes (*Meloidogyne* species). Qd J. Agric. Sci. 15:101-136.

GOHEEN, A. C., and MCGREW, J. R. 1954. Control of endoparasitic root nematodes in strawberry propagation stocks by hot-water treatments. Plant Dis. Reptr 38:818-826.

GOHEEN, A. C., MCGREW, J. R., and SMITH, J. B. 1956. Tolerance of strawberry plants to hot-water therapy. Plant Dis. Reptr 40:446-451.

STANILAND, L. N. 1953. Hot-water treatment of strawberry runners. Plant Path. 2:44-48.

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