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Cover Page Footnote
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SUGAR BEET EELWORM (Heterodera schachtii Schmidt) ON CAULIFLOWERS AND ITS CONTROL

By Olga M. GOSS, B.Sc., Hons., Plant Pathologist

SUGAR beet eelworm causes severe damage to summer-grown cauliflowers in some areas in Western Australia, particularly those areas of Spearwood, Balcatta and Osborne Park which border the swamps.

Without treatment, affected crops can be a complete failure. Soil fumigation with DBCP has been shown to give good control of this eelworm on cauliflowers even when used at only two gallons per acre (Fig. 1). Other crops damaged by the sugar beet eelworm include cabbage, red and silver beet, swedes and turnips.

Symptoms of Attack

The whole plant is severely stunted (Fig. 2) and either produces small, low value heads or fails completely. During periods of heat the plants wilt very rapidly (Fig. 3.)

When infested plants are removed from the soil it will be noticed that there is an excessive development of fibrous roots so that the roots look bearded (Fig. 4). Closer examination will reveal the presence of small, rounded glistening white bodies about the size of a pin's head attached to the roots (Fig. 5). These are the mature female worms. Later they turn brown and are referred to as cysts. At this stage each is really a bag of eggs.

The poor growth first occurs in patches but as infestation builds up, these areas become larger until the ground is useless for cropping plants of the cabbage and beet families during the summer months.
Life History

The egg hatches into a tiny worm-like larva which enters the root near the tip and gradually develops into the mature egg-laying adult which protrudes from the root.

The time taken to complete the life cycle varies with the season of the year. In summer it may be completed in four weeks, whereas in winter, 10 weeks may be taken. Hence, in summer three or four cycles may develop during the growth of one crop so that the infestation rating and resultant damage is much greater than in winter.

At full maturity, the female dies and her body wall undergoes change to a brown leathery cyst which is little more than a bag of 100-600 eggs.

Carry Over of the Disease

The cysts serve to carry over the disease from year to year. They are very resistant to drying and can persist in the soil for a number of years. When soil is moistened and no host plants are present, a few of the eggs will hatch, but many do not hatch until they are stimulated by a chemical substance secreted by host plant roots. For this reason, eggs may remain alive but unhatched in the soil for long periods. Thus control by avoiding susceptible crops is a very long process.

Many common weeds, such as wild turnip, rape, mustard, docks, chickweed, shepherd's purse and fat hen are also susceptible to sugar beet eelworm. These of course tend to maintain the population at a high level, even in the absence of host crops such as red or silver beet, swede, cabbage and rhubarb.

Spread

Spread of the disease is caused mainly by the planting of infested seedlings, by movement of infested soil on implements or clothing of garden workers, and by wind and water movements.

Experiments on Control

In West Australian market gardens, fumigation with DD or EDB for the control of root knot eelworm has been
adopted as a normal routine. Because of the resistant cyst walls, however, *Heterodera schachtii* is harder to control with fumigants and many workers have considered fumigation unprofitable. Some West Australian gardeners had already tried DD and EDB for controlling *Heterodera schachtii* and found it paid, but it was essential to treat the soil each year. It was therefore considered desirable to check the various nematicides available:

Over the past few years, experiments have been conducted to evaluate—

1. The effectiveness of various soil treatments.
2. The most economic rate of application.
3. The best time for application of the fumigant.

All experiments have been done on a heavily-infested area of coarse sand on the property of Mr. J. Mayor, Coogee. A randomised block design set within a commercial planting was used in each trial. The plot size was about 20 ft. by 10 ft. (this varied slightly with the number of treatments in each experiment). Assessment of results has been by yields and cyst counts from random soil and root samples using the technique of Fenwick and Reid (1951). The results obtained from these experiments are tabulated below.

**Discussion**

All experiments have shown that DBCP is superior to any other soil treatment tested for the control of *Heterodera schachtii*. Dosages as low as two gallons per acre have proved superior to DD, which was the standard treatment used by the market gardener.

Yields obtained from DD-treated areas have appeared comparable to those from the DBCP plots, but the cyst counts have been consistently higher in the DD areas. It is thought that DD destroys sufficient eelworms to enable good initial growth and resultant yield, but that a rapid build-up occurs so that the final count is high.

With DBCP treatment, either the fumigant penetrates the cysts, or the killing action is prolonged so that there is less opportunity for build-up. Therefore, not only is an excellent yield obtained, but the eelworm cyst count is still low at harvest.
Table 1.—Effect of DBCP, EDB and Vapam
(Experiment conducted summer of 1958-59 (1))

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean No. of Cysts per gram of root (dry weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBCP (*) (Nemagon at 8 gal. per acre)</td>
<td>18-46**</td>
</tr>
<tr>
<td>15% EDB at 20 gal. per acre</td>
<td>146-6</td>
</tr>
<tr>
<td>Vapam at 200 lb. per acre</td>
<td>598-1</td>
</tr>
<tr>
<td>Control Untreated</td>
<td>608-8</td>
</tr>
</tbody>
</table>

** Significantly better than other treatments (P < 0.01)

1 Experiment conducted by S. C. Chambers.
2 Dl-bromo-chloro-propane used as Nemagon E.C. from Shell Chemicals.
3 Lack of facilities prevented correct usage of Vapam. This may, in part, account for its failure to reduce the eelworm population.

Table 2.—Effect of DBCP and EN18133
(Grower's treatment = DD). Experiment conducted summer of 1959-60

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean No. of cysts per gram of root (dry weight)</th>
<th>Mean Yield Special Grade</th>
<th>Mean Total Marketable Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBCP 5 Gallons per acre</td>
<td>33***</td>
<td>62-1***</td>
<td>98-0</td>
</tr>
<tr>
<td>EN18133 4 (4 lb. per acre)</td>
<td>370</td>
<td>6-9</td>
<td>70-2</td>
</tr>
<tr>
<td>EN18133 (8 lb. per acre)</td>
<td>367</td>
<td>12-7**</td>
<td>72-6</td>
</tr>
<tr>
<td>EN18133 (16 lb. per acre)</td>
<td>384</td>
<td>15-6**</td>
<td>56-6</td>
</tr>
<tr>
<td>DD 20 gallons per acre</td>
<td>255**</td>
<td>3-5</td>
<td>56-6</td>
</tr>
<tr>
<td>Control</td>
<td>556</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*** Significantly better than other treatments (P < 0.001)

4 New experimental nematicide (0,0-dieethyl 0-2-pyrazinyl phosphorothioate) obtained from American Cyanamid.

Table 3.—The effects of rates of DBCP and times of application
Experiment conducted summer 1960-61

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean No. of Cysts per gram of root (dry weight)</th>
<th>Yields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean yields special grade per plot</td>
<td>Mean marketable yield</td>
<td></td>
</tr>
<tr>
<td>1 gal. DBCP 12 days before planting</td>
<td>843</td>
<td>16</td>
</tr>
<tr>
<td>1 gal. 6 weeks before planting</td>
<td>426*</td>
<td>15</td>
</tr>
<tr>
<td>2 gal. 12 days before planting</td>
<td>121***</td>
<td>33*</td>
</tr>
<tr>
<td>2 gal. 6 weeks before planting</td>
<td>154***</td>
<td>30*</td>
</tr>
<tr>
<td>4 gal. 12 days before planting</td>
<td>35***</td>
<td>36**</td>
</tr>
<tr>
<td>4 gal. 6 weeks before planting</td>
<td>45***</td>
<td>41***</td>
</tr>
<tr>
<td>Control</td>
<td>840</td>
<td>17</td>
</tr>
<tr>
<td>DD</td>
<td>348**</td>
<td>...</td>
</tr>
</tbody>
</table>

*** Significantly better than other treatments (P < 0.001)
EN18133 did not show promise for the control of *Heterodera schachtii*.

As a result of these experiments, it is considered that DBCP E.C. at 2 gallons per acre applied as a broadcast treatment gives adequate control of *Heterodera schachtii* on cauliflowers under West Australian conditions and results in yield differences which more than offset the cost of fumigation.

Raski and Lear (1958) and Jones (1957), who experimented with control of this eelworm on sugar beet, concluded that although fumigants gave good control, their use was not economic. This is not the case with the higher value crop under consideration and in an area where summer conditions are so conducive to disease build-up. It is probably still desirable to fumigate annually to ensure a good crop, but at two gallons per acre it will prove both more economic and more effective than the soil fumigants now employed.

**RECOMMENDATIONS FOR CONTROL**

Use DBCP emulsifiable concentrate at two gallons per acre about two weeks before planting cauliflowers on land heavily infested with sugar beet eelworm. Do not forget to treat the seed beds. Annual fumigation at this rate is advisable.

If Nemagon 90 is used the rate should be doubled as this formulation is only half strength.

**Caution**

DBCP should not be used—

- To control *Heterodera schachtii* on red beet, or
- When potatoes or onions are planned to immediately follow cauliflowers in the crop rotation.

These plants are susceptible to damage by DBCP. In these cases, either DD or EDB should be used at 20 gallons per acre.

**Method of Using DBCP**

DBCP can be mixed with as much water as desired. As most market gardeners already have fumigation equipment for DD or EDB, their easiest method of application will be to add sufficient water to bring the two gallons per acre of DBCP up to the gallonage used for DD or EDB and proceed as for these fumigants. Follow up by lightly watering the treated area immediately after treatment. Alternatively, the fumigant can be applied through the irrigation system.

**ACKNOWLEDGMENTS**

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**REFERENCES**


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