Translation from Dutch

PROJECT

Biological and chemical control of vine weevil

(Otiorhynchus sulcatus) (4102)

INTERNAL REPORT

TEST

Control of vine weevil larvae in the open ground - 1991/92

Boskoop 1992 (4102-02)

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SUMMARY

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Chlorpyrifos* (slow-release formulation), carbofuran (Curater), fonofos* and imidachlobrid* were not effective against the larvae of the vine weevil (Otiorhynchus sulcatus) in the open ground. Of the biological control methods, the Nemasys H eelworm (Het) was very effective, and the Bio-erre eelworm reasonably effective, against the larvae of the weevil. Results with the Groene Vlieg eelworm were unsatisfactory. The mould, Metarhizium anisopliae (BI01020)*, was also reasonably effective this year in the open ground. It appears that, in open-ground cultivation, it is essential to select the correct eelworm population. The time at which the eelworm is applied the the method of application are also of great importance in achieving a successful result.

The products or treatments marked with a * are not approved for the purpose stated in arboriculture.

AIM

To determine the effect of insecticides and biological control methods on the larvae of the vine weevil in the open ground. The effect of three insecticides is compared with the recommended product carbofuran (Curater liquid). At the same time, the effects of BI01020* (Metarhizium anisopliae, an insect-pathogenic fungus) and three populations of insect-parasitic eelworms (Heterorhabditis spp.) were also investigated.

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EXPERIMENTAL SET-UP

Ten treatments were carried out in triplicate, using five test plants per parallel, surrounded by 12 edging plants. The plants were inoculated three times with 50 eggs per plant each time. This was carried out on 29 July, 12 August and 27 August 1991.

The treatments carried out, together with their application rates, are given in Table 1. On 25 April, 3 x 5 litres of EGO-Universeel were measured out, placed in an open plastic bag and mixed with 50 g of BI01020*. This soil containing BI01020* was then set aside, warm and partly covered, in a glasshouse. After one week, this mixture was shaken thoroughly so that enough oxygen could enter the soil (this was necessary for spore formation). After mixing into the top 5 cm of soil outside, the actual concentration was 1 g/l. Since I would rather mix in to a depth of 10 cm, thus giving the larvae more chance of coming into contact with the mould spores, on the day of planting a further 50 g of BI01020 per 5 l of

soil was mixed in and then on 15 May 1991 this substrate was spread over the three plots (5 l per plot) and lightly dug in (approx. 10 cm). On 15 May 1991 a soil sample was taken from the premix (10 g/l) and on 25 July 1991 (immediately before egg inoculation) and 24 March 1992 (harvesting-date test), soil samples were taken from the test plot (100 mg/m²), and sent to Bayer for determination of spore density in the soil.

On 22 July 1991 treatments B, E and L were carried out. These treatments were repeated on 3 September 1991. Treatments C, D and K were carried out on 15 May 1991 (see Basic Information 1). In the case of the liquid products, a dispenser was used to apply 25 ml of spray mixture per plant. The granulates (C and D) were mixed into the uppermost layer of soil (approx. 10 cm) before planting. In treatments C, D and K, the root balls of the test plants were thoroughly shaken out so that, when planted out, the granulate or mould spores would reach the whole root ball (up to the root collar). Basic Information 1 gives the exact dosages used.

On 26 September 1991 treatment F was carried out. This treatment was repeated on 24 October 1991. Treatments G and H were carried out on 1 October 1991 and repeated on 24 October 1991. Basic Information 1 describes the way in which these treatments were carried out.

Table 1 - Treatments and application rates

Active substance #	Trade name	Rate	% a.s.	Number
A. Untreated	-	-	-	-
B. Carbofuran	Curater liquid	37.5 l/ha	20	2x
C. Chloropyrifos*	SusconGreen	375 kg/ha	10	1x
D. Chloropyrifos*	SusconGreen	750 kg/ha	10	1x
E. Imidachlobrid*	Confidor	37.5 l/ha	20	2x
F. Heterorhabditis spp.	Nemasys H	10E6/m^2	-	2x
G. Heterorhabditis spp.	Groene Vlieg (HD)	10E6/m^2	-	2x
H. Heterorhabditis spp.	Bio-erre	10E6/m^2	-	2x
K. Metarhizium anisopliae*	BIO1020	100 g/m^2	-	1x
L. Fonofos*	Dyfonate liquid	37.5 l/ha	25	2x

% a.s. = percentage of active substance.
Number = Number of repeat applications.

OBSERVATIONS

The plants were checked on 23 and 24 March. The soil of each test plant was searched to determine the presence of vine weevil larvae. The number of larvae found per test plant was noted. At the same time, the root systems of the test plants were assessed for biting damage. This was done by means of an assessment score (on a scale from 0 to 5, in which 0 signified an undamaged root collar and 5 signified biting damage all the way round the root collar. The observations are given in Basic Information 2. At the same time, the temperature in the open ground was measured from the time of inoculation with eelworms to the end of the trial. By means of a data logger and a thermocouple, the soil temperature was measured every two hours. Basic Information 3 of iv 4102-01 gives these measurements.

RESULTS AND DISCUSSION

Table 2 gives a summary of the results. The number of larvae is an average of three parallels and is shown as the number of larvae per plant. The same applies to the assessment score for the root system. The results have been statistically processed using ANOVA (See Basic Information 3). The result of this processing is shown in the table. In order to carry out a statistical analysis of the number of larvae, it was necessary to convert the figures. In this case we chose the square root of the figures.

Table 2 - Average number of larvae per plant and average assessment score for root-system damage per plant

Treatment#	Larvae	Damage	Stage
A. Untreated	5.1 ab	0.2 a	4.6
B. Carbofuran	3.1 bc	0.0 a	4.9
C. Chlorpyrifos (SuscGr.)*	5.2 a	0.2 a	4.5
D. Chlorpyrifos (SuscGr.)*	3.6 ac	0.0 a	4.6
E. Imidachlobrid*	4.1 bc	0.0 a	4.5
F. Heterorhabditis (Nemasys)	1.4 d	0.1 a	4.2
G. Heterorhabditis (Gr.Vlieg)	4.3 a	0.0 a	4.6
H. Heterorhabditis (Bio-erre)	2.1 cd	0.0 a	4.7
K. M. anisopliae (BI01020)*	2.5 c	0.3 a	4.8
L. Fonofos*	3.6 ac	0.0 a	4.5

Larvae = average number of larvae per plant.
Damage = damage to root collar (scale: 0 to 5).
0 = no damage and 5 = maximum damage.
The figures in the table followed by the same letter are not significantly different, with a 95 % confidence limit.

As in the container test described in Boskoop (4102-01), the soil temperature was measured every two hours from the time when the eelworms were applied to the end of the test. The number of days for which the temperature was higher than 12 °C was 15.5 days in the case of treatment F and 11.3 days for treatments G and H. The selection of 12 °C as a minimum working temperature for the eelworms is based on the results of the controlled-environment test in 1991 (see Internal Report 49/91 (4102-3)). Of the eelworms, only for treatments F and H were results significantly better than forthe untreated plants. For F the control effect was approximately 70 % and for H approximately 60 %. In comparison with treatment B (carbofuran), only the Nemasys eelworms (F) gave significantly better control.

Compared with the container test, there were a few more days on which temperatures of > 12 °C were reached.

The results given in Table 2 can be summarized as follows:

1) Of the chemical products, no product was effective. Even carbofuran produced no results this year. These results are completely in line with last year's results.

2) Metarhizium anisopliae* (BI01020) (K) had a reasonable effect on the weevil larvae this year. This is in contrast to last year. The reason for this may lie in the alteration to the test, in comparison with last year. This is examined in more detail in the discussion.

3) Of the insect-parasitic eelworms, Nemasys (F) was particularly effective. The Bio-erre eelworms had a reasonable effect, and the GroeneVlieg eelworms had no effect. The result obtained with Nemasys eelworms is in line with last year's results. The Bio-erre eelworm and the HSH [sic] strain of Groene Vlieg had not been previously tested.

PROVISIONAL CONCLUSION

Like last year, the chemical products were not very effective. All the more striking, then, is the good to reasonable control achieved with some of the biological control products. The poor efficacy of the granulate

containing chlorpyrifos* is in contrast to the good result obtained in the tests on potted plants (4102-01). In the open ground, however, many chemical products are less effective than in pots. The critical concentration (before the larvae hatch) of the chlorpyrifos* released from the granules in the soil is evidently too low in the open ground. More rapid dilution, degradation or fixation of the active substance released, in the open ground as opposed to in pots, are some of the possible causes.

The Nemasys eelworms gave an outstandingly positive result, though this was only to be expected, given the longer period of high temperatures following the application of the eelworms. In the open ground, temperature is probably not the only factor that influences the effect of the eelworms. It is probably the combination of temperature and soil antagonism that determines whether a given eelworm strain is able to work well. Naturally, more vigorous populations that are cold-tolerant are able, by quickly finding a host, to avoid the antagonistic effect of the soil flora and fauna. It is striking that the effect of H. bacteriophora Bio-erre is reasonable compared with that of H. megidis Groene Vlieg. In the container test, it emerged that H. megidis Groene Vlieg and H. megidis Nemasys were more effective than H. bacteriophora Bio-erre. It is not easy to explain this. It may be that poor searching behaviour, slow spread in the soil, a less vigorous consignment of eelworms and/or greater susceptibility to antagonistic soil flora and fauna are partly responsible. Another good control result was obtained with Metarhizium anisopliae* (BIO1020). In contrast to last year, this product gave a good result in the open ground too. One reason for this may be the altered method of application. Last year, BIO1020* was incubated for 2 weeks at a concentration of 50 g of BIO1020* per litre of soil. Then, for each 1 m² plot, 1 litre of this incubated soil was mixed into the uppermost 5 cm layer of soil. It is known that spore formation during pre-incubation is inhibited when the concentration greatly exceeds 10 g per litre. During the past year, pre-incubation at 20 g per litre of soil was used, and in addition 5 litres of this soil was worked into the uppermost 10 cm of soil. Spore density in the open ground was also much better this year than last year.

Finally, it should be noted that the results for the biological control methods in the open ground could have been even better if, in this plot trial, one of the plots had not had such a low number of larvae (both in the control and in the treated areas). The reason was the relatively dry upper layer of soil in this plot, caused by incorrect watering. At the time the weevil eggs were inoculated, there was therefore a high natural mortality rate in the plot in question. In the correctly watered plot, an average of 12 larvae per plant were found in the control, as opposed to only 2 larvae per plant in the poorly watered plot.

Next year, the tests will be continued using various eelworms. In addition to Heterorhabditis, certain Steinernema species will also be examined. There would appear to be several promising species here. The advantage in using Steinernema as opposed to Heterorhabditis is that they are easier to breed and they remain active in the soil for longer. In view of the results obtained in both the container and field trials outside this year, there are now few obstacles in the way of a more widespread application in arboriculture. It is important, however, that we should now, in practice, come up with the correct method of application, and in particular the correct time to apply the eelworms. An autumn application is the correct time in order to hatch the larvae. If application is too late, the soil temperature will have sunk too far to achieve a good effect, and if it is too early, the smaller larvae and eggs still being laid by the beetles will escape. Generally, therefore, the control time will be in September and October. The safest solution is to apply in September, followed by another application in October. In the open ground especially, it seems that it is then very important to select the correct eelworm population, as this test has shown.

Next year, further experiments are to be carried out using BIO1020*. It is very important, especially for open ground cultivation, to find the correct method of application, and a comparison will also be made between variations in application.