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CONTROL OF *RHIZOGLYPHUS* (ASTIGMATA: ACARIDAE) MITES BY METHAM-SODIUM SOIL DISINFECTION*

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ABSTRACT

Rhizogiyphus (Astigmata: Acaridae) mites are pests of onion and garlic in Israel. Complete mortality of mites was obtained in infested seeds buried before soil treatment with metham-sodium. Metham-sodium, applied through the irrigation system during summer, reduced the soil population during the next season. *KEY WORDS: Rhizogiyphus robini,* control, metham-sodium, soil disinfection.

INTRODUCTION

Rhizogiyphus (Astigmata: Acaridae) mites are known pests of underground plant parts. They were known to be present in Israel, but damages caused by them became evident only during the last two decades (Yathom *et al.*, 1980). At present, *Rhizogiyphus robini* Claparede is a pest of onion and garlic in Israel, weakening the plants or causing "damping off in seedlings.

The mites remain in the soil throughout their life cycle, their presence being manifested by the damage they cause. Fields known to be infested can be disinfected before planting by metham-sodium (Vapam), a compound long recognized as a potent biocide. In the soil it is soon converted to methyl-isothiocyanate (Gerstl *et al.,* 1977), which is the bioactive agent (Munnecke *et al.*, 1962). It was tried almost 30 years ago against *Rhizogiyphus* mites with some success (Jefferson *et al.,* 1956).

Metham-sodium 32.7% a.i. (as Edigan)[0] is used in Israel to disinfect soils and is given through the sprinkler irrigation system. In loess soils it is applied in a fixed dilution against nematodes (Krikun *et at.*, 1976) and against soil fungi as a concentrated solution, dissolved in the first portion of the irrigation water (Ben-Yephet *et al.,* 1983).

The purpose of the present study was to examine the effect of metham-sodium on *R. robini* under local soil conditions.

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•Edigan, metham-sodium 32.7% a.i., Agan Chemical Manufacturers, Ashdod, Israel.

MATERIALS AND METHODS

Rhizoglyphus mites were mass-reared in the laboratory at 25 ± 2°C on an artificial diet developed for lepidopterous larvae and reported to support large populations of *Rhizoglyphus* mites (Coudriet, 1970). With some alterations the diet used for this study consisted of alfalfa meal (50 g), potato meal (12.5 g), agar (5 g), methyl-p-hydroxy benzoate (10 g), ascorbic acid (2 g), and synthomycin (0.125 g). The solid ingredients were mixed with 150 ml water, and the agar was mixed in an additional 100 ml warm water and autoclaved for 20 minutes. The preparation was kept in the refrigerator and when needed, the medium was spread in petri dishes and inoculated with mites. Peanut seeds, after being soaked in water were placed into a rich culture of mites for inoculation. Control tests were carried out in several stages as follows:

A. The effect of direct contact with various concentrations of aqueous solutions of metham-sodium on *R. robini* mites was assayed using the slide-dip method (Dittrich, 1962). The mites were brushed off from infested seeds and only adult females were collected under a low power stereomicroscope using a fine needle. The mites were fixed dorsally to masking tape, which was then secured to double-faced "cellophane Scotch" tape glued onto a glass slide. The mites fixed on the slides were dipped for 5 seconds in the various concentrations of metham-sodium, and the controls were dipped in tap water. The solutions were kept for 1 and 5 hours and then other series of mites were dipped in them.

The slides with the mites affixed to them were held for 24 hours in a water-saturated atmosphere. Mortality was recorded under a stereomicroscope. The criterion of mortality was complete lack of movement, when the mite was probed with a fine brush. Data were based on ten mites per replicate, eight replicates for each concentration. Tests were rerun if the initial ones showed excessive control mortality. All data were corrected for control mortality, using Abbott's formula (Abbott, 1925).

B. The effect of soil disinfection with metham-sodium on large populations of *R. robini* mites was tested in soil columns and under field conditions.

Heavily infested seeds, each harboring thousands of mites, were buried within small-mesh nylon bags at various soil depths. Columns 48 cm in height and 7.5 cm in diameter were prepared by connecting plastic segments. All columns were packed with air-dried soil to achieve a bulk density of 1.28 g/cm^3. The infested seeds were placed at depths of 5, 10, 20, 30 and 40 cm. The water volume added was calibrated to wet 2.1 kg soil to field capacity (depth of 41 cm). Columns were irrigated for 6 hours with the disinfectant solution at rates of 0.16, 0.08, 0.04 and 0.02 ml/kg soil. The infested seeds were collected 2 days after treatment and were examined for mite viability; this test was replicated four times.

In the field tests metham-sodium was applied in the overhead sprinkling system, in the first 10-25% of irrigation water, as penetration of the chemical had been found to be maximal when its dose was dissolved in the first 10% of the total irrigation water (Ben Yephet *et al.*, 1983). The rest of the water carried the toxicant to the desired depth. Control plots were irrigated to corresponding depths.

Trial 1 was carried out in loess soil; the disinfectant was applied at a rate of 400 l/ha in 350 m^3 water. Six batches of infested seeds were buried at a depth of 15-20 cm one day before treatment.

Trial 2 was conducted in light soil, in a randomized block design replicated four times. Metham-sodium was applied at rates of 400, 600 and 800 l/ha, accompanied by

330, 500 and 650 m^3 water, respectively. Two sets of infested seeds were buried in each plot before treatment, to be examined 1 and 10 days after disinfection.

Trial 3 was carried out in loess soil, with extremely low and high doses of 150 and 800 l/ha in 600 and 800 m^3 water, respectively, in a randomized block design replicated five times. Two sets of infested seed were buried in each plot, to be examined at two different dates after treatment. The vast number of live mites in the controls and the surviving ones in some of the soil columns and field treatments precluded counting hence a ranking method was adopted instead (Gerson *et al.*, 1981). Mite numbers were estimated and ranked accordingly, on a scale of 0 = no live mites, 1 = very few live mites, 2 = ten to a few dozen, 3 = hundreds, and 4 = thousands of live mites. The ranks were then multiplied by the appropriate factor, namely 1 = 1, 2 = 10, 3 = 100 and 4 = 1000. The values thus obtained from various replicates of each treatment were added up and divided by the number of replicates. For instance, at 0.2 ml/kg, the ranks for the four replicates at 40 cm were 2, 3, 3 and 0. Multiplying them by their appropriate factors (1 x 10 + 1 x 100 + 1 x 100 + 0) one obtains 210, which, when divided by the number of replicates, 4, provides the result 52.5 for that dose and depth (Table 2).

C. Observations and monitoring of natural soil mite populations in a field treated with metham-sodium. A field previously planted to onions, which became heavily infested with *R. robini*, was treated in July with 600 and 1000 l metham-sodium/ha in 600 m^3 irrigation water. The control was concurrently sprinkled with water. Infested bean seeds were buried one day pre-treatment at depths of 5 and 10 cm; these were removed and examined on the day following treatment. The field was planted to potatoes in the autumn and the natural *Rhizoglyphus* populations were monitored, using soil traps which attracted the mites. The soil traps consisted of a plastic tube (135 x 24 mm) fitted with a perforated cap at one end and with a wide-mesh metal sieve welded on at the other end.Peeled wounded garlic cloves were placed on the sieve and the tube was then introduced into the soil at a depth of 5 cm. A colored ribbon was bound around the trap to mark its site in the field.

RESULTS AND DISCUSSION

A. The mortality rates of *R. robini* mites after being dipped in water solutions of various concentrations of metham-sodium are presented in Table 1. Complete mortality occurred in concentrations exceeding 320 ppm and 50% kill in 65-130 ppm. At all

TABLE 1. PERCENT MORTALITY OF *RHIZOGLYPHUS ROBINI* MITES AFTER DIPPING IN VARIOUS CONCENTRATIONS OF METHAM-SODIUM AGED FOR VARIOUS PERIODS

Age of solution (hours)	Concentration (ppm)							
	650.0	327.0	131.0	65.6	32.7	13.1	6.5	3.79
0	100	81.8	67.2	41.7	27.4	12.3	10.75	5.79
1	100	94.4	78.3	51.5	37.9	11.2	4.1	4.0
5	100	100	75.7	60.0	43.0	39.5	38.0	31.0

concentrations mortality was high in the set of mites dipped after the solutions aged for 1 and 5 hours, indicating the advanced decomposition of metham-sodium and increased concentration of methyl-isothiocyanate, which is the bioactive agent (Gerstl *et al.*, 1977).

B. Disinfection of soil columns with metham-sodium resulted in complete extermination of mites down to a depth of 40 cm, with 0.16 ml metham-sodium/kg soil (Table 2). With 0.08 ml/kg there was some survival at 40 cm. Even the lowest dose (0.02 ml/kg) reduced mite populations to some extent. In the first field trial the control samples yielded a value of 850.0 whereas those from the treated area yielded a ranking value of only 1.66.

TABLE 2. ESTIMATED SURVIVAL OF *RHIZOGLYPHUS ROBINI* (APPRAISED BY RANKING) AFTER METHAM-SODIUM TREATMENT IN SOIL COLUMNS

Sample depth (cm)	Dose (ml/kg soil) 0.0	0.02	0.04	0.08	0.16
5	1000.0	50.0	25.0	0	0
10	1000.0	3.0	2.5	0	0
20	1000.0	375.0	0	0	0
30	1000.0	300.0	0	0	0
40	775.0	52.5	502.5	275.0	0

The results obtained in trials 2 and 3 (Table 3) show low survival values for the treated plots as compared with the controls. When live mites were present after treatment, they were found where the toxicant solution did not penetrate adequately such as between the closed cotyledons, whereas mites which were found where the toxicant reached, were dead.

C. In the observation field treated in July, all mites in the buried samples exposed to both metham-sodium doses were dead by the following day, whereas those in the control remained alive. Weekly monitoring of natural mite populations in the field during the autumn indicated the efficacy of the higher dose (1000 l/ha), compared with the control. In November, however, mite activity became uniform all over the field.

Metham-sodium was found to be effective in killing *R. robini* mites which injure roots of onion and garlic in Israel. Metham-sodium (600 l/ha) killed microsclerotia of *Verticillium dahliae* which had been buried to a depth of 40 cm (Ben-Yephet *et al.*, 1983), whereas a low dose of 150 l/had killed *R. robini* mites buried at a depth of 30 cm, and the equivalent of 200 l/ha killed the mites down to 40 cm in soil columns.

The discrepancy in concentrations needed to obtain total kill in the dipping tests (Table 1) as compared with the soil tests and the field trials (Tables 2 and 3) can be explained by the short exposure periods (5 seconds) used in the slide dip method, whereas in the columns and in the field, the mites remained in constant contact with the disinfectant in the soil.

TABLE 3. ESTIMATED SURVIVAL OF *RHIZOGLYPHUS ROBINI* (APPRAISED BY RANKING) FOLLOWING SOIL TREATMENT WITH METHAM-SODIUM

Metham-sodium (l/ha)	150		400		600		800	
Penetration depth (cm)	20		20		30		40	
Day after treatment	1	10	1	10	1	10	1	10
Trial 2, untreated	–	–	100.0	550.0	775.0	775.0	550.0	1000.0
treated	–	–	0.25	0.25	0.25	0	0	0
Trial 3, untreated	460.0	1000.0	–	–	–	–	820.0	1000.0
treated	24.2	400.0	–	–	–	–	22.0	0

In local loessial soils infested with *V. dahliae* in Israel, and which are to be planted to potatoes in autumn, it is recommended to treat them with 600 l/ha metham-sodium. This dose should efficiently control any *R. robini* mites present. A dose of 200 l/ha would probably suffice to control soil mites to a depth of 40 cm.

Application of metham-sodium to protect the field for autumn and winter crops in Israel is recommended during summer or autumn, when mites enter deeper soil layers. An application of concentrated metham-sodium would probably result in good control of mites at these depths.

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