# Metham Sodium Applied by Sprinkler Irrigation to Control Pod Rot and Verticillium Wilt of Peanut

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**ABSTRACT**

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Peanut pod rot, caused by a *Pythium*-centered disease complex, was efficiently controlled by metham sodium. The biocide was applied through sprinkler irrigation to a depth below the geocarposphere. Although methyl isothiocyanate was not highly effective against *Pythium* oospores, the treatment considerably reduced pod rot in the same season's yield but had no aftereffect on the next peanut crop. Apparently, for one season metham sodium efficiently reduced microbial populations that are synergistic with *Pythium* spp. in causing pod rot. The treatment also controlled Verticillium wilt by killing microsclerotia of *Verticillium dahliae*. Tests are being conducted to define optimum dosages and depths of application of the biocide in various soils.

Additional key words: *Arachis hypogaea, Fusarium solani, Pythium myriotylum*

One of two major crops in the Eshkol Region in northwestern Negev, Israel, is peanuts (*Arachis hypogeaea* L.). It is found in rotation with wheat and potatoes and is the only export crop of the three. Although the sandy soil and excellent climatic conditions make this area very favorable for producing this high-value crop, the environment also favors infection by pod-rotting fungi. Easily available water, from the frequent irrigation, and simultaneous good aeration are factors that increase pod rot caused by *Pythium myriotylum* Drechsler as synergistically predisposed by *Fusarium solani* and completed by saprophytes (2,3). This disease complex has been a severe problem from the inception of cultivation of peanut in the area.

No cultivars are now available that incorporate necessary agronomic characteristics and high resistance (4). Krikun et al (8) pointed out conditions under which soil fumigation becomes feasible. Various methods of drench applications of metham sodium, which yields the biocide methyl isothiocyanate (MIT), have been tested in the laboratory (5,6). A brief report of field experimental results was published (9). We report here on the method of application and results in controlling two diseases of peanut, Verticillium wilt and Pythium pod rot.

When metham sodium is applied via the sprinkler system, water carries the chemical to the desired depth. The chemical is distributed throughout the soil profile by its continuous, calibrated injection into irrigation water for the entire period of sprinkling. Gerstl et al (5,6) studied the distribution of MIT in sandy, relatively light loamy soils, comparing equal amounts of metham sodium applied continuously or as a concentrated pulse followed by water. A more even distribution of MIT was found following continuous application.

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## MATERIALS AND METHODS

Metham sodium was applied using two water-powered fertilizer injection pumps, which were developed to ensure application of liquid fertilizer at a constant concentration in the irrigation water. The pumps required no outside power source, other than water pressure, and they were easily portable. In one pump (TMB Ltd., P.O.B. 1, Qiryat Bialik, Haifa, Israel), the minimal water pressure needed for operation was 1.8 atm. The range of chemical solution output was 20–300 L/hr, as regulated by an adjustable valve. In the other pump (Amiad Filtration and Irrigation Systems, Mobile Post, Korezim Region, Israel), the minimal water pressure needed was 0.5 atm. The range of chemical output was 4–340 L/hr, depending on pressure as adjusted by a hand valve. The suction head of this pump was placed in the tank containing the chemical. Because very exacting flow rates were needed, the pump was connected to a Unitrol flow-regulator gasket, which allowed only preset amounts (30, 60, and 110 L/hr) to pass into the irrigation system despite possible fluctuations of water pressure in the mains.

**1976 season.** A commercial field naturally infested with *Verticillium dahliae* Kleb. and pod-rotting organisms was used in a preliminary experiment. Two treatments, sprinkler-applied 32.7% metham sodium at the rate of 600 L/ha to a depth of 50 cm and a control, were tested with six replicates. Net size of plots was 180 $m^2$. Soil samples were collected to a depth of 40 cm 6 wk after treatment, and the method of Ben-Yephet and Pinkas (1) used to determine the number of viable *V. dahliae* microsclerotia. *Verticillium* counts were determined from five samples per replicate with each sample composed of five subsamples. *Fusarium* propagules attached to small particles of organic matter were also detected by this method. At the end of the growing season, 100 plants from each replicate were dug. Main stems were cut to determine frequency of plants showing vascular discoloration, and the percentage of plants exhibiting pod rot was recorded.

**1977–1978 seasons.** A field of 2.4 ha at the Besor Regional Experiment Station was used. This field was naturally infested with organisms causing pod rot. Sprinkler risers were set every 12 m and lines were 12 m apart; the net area of each experimental unit was thus 144 $m^2$. A formulation of 32.7% metham sodium (Edigan, Agan Chemical Co., Ashdod, Israel) was injected into the irrigation system as described above. The amount of water needed to moisten the soil was calculated as 1 mm of water for each 1 cm of depth to be treated. The trial was conducted for two seasons, with eight randomized replicates and the five treatments listed in Table 1.

In both years, peanuts were seeded on all the plots 20 days after treatment. By this time, MIT was degraded to a level that was not phytotoxic (6). After the 1977 season, the percentage of rotted pods was appraised visually on the peanut yield from 65 $m^2$ of each plot. In 1978, plants from 18 $m^2$ in each plot were dug and pods were graded as symptomless (I), blemished (II), or rotted (III). The number of pods and total weight per category were then determined. Incidence of rotted pods was expressed as a percentage of total pods counted in each sample.

## RESULTS

**1976 season.** An average of 31.1 *V. dahliae* microsclerotia were recovered from control plots, and 0.4 were recovered from treated plots. *Fusarium* propagules were 81.5 and 10.5, respectively, in control and treated plots. Plants affected with *Verticillium* and *Pythium* were 87 and 18% in controls and 5 and 0% in treated plots, respectively. Results on *Verticillium* control, both in kill of microsclerotia and reduction in diseased plants, were better than those obtained previously on other crops (5,9).

**1977–1978 seasons.** Ratings of rotted pods in the 1977 treatments were evaluated on the crops grown in 1977 and 1978. They were also compared with the results from the plots treated in 1978. Results (Table 1) in 1978 demonstrated no residual effect of the 1977 treatments. Moreover, the rot frequency in the consecutive 1977–1978 control treatment was in 1978 about double that recorded for the same treatment in 1977.

Yields obtained from 1978 treatments and from consecutive controls and their segregation into quality groups illustrated the efficacy of metham sodium in improving pod quality and increasing marketable yield (Fig. 1). Both metham sodium treatments increased the symptomless yield similarly. However, the deeper treatment was more effective in preventing pod disintegration. Total yields of rotted pods are given as the quivalent weight of marketable lots. Actual weights are not specified because rotted pods had low and variable weights when compared with marketable ones. In addition to disease control, reduced weed contamination was observed in the metham sodium treatments.

## DISCUSSION

Injection of metham sodium into a sprinkler irrigation system was first developed by R. C. Cetas (*personal communication*). He and Oren (14), however, used a concentrated pulse application followed by water. The method reported here is a modification of laboratory experiments of Gerstl et al (5,6). The toxicant was distributed throughout the soil profile over the entire sprinkled area and introduced evenly to the desired depth by regulating the amount of water used. The previously used method leached the metham sodium or its conversion product, MIT, into deeper soil layers, leaving the upper layer devoid of or with a low toxicant concentration. Only a few untreated loci occur in the soil when treated by the described method, in contrast to soil injection of metham sodium (10,11).

MIT, because of its high water solubility, gives a water:air ratio of 92:1 as compared with a ratio of 4.1:1 for methyl bromide (7). For this reason, tarping is unnecessary with the metham sodium drench. A good example of the difference obtained by the two methods used for metham sodium application is provided by McCarter et al (12) in experiments on control of *Sclerotium rolfsii*, where the same rate of toxicant (148 L/ha) gave 3.8 infection loci when applied as a drench and 41.3 when injected. Results of *Verticillium* microsclerotia kill using the reported method are very striking, considering that these propagules are difficult to kill even with such a potent biocide as methyl bromide (13).

The present work indicates that metham sodium controls *Pythium*-centered peanut pod rot in the season of treatment. When comparing yields from the different treatments of the 1978 season (Fig. 1), both treatments increased

**Table 1.** Effect of metham sodium on frequency of peanut pod rot

| | | | Rotted pods (%)[c] | |
|---|---|---|---|---|
| **Toxicant (L/ha)** | **Application season (depth, cm)** | | **1977** | **1978** |
| None[d] | 1977 (60) | 1978 (50) | 19.0 a | 41.1 x |
| 300 | 1977 (30) | ··· | 4.5 b | 40.0 x |
| 600 | 1977 (60) | ··· | 2.0 b | 36.5 x |
| 250 | ··· | 1978 (25) | ··· | 18.0 y |
| 500 | ··· | 1978 (50) | ··· | 7.0 y |

[c] Figures followed by the same letter do not differ significantly at the $P \leqslant 0.05$ level for 1977 results and at the $P \leqslant 0.01$ level for 1978 results.
[d] Control plots were irrigated at treatment time to depth of deeper toxicant applications.

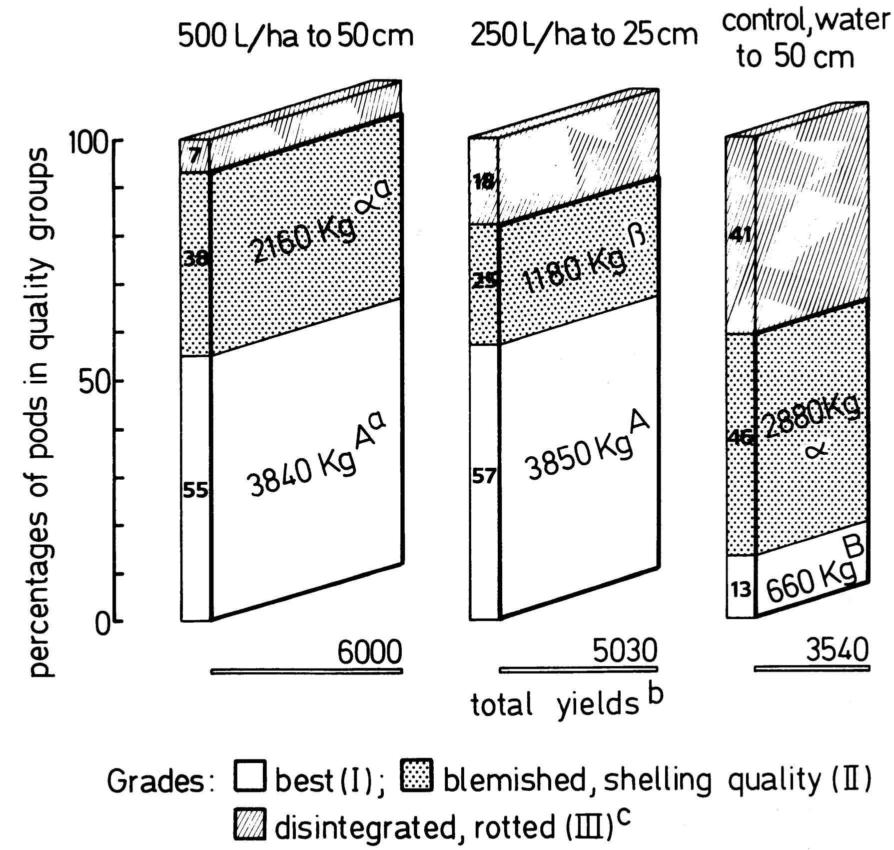


**Fig. 1.** Effect of metham sodium treatments on marketable yield (kg/ha) and incidence of pods in grades I–III. a = $P \leqslant 0.001$; b = marketable yield only, rotted pods excluded; and c = weights of unmarketable lots not specified because of low and highly variable weights of rotted pods. Best-grade means followed by capital letters; means of shelling quality by Greek letters. Values followed by the same letter do not differ.

yields of symptomless pods (grade I) over the control. The treatments thus interfered with primary disease development, which is caused by an interaction between *F. solani* and *P. myriotylum* (3). The deeper application of metham sodium resulted in more grade II (externally blemished) pods than the shallower application, and the percentage of rotted pods was smaller (Fig. 1). The additional amount of toxicant seems to have retarded conversion of grade II pods to totally rotted pods (grade III).

We inferred that the deeper treatment controlled organisms that promote disintegration of blemished pods. These organisms include saprophytic soil inhabitants (3). Their easily resumed buildup, together with the survival ability of *Pythium* oospores, may contribute to the lack of a long-term effect of the treatment. The deeper treatment increased weight of marketable yields more than expected from reduction in rotted-pod incidence. Two causes may account for this weight increase: more pods matured in an unrotted condition and attained maximum weight (2), and pod set was more extensive from the beginning. The deeper treatment may be excessive, whereas shallow treatment was shown to be less effective. It therefore seems advisable to test the application of intermediate amounts of the biocide to an intermediate depth to provide a sufficiently deep safety zone beyond the geocarposphere.

We have shown that sprinkler-applied metham sodium effectively controlled peanut pod rot and Verticillium wilt, improved quality, and greatly increased marketable yield. The method was simple, efficient, and inexpensive. Tarping was not needed, and the method was compatible with present irrigation technology (including computer-controlled systems). Since the first experiments were performed, nearly 1,000 ha have been treated with excellent results.

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