Practical methods of evaluating soil fumigations

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Growers and pest control advisors have used numerous methods to assess the degree of nematode control achieved following a soil fumigation. These methods have included: (1) observations on crop appearance and yield after fumigation, (2) observations on weed control achieved with certain fumigants, (3) checking for the odor of fumigant in soil several months after fumigation, (4) checking for the odor of fumigant in air during fumigation, (5) number of nematodes in soil samples following fumigation.

Validity of present evaluation methods

Each of these methods has some shortcomings. Growers are most concerned with crop appearance and increased yields. The major limitation of these criteria for evaluating a fumigation is that most growers do not leave untreated areas for comparison.

Weed seed control after a tarped application of methyl bromide does perhaps provide an indication of nematode control if an annual crop is to be planted. For perennial crops, where greater depth of chemical movement is necessary, weed control observations do not provide an adequate assessment. Non-tarped fumigations involving methyl bromide or 1,3-Dichloropropines (1,3-D is sold as D-D or Telone II) which provide obvious control of seedling weeds may, sometimes, reveal that an adequate fumigation took place; however, fewer weeds are more likely an indication of poor sub-surface movement of the fumigant which allows nematodes to escape deeper in the soil.

The faint odor of fumigants in the atmosphere during a fumigation may indicate that: (1) chisel injection is too shallow, (2) field surface is inadequately smoothed and settled following application, (3) soil porosity is high, (4) that there is no wind movement. This method does not yield reliable information regarding the effectiveness of fumigation. Neither is the odor of 1,3-D fumigants in soil months after a fumigation an adequate indicator of an effective treatment. It can indicate poor fumigant movement—because the soil was too wet, or too cold.

Methyl bromide has no odor, but for the 1,3-D fumigants there are at least two odors in soil following application. One distinct odor indicates the presence of pure 1,3-D. A second, 'musty' odor increases in richness with quantity of chemical applied and the wettness of soil during application. This second odor can be duplicated by sniffing various living things which have been exposed to vapors of 1,3-D.

Nematode sampling as a means of fumigant evaluation is expensive and the results can be confusing because of the limitations of soil sampling.

Gas chromatography

Gas chromatography has been a useful tool for assessing the quality of a fumigation, but the equipment and techniques required are too elaborate and time consuming to be of value for routine commercial use. However, several helpful concepts concerning soil fumigation have become apparent from its use.

While using gas chromatography we have learned that there are four areas in fumigated fields which typically receive the lowest dosages of chemical.

- The zone near the field surface (0 to 15 cm depth) in the area between chisel lines
- Deep in the soil
- Within and adjacent to live root pieces (which may harbor endoparasitic nematodes)
- Those areas of the field with the highest moisture content

Any assessments of a soil fumigation should involve observations in the above areas. This report suggests two practical tools to assist in the evaluation.

Observations of old roots

Plant parasitic nematodes are capable of surviving in roots of perennials many years after crop removal, and nematodes within such roots are among the most difficult to control. In fact, to control root knot nematodes deep within roots, the root must be killed. The larger the root in diameter the greater the quantity of chemical needed for kill. If there is a population of endoparasitic nematodes in a field, old root pieces must be killed. Live roots in the soil can be assumed to harbor nematodes; they therefore provide an indirect assessment of nematode control.

Red worms as a bioassay tool

During our studies of the effects of preplant fumigants on various soil organisms, we found that red worms, sold commercially in California as hybrid red worms or red fishing worms, have almost the same sensitivity to fumigants as active, infective nematodes in soil. Placement of ten red worms in a porous metal or glass container (salt and pepper shakers work well) along with a strip of white paper toweling can provide a useful bioassay for the presence of nematoxic quantities of soil fumigant.

This technique is most useful if the red worms are placed in that area of the soil profile, or of the field, where the lowest dosages of fumigant are expected—usually near the field surface soon after fumigation, and then checked every 24 hours. If a red, blood-like stain is observed on the white paper toweling during the first 24 hour period, exchange the contents for fresh red worms and paper. Replace the container into a different area, but one similar in soil profile, and check again in 24 hours.

Red stain at the end of the first 24 hours indicates that there is enough chemical in that area to kill root-knot nematode infective juveniles; red stain on 3 successive days indicates there is at least three times (3x) the quantity of chemical needed.

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