DEVELOPMENTS IN THE USE OF BIOLOGICAL AND NATURAL PRODUCTS FOR MANAGING PLANT PARASITIC NEMATODES IN CALIFORNIA

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Twenty-five years of testing biological and natural products in replicated field trials for managing plant parasitic nematodes on various crops throughout California have led to some interesting observations. This testing began in 1991 during a multi-year suspension of use in California of 1,3-dichloropropene. This product had been the state's most widely used pre-plant fumigant. The major crops on which it was used as a pre-plant fumigant were: carrots, tomatoes, cotton, sweet potatoes, potatoes, broccoli, cauliflower, sugar beets and Brussels sprouts. Biological and natural products can be broadly categorized as microbials, chitinolytic, plant based, micronutrients, and plant growth regulators. Several of these products have achieved US EPA registration.

Many of the variables that determine the effectiveness of products for nematode management are the same for biological and natural products as for chemical nematicides. A listing of these variables include: is the product a fumigant or a non-fumigant; is it effective pre-plant, post-plant, or as a seed treatment; does it have the ability to move through soil; is it a nematicide or a nematistat; is it systemic or non-systemic; does it provide control or suppression; what is the best formulation, rate, and method of application to annuals and perennials; what are its effects on soil biodiversity; does it require single or multiple applications; what is the optimum timing of applications; do we see population reductions or population increases following application; does it stimulate plant growth; does it affect how the plant reacts to nematode infestation.

One logical question to ask is should we expect other products to work as well as fumigants? The answer is probably not. Nematodes are aquatic organisms that live in the film of water that lines soil pores. Fumigants essentially move themselves through the air in the soil pores and then dissolve in the water film to kill nematodes. Non-fumigants, on the other hand, need to be moved through soil by other means such as with water or with tillage. This typically limits the depths to which they can be used effectively, particularly for pre-plant use on perennial crops. Movement of products through soil is also greatly affected by their water solubility, and by soil type. Better movement of nematicides typically occurs through coarse textured than through fine textured soils, and through soils with lower levels of organic matter.

Many of the non-fumigant products currently available for testing require multiple applications to be effective. The timing of multiple applications is problematic for products that must come into contact with nematodes such as root-knot, cyst and root lesion that spend much of their life within roots. For example, juveniles of root-knot nematode enter roots soon after germination and remain there for the duration of their life. After a few weeks, eggs laid within roots hatch, releasing new juveniles into the soil. These newly hatched juveniles then quickly penetrate into roots.

Timing of multiple applications is less problematic for products such as micronutrients and plant growth regulators that are designed to affect the reaction of plants to nematode infestation. Traditional management practices have focused on increasing yields by reducing nematode populations. Field trials with of a number of the newer products on annuals, perennials and ornamentals have demonstrated, that in some cases, they are effective in improving plant growth and yield either without reducing, or at times even increasing nematode populations. Possible reasons for these results include plant growth stimulating properties, and healthier root systems being able to support greater nematode populations. Other intriguing observations include whiter roots, larger galls, and less root rot on treated than on untreated plants, and earlier ripening of fruit on untreated than on treated plants.

Numerous field trials conducted from 1991 to 2016 have shown that in general, biological and natural products can provide yield increases relative to untreated controls. However, in most cases these increases are not equivalent to those provided by 1,3-dicholorpropene treatments in the same trials. The newer products do show great potential for use in IPM programs in combination, with newer chemicals, or with cultural methods of control.