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Non-fumigant nematicides for root-knot damage mitigation in carrot production

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Synopsis

Despite frequently voiced opinions in scientific and popular media about the general loss of nematicides because of their actual or perceived toxicity, crop protectants against nematodes are going through an astonishing revival. Scientists from the Nematology Department at the University of California Riverside (UCR) and a UCCE Kern County farm advisor demonstrated during a four-year project that three novel contact nematicides effectively protect fresh market carrots against root-knot nematodes damage (RKN). Equally important, they are typically less toxic to non-target organisms and the environment than previous generations of nematicides. Once registered in California, these products will likely have broader use in crops susceptible to damage by RKN and other plant-parasitic nematodes.

The Problem

California's growers harvested 86.5% of the 2020 US fresh market carrots acreage. A significant challenge for growers are RKN. Those tiny roundworms with a ferocious appetite and huge reproduction potential are the primary causes of root disease problems. They induce disfiguring forking and galling of the roots, often resulting in unmarketable produce. In recent years, nearly 45% of the state's carrot acres were treated with pre-plant soil fumigants to protect against plant-parasitic nematodes and other soilborne pathogens. While soil fumigants often reduce the nematode populations to mitigate root damage, they are considered potential human health and environmental hazards. Their future use will be increasingly complex and costly by regulatory restrictions. Despite progress in breeding for RKN-resistant carrots, all commercially available cultivars are still susceptible to RKN. In the past, non-fumigant nematicides did not receive registration in California. Including nonhosts in the crop rotation scheme alone often does not sufficiently reduce the nematode population due to the sizeable RKN reproduction potential and the low damage threshold.

The Field Research

Plant-parasitic nematodes are typically not uniformly distributed in grower fields. The spotty occurrence makes it challenging to evaluate the efficacy of control strategies. Furthermore, development products require special permission for testing. Such treatment safety precautions are not always easy to ensure in grower fields. Consequently, the investigators created and maintained year-round uniformly RKN-infested sites at two UC Research and Extension Centers at Irvine and Reedley and a research farm near Shafter. Such locations permitted the testing of biological control agents and botanical and synthetic nematicides while maintaining high RKN disease pressure. Each trial was laid out in a randomized complete block design, statistically minimizing the results' variability. It helped to provide an unbiased rating of

the treatments by avoiding interference from other factors. The nematodes' presence and distribution were confirmed before and after each trial by soil sampling, RKN extraction, and counting the nematodes in representative samples.
Carrot seedling vigor and early gall rating of the fibrous roots 6-7 weeks after seeding reflected the test products' protection capacity. At harvest, taproot galling and marketable carrot yield were determined and statistically analyzed. All test products were evaluated for several years and compared to commercial nematicides and untreated control. After years of insufficient efficacy by various development products, three new nematicides with novel mode-of-action consistently outperformed all other test materials at high RKN population densities and severe disease pressure. Pre-seeding applications of Salibro (a.i. fluazaindolizine, Corteva) or Nimitz (a.i. fluensulfone, Adama) significantly reduced root galling compared to the untreated control (Fig. 1). Velum One (a.i. fluopyram, Bayer) also resulted in less galling but lacked sufficient soil penetration, which often left the lower part of the taproot unprotected.

The Upshot

Fig. 1 Carrots from an untreated (left) and a nematicide-treated plot (right).

Once registered by the California Department of Pesticide Regulation, the new nematicides will be valuable tools for mitigating the state's RKN problems in carrots and likely many other crops. Together with their favorable toxicological and environmental dossiers, they are examples of a much improved next generation of nematicides. Previously, nematicides had the signal word “Danger” on their label, a category used for the most toxic pesticides. Each new product will be labeled “Caution”, the lowest hazard level, typically found on many botanical or microbial products such as neem oil or MeloCon WG.

The long-term impact of this research is that the carrot industry will have effective low-hazard alternatives to replace soil fumigants for mitigating RKN problems. These outcomes demonstrate how UCR's agricultural research contributes to increased farm efficiency and profitability and the public value of promoting California's economic prosperity.

Literature

[1] Becker, J.O., A. Ploeg, and J.J. Nuñez 2019. Multi-year field evaluation of fluorinated nematicides against *Meloidogyne incognita* in carrots. Plant Disease 103:2392-2396. Doi:10.1094/PDIS-03-19-0489-RE