IMPROVED PLANT PROTECTION AGAINST ROOT-KNOT NEMATODES BY COMBINING BIORATIONAL APPROACHES

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Endoparasites of plant parasitic nematodes are frequently considered as promising prospects for commercial development as biocontrol agents. By castration or elimination of sedentary nematode females or destruction of their eggs they provide considerably greater suppression of a nematode population development than those organisms that trap or attack juveniles. However, under high disease pressure it is the early attack and consequent parasitism by the invading juveniles that cause the greatest plant damage in annual crops. Secondary infections by fungal pathogens and other deleterious microorganisms may amplify the severity of the nematode activity. By the time female and/or egg parasitic fungi encounter their prey, much of the plant damage has already occurred. Consequently, the biocontrol efficacy is often too little, too late. In contrast, coating seeds with the microbial-derived nematicide abamectin significantly reduced the attack and damage of infective juveniles for the first 2-3 weeks in various crops. Abamectin is a mixture of macrocyclic lactone metabolites that are produced by the actinomycete *Streptomyces avermitilis* and possess insecticidal, acaricidal, and antihelminthic activity. Recent trials in cucumber, tomato and cotton have shown that the seed-delivered protection against plant parasitic nematodes resulted in higher yields compared to the non-treated control. More impressive, the results were typically similar to those achieved with organophosphate or carbamate nematicides that were applied to the soil at 50-100 times higher rates per hectare. Nevertheless, for long season crops or situations where several nematode generations occur, it would be desirable to extend the protection period with a technology that suppresses the nematode population build-up. In this research we explored the possibility of combining the biocontrol agent *Pochonia chlamydosporia* with the abamectin seed coating in an integrated pest management approach against the southern root-knot nematode (rkn) *Meloidogyne incognita*.

Non-treated cucumber seeds (cv. Straight Eight) or coated with 0.1 or 0.3 mg abamectin/seed were provided by Syngenta Seeds, Enkhuizen, The Netherlands. Pots were filled with pasteurized sandy soil infested with 12,000 eggs of *M. incognita* per 100 cm^3. The biocontrol fungus *P. chlamydosporia* was mixed into the soil at approximately 2000 chlamydospores/g soil for rate 1 and 4000 chlamydospores/g soil for rate 2. The treatments included all possible combinations of abamectin-coated seeds with and without the biocontrol agent at either infestation level as well as the appropriate controls. The pots were arranged in a randomized complete block design in a greenhouse at ca. 24 ± 3 C and ambient lighting. Three weeks after seeding, plant height was determined. Five weeks later, the plant tops were cut off and their dry weight was determined. The roots were placed in erioglaucin solution overnight. Stained egg masses of the root-knot nematodes were counted and the roots were rated for galling. The trial was repeated once. All data were subject to ANOVA and, if appropriate, means separation with Fisher's protected LSD (P=0.05).

Both abamectin seed coating rates increased early seedling growth in rkn-infested soil although the lower rate was more variable. Plant dry weight and vine length were also increased, but the treatments had little effect on the number of egg masses. The biocontrol agent by itself had no effect at either rate in the first trial but improved plant growth and reduced galling in the second trial. The combination of either rate of abamectin with the high rate of *P. chlamydosporia* was overall superior to the other treatments in nearly all parameters and was not significantly different to the nematode-free control in terms of plant performance. The analysis of results indicated that the plant growth performance observed in the combination treatments were additive responses.

We demonstrated that the combination of abamectin seed coating with the nematode-destroying fungus *P. chlamydosporia* is a potentially successful strategy to utilize the strength of both systems while helping to overcome their individual shortcomings. Seed coating with abamectin protected the early phase of root growth and development against the attack of second-stage juveniles of *M. incognita*. Meanwhile, *P. chlamydosporia*, insensitive to the abamectin seed coating, established and was ideally suited to attack eggs that were produced by rkn females. The combination of both protection systems resulted in superior plant performance.