SYSTEMIC AND LOCALIZED EFFECTS OF *BACILLUS FIRMUS GB-126*

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Abstract

Bacillus firmus GB-126 was evaluated in a split-root experiment to better understand the biological mode of action when used as a biological control of the soybean cyst nematode (*Heterodera glycines*) in soybeans and root-knot nematode (*Meloidogyne incognita*) in corn. The objectives for this study are: 1.) determine if GB-126 has systemic capabilities when used as control against soybean cyst nematodes and 2.) determine if GB-126 has systemic capabilities when used as a control against root-knot nematodes. Data from the soybean cyst nematode split-root experiment show that both systemic and localized effects where observed at 51 days after inoculation. Data from the root-knot nematode split-root experiment on corn show that only localized effects occurred in this experiment.

Introduction

The market withdrawal of aldicarb, the agriculture industry's leading nematicide, has caused an increase in interest in bio-control agents in nematode management. The antagonist bacterium, *Bacillus firmus* GB-126, has shown to be a promising bio control of soybean cyst nematodes and root-knot nematodes. GB-126 has demonstrated the ability to significantly reduce mobility of soybean cyst nematodes in previous *in vitro* experiments (Schrimsher *et al.,* 2010). GB-126 has also shown the capacity to reduce root-knot nematode populations in vegetable crops (Mendoza *et al.,* 2008).

In this study, *Bacillus firmus* GB-126 was evaluated in a split-root experiment to better understand the biological mode of action when used as a biological control of the soybean cyst nematode (*Heterodera glycines*) on soybeans and root-knot nematode (*Meloidogyne incognita*) on corn. The hypothesis for this experiment is that *Bacillus firmus* GB-126 can have systemic effects when used as a control agent against plant parasitic nematodes. The objectives of this experiment were: 1.) Determine if GB-126 has systemic capabilities when used as a control against soybean cyst nematodes on soybeans; 2.) Determine if GB-126 has systemic capabilities when used as a control against root-knot nematodes on corn.

Materials and Methods

Soybean Cyst Nematode on Soybeans

Hutcheson soybean seed were germinated five days prior to planting to ensure a root radical length of 1 in. Each radical was evenly split (longitudinally) with a razor blade and planted into two separate cone-tainers. Two independent root halves were established by 10 days after planting (DAP) and inoculated with either GB-126 at a concentration of $1x10^7$ cfu/ml or soybean cyst nematodes (SCN) at a concentration of 2000 J2s/5 ml or a combination of both organisms. There were a total of four different split-root treatment combinations: GB-126 and SCN on opposite root halves, both organisms on one root half, SCN alone, or a control with neither one. The soybean plants were allowed to grow for 60 days in a greenhouse environment. The parameters measured were the number of SCN J2s and cysts/$150cm^3$ of soil, shoot and root fresh weights, and plant heights.

Root Knot Nematode on Corn

Corn seeds were planted in a 3 fl oz. polystyrene cup with the bottom removed and positioned equally over two separate $1000cm^3$ plastic growth pots. The corn plant's fibrous root system allows two independent root halves to naturally form. The two separate root halves were allowed to grow for 10 DAP and inoculated with either GB-126 at a concentration of $1x10^7$ cfu/ml, root-knot nematodes (RK) at a concentration of 2000 J2s/5 ml or a combination of both organisms. There were a total of four different treatment combinations: GB-126 and RK on opposite root halves, both organisms on one root half, RK alone on one root half, and control with neither organism. The corn plants were allowed to grow for 60 days in a greenhouse environment. The parameters measured in this experiment

include the number of RK J2s/150cm^3 of soil, RK females per gram of root, root and shoot fresh weights, and plant heights.

Experimental Design

The experimental design for this trial was a randomized complete block design with five replications. The soybean split-root trial and the corn split-root trial were repeated two times each. The data collected from these two trials were analyzed with SAS 9.2 (SAS Institute, Inc., Cary, NC) using the Glimmix procedure. The LSmeans were separated by an adjusted p-value for multiple comparisons.

Results and Discussion

Soybean Cyst Nematode on Soybeans

The soybean cyst nematode split-root experiment found GB-126 has both systemic and localized effects on soybean cyst nematodes. A decrease in SCN cyst populations was observed when GB-126 was present (Figure 1). A translocatable effect of GB-126 was obsereved in the treatment SCN/GB-126 on opposite root halves. The number of cysts per 150cm^3 was reduced by 27% when compared to the SCN/Check split-root system. The concomitant treatment significantly decreased the number of cysts per 150cm^3. The concomitant treatment reduced populations of cysts per 150cm^3 by 84% when compared to the SCN/Check split-root systems. A significant decrease in SCN J2 populations was observed in both treatments where GB-126 was present (Figure 2). The SCN/GB-126 treatment on opposite root halves significantly reduced the number of J2s per 150cm^3 by 43%, while the concomitant SCN+GB-126/Check reduced J2s per 150cm^3 of soil by 91% when compared to the SCN/Check treatment.

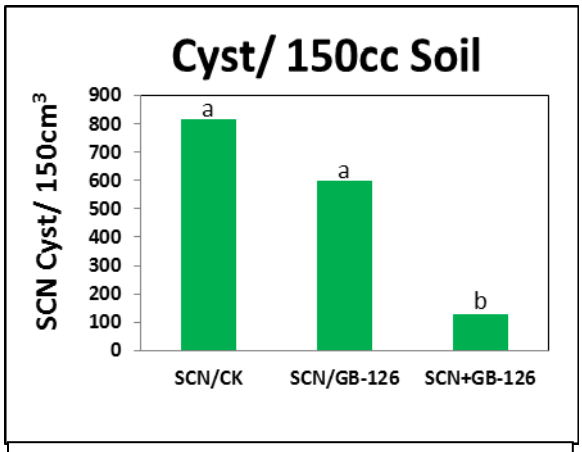

Figure 1: SCN population mean comparisons between split root treatments per 150cm^3 of soil.

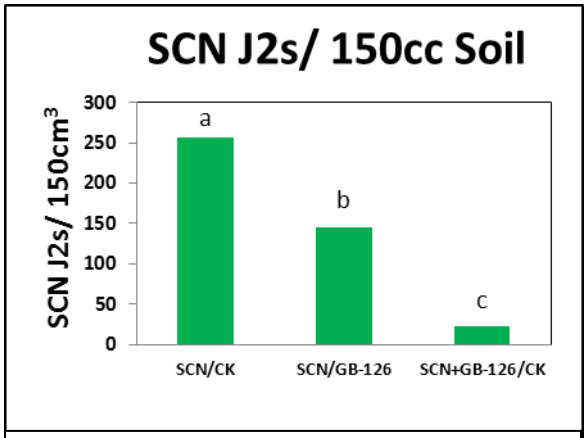

Figure 2: SCN J2 population mean comparisons per 150cm^3 of soil.

Root Knot Nematode on Corn

The root-knot nematode split-root experiment on corn indicated that GB-126 has a localized effect on root-knot nematodes. A decrease in root-knot females per gram of root was only evident in the concomitant treatment with RK+GB126/Check on one root system (Figure 3). The concomitant treatment reduced females per gram of root by 48% when compared to the RK/Check split-root system. No translocatable results were found when comparing the RK/GB-126 on opposite root systems to the RK/Check. Similar results were found when comparing the means from root-knot J2s per 150cm^3 of soil (Figure 4). The concomitant treatment RK+GB126/Check significantly reduced the number of RK J2s by 33% when compared to the RK/Check treatment. No systemic effects on RK numbers were evident when RK/GB-126 was on opposite root halves.

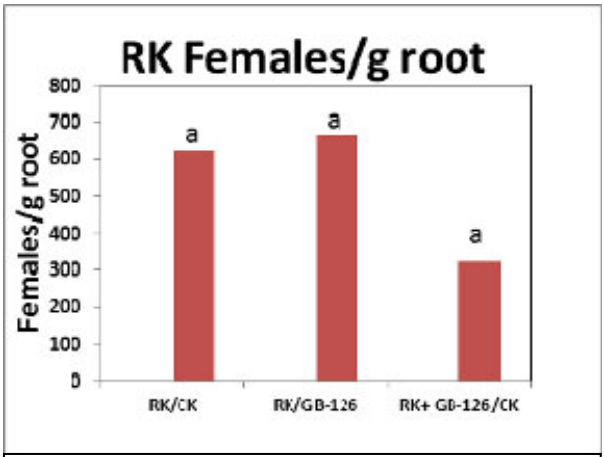

Figure 3: Mean comparisons of root-knot (RK) females per gram of root.

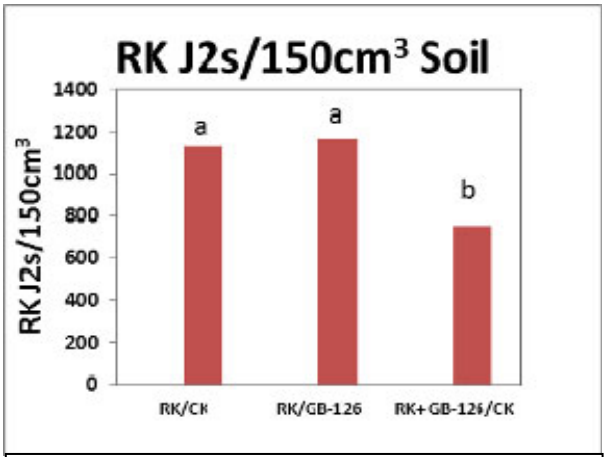

Figure 4: Mean comparisons of root-knot (RK) J2s per 150cm^3 of soil.

Conclusions

In this study, systemic effects were evident when GB-126 was applied to the roots of soybeans for control against the soybean cyst nematode. However, no systemic effects were evident when GB-126 was applied to the roots of corn for control against the root-knot nematode.

Literature Cited

Mendoza , A.R, Kiewnickb, S., and Sikora, R.A., Biocontrol Science and Technology, Vol. 18, No. 4, 2008, 77389

Schrimsher, D.W., K.S. Lawrence, J. D. Castillo, S.R. Moore, and J.W. Kloepper. 2011. Effects of *Bacillus firmus* on the soybean cyst nematode mobility *in vitro*. Phytopathology 101:S161.