EFFECT OF SOIL POTASSIUM ON RENIFORM NEMATODE DAMAGE IN COTTON

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Abstract

A greenhouse study indicated that high levels of soil potassium could not overcome the deleterious effect of high reniform nematode populations on cotton yield and maturity. Reniform nematodes affected plant height and weight but did not affect root mass. Reniform nematodes did delay crop maturity by as much as 2 to 3 weeks. Results suggest that reniform nematodes may adversely affect cotton growth by inhibiting cotton roots from extracting potassium from the soil efficiently.

Introduction

Nematicides and crop rotation are currently the only effective control alternatives for reniform nematodes in cotton. Efforts are continuing to find less expensive and more effective means of controlling these troublesome pests.

A cotton field in Escambia County was observed to produce good cotton yields despite having an extremely high population of reniform nematodes. This field was found to have a relatively high level of potassium in its subsoil. It is possible that high levels of potassium in the subsoil could be taken up by the plants' reniform damaged roots in sufficient quantity to satisfy cotton's high potassium requirements.

The purpose of this greenhouse test was to determine (1) if high soil potassium levels could compensate for reniform nematode damage; (2) if potassium affects reniform nematode population development; and (3) if there was an interaction between reniform nematodes and soil potassium levels affecting cotton's growth and development.

Methods

Soil was collected from a reniform nematode infested cotton field in Escambia County and from the "low potassium" plots of the Cullars rotation experiment in Auburn. Three parts of the low potassium "Cullars" soil was mixed with 1 part of the reniform infested Escambia County soil to form a "reniform infested" soil. The "Cullars" soil was also mixed in the same proportion (3:1) with steam sterilized Escambia County soil to form a "reniform free" soil. The soil pH was adjusted to 6.5. Cotton seed, 'DPL 5690' variety, were planted in 2 gallon pots containing 1 of the 2 soil mixes on 1 Oct 94. Plants were thinned to 3 plants per pot after the seedlings had emerged. Cotton seedlings were watered with a (N, P, S) nutrient solution as needed until they reached the true leaf stage. Thereafter, plants were watered only after they had become drought stressed.

The experimental design was a factorial with 4 replications (i.e. 2 nematode levels x 5 K levels x 4 replications = 40 pots). Treatments were as follows:

	Reniform	Potassium (PPM)	Approximate Potassium (lb/A)
1.	-	0	0
2.	-	25	60
3.	-	50	120
4.	-	100	240
5.	-	200	480
6.	+	0	0
7.	+	25	60
8.	+	50	120
9.	+	100	240
10.	+	200	480

Soil samples for nematode analyses were collected 1) from the Cullars soil and from the Escambia County soil prior to planting and 2) from each pot just prior to harvest. Data collected included plant mapping, plant tissue analyses, soil nutrient analyses, plant height, plant dry weight, and root dry weight. Plants were harvested on 13 December 1994. Just prior to harvest, square and boll counts were recorded to determine the stage of plant development.

Results and Discussion

Initial soil analyses prior to mixing revealed the "Cullars" soil to be very low in potassium (29 lb/A) with a soil pH 6.7 and contained a high level of root-knot nematodes (52/100cc) but not reniform nematodes. The "Escambia County" soil contained a high level of potassium (201 lb/A) with a pH 6.0 and was infested with a high population of reniform nematodes (1590/100cc soil) but had no root-knot nematodes.

The results of this test indicated that both the potassium level and reniform nematodes had a strong influence on plant height and above ground plant weight but did not influence root weight (Table 1). Reniform nematodes had the most profound impact on plant height and weight (Table 2). Plants grown in reniform infested soil were visibly stunted, regardless of the potassium levels. Potassium levels affected above-ground plant growth but to a much less degree than reniform nematodes (Table 2). Potassium levels or reniform nematodes did not appear to affect root mass. The failure to distinguish a difference in root mass could be attributed to a problem in extracting the roots intact from the pots.

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According to soil test analysis, potassium levels were higher in the soil, except at the highest potassium level, where reniform nematodes were present (Table 3). This indicates that reniform damaged cotton roots may be unable to take up potassium from the soil as efficiently as healthy roots. There was no potassium level x reniform nematode interaction (Table 1). Higher levels of potassium in the soil could not negate or minimize the adverse impact on cotton growth caused by reniform nematodes (Table 2).

Reniform nematodes delayed cotton maturity (Table 4). Well developed bolls and squares were found on cotton growing in reniform-free soil; whereas, only a few "matchhead" size squares were found on cotton in "reniform infested" soil. High levels of potassium also appeared to enhance fruit maturity but not as strongly as the absence of reniform nematodes.

A soil analysis for nematodes indicated that reniform nematodes maintained a substantial population in the non-treated Escambia soil/Cullars soil mix. In soil that contained mixed populations of reniform and root-knot nematodes, the root-knot nematode population, 40/100cc at planting, disappeared completely by harvest time. In the "heat treated" Escambia/Cullars soil mix (i.e. soils without reniform nematodes), root-knot nematodes declined to 11/100cc soil but did not disappear. The failure to maintain root-knot nematodes in soil where reniform nematodes are present may reflect an incompatibility between these two nematode genera. In a previous statewide survey conducted in 1990, root-knot nematodes were found in only one cotton field where reniform nematodes were present. Root-knot nematodes were found on one side of the field and reniform on the other side. Five years later, reniform nematodes were found over the entire field and root-knot nematodes had completely disappeared from the field.

Conclusion

According to this test, reniform damage can not be overcome by increasing potassium levels in the soil. Reniform nematodes reduced overall plant size and height, resulting in stunted plants. Surprisingly, reniform nematodes did not appear to affect root mass.

Reniform nematodes' ability to reduce yield has been well documented in previous field studies, so it was not necessary to measure yield losses in this greenhouse study. This test did confirm the role of reniform nematodes in delaying crop maturity which is critical to cotton growers in terms of both cotton yield and quality. These data suggest reniform nematodes woulddelay cotton maturity a minimum of 2 to 3 weeks--a situation cotton growers would understandably want to avoid.

Table 1. Effect of Potassium Fertility and Reniform Nematodes Interaction on Cotton Growth and Soil Potassium Levels.

	Soil Potassium	Plant Top Weight	Plant Top Height	Roots Weight
Potassium Fertility	**	**	**	NS
Reniform Population	NS	**	**	NS
Potassium x Reniform	*	NS	NS	NS
C.V.	27.1%	12.3%	5.1%	44.1%

* = Significant at the 0.10 level.
** = Significant at the 0.01 level.

Table 2. Effect of Potassium Fertilization and Reniform Nematodes on Plant Size.

Reniform Nematodes	Potassium Added (PPM)	Top Height	Top Weight[a/]	Root Weight
-	0	15.0"	12.0	33.3
+		11.4"	7.1	22.8
-	25	15.7"	15.1	26.2
+		12.8"	9.9	20.8
-	50	16.7"	15.0	25.0
+		13.1"	8.6	25.4
-	100	16.2"	16.0	23.4
+		14.1"	10.9	19.0
-	200	15.2"	15.4	25.6
+		13.5"	10.5	23.2
LSD (0.05)		1.1	2.1	NS

[a/]Weight in total grams per pot.

Table 3. Effect of Potassium Fertilization and Reniform Nematodes on Soil Nutrient Content.

Reniform Nematodes	Potassium Added (PPM)	Soil Nutrient Content (Pounds/Acre) P	K	Ca	pH
-					
-	0	143	38	1110	6.1
+		142	47	1270	6.1
-	25	157	41	1220	5.8
+		155	54	1450	6.2
-	50	159	56	1170	5.8
+		143	78	1320	6.1
-	100	148	93	1160	5.8
+		153	120	1490	6.0
-	200	149	241	1175	5.7
+		158	196	1548	6.1
LSD = 0.05		NS	38	293	0.15

Table 4. Effect of Potassium Fertility and Reniform Nematodes on Fruit Development.

			Number of:		
Reniform Nematodes	Potassium Added (PPM)	"Match Head" Squares	Squares	White Blooms	Bolls
-	0	1	0	0	3
+		0	0	0	0
-	25	1	2	0	5
+		0	0	0	0
-	50	0	2	0	6
+		0	0	0	0
-	100	1	2	0	7
+		2	0	0	0
-	200	0	5	0	9
+		1	0	2	0

Table 5. Reniform and Root-Knot Nematode Populations At Harvest.

Treatment	Root-Knot/100cc	Reniform/100cc
Heat Treated Escambia Soil[a/]	11	0
Non-Treated Escambia Soil[b/]	0	1195

[a/] Reniform nematode infested soil (Escambia County) steam sterilized and mixed (1:3) with untreated "Cullars" soil infested with root-knot nematodes.

[b/] Unsterilized reniform nematode infested soil (Escambia County) mixed (1:3) with untreated "Cullars" soil infested with root-knot nematodes.