THE EFFECTS OF K FERTILIZATION ON RENIFORM NEMATODE DAMAGE TO COTTON

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Abstract

A greenhouse study indicated that high levels of soil K could not overcome the deleterious effect of high reniform nematode (*Rotylenchulus reniformis*) populations on cotton yield and maturity. Reniform nematodes and K fertilization independently affected plant height and weight but did not affect root mass. Reniform nematodes delayed crop maturity by as much as 2 to 3 weeks, but had no effect on K concentration in whole plants. There was no interaction between level of K fertilization and reniform nematodes on any of the cotton growth parameters measured. Reniform nematodes suppressed root-knot nematodes.

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, Alabama, 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 K in its subsoil and the grower applied more K than recommended by plow layer soil tests. Since nematodes are known to damage root hairs and reduce the root surface through which K absorption occurs, the authors thought that high levels of soil K may overcome some of the damaging effects of the nematodes and satisfy cotton's high K requirements.

The purpose of this greenhouse study was to determine (1) if high soil K levels could compensate for reniform nematode damage, (2) if K affects reniform nematode population development, and (3) if there is an interaction between reniform damage and soil K levels affecting plant growth and development.

Methods

Soil was collected from the plow layer of a reniform nematode infested cotton field in Escambia County, Alabama (fine-loamy, siliceous, thermic Typic Paleudults) and from the "no K" treatment of the long-term "Cullars Rotation" (circa 1911) experiment in Auburn, Alabama (fine-loamy, siliceous, thermic Typic Kanhapludults). Both soil textures were sandy loam. Soil from the Cullars Rotation had no reniform nematodes. Three parts of the low-K "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 with steam sterilized Escambia County soil to form a "reniform free" soil. The soil pH was adjusted to 6.5 with ground, dolomitic agricultural limestone. The experimental design was a factorial with 5 levels of applied K (0 to 200 mg K/kg) and 2 levels of reniform infestation (none and plus reniform) replicated 4 times. Cotton seed ('DPL 5690') were planted in 40, 2-gallon pots containing the soil mixes on 1 October 1994. Plants were thinned to 3 plants per pots after the seedlings had emerged. Cotton seedlings were watered with a dilute N-P-S nutrient solution until they reached the true leaf stage. Thereafter, plants were watered only after they had become drought stressed. The authors' experience suggested that reniform damage is more severe on drought stressed cotton than on cotton grown under optimum, greenhouse conditions.

Potassium was applied as K_2SO_4 dissolved in water once the first true leaves were fully expanded. Soil nematode counts were made on the soil collected for the experiment and on the soil from each pot at harvest. Other data included plant mapping, plant tissue analysis, soil nutrient analyses, plant height, plant dry weight at harvest, root dry weight at harvest, and square and boll counts at harvest. Plants were harvested on 13 December 1994 during early boll development.

Results and Discussion

Initial soil analyses prior to mixing revealed the Escambia County soil to have a high level of Mehlich-1 extractable soil K (100 mg K/kg) and a very high population of reniform nematodes (1590/100 cm^3 soil). Soil from the "Cullars Rotation" experiment was very low in extractable K (15 mg K/kg) with no reniform. It did, however, contain 52 root-knot larva/ 100 cm^3 (*Meloidogyne incognita*).

As expected, both the K level and the reniform infestation had a dramatic effect on plant height and above ground plant weight, but did not influence root weight (Table 1). Reniform had the most profound impact on plant height and weight (Table 2). Plants grown in reniform infested soil were visibly stunted, regardless of the soil K level. Potassium levels affected above-ground plant growth but to a much lesser degree than the nematodes (Table 2). The lack of a significant effect on root mass may have been due to high error associated with washing and measuring roots. There was no K level x reniform interaction on plant growth parameters. This indicates that our theory was incorrect that higher soil K levels could overcome some of the negative effects of reniform nematodes on cotton.

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As expected, K fertilization increased Mehlich-1 (dilute double acid) extractable K in the soil at harvest (Table 3). There was a slightly significant (P<.10) interaction between nematode level and extractable soil K. Extractable K tended to be higher where reniform nematodes were present. This suggests that reniform damaged cotton roots may be unable to take up K from the soil as efficiently as healthy plants, but obviously, reniform damage is much more severe than creating a simple K deficiency.

Surprisingly, reniform had no effect on K concentration in the whole cotton plants at the termination of the experiment. However, the rate of applied K did have a dramatic effect on K concentration in the plants which confirms the observed K deficiencies (Fig. 1). There was no interaction between K applied and reniform nematodes on K concentration in plants.

Reniform nematodes delayed cotton maturity (Table 4). Well developed bolls and squares were found on cotton growing in reniform-free soil 74 days after planting; only a few "matchhead" size squares were found on cotton in reniform infested soil. High levels of K also appeared to enhance fruit maturity but not as strongly as the absence of reniform nematodes.

Reniform nematodes maintained a substantial population in the Escambia County/Cullars Rotation soil mix. Table 5 presents only the mean values because the level of K treatment had no significant effect on the nematode count at harvest. Since all soil treatments contained 1/4 soil from the Cullars Rotation, root knot nematodes were inadvertently introduced into the experiment. An interested observation is that the root knot population completely disappeared by harvest time where reniform nematodes were present. Root knot seemed to maintain its population in the absence of reniform. Based upon the initial nematodes counts in the two soils, the final nematode count without sterilization at the initiation of the experiment should have been 13 root knot (52 x .25 = 13) and 1192 reniform (1590 x .75 = 1192). 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. Five years later, reniform nematodes were found over the entire field and root-knot nematodes had completely disappeared from the field. This effect was not changed by K fertilization. This unexpected observation may be the most significant observation from this experiment.

Conclusion

This greenhouse experiment indicates that reniform damage to cotton cannot be overcome by increasing K levels in the soil i.e. increased K fertilization rates. Reniform nematodes and K deficiency independently reduced overall plant size and height, resulting in stunted plants. Surprisingly, neither reniform nematodes or level of K fertilization affected root mass. The presence of reniform nematodes did not affect K concentration in the plant.

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

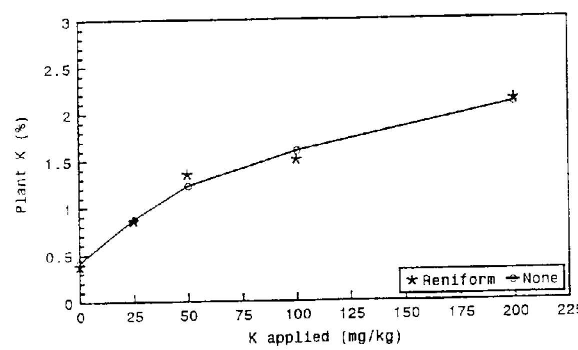

Fig. 1. The effect of reniform nematodes and applied K on K concentration in whole cotton plants after 74 days.

Table 1. Statistical effects of applied K and reniform nematode interaction on cotton growth and extractable soil K after 74 days of growth in the green-house.

		Plant top		Root
	Soil K	Dry wt.	Height	Dry wt.
Applied K	**	**	**	ns
Reniform population	ns	**	**	ns
K x reniform	*	ns	ns	ns
C.V.	27.1%	12.3%	5.1%	44.1%

*, ** = significant at P<.10 and P<.01 level, respectively.

Table 2. Effect of applied K and reniform nematodes on measured plant growth parameters after 74 days of growth.

Reniform nematodes	Total K applied	Plant height	Top dry weight	Root dry weight
	-mg/kg-	--cm--	---------g/pot--------	
-	0	38	12	33
+		29	7	23
-	25	40	15	26
+		32	10	21
-	50	42	15	25
+		33	9	25
-	100	41	16	23
+		36	11	19
-	200	39	15	26
+		34	10	23
L.S.D.$_{(P<.05)}$		3	2	ns

Table 3. Effect of K fertilization and reniform nematodes on soil test levels after 74 days.

Reniform nematodes	Total K applied	P	Mehlich-1 Extractable K	Ca	Soil pH
	-mg/kg-	---------------mg/kg----------------			
-	0	71	19	555	6.1
+		71	24	635	6.1
-	25	78	20	610	5.8
+		77	27	725	6.2
_	50	79	28	585	5.8
+		71	39	660	6.1
-	100	74	46	580	5.8
+		76	60	745	6.0
-	200	74	120	587	5.7
+		79	98	774	6.1
L.S.D.$_{(P<.05)}$		ns	19	146	0.15

Table 4. Effect of applied K and reniform nematodes on fruit development after 74 days.

Reniform nematodes	Total K applied	"Match-head" squares	Mature squares	White blooms	Bolls
	-mg/kg-	----------average no. per plant----------			
-	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. Average reniform and root-knot nematode populations at harvest (74 days).

Treatment	Root-knot	Reniform
	-----------no./100 cm^3------------	
Heat-sterilized, reniform-infected soil mixed with unsterilized "Cullars Rotation" soil (1:3 mix)	11	0
Unsterilized, reniform-infected soil mixed with unsterilized "Cullars Rotation" soil (1:3 mix)	0	1195