AN ASSESSMENT OF SMALL GRAIN COVER CROPS AS POTENTIAL ROTATION CROPS FOR ROOT-KNOT AND RENIFORM INFESTED ALABAMA COTTON FIELDS

S.E. McPeak
K.S. Lawrence
Auburn University
Auburn, AL
D. Herb
OreGro Seeds Inc.
Albany, OR

Abstract

The objective of this study was to assess the plant growth and host susceptibility of small grain cover crops to the southern root-knot (*Meloidogyne incognita*) and reniform (*Rotylenchulus reniformis*) nematodes in Alabama cotton fields. In 2019-2020, trials were conducted on 31 varieties of small grain cover crops in three separate fields: a naturally infested root-knot field in Tallassee, AL, a naturally infested reniform field in Shorter, AL, and a non-nematode field in Germanton, NC. Root samples were collected after planting and near harvest to measure root-knot and reniform population density changes throughout the growing season. In this study, neither root-knot nor reniform egg numbers increased from January to May. In the root-knot field, triticale varieties had consistently lower root-knot eggs/g of root compared to the other small grain types. In the reniform field, all small grain types tested had similar reniform eggs/g of root. Above-ground biomass cuttings were weighed near harvest to identify possible high-residue varieties, which may be beneficial for weed suppression and erosion control. Oat, rye, and triticale, respectively, produced the greatest above-ground biomass in both root-knot and reniform fields. 'Shooter' and 'Buck Forage' oat varieties had the greatest above-ground biomass in the root-knot field. In the reniform field, developmental triticale varieties 'OG170035' and 'OG170012' produced the most above-ground biomass. In the non-nematode field, above-ground biomass production was similar among all small grain types tested with 'KGAL' wheat and developmental triticale variety, 'OG170035' having the greatest above-ground biomass. A biomass sample during vegetative growth in the non-nematode field was tested for forage quality to estimate potential value of the grains as grazing crops. Forage quality results from the non-nematode field suggests that all small grains tested had statistically similar forage quality when comparing relative feed value. Additionally, grain was harvested from both the root-knot and reniform fields. The 'TAM 411' oat variety was superior in both nematode trials producing significantly ($P \leq 0.05$) more bushels per acre compared to all other grains tested. The results indicate that the small grains tested are suitable hosts for the southern root-knot and reniform nematodes. Some potentially high-residue small grain varieties may be beneficial beyond nematode management for their overall value as cover crops.

Introduction

In 2019, an estimated 865,100 bales of cotton in the U.S Cotton Belt were lost to plant-parasitic nematodes (Lawrence et al., 2020). The southern root-knot nematode (*Meloidogyne incognita*) and the reniform nematode (*Rotylenchulus reniformis*) were responsible for 73% and 22%, respectively, of total bales lost to nematodes in 2019 (Lawrence et al., 2020). The use of cover crops is a predominant method for suppressing nematodes during the winter, however, winter survival of plant-parasitic nematodes on cover crops has been reported in the southeastern U.S. (Timper et al., 2006). Mild winter temperatures in the South provide an adequate environment for nematode reproduction. The combination of a susceptible cover crop and a mild winter encourages nematode activity and reproduction. Therefore, winter survival of plant-parasitic nematodes could result in increased risk for subsequent crops due to high nematode population density at the time of planting (Timper et al., 2006).

Small grains can be beneficial as short-term rotation crops for maintaining soil health and structure. They fit into most rotations, are easy to establish, and grow rapidly. Small grains produce a substantial amount of biomass, which provides increased surface cover that is sufficient for suppressing weeds and reducing erosion. Furthermore, small grains can be grazed and/or harvested for grain to provide additional profit for growers. Nonetheless, there is little information on the host status of small grains to plant-parasitic nematodes. The overall goal of this study was to evaluate the host susceptibility of barley, oat, rye, triticale, and wheat to the southern root-knot and reniform nematodes in addition to assessing each crop's beneficial properties as a cover crop.

Materials and Methods

Field trials were conducted on commercial varieties and advanced breeding lines provided by OreGro Seeds, Inc., which included 14 triticale, 5 barley, 5 oat, 4 wheat, and 3 rye varieties. Trials were organized by crop and arranged in a randomized complete block design with five replications. Individual plots were 4-foot wide and 20-foot long with a 10-foot alley between replications. The seeding rate for all trials was 100-g seed/plot at 0.5-inch planting depth. Both nematode trials were drill-seeded at 7.5-inch row spacing with a HEGE plot drill, and the non-nematode trial was push-planted at 6-inch row spacing. To accurately assess the inherent ability of each small grain variety to survive in the humid climate of the southeastern U.S., there were no herbicide or fungicide applications. Four random plant samples were dug from each plot around 80 DAP and 175 DAP to estimate root-knot and reniform population density changes throughout the growing season. An above-ground biomass cutting, within a 1-foot square, was taken and weighed to determine the pounds of biomass/plot provided by each variety to identify potential high-residue varieties. A composite biomass sample of each variety from all five replications from the non-nematode field during vegetative growth were sent to the Dairy One Forage Lab in Ithaca, NY for a forage quality analysis. The small grains tested are primarily forages, however, grain was harvested with an ALMACO SPC40 plot combine and recorded as bushels/acre from both the root-knot and reniform fields. Grain was not harvested in the non-nematode field due to lack of equipment. Data collected from field trials were analyzed in SAS 9.4 (SAS Institute, Cary, NC) using the PROC GLIMMIX procedure and means were separated using the Tukey-Kramer method with a significance value of $P \leq 0.05$.

Results and Discussion

In the root-knot field, the average root-knot nematode eggs/g of root (Table 1) did not increase from January to May. Root-knot egg numbers were significantly higher on barley in May than the other grains tested. In May, near harvest, root-knot nematode egg numbers (Table 2) were similar among the varieties tested within their respective crop. There were no significant differences between triticale, wheat, barley, or rye varieties. However, 'TAM 411' oat did have significantly ($P \leq 0.05$) lower root-knot nematode eggs/g of root compared to the other oat varieties tested. There was little variation in above-ground biomass weights between the small grain varieties in the root-knot field (Table 2). Developmental triticale variety, 'OG170035', produced the most pounds of biomass/A followed by the 'Doublet' variety. Wheat varieties, 'OG9484' and 'KGAL', respectively, produced significantly ($P \leq 0.05$) more pounds of biomass compared to the other wheat varieties tested. The oat varieties had comparable above-ground biomass weights with 'Shooter' and 'Buck Forage', respectively, having the greatest pounds of biomass/A. All barley and rye varieties had statistically similar ($P \leq 0.05$) pounds of biomass/A within their respective crop. Grain yield in the root-knot field (Table 2) was overall low, but there were some significant differences. 'Doublet' triticale and developmental wheat variety, 'OG9484', had significantly ($P \leq 0.05$) more bushels/A compared to the other varieties tested within their respective crop. 'TAM 411' and 'Buck Forage' oat had the greatest bushels/A of the oat varieties tested. All barley and rye varieties had statistically similar ($P \leq 0.05$) grain yields within their respective crop.

In the reniform field, the average nematode eggs/g of root did not increase from January to May (Table 3). Rye had significantly ($P \leq 0.05$) higher reniform nematode egg numbers compared to the other grains tested, but this may be due to overall dry sampling conditions. In May, all varieties of small grain within their respective crop had statistically similar reniform nematode eggs/g of root (Table 4). In the reniform field, developmental triticale varieties, 'OG170035' and 'OG170012', 'KGAL' wheat, 'Buck Forage' and 'TAM 411' oat, and 'Abruzzi' rye produced significantly ($P \leq 0.05$) more pounds of above-ground biomass/A (Table 4) compared to the other varieties tested within their respective crop. All barley varieties tested had statistically similar ($P \leq 0.05$) above-ground biomass weights. Grain yield in the reniform field (Table 4) was overall low due to a delayed harvest. However, 'Doublet' triticale, developmental wheat variety, 'OG9484', 'TAM 411' oat, 'Alba' barley, and 'Abruzzi' rye yielded significantly ($P \leq 0.05$) more bushels/A compared to the other varieties tested within their respective crop.

In the non-nematode field, there were few differences in above-ground biomass production. Developmental triticale varieties, 'OG170035' and 'OG170012' produced the greatest pounds of biomass/A of the triticale varieties tested. 'KGAL' wheat and 'Alba' barley produced significantly more pounds of biomass/A compared to the other varieties tested within their respective crop. The oat and rye varieties had similar above-ground biomass weights compared to the varieties within their respective crop. The forage quality results (Table 6) from the vegetative biomass sample in the non-nematode field suggest that all small grain crops tested had statistically similar forage quality when comparing the relative feed value. Oat, barley, and rye did have a significantly higher percent of total digestible nutrients than triticale and wheat.

Table 1. Average root-knot nematode eggs/g of fresh root on each small grain crop varieties averaged by crop in the root-knot field in Tallassee, AL in January 2019 versus May 2020.

Crop	Root-knot Eggs/g of Root – Jan[z]	Root-knot Eggs/g of Root – May[z]
Triticale	4 a[z]	1 c[z]
Wheat	4 a	2 bc
Oat	3 a	3 b
Barley	11 a	6 a
Rye	1 a	1 bc

[z] Values followed by the same letter are not significantly different at $P \leq 0.05$ as determined by the Tukey-Kramer method.

Table 2. Above-ground biomass, yield, and root-knot nematode numbers of varieties tested in the root-knot field in Tallassee, AL in May 2020.

Type	Variety	Above-ground Biomass lbs/A[z]	Bushels/A[z]	RKN Eggs/g of Root[z]
Triticale	Doublet	24847 ab[z]	78 a[z]	2 abc[z]
	OG8782	8782 f	28 bc	3 a
	OG8783	18975 a-d	36 b	1 ab
	Forerunner	21736 abc	21 cde	1 ab
	158 EP	10123 ef	37 b	2 a
	Round Table	14880 c-f	16 de	1 bc
	OG170004	19044 a-d	19 cde	1 bc
	OG170012	20438 a-d	20 cde	1 c
	OG170023	18618 a-d	28 bc	1 ab
	OG170035	25247 a	19 cde	1 bc
	OG170036	16361 cde	24 cd	2 a
	OG170039	19898 a-d	20 cde	1 bc
	OG170040	17651 bcd	13 e	1 abc
	OG170043	14253 def	21 cde	1 bc
Wheat	KGAL	14627 a	19 b	2 a
	Summit 515	4291 b	8 c	3 a
	Willow Creek	6482 b	2 c	0 a
	OG9484	17372 a	54 a	2 a
Oat	Intimidator	25056 ab	20 c	3 a
	Shooter	35597 a	53 bc	4 a
	TAM 411	22808 bc	97 a	1 b
	Buck Forage	28819 b	74 ab	3 a
	OG6285	17703 c	20 bc	5 a
Barley	Verdant	11291 a	40 a	5 ab
	ALBA	14201 a	34 a	6 ab
	OG140760	12946 a	49 a	14 a
	OG140789	16117 a	38 a	2 b
	OG140797	16640 a	35 a	3 ab
Rye	Goku	19776 a	30 a	0 a
	Elbon	18565 a	30 a	1 a
	Abruzzi	25003 a	26 a	2 a

[z]Values followed by the same letter are not significantly different at $P \leq 0.05$ as determined by the Tukey-Kramer method.

Table 3. Average reniform nematode eggs/g of fresh root on each small grain crop varieties averaged by crop in the reniform field in Shorter, AL in January 2019 versus May 2020.

Crop	Reniform Eggs/g of Root – Jan[z]	Reniform Eggs/g of Root – May[z]
Triticale	10 a[z]	2 b[z]
Wheat	5 a	0 c
Oat	17 a	0 c
Barley	10 a	1 bc
Rye	5 a	4 a

[z]Values followed by the same letter are not significantly different at $P \leq 0.05$ as determined by the Tukey-Kramer method.

Table 4. Above-ground biomass, yield, and reniform nematode numbers of varieties tested in the reniform field in May 2020 in Shorter, AL.

Type	Variety	Above-ground Biomass lbs/A[z]	Bushels/A[z]	RR Eggs/g of Root[z]
Triticale	Doublet	10803 bc[z]	22 a[z]	2 ab[z]
	OG8782	4879 e	3 ef	0 ab
	OG8783	8590 b-de	16 b	1 ab
	Forerunner	9165 bcd	8 de	0 ab
	158 EP	5750 de	3 ef	2 ab
	Round Table	8181 bc	3 f	3 a
	OG170004	8477 b-e	7 def	1 ab
	OG170012	16387 a	14 bc	2 ab
	OG170023	7153 cde	6 def	3 ab
	OG170035	17485 a	17 b	1 ab
	OG170036	12092 b	10 cd	0 b
	OG170039	9252 bcd	10 cd	2 ab
	OG170040	10245 bc	7 de	3 ab
	OG170043	9784 bcd	10 cd	1 ab
Wheat	KGAL	13835 a	8 b	3 a
	Summit 515	2840 b	3 c	0 a
	Willow Creek	4029 b	2 c	3 a
	OG9484	6430 b	19 a	7 a
Oat	Intimidator	8921 b	4 c	1 a
	Shooter	11291 ab	5 c	0 a
	TAM 411	14566 a	59 a	0 a
	Buck Forage	14680 a	11 bc	0 a
	OG6285	8067 b	16 b	0 a
Barley	Verdant	7074 ab	10 c	0 a
	Alba	6003 ab	36 a	0 a
	OG140760	5279 ab	27 b	0 a
	OG140789	7353 a	13 c	2 a
	OG140797	4887 b	15 c	1 a
Rye	Goku	7684 b	9 c	7 a
	Elbon	6795 b	13 b	4 a
	Abruzzi	15690 a	28 a	1 a

[z]Values followed by the same letter are not significantly different at $P \leq 0.05$ as determined by the Tukey-Kramer method.

Table 5. Pounds of above-ground biomass/A of varieties tested in the non-nematode field in Germanton, NC.

Type	Variety	Above-ground Biomass lbs/A[z]
Triticale	Doublet	33828 bc[z]
	OG8782	18319 ef
	OG8783	26102 c-f
	Forerunner	30231 bcd
	158 EP	16206 f
	Round Table	31038 bcd
	OG170004	23013 def
	OG170012	32863 bcd
	OG170023	38259 ab
	OG170035	45688 a
	OG170036	29406 bcd
	OG170039	27984 cde
	OG170040	23436 c-f
	OG170043	30078 bcd
Wheat	KGAL	54394 a
	Summit 515	8374 d
	Willow Creek	37357 b
	OG9484	26428 c
Oat	Intimidator	30884 a
	Shooter	33266 a
	TAM 411	25987 a
	Buck Forage	32248 a
	OG6285	19341 b
Barley	Verdant	7375 c
	Alba	12888 a
	OG140760	9603 b
	OG140789	9075 bc
	OG140797	8028 bc
Rye	Goku	25122 a
	Elbon	30231 a
	Abruzzi	28099 a

[z]Values followed by the same letter are not significantly different at $P \leq 0.05$ as determined by the Tukey-Kramer method.

Table 6. Forage quality results from Dairy One Forage Lab in Ithaca, NY of vegetative biomass bulk sample averaged by grain crop in January, 80 DAP, in the non-nematode field in North Carolina 2019?.

	% Crude Protein[z]	% Acid Detergent Fiber[z]	%Neutral Detergent Fiber[z]	%Total Digestible Nutrients[z]	Relative Feed Value[z]
Triticale	25 a[z]	29 a[z]	48 a[z]	66 b[z]	131 a[z]
Wheat	21 ab	29 a	48 a	65 b	137 a
Oat	20 bc	27 a	45 a	70 a	143 a
Barley	15 c	25 a	44 a	70 a	146 a
Rye	18 bc	25 a	45 a	70 a	146 a

[z]Values followed by the same letter are not significantly different at $P \leq 0.05$ as determined by the Tukey Kramer method.

Summary

In this study, neither root-knot nor reniform nematode egg numbers increased from January to May. Root-knot nematode eggs/g of root were similar among the small grain crops tested. However, the data suggests the barley varieties supported more root-knot nematode reproduction compared to the other small grains. In the reniform field, there were no significant differences in reniform eggs/g of root between the small grain varieties tested. The data suggests above-ground biomass production may be unaffected by a higher nematode population density. In both the root-knot and reniform fields, oat, rye, and triticale varieties produced greater above-ground biomass compared to wheat or barley. In the non-nematode field, above-ground biomass production was statistically similar between wheat, triticale, oat, and rye varieties followed by barley. Grain yield was overall low in both the root-knot and reniform fields, however, 'TAM 411' oat yielded the most bushels/A in both nematode trials. Overall forage quality based on relative feed value was statistically similar for all small grain types in the vegetative stage in the non-nematode field. Additional testing is ongoing to further evaluate the susceptibility of these small grain cover crops and analysis of their cover crop quality.

References

Lawrence, K., A. Hagan, R. Norton, J. Hu, T. Faske, R.B. Hutmacher, J. Muller, I. Small, R. Kemerait, P. Price, T. Allen, S. Atwell, J. Idowu, L. Thiessen, J. Goodson, H. Kelly, T. Wheeler, T. Isakeit, and H. Mehl. 2020. Cotton Disease Loss Estimate Committee Report, 2019. Proc. Beltwide Cotton Conf. National Cotton Council of America, Memphis, TN.

Timper, P., Davis, R.F., Tillman, P.G., 2006. Reproduction of *Meloidogyne incognita* on Winter Cover Crops Used in Cotton Production. J Nematol 38, 83–89