EVALUATION OF BRASSICA WINTER CROPS AND METAM SODIUM FOR NEMATODE CONTROL ON DOUBLE-CROPPED SQUASH

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Introduction

In the subtropical climate of the southeastern US, polyethylene beds are commonly used for two to four vegetable crops before they are destroyed (double- or multiple cropping). The following test was looking at a double-cropped system in the previously reported "**EVALUATION OF BRASSICA WINTER CROPS AND METAM SODIUM ON SOILBORNE PEST AND DISEASE CONTROL IN EGGPLANT".** A squash crop was grown as a second crop following a first crop of eggplant to evaluate the effect of winter crops, fumigants and biomass incorporation on double -cropped vegetable systems.

Materials and Methods

The study was located at the Blackshank Farm, CPES, Tifton, GA. Beds were installed in spring and a first crop of eggplant was grown from 24 March till 27 June, 2004 (see previous report). Following eggplant, all beds that were fumigated (with methyl bromide or metam sodium) prior to the first crop were drip-fumigated with metam sodium (37.5 gal/A) on 30 July (Table 1). Non-treated beds were sprayed with glyphosate to kill eggplant and plastic mulch was painted white.

Squash seedlings, cv. Destiny III, were produced in nutrient tray system to the 4-leaf stage. A single plant was transplanted using a mechanical type transplanter, which cuts holes in the plastic just ahead of the planters in the center of the plastic bed adjacent to the drip tape on 23 August. Plant spacing was 12 in.

Fertilizer on squash was added in the form of liquid fertilizer (4-0-8) injected through the irrigation tubing during the growing season. All squash plots were sprayed on a 4 to 7 day interval with Manex with Zinc (2.4 qt/A) plus Kocide LF (0.5 gal/A) and Bravo (2 pts/A) for control of foliar diseases, and Ambush (10 oz./A) alternating with Pounce 3.2 (6 oz./A), Asana XL (6 oz./A) and Avaunt (3 oz./A) for insect control.

Stand counts were made to record live plants on 8 and 21 September and plant vigor ratings were done on 8 and 16 September. Plant vigor was rated on a 1 to 10 scale, 10 representing live and healthy plants and 1 representing dead plants.

Twelve cores of soil, 2.5-cm-diam × 25-cm-deep, were collected from the center of each plot at planting of squash (25 August) and at harvest (8 November) of squash. Nematodes were extracted from a 150-cm^3 soil sub-sample using a centrifugal sugar flotation technique, except at planting when they were extracted in Baermann pans (to capture only active nematodes). On 17 September (at flowering stage) an early root gall evaluation was done on three plants per plot using a 0 to 10 scale, whereby, 0 = no galls, 1 = very few small galls, 2 = numerous small galls, 3 = numerous small galls of which

some are grown together, 4 = numerous small and some big galls, 5 = 25 % of roots severely galled, 6 = 50 % of roots severely galled, 7 =75 % of roots severely galled, 8 = no healthy roots but plant is still green, 9 = roots rotting and plant dying, 10 = plant and roots dead. Again following final harvest on 18 October ten plants per plot were evaluated for root galls using that same scale.

All squash fruits were hand-harvested from the 15-ft center area of each bed (15 plants per plot). Each harvest was separated into marketable and cull fruits, counted, and weighed. There were a total of four harvests, on 21 and 29 September, and 5 and 12 October.

All data collected was analyzed with an analysis of variance (P = 0.05) and means were separated using Duncan's Multiple range test.

Summary

Following fumigation with metam sodium, at planting of squash, populations of root-knot nematodes were significantly reduced, more so when metam sodium instead of methyl bromide had been applied on the first crop (Table 1). Root-knot nematode populations were numerically (but not significantly) greater in plots that had rutabaga as a winter crop, and in plots where winter crop biomass was removed. Other plant-parasitic nematodes were low and not different among treatments. Omnivorous nematodes were significantly greater following rye and were reduced by fumigation, but only when metam sodium (second crop) followed metam sodium (first crop). Fungivorous nematodes were increased when metam sodium (second crop) followed methyl bromide (first crop).

By harvest of squash, populations of root-knot nematodes had increased significantly, and populations were still numerically (but not significantly) higher with rutabaga > turnip > rye (Table 2). Fumigation did no longer have a significant effect on nematode populations at this stage, although root-knot nematodes were still numerically higher in untreated plots.

Squash growth, in terms of plant vigor and plant weight at mid season, was best following rye (Table 3). Fumigated plots, irrespective of the fumigant used on the first crop, showed better growth than untreated plots.

Root-knot gall indices (GI) indicated high nematode pressure and GI at mid season and at harvest were significantly reduced following fumigation, irrespective of the fumigant used on the first crop (Table 3). Rye winter crop resulted in lower GI at mid season. Biomass incorporation/removal had no effect on plant vigor and GI.

Squash yield, specifically the number of marketable fruits, were somewhat greater following rye as compared to rutabaga (Tables 4, 5). Significantly greater squash yields (three- to six-fold) were recorded following fumigation with metam sodium, as compared to untreated plots. The fumigant used on the first crop, methyl bromide or metam sodium, did not significantly affect yields of the second crop.

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Table 1. Populations of plant-parasitic and free-living nematodes at planting of squash, following a first crop of eggplant, as affected by previous winter cover crops, pre-plant fumigants, and incorporation/removal of winter crop biomass, summer 2004, Black Shank Farm Tifton, GA.

Factor Effects	Plant-parasitic nematodes /150 cc			Free-living nematodes / 150 cc soil			
	Root-knot	Stubby	Total	Bacteri-ovores	Fungi-ovores	Omni-ovores	Total
WINTER CROP							
Turnip	170	3	173	484	25	14 b	523
Rutabaga	362	2	364	453	26	15 b	494
Rye	103	4	107	628	40	36 a	704
Fpr	0.38	NS	0.65	NS	NS	<0.01	NS
FUMIGANT (CROP1-CROP2)							
Metam sodium-Metam sodium	3 b	3	6 b	571	38 b	11 b	710
Methyl bromide-Metam sodium	75 b	4	79 b	624	104 a	34 a	655
Control-Control	415 a	5	420 a	419	36 b	37 a	492
Fpr crop 1 MS VS MBr	0.01	NS	0.03	NS	0.06	0.03	NS
Fpr crop 2 MS VS UTC	<0.01	NS	<0.01	NS	<0.01	<0.01	NS
BIOMASS							
Incorporated	154	3	156	609	31	25	664
Removed	270	4	274	434	30	19	483
Fpr	0.16	NS	NS	NS	NS	NS	NS
INTERACTIONS *Fpr* (all)	NS	NS	NS	NS	NS	NS	NS

Nematode samples were collected on April 30; Root-knot nematode (*Meloidogyne* spp.); Stubby root nematode (Trichodoridae); B'vores = bacterial-feeding, F'vores = fungal-feeding, O'vores = predatory and omnivorous nematodes; Free-living nematodes = non-parasitic nematodes

Data are means of five replications. Means in the same column followed by the same letter are not different (P = 0.05) according to Duncan's multiple range test. No letters indicate non-significant difference; NS = not significant. Fumigant effects averaged over all plots (n=56); Winter crop and biomass effects averaged for all plots excluding Rye + MBr (n=48)

Table 2. Populations of plant-parasitic and free-living nematodes at harvest of squash, following a first crop of eggplant, as affected by previous winter cover crops, pre-plant fumigants, and incorporation/removal of winter crop biomass, summer 2004, Black Shank Farm Tifton, GA.

Factor effects	Plant-parasitic nematodes /150 cc			Free-living nematodes / 150 cc soil			
	Root-knot	Stubby	Total	Bacteri-ovores	Fungi-ovores	Omni-ovores	Total
WINTER CROP							
Turnip	1307	17	1324	506	24	57	586
Rutabaga	1123	27	1149	528	43	76	647
Rye	953	16	969	545	55	89	688
Fpr	NS	0.06	NS	NS	NS	NS	NS
FUMIGANT (CROP1-CROP2)							
Metam sodium-Metam sodium	763	26	789	503	66	44	613
Methyl bromide-Metam sodium	1120	11	1131	543	66	84	693
Control-Control	1315	16	1330	514	21	110	645
Fpr crop 1 MS VS MBr	NS	0.09	NS	NS	NS	NS	NS
Fpr crop 2 MS VS UTC	NS	NS	NS	NS	0.03	<0.01	NS
BIOMASS							
Incorporated	1318	14	1332	569	39	83	689
Removed	887	25	911	489	46	70	605
Fpr	NS	<0.01	NS	NS	NS	NS	NS
INTERACTIONS *Fpr* (all)	NS	NS	NS	NS	NS	NS	NS

Root-knot nematode (*Meloidogyne* spp.); Stubby root nematode (Trichodoridae); B'vores = bacterial-feeding, F'vores = fungal-feeding, O'vores = predatory and omnivorous nematodes; Free-living nematodes = non-parasitic nematodes. Data are means of five replications. Means in the same column followed by the same letter are not different (P = 0.05) according to Duncan's multiple range test. No letters indicate non-significant difference; NS = not significant. Fumigant effects averaged over all plots (n=56); Winter crop and biomass effects averaged for all plots excluding Rye + MBr (n=48)

Table 3. Plant vigor and root-gall indices of squash, following a first crop of eggplant, as affected by previous winter cover crops, pre-plant fumigants, and incorporation/removal of winter crop biomass, summer 2004, Black Shank Farm Tifton, GA.

Fumigant	Plant stand		Plant vigor [a]		Root gall index [b]	
	At 2w	At harvest	At 1 w	At 2 w	At 20 d	At harvest
WINTER CROP						
Turnip	14.6	7.2 b	6.0 b	5.7 b	5.2 a	7.9
Rutabaga	14.4	8.3 ab	6.0 b	6.1 ab	3.9 b	7.9
Rye	14.7	9.8 a	6.9 a	6.8 a	3.9 b	7.6
Fpr	NS	0.03	0.01	0.05	0.06	NS
FUMIGANT (CROP1-CROP2)						
Metam sodium-Metam sodium	14.8	10.5 a	7.9 a	8.3 a	2.1 b	6.1 b
Methyl bromide-Metam sodium	14.9	10.0 a	7.4 a	8.1 a	1.7 b	6.0 b
Control-Control	14.4	6.3 b	4.8 b	4.0 b	6.6 a	9.8 a
Fpr crop 1 MS VS MBr	NS	NS	NS	NS	NS	NS
Fpr crop 2 MS VS UTC	NS	<0.01	<0.01	<0.01	<0.01	<0.01
BIOMASS						
Incorporated	14.3	8.6	6.3	6.2	4.2	7.4
Removed	14.8	8.3	6.4	6.2	4.2	8.2
Fpr	NS	NS	NS	NS	NS	NS
INTERACTIONS *Fpr* (all)	NS	NS	0.01 (winter crop x fumigant)	NS	NS	NS

[a] Vigor was done a 1-10 scale with 10= live and healthy plants and 1=dead plants; [b] Root Gall Index 0-10 scale whereby, 0 = no galls, 1 = very few small galls, 2 = numerous small galls, 3 = numerous small galls of which some are grown together, 4 = numerous small and some big galls, 5 = 25 % of roots severely galled, 6 = 50 % of roots severely galled, 7 =75 % of roots severely galled, 8 = no healthy roots but plant is still green, 9 = roots rotting and plant dying, 10 = plant and roots dead; Fumigant effects averaged over all plots (n=56); Winter crop and biomass effects averaged for all plots excluding Rye + MBr (n=48). Data are means of five replications. Means in the same column followed by the same letter are not different (P = 0.05) according to Duncan's multiple range test; NS = not significant.

Table 4. Fruit yield number of of squash, following a first crop of eggplant, as affected by previous winter cover crops, pre-plant fumigants, and incorporation/removal of winter crop biomass, summer 2004, Black Shank Farm Tifton, GA.

Fumigant	Number of marketable fruits*					Number of culls
	Yield 1	Yield 2	Yield 3	Yield 4	Total	Total
WINTER CROP						
Turnip	4.9	6.6	2.3 ab	4.8	18.5 ab	6.3
Rutabaga	3.7	6.4	1.5 b	4.8	16.3 b	5.8
Rye	5.1	7.4	3.1 a	5.8	21.5 a	7.4
Fpr	NS	NS	0.10	NS	0.10	NS
FUMIGANT (CROP1-CROP2)						
Metam sodium-Metam sodium	8.0 a	10.6 a	3.8 a	8.1 a	30.6 a	10.6 a
Methyl bromide-Metam sodium	5.0 b	9.0 a	2.8 a	8.8 a	25.5 a	9.5 a
Control-Control	1.1 c	3.0 b	0.8 b	2.1 b	7.0 b	2.4 b
Fpr crop 1 MS VS MBr	0.10	NS	NS	NS	NS	NS
Fpr crop 2 MS VS UTC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BIOMASS						
Incorporated	4.4	7.2	2.4	5.5	19.5	7.3
Removed	4.8	6.4	2.2	4.7	18.1	5.7
Fpr	NS	NS	NS	NS	NS	NS
INTERACTIONS *Fpr* (all)	NS	NS	NS	NS	NS	NS

* per 15 ft bed length; Data are means of five replications. Means in the same column followed by the same letter are not different (P = 0.05) according to Duncan's multiple range test. No letters indicate non-significant difference; NS = not significant. Fumigant effects averaged over all plots (n=56); Winter crop and biomass effects averaged for all plots excluding Rye + Mbr (n=48).

Table 5. Fruit yield weight of squash, following a first crop of eggplant, as affected by previous winter cover crops, pre-plant fumigants, and incorporation/removal of winter crop biomass, summer 2004, Black Shank Farm Tifton, GA.

Fumigant	Weight of marketable fruits (lbs)*					Weight of culls (lbs)
	Yield 1	Yield 2	Yield 3	Yield 4	Total	Total
WINTER CROP						
Turnip	1.4	2.5	0.8	1.8	6.4	1.6
Rutabaga	0.9	3.1	0.7	1.6	6.3	1.5
Rye	1.3	3.2	1.2	2.4	8.1	1.6
Fpr	NS	NS	NS	NS	NS	NS
FUMIGANT (CROP1-CROP2)						
Metam sodium-Metam sodium	2.3 a	4.9 a	1.6 a	3.2 a	12.0 a	2.7 a
Methyl bromide-Metam sodium	1.5 b	4.9 a	1.2 a	3.7 a	11.4 a	2.3 a
Control-Control	0.2 c	1.0 b	0.2 b	0.6 b	2.0 b	0.5 b
Fpr crop 1 MS VS MBr	0.11	NS	NS	NS	NS	NS
Fpr crop 2 MS VS UTC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
BIOMASS						
Incorporated	1.2	3.2	0.9	2.2	7.4	1.7
Removed	1.2	2.7	0.9	1.7	6.5	1.4
Fpr	NS	NS	NS	NS	NS	NS
INTERACTIONS *Fpr* (all)	NS	NS	NS	NS	NS	NS

* per 15 ft bed length; Data are means of five replications. Means in the same column followed by the same letter are not different (P = 0.05) according to Duncan's multiple range test. No letters indicate non-significant difference; NS = not significant. Fumigant effects averaged over all plots (n=56); Winter crop and biomass effects averaged for all plots excluding Rye + MBr (n=48).