2007

Soil Pretreatment Management Practices Effects on Grapevine Plant Growth, Pest Populations, and Soil Characteristics

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Abstract
Rotations of cover crops with cropping systems have been found to improve soil quality, reduce erosion, and suppress pests such as nematodes and weeds. Cover crops can provide a sustainable alternative to chemical pesticides by reducing pest accumulation, while preventing the degradation of soil structure. The objective of this study was to investigate how different cover crops affect weed and nematode populations and soil physical, chemical and biological properties when used in replant sites with *Vitis spp*. (grape) compared with conventional tillage or herbicide treatment.

Keywords
Horticulture

Disciplines
Agricultural Science | Agriculture | Horticulture

Soil Pretreatment Management Practices Effects on Grapevine Plant Growth, Pest Populations, and Soil Characteristics

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Introduction

Rotations of cover crops with cropping systems have been found to improve soil quality, reduce erosion, and suppress pests such as nematodes and weeds. Cover crops can provide a sustainable alternative to chemical pesticides by reducing pest accumulation, while preventing the degradation of soil structure. The objective of this study was to investigate how different cover crops affect weed and nematode populations and soil physical, chemical and biological properties when used in replant sites with *Vitis* spp. (grape) compared with conventional tillage or herbicide treatment.

Materials and Methods

The experiment was established in 2000 at the Iowa State University, Horticulture Research Station, Ames, IA in plots that had Seyval Blanc grapevines growing from 1986 to 1996. The plots were fallow for four years before establishing the treatments. Four soil management treatments served as the main plots and included *Rudbeckia hirta* L. (black-eyed Susan), *Panicum virgatum* L. (switchgrass), hand cultivation, and conventional herbicide application. In 2005, cover crops or weeds were chemically treated followed by planting Seyval Blanc grapevines on their own roots and Seyval Blanc grapevines grafted onto C-3309 rootstock. Types (grafted or own-rooted) of plants served as the split plot and were randomized within the main treatment plots and replicated four times. In fall 2005, treatment rows were mulched with straw to cover graft unions for winter protection. In spring 2006, mulch was removed and discarded from rows. Plots were treated with contact herbicide each month after weed data collection. Weed growth was evaluated by visual percentage, number of weeds, type of weeds, and weed shoot biomass (dry weight). Grapevine plant biomass was evaluated by current season cane vigor (height) and pruning weight (spring 2007). Soil quality will be determined by measuring macroaggregate mass (wet aggregate stability), bulk density, water infiltration, percentage organic carbon, and nitrogen, pH, and nitrogen and carbon utilization. Nematodes were enumerated from soil by sugar extraction.

Results and Discussion

Weed growth results. In 2005, weed growth in plots that had previously grown *R. hirta* had a lower number of grasses in July and August compared with the herbicide-treated plots (Table 1).

In 2006, grass weed growth was generally higher in the cover crop treatment plots compared with the herbicide treatment plots. Weed biomass (dry weight) was higher in June than in August (Table 2).

Shoot growth results. In 2005, more grape shoot growth occurred on grafted vines compared with vines on their own roots (own-rooted). Shoot growth of grafted vines was higher in the *R. hirta* treatment compared with the *P. virgatum* and hand-cultivated treatments (Table 3). There were no differences in growth among weed management treatments in the own-rooted plots.

In 2006, grape shoot growth was greater on grafted plants in herbicide treatment plots than on grafted plants in *P. virgatum*, hand cultivated treatment plots, and all plots of own-rooted plants. When weed management treatments were averaged together, grafted plants grew as much as three times more than own-rooted plants (data not presented).

Water infiltration results. Soil in *R. hirta* plots had higher water infiltration rates than the hand-cultivated or herbicide-treated plots in the spring of 2005 (Table 4). *R. hirta* plots also had higher water infiltration than *P. virgatum* and herbicide treatments in the fall of 2005. There was no difference between treatment plots in 2006. All water infiltration values presented in Table 4 are considered very rapid rates according to the USDA, Soil Quality Test Kit Manual.

The study will be continued in the 2007 growing season to determine grapevine plant and weed growth of the treatment plots. In addition, soil and nematode analyses will be completed.

Table 1. Incidence of weed growth in Seyval Blanc grapevine rows grown in sites with previous cover crop or control treatments, July and August 2005.^{zy}

	2005									
	Weed cover (%)		Grasses (no.)		Broadleaves (no.)		Grass dry weight (g)		Broadleaf dry weight (g)	
Treatments	July	Aug.	July	Aug.	July	Aug.	July	Aug.	July	Aug.
R. hirta	4.2 b	18.1 b	8 b	5 b	1	7 a	0.5 b	2.2 b	0.1	1.1 b
P. virgatum	12.1 ab	40.8 a	20 ab	9 a	4	7 a	2.0 ab	7.4 a	0.7	1.7 ab
Hand cult.	13.3 ab	33.8 ab	10 b	6 ab	6	7 a	0.6 b	4.0 ab	1.5	6.0 a
Herbicide	24.6 a	24.2 b	31 a	9 a	6	6 ab	8.4 a	3.7 ab	1.2	0.7 b
LSD $P \leq 0.05$	16.3	16.3	22	4	NS	6	6.8	4.9	NS	4.6

^{z}Means of four replications. Means within columns followed by the same letter are not different.
^{y}Data presented are averages of three samples (.5 meter^2) per plot.

Table 2. Incidence of weed growth in Seyval Blanc grapevine rows grown in sites with previous cover crop or control treatments, June and August 2006.^{zy}

	2006									
	Weed cover (%)		Grasses (no.)		Broadleaves (no.)		Grass dry weight (g)		Broadleaf dry weight (g)	
Treatments	June	Aug.	June	Aug.	June	Aug.	June	Aug.	June	Aug.
R. hirta	33.9 ab	31.5	34 a	22	4	3 b	7.5 b	7.9 ab	16.6 a	1.5 b
P. virgatum	57.2 a	38.9	20 ab	12	6	3 b	37.7 a	9.9 a	7.3 ab	1.0 b
Hand Cult.	29.4 b	22.5	16 ab	7	4	3 b	8.5 b	3.7 ab	6.9 ab	1.7 b
Herbicide	14.1 b	39.4	10 b	5	6	8 a	1.5 b	3.3 b	0.9 b	4.2 a
LSD $P \leq 0.05$	25.3	NS	23	NS	NS	4	17.2	6.5	15.1	2.3

^{z}Means of four replications. Means within columns followed by the same letter are not different.
^{y}Data presented are averages of three samples (.5 meter^2) per plot.

Table 3. Seyval Blanc grapevine plant growth in the first and second year of growth with previous cover crop, conventional or control treatments. $^{z\ y}$

Treatments	Type of plant	Avg. growth in 2005 (cm)	Avg. growth in 2006 (cm)	Difference in growth (cm) between 2005 and 2006
R. hirta	Own roots	100.4 c	210.8 cd	110.4 bc
P. virgatum	Own roots	127.6 c	211.8 cd	84.1 bc
Hand Cult.	Own roots	85.1 c	151.1 d	66.0 bc
Herbicide	Own roots	115.3 c	171.4 cd	56.1 c
R. hirta	Grafted	380.1 a	676.4 ab	296.3 ab
P. virgatum	Grafted	274.6 b	430.1 bc	155.5 bc
Hand Cult.	Grafted	271.9 b	375.8 cd	103.9 bc
Herbicide	Grafted	301.8 ab	720.6 a	418.9 a
LSD P≤0.05		87.15	260.14	237.67

^{z}Means of four replications. Means within columns followed by the same letter are not different.
^{y}Data presented are total growth first year plants.

Table 4. Effect of cover crop or control treatment on water infiltration into the soil. $^{z\ y\ x}$

	2005		2006
Treatments	Spring (in./hour)	Fall (in./hour)	Fall (in./hour)
R. hirta	123.8 a	108.7 a	71.1 a
P. virgatum	105.2 ab	58.3 b	88.03 a
Hand Cult.	42.3 bc	69.7 ab	66.4 a
Herbicide	29.8 c	40.7 b	49.4 a
LSD P≤0.05	67.7	44.0	NS

^{z}Means of four replications. Means within columns followed by the same letter are not different.
^{y}Data presented are averages of three samples per plot.
^{X}Preliminary analysis, percent moisture has not been figured into the infiltration of the soil.