Sustainable Weed Management Systems to Improve Soil Quality in Midwest Viticulture

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Introduction

The use of herbicides in vineyards has been an effective and cost-efficient means of in-row weed management. However, as public concerns about environmental issues have increased, grape growers have become aware of a need for alternative methods of weed management. The overall objective of this project is to identify optimal weed management practices that maximize grapevine growth and development as well as the quality of vineyard soils. A secondary objective of the project is to determine physical and biological soil measurements that could be used in combination with standard chemical soil analyses to indicate an improving or declining condition of a vineyard soil. Another secondary objective is to develop a soil quality index to be used by producers as a tool to assist with vineyard soil management decisions.

Materials and Methods

Two vineyards at the Iowa State University Horticulture Station, Ames, Iowa, were used in the experiment: a mature vineyard (est. 1985) and a three-year-old vineyard (est. 2002). The experimental design was a randomized complete block with four weed management treatments and four replications. Treatments applied to the mature vineyard were as follows:
1) conventional herbicide, 2) cultivation/tillage, 3) straw mulch, and 4) living mulch of creeping red fescue (*Festuca rubra*). The three-year-old vineyard contained all treatments except the creeping red fescue-living mulch treatment (three treatments).

Results and Discussion

In the three-year-old vineyard, average grapevine cluster weight and number were lower in the straw mulch treatment compared with the herbicide or cultivation treatments (Table 1). There were no differences between weed management treatments for Marechal Foch yield variables in the mature vineyard (data not presented). In the three-year-old vineyard, percent weed cover was lowest in the straw mulch treatment plots in May and July 2005 compared with the other two treatments (Table 1). In the mature vineyard, percent weed cover was lowest in the living and straw mulch treatment plots (Table 2).

Soil quality factors of water infiltration, bulk density, volumetric water content, and water-filled pore space were similar for all treatments in the three-year-old vineyard (data not presented). Infiltration rate was greatest in the living mulch treatment, and air-filled pore space was similar between the living mulch and cultivation treatments (Table 2). Preliminary results indicate that the rate of soil respiration, an indicator of microbial activity in the soil, was highest in the living mulch treatment plots of the mature vineyard at both 0–3 and 3–6 in. soil depths (data not presented). Soil respiration rate was not different among the three treatments of the three-year-old vineyard at either soil depth. The preliminary results of this study show that using a living mulch of creeping red fescue for weed control in the mature vineyard row had the benefits of reducing weed populations to negligible levels, while improving physical (soil infiltration and air-filled pore spaces) and biological (increased soil respiration) soil properties without reducing grape yield. Continued research is needed to verify these findings and the experiments will be continued in 2006.

Acknowledgments

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Table 1. Marechal Foch grape yield and percent weed cover data collected from three weed management treatments in a three-year-old vineyard at Iowa State University, 2005.

			Percent weed cover[y]		
Treatment[z]	Avg. grape cluster no./vine	Avg. grape cluster wt. (g)	May	July	August
Straw mulch	9 b	36.1 b	0.3 b	3.9 c	8.3
Herbicide	16 a	61.0 a	16.0 a	90.8 b	8.2
Cultivation	20 a	56.7 a	12.7 a	97.1 a	3.4
LSD[x]	6	12.3	8.8	4.7	NS

[z]Means of four replications.
[y]Means were obtained from the average of three 0.25m^2 quadrats/plot.
[x]Least significant difference @ P<.05; NS=not significant. Values with the same letter are not significantly different from each other.

Table 2. Percentage weed cover and six soil quality measurements taken at the 0–3 in. soil depth from four weed management treatments at ISU in a mature vineyard soil quality experiment, 2005.

	Percent weed cover[y]			Infiltration	Volumetric water content	Air-filled pore space	Water-filled pore space
Treatment [z]	May	July	August	in./hr	(%)	(%)	(%)
Living mulch	1.1 bc	3.3 c	3.5 c	102.01 a	15.8 b	25.8 a	37.7 b
Straw mulch	8.7 bc	0.0 c	2.4 c	41.47 b	24.8 a	19.5 b	56.1 a
Herbicide	16.8 b	87.9 b	30.0 b	28.34 b	22.0 b	20.0 b	52.5 a
Cultivation	98.3 a	95.2 a	93.0 a	44.42 b	22.3 b	23.3 a b	48.9 a
LSD[x]	10.6	7.0	9.4	33.5	4.3	4.4	8.2

[z]Means of four replications.
[y]Means were obtained from the average of three 0.25m^2 quadrats/plot.
[x]Least significant difference @ P<.05; NS=not significant. Values with the same letter are not significantly different from each other.