Weed Management and Soil Quality in Vineyard Agroecosystems

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A new project to examine the effects of conventional and alternative weed management on soil quality in vineyards in three states was initiated in 2004. Vineyards used in the experiment at Iowa State University (ISU) consist of a mature vineyard (est. 1985) and a newly established vineyard (est. 2002). The vineyards used for the experiment in cooperating states of Indiana and North Dakota include newly established vineyards at Purdue University and North Dakota State University (NDSU). The goal of the project is to identify optimal weed management practices for soil quality and grapevine growth and development. A sub-objective of the project is to determine biological parameters that can be measured and used in combination with standard chemical and physical soil measurements to indicate an improving or declining condition of a vineyard soil. Data from the measurements will be normalized and incorporated into a mathematical index, called a soil quality index, to be used to gauge the level of an improving or declining soil condition. Four weed management treatments were established and include: 1) conventional herbicide, 2) cultivation/tillage, 3) straw mulch, and 4) a living mulch of creeping red fescue. The fescue was planted in fall 2003 and initial weed control treatments began in spring 2004. In Ames, during the spring, summer, and fall of 2004, data were collected on weed growth and development (number, species, and percentage cover), 'Foch' grape yield (total yield per vine, cluster number and weight, berry weight) and quality (pH, percent soluble solids, titratable acidity), nutrient status of plant petiole, nutrient status of soil, microbial activity of soil (microbial biomass carbon, soil respiration, potentially mineralizable nitrogen), number of earthworms present, and physical indicators of soil quality (soil texture, water retention, bulk density, wet aggregate stability, water infiltration, and soil temperature). Creeping red fescue was planted and initial soil samples were collected at Purdue University and NDSU. Preliminary results are presented in Table 1.

Summary of data presented in Table 1.

Plots in the mature vineyard at ISU had a higher percentage weed cover in the cultivated treatments compared to the other treatments in both July and August (Table 1). Herbicide-treatment plots had a similar percentage weed cover in July and August as plots receiving the straw mulch and living mulch treatments. In August, plots receiving the straw mulch treatment had a lower percent weed cover than the living mulch treatment plots and had an amount similar to the herbicide treatment. The primary weed species in the living mulch treatment plots was clover.

Infiltration rate and bulk density did not differ between treatments. Plots receiving the straw mulch treatment had a higher volumetric water content and percentage water-filled pore space than all other treatments. Thus, the soil receiving the straw mulch treatment held more water in the top three inches of soil compared to the other treatments. Percentage of total soil porosity

measured from plots receiving the living mulch and straw mulch treatments showed a higher percentage than the herbicide treatment data, but their percentages did not differ from the cultivated treatment plots.

Grape yield, including average berry weight, average cluster number per vine, average cluster weight per vine, average yield per vine, and quality, including percent soluble solids, pH, and titratable acidity, were similar among all treatments (data not presented).

Soil samples from plots of the newly established vineyards at ISU and Purdue University showed no differences for infiltration rate, volumetric water content, bulk density, total porosity, air-filled porosity, and water-filled pore space (data not presented). Soil samples from NDSU plots have been obtained and currently are being analyzed.

Table 1. Percentage weed cover and six soil quality measurements taken from four weed management treatments at ISU in mature vineyard soil quality experiment, 2004. Variables included infiltration rate, volumetric water content, bulk density, total porosity, air-filled porosity, and water-filled pore space.

Soil management treatment [z]	Percent Weed cover [y] July		Percent Weed cover [y] August		Infiltration rate (in/hr)	Volumetric water content (%)		Bulk density (g/cm^3)	Total porosity (%)		Air-filled Porosity (%)		Water-filled pore space (%)	
Living mulch (fescue)	7.2	b	10.5	b	31.5	23.8	b	1.35	49.1	a	25.3	a	48.5	c
Straw mulch	2.7	b	0.8	c	37.2	32.3	a	1.35	49.0	a	16.7	b	65.9	a
Herbicide	3.4	b	7.1	bc	10.4	25.2	b	1.45	45.3	b	20.1	b	55.8	b
Cultivation	89.8	a	20.4	a	13.5	23.7	b	1.38	47.9	ab	24.1	a	49.6	c
LSD [x]	8.4		8.6		NS	2.4		NS	3.4		3.7		5.6	

[z] Means of four replications.
[y] Means obtained from the avg. of three, $0.25m^2$ quadrats per plot.
[x] Least significant difference ($P \leq 0.05$); NS = Not significant

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