No-Till Systems and Permanent Cover Cropping Enhances Plant Available Water in Vineyards

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Introduction

The San Joaquin Valley of California is the leading irrigated viticulture region in the world. However, as climate change advances, lower precipitation and higher temperatures challenge the water contents in soils. It is well known that cover crops mitigate soil erosion and water loss, however, there is a lack of information on what could be the best strategy to preserve plant available water in soil prior to the initiation of irrigation.

Cover crops and reduced tillage practices have also been shown to enhance the storage of soil organic carbon (SOC). Soil respiration is a key component of C content in agricultural soils and is primarily the result of the oxidation of organic matter by microorganisms (Steenwerth et al., 2008). In fact, the production of CO_2 during respiration is the primary loss of C from terrestrial ecosystems. The application of cover crops and altered tillage practices to sequester C has received increased attention with the goal of mitigating greenhouse gas emissions, but research is limited regarding their impact in perennial cropping systems such as vineyards (Wolff et al., 2018). We conducted a study in Fresno and Oakville with three cover crops, including grass (*Poa bulbosa* hybrid), barley (*Hordeum* spp), and native vegetation under till vs. no-till systems to investigate the influence of these cover crops on plant available water and potential for carbon sequestration.

Figure 1. Poa bulbosa in foreground.

Objective

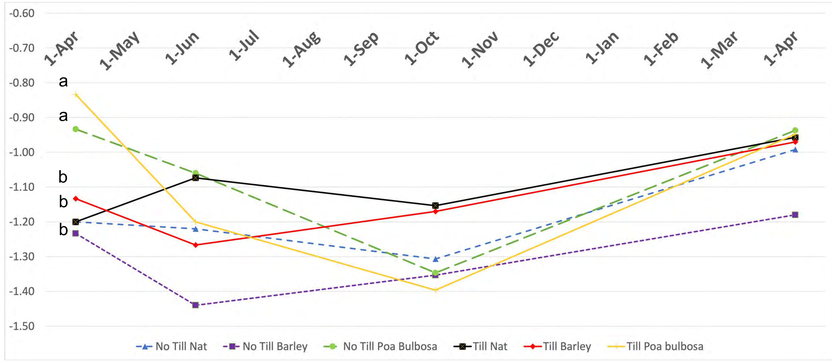
The objective of the study is to assess the effect of different cover crops and tillage management practices on total organic carbon storage and plant available water. We also hope to provide a science-based recommendation to growers regarding the utility of a novel cover crop, *Poa bulbosa*, in California vineyard systems.

Materials and Methods

This experiment is conducted at two sites: the University of California Oakville Experimental Station and in Fresno County. It was initiated with cover crop seeding in Fall/Winter 2019 and will continue through the 2022 season. Two cover crops: *Poa bulbosa* (RPb) and barley (*Hordeum vulgaris*) in addition to an untreated control ("natural" weed population) were assessed under till and no-till systems in two vineyards for three growing seasons.

Grapevine water status was measured according to Williams and Araujo 2002 using a pressure chamber (Model 1000, PMS Instrument Co.). Midday leaf water potential measurements were taken between 12:30 and 13:30 hours PDT. Leaves chosen for water potential measurement were fully expanded, mature leaves exposed to direct solar radiation. Leaf blades were covered with a plastic bag, quickly sealed, and petioles swiftly cut and immediately pressurized to determine grapevine water content. Total organic carbon (TOC) was determined via elemental analyzer conducted by Dellavalle labs in Fresno, CA. Soil respiration, temperature, and evaporation were measured in situ with a Soil respiration chamber (SRC-2) coupled to Ciras 3 system (PP Systems, Amesbury, MA) at solar noon.

Results



Date ***
Cover crop *
Tillage ns
Cover crop x tillage *
Date x cover crop x tillage ***
*** P ≤ 0.001 ** P ≤ 0.01 * P ≤ 0.05 ns not significant

Figure 2. Fresno site leaf water potential April 2020 to April 2021. RPb preserved plant available water early in the season (mid-April).

Tillage	Cover crop	Oakville C respired (tons/ha)	Fresno C respired (tons/ha)
No Till	Barley	0.17	0.14
	Natural	0.28	0.14
	Poa bulbosa	0.17	0.12
Till	Barley	0.17	0.15
	Natural	0.16	0.12
	Poa bulbosa	0.17	0.12

Table 1. Soil C respiration extrapolated to tons/hectare. RPb demonstrated lower values than other cover crops in Fresno, and similar results to barley in Oakville.

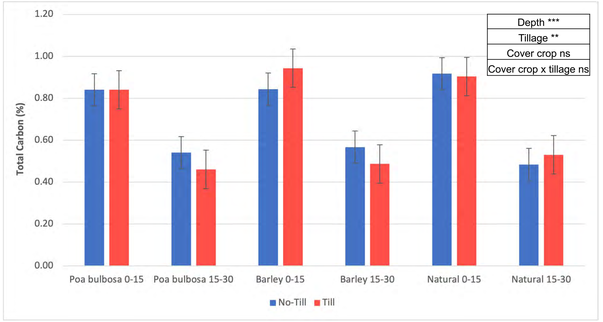


Figure 3. Fresno site total organic carbon %. Significant differences were observed among depths (0-15 cm and 15-30 cm) as well as tillage system.

Tillage	Cover crop	Berry weight (g)	°Brix	must pH	Total acidity (g/L)	Total anthocyanins (mg/berry)	Yield per plant (kg)
No Till	Barley	1.83	21.77	3.89	0.54	2.63	17.77
	Natural	1.78	17.23	3.84	0.57	2.53	15.32
	Poa bulbosa	1.58	18.67	3.88	0.54	2.36	16.77
Till	Barley	1.58	20.37	3.80	0.63	1.95	15.97
	Natural	1.78	20.43	3.89	0.56	2.75	17.59
	Poa bulbosa	1.77	20.83	3.88	0.56	2.47	19.73
Tillage		ns	ns	ns	ns	ns	ns
Cover crop		ns	ns	ns	ns	ns	ns
T x CC		ns	ns	ns	ns	ns	ns

Table 2. No significant differences were observed in yield or yield components between cover crops or tillage system.

Conclusions/Further Study

First year results suggest the potential of the permanent grass cover crop to increase plant available water and enhance organic carbon storage. At the Fresno site, a 30% decrease in midday leaf water potential was observed in early spring and a 10% decrease in spring 2021 thus far. Despite a lack of significant differences in TOC between cover crops, when extrapolated to a hectare scale RPb demonstrated a decrease in soil respiration which is one of the primary sources of C loss in agricultural soils.

Further research will include greenhouse gas (GHG) emissions to quantify the production and consumption of the three primary biogenic gases (CO_2, CH_4, and N_2O) in these vineyards as well as the characterization of bacterial and fungal communities by functional groups. Ultimately, these findings will provide a greater understanding of dynamics of soil-grapevine-atmosphere continuum in the San Joaquin Valley under future warming conditions.

References

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