Do Cover Crops Stabilize Wine Grape Productivity in a Variable Climate?

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Introduction

In humid, eastern climates, viticulturists must employ labor-intensive vigor reduction strategies (ie. pruning) to control excessive grapevine vegetative growth.

Undervine cover crops may reduce vigor while providing a variety of environmental benefits and services (in comparison to herbicide-maintained bare soil).

Rootstock selection likely augments cover crop effects on growth and production

Belowground examinations of cover crop and rootstock practices may provide insight into management strategies to provide resiliency in a changing climate.

Methods

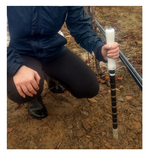
Site and Treatments: The study took place during the 2017 season in a Noiret (*Vitis* interspecific hybrid) research vineyard in central PA. Rootstock vigor (High vs low) and groundcover (bare soil vs *Festuca* cover crop) treatments were applied in a split plot design with rootstock as the main plot.

Aboveground Production and Growth: standard measures of pruning weight, yield, brix, TA, pH, and YAN

Root length density (mm root/cm3): 1 m deep root cores were separated into 5 depth increments. Roots were extracted, separated into fine (1st and 2nd order) and coarse (>2nd order) classifications, scanned on transparencies, and analyzed for length and diameter in Whinrhizo computer software.

Above- and belowground resource status: nutrient status of tissue components and nutrient content of soil from cores with standard practices by PSU Analytical services.

Water depletion: soil water availability (% volume) was measured at 5 depths to 1 meter, weekly from July 17-October 10 (Pr2 probe, Delta T Devices)



Research Questions

1. Compared to bare soil, do undervine cover crops:
   - A) decrease shallow soil resource availability?
   - B) reduce grapevine water and nutrient status?
   - C) reduce grapevine vigor?
2. Does the influence of cover crop depend on the vigor of the rootstock?

Results

2017 Growing Season was cool and wet. Precipitation occurred on 49% of days between April and October (harvest).

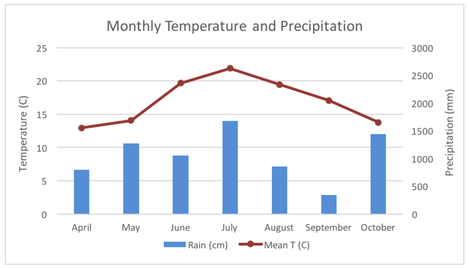


Figure 1: Monthly temperature and precipitation over the grapevine growing season (April -October). Data collect at a weather station at the vineyard site (newa.cornell.edu).

Grapevine fine roots were reduced in overall length and shifted below a shallow, cover-crop root compartment (0-20 cm contained 93% of cover root mass).

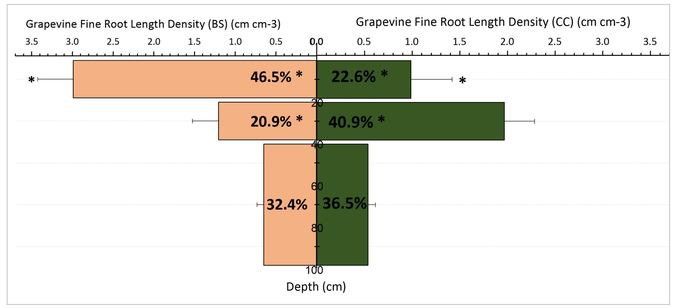


Figure 2: Root Length Density for 0-20, 20-40, and 40-100 depth increments. Pgc=0.089, Pdepth<0.001 , Pgc*depth<0.001. Percentages within columns indicate percent root length within each depth by treatment. (*) indicate Pgc<.05 by depth.

Cover crop reduced nutrients in grapevine tissues, but did not cause deficiencies.

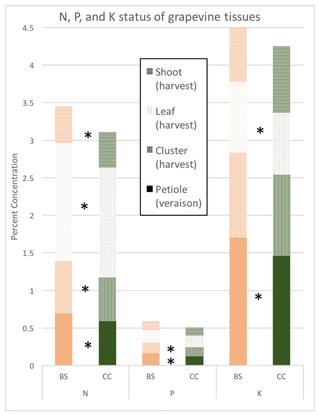


Figure 3: Percent concentration of N, P, and K in grapevine shoot, leaf, and cluster tissues sampled at harvest and petiole tissues sampled at veraison. (*) denotes significant differences (P_{gc}<0.05) between tissue types.

Management practices consistently interacted to influence water availability at 30 cm: cover crop increased available water to the low vigor rootstock and decreased available water for the high vigor rootstock.

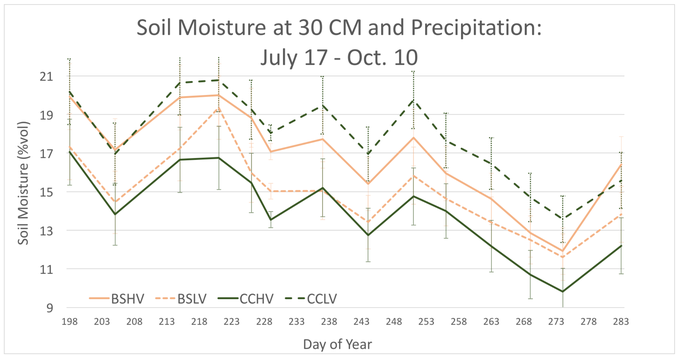


Figure 4: Rootstock and groundcover interactive effects on soil moisture at 30 cm measured weekly from July 17-October 10. Bars represent standard error, P_{gc*rs}<0.05 from day of year 229-283.

Soil nutrients were consistently higher in the shallow (0-20 cm) soil compartment (P_{depth}<0.05).

Vines did not show signs of water stress nor differences in water status over the season (P>0.05). Depth, date, and management practices influenced soil moisture ($P_{depth*gc*rs}$, P_{doy}<.001).

Results

Cover crops favorably reduced vine vegetative growth but did not influence production.

Table 1. Yield, cluster weight, and juice chemistry measures for Noiret (interspecific *Vitis* hybrid) planted with a relatively high (HV) or low (LV) vigor rootstock and with undervine management of herbicide (BS) or cover crop (CC). Significant differences (P<0.05) highlighted in bold[a].

Groundcover x Rootstock	Pruning Weight (g/shoot)	Yield (Kg/m)	Cluster Weight (g)	Soluble Solids (°brix)	pH	Titratable Acidity (g/L)	Yeast Assimil-able N (mg/L)
BS*HV	51.6 a	2.75	112.5 a	19.2	3.42 a	6.38 a	168.1
BS*LV	42.6 b	2.28	97.5 b	19.6	3.48 a	6.12 a	172.4
CC*HV	34.3 c	2.25	89.6 c	19.6	3.33 b	6.67 b	183.7
CC*LV	36.3 bc	2.38	106.1 ab	19.5	3.41 b	6.43 b	170.8
GC	**0.002**	0.285	0.082	0.431	**0.033**	**0.032**	0.766
RS	0.227	0.452	0.813	0.522	0.188	0.136	0.860
*GC*RS*	0.055	0.126	**0.004**	0.320	0.777	0.938	0.716

[a]Treatment means within columns followed by different letters for *P*<.05. Means separation tests performed for *P*<.06.

Conclusions

In this humid climate study, cover crops:

- Were a viable groundcover management practice.
- Favorably restricted aboveground vegetative growth without reducing production.
- Shifted grapevine roots to a deeper soil compartment of lower nutrient content but more stable water availability.
- Interacted with rootstock practices to augment belowground water use and moderate vegetative growth.
- Influenced above and belowground responses of grape more than rootstock selection.

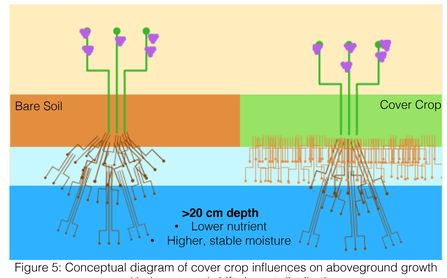


Figure 5: Conceptual diagram of cover crop influences on aboveground growth and below ground shifts in root distribution

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