Vineyard Cover Crops and Tillage Practices

Dr. Kerri Steenwerth

USDA-ARS

Today's Roadmap

- Reducing Soil Erosion, Runoff, and Dust
- Reducing Greenhouse Gas Production by Altering Tillage Practices
- Soil Biology and Organic Matter
- Weed and Vine Management

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Form and Function

Erosion and Runoff

Trios 102 or Rye

Cultivation

- cover crops gave 45% and 80% reduction in runoff
- dependent upon cover crop type
- nutrient concentrations of runoff were the same among treatments
- ***MORE*** total nutrients were lost from cultivated soils.
- slope was only 1-2%
- Only 7-9” rain per year!

Larry Bettiga, Michael Kahn, Richard Smith, UCCE Farm Advisors

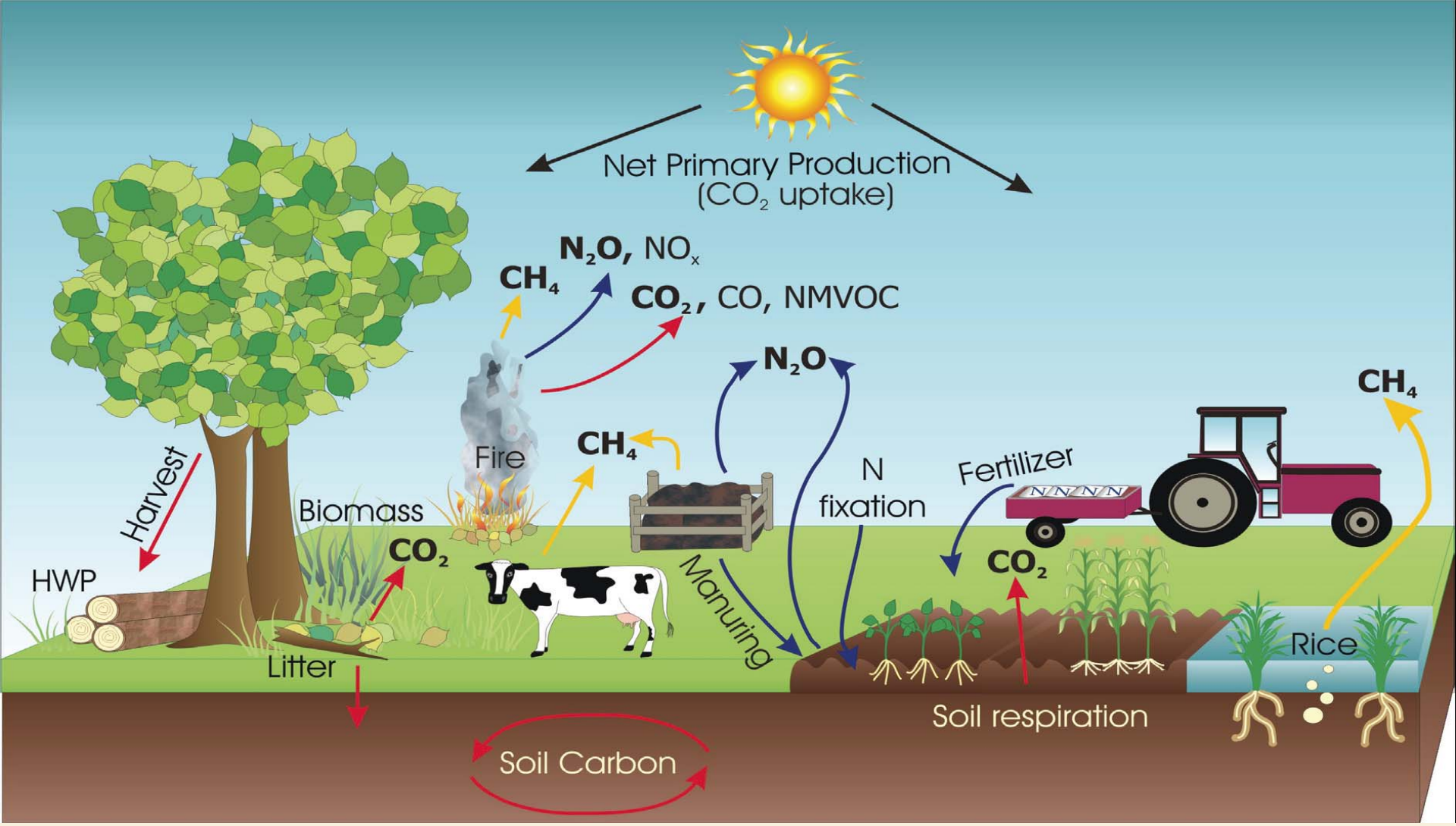
Smith et al. 2008, California Agriculture

Dust Reduction

- Provide improvements in air quality
- Reductions in dust generation related to reductions in mite pressure
- Potential improvements in predatory mite habitat
- Adopt no-till or reduced tillage practices

Revisiting the Roadmap

- Reducing Soil Erosion, Runoff, and Dust
- Reducing Greenhouse Gas Production by Altering Tillage Practices



- Viticultural activities that produce GHGs
- AB 32 requires monitoring of CO_2 emissions
- N_2O emissions not required to be monitored yet

Fossil Fuel Combustion

- One of largest components of GHG emissions
- Best understood
- Most easily **controlled** and **measured** by growers
- More fuel = more GHG emissions
  - gal. diesel = 12 kg CO_{2e}
  - gal. gasoline = 10.5 kg CO_{2e}
- Management
  - Biofuels can lessen impact
  - Onsite energy generation
  - Minimize fuel usage
- Research needs

Vineyard floor management

- **Conventional tillage** (<30% of crop residues left on the surface, multiple passes)
  - less carbon enters soil organic matter
  - greater production of CO_2
  - some N_2O production
  - greatest requirement for fossil fuels

- **Conservation tillage** (>30% of crop residues left on surface)
  - more carbon enters soil organic matter
  - less CO_2 produced due to soil management
  - less fuel required

- **No-Till systems** (No disturbance of the soil surface)
  - most carbon enters soil organic matter
  - least amount of fuel required
  - cover crops may decrease need for synthetic fertilizers
  - BUT may result in higher N_2O production

- Research needs

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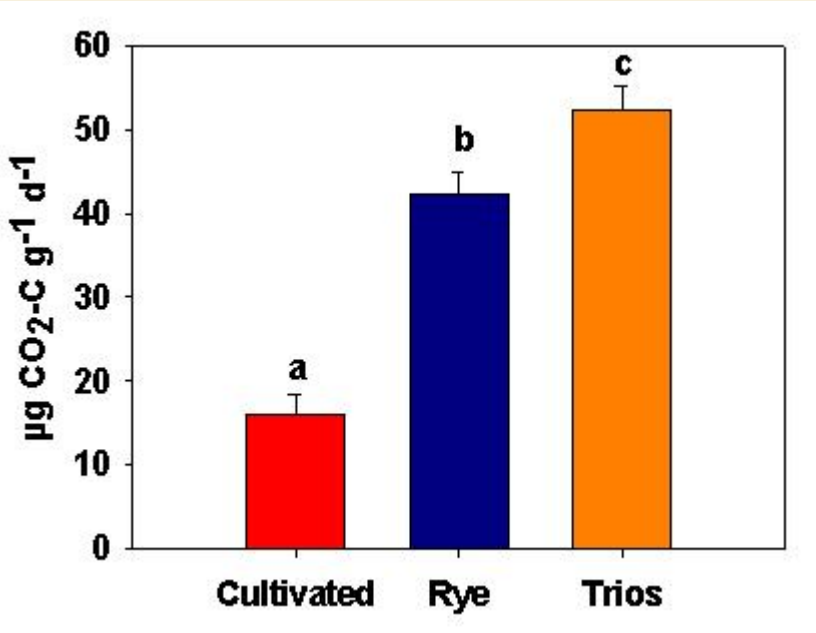
Cover crops vs. Cultivation

Trios 102 or Rye

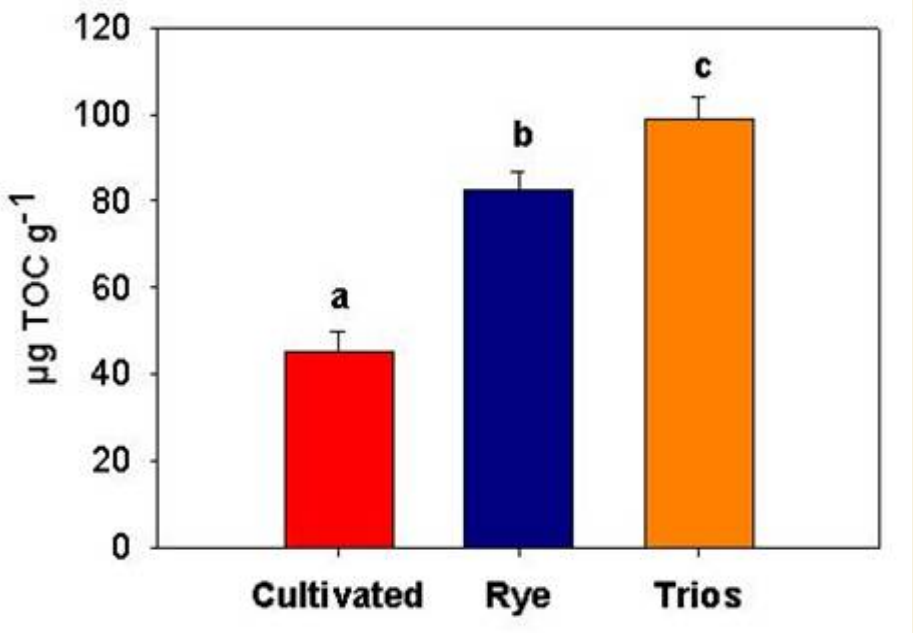
Cultivation

Cover crops improve soil carbon content

Microbial Respiration



Dissolved Organic C



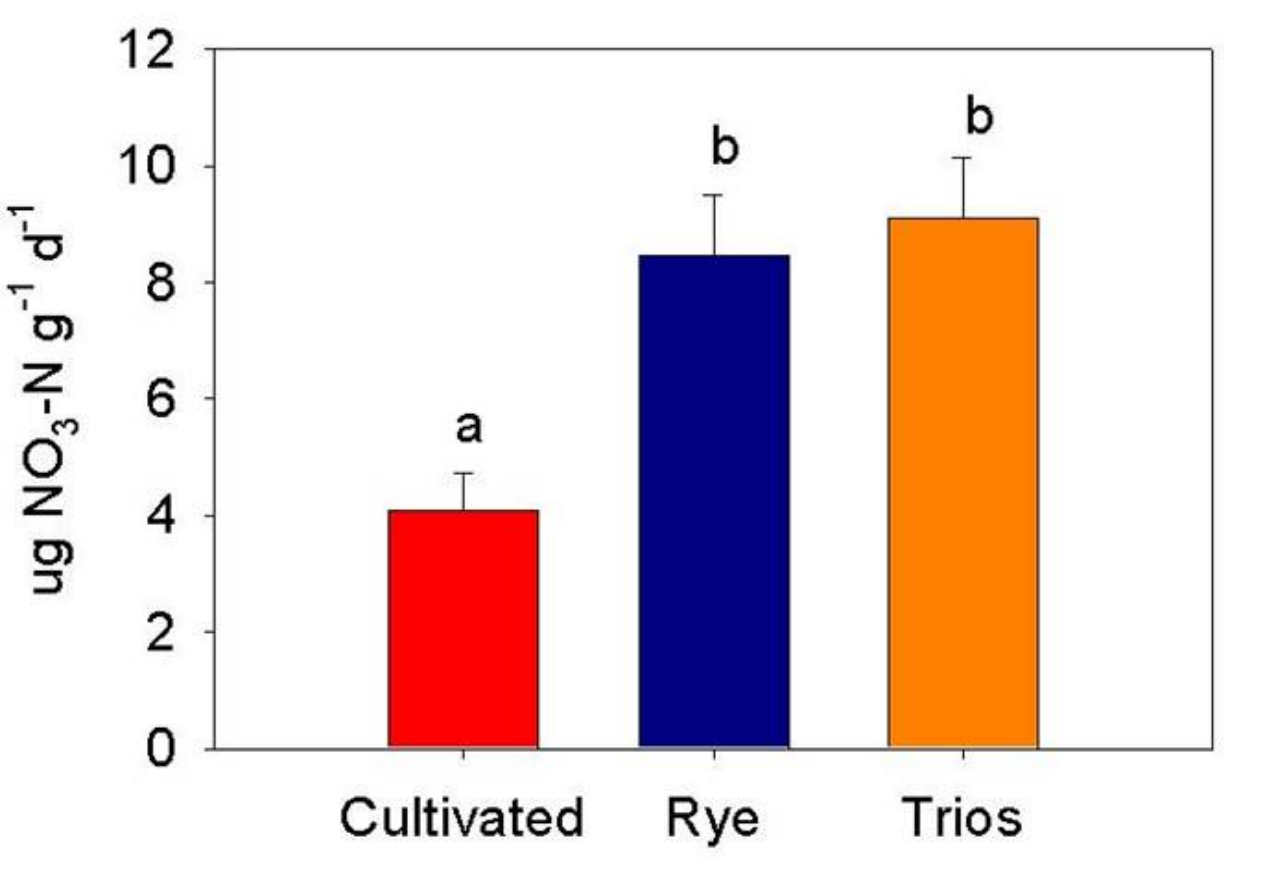
Soil Organic Matter

'Trios', 10.98 ± 0.30 mg C kg^{-1}
'Rye', 9.45 ± 0.34 mg C kg^{-1}
'Cultivation', 7.18 ± 0.18 mg C kg^{-1}

Steenwerth and Belina, 2008

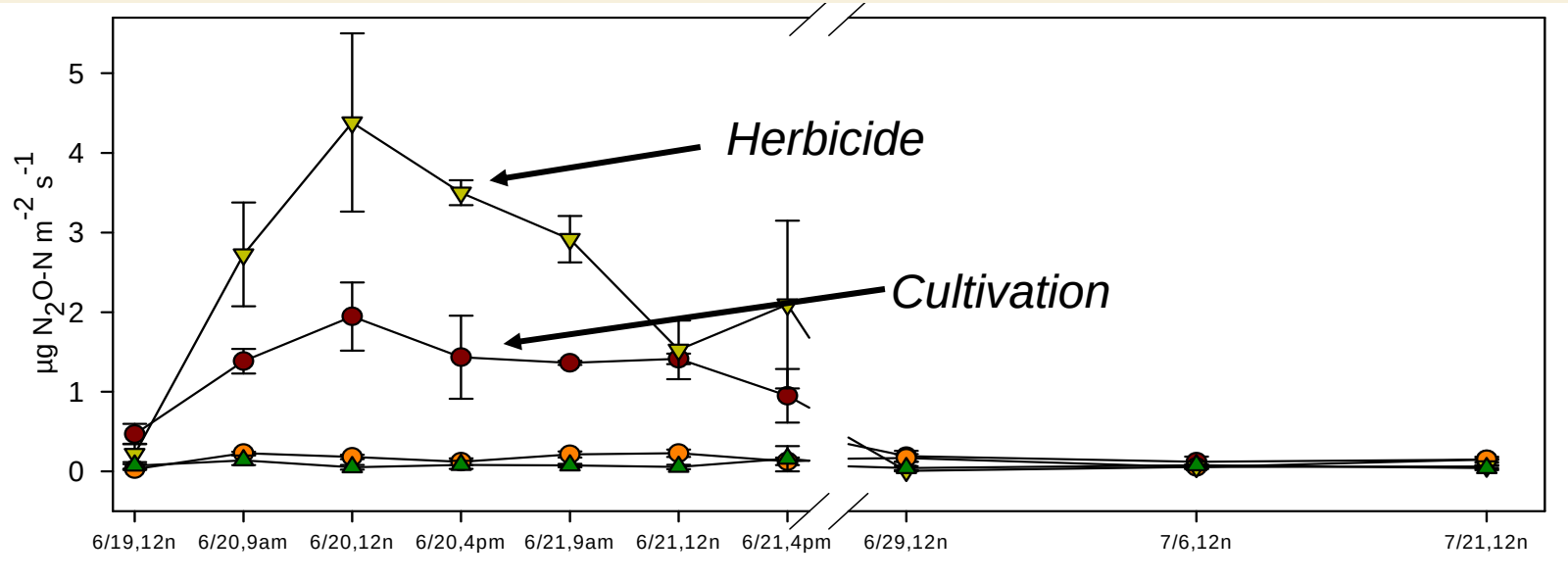
Cover crops improve soil N dynamics

Potential Nitrification



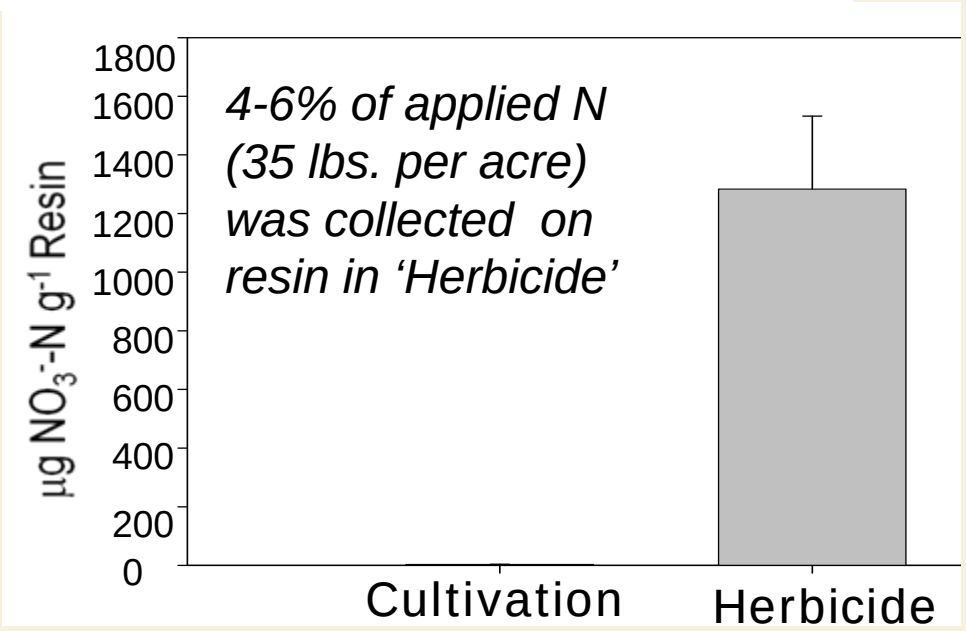
SAME TREND: Microbial Biomass N and Potential N Mineralization

In-row cover crops?



8-11” annual precipitation

240 gal/vine/year



Can cover crops reduce nematodes?

	Bacteria feeders	Fungal feeders	Plant parasitic	Omnivorous	Carnivorous
Veraison: under vine	15%	9%	74%	99% ring 91% stunt	<1%
inter-row	52%	24%	19%		0
Harvest: under vine	9%	13%	77%	96% ring 91% stunt	<1%
inter-row	38%	41%	14%		1%
Dormancy: under vine	5%	9%	85%	97% ring 90% stunt	0.4%
inter-row	48%	36%	13%		0%

S.R. Parker, USDA/ARS

Revisiting the Roadmap

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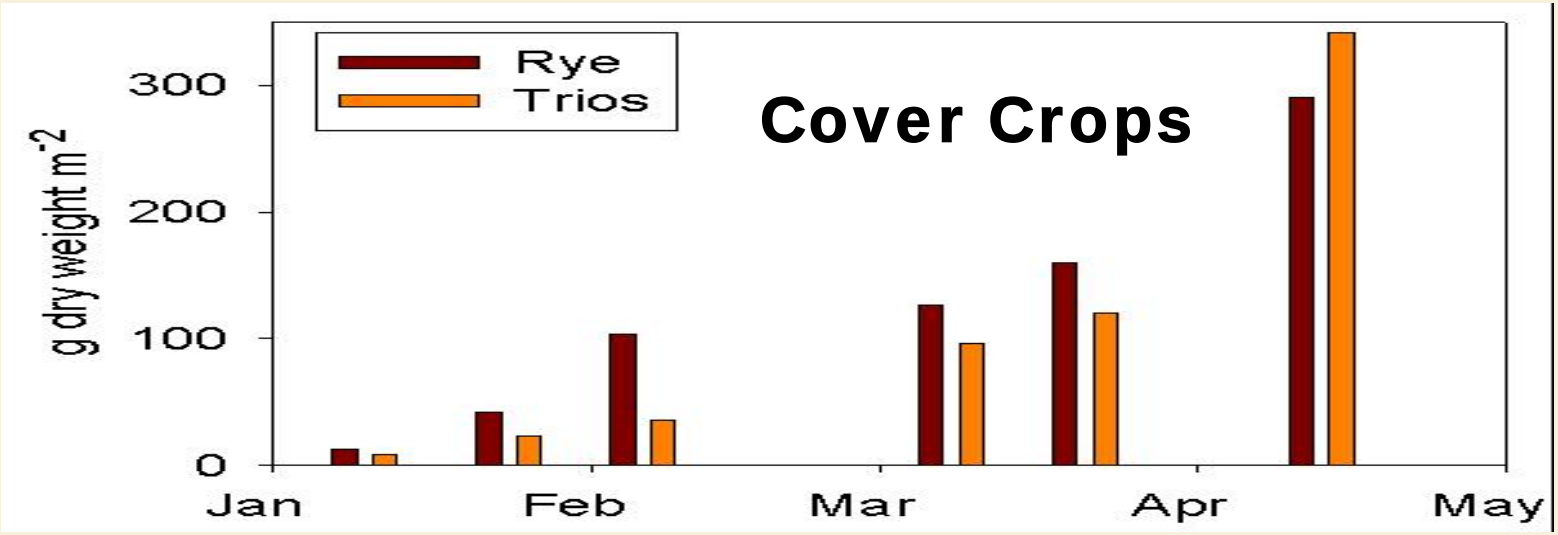
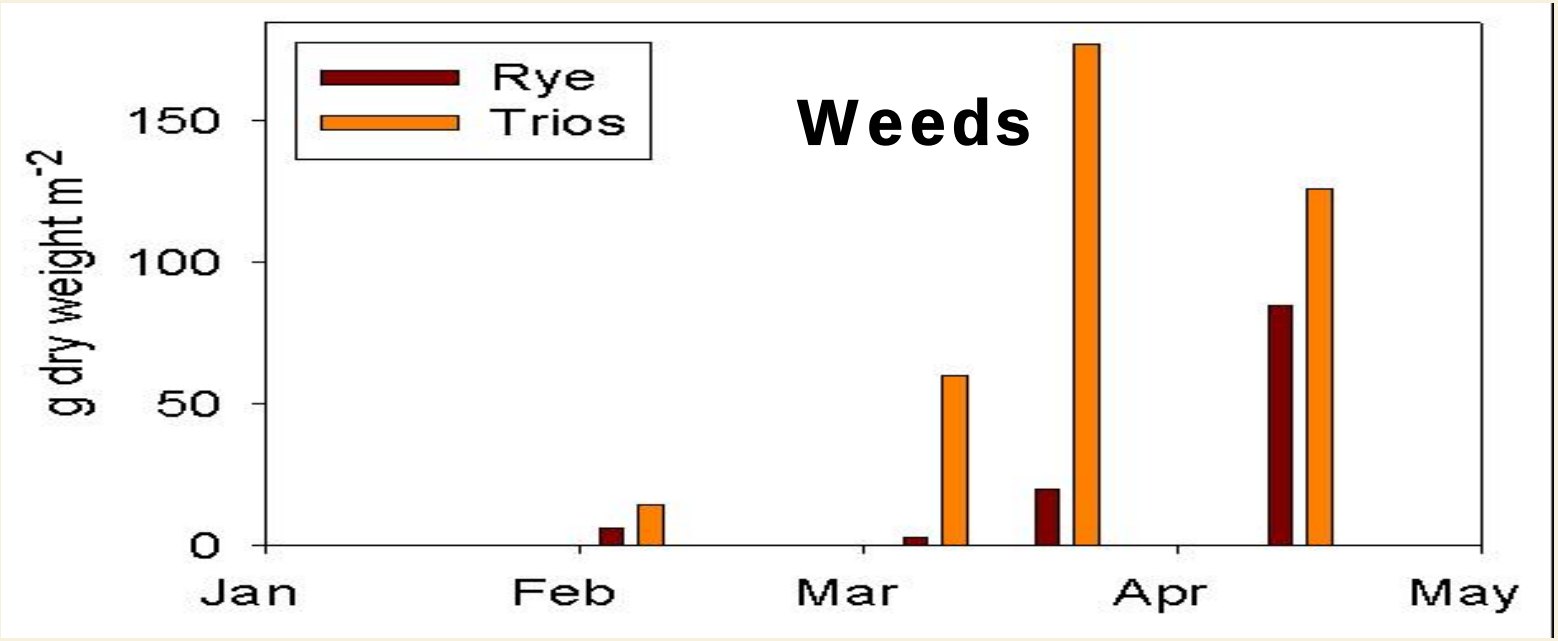
Cover crops suppress weed biomass





Cover crop effects on vines?

- Documentation of reduced vigor

- In many cases, no effect on petiole nutrition or yield
  - *Merlot, Napa Co. – 3 yrs.* *Baumgartner et al., 2008*
  - *Chardonnay, Monterey Co. – 5 yrs.* *Smith et al., 2008*
  - *Merlot, San Joaquin Co. – 1 yr.*, *unpublished data*

- Yeast assimilable nitrogen content and free amino acids in juice – no effect
  - *Cabernet sauvignon, Napa Co. – 2 yrs.*

    J. Lee and K. Steenwerth

Cover crop effects on vines?

- Water Stress - no effect on vine leaf water potentials?
  - Findings inconclusive
- Confounding factors: management of canopy and fertilizer, age of vineyard, scion and rootstock, and soil fertility

Hypothesis:

Cover crops enhance water infiltration despite water use via transpiration, potentially offsetting competition for water (Celette et al., 2005).

Cover crops as functional types?

- Build soil organic pools and soil microorganisms
- Enhance nitrogen retention
- Weed biomass reduction
- Shift weed and nematode composition
- Tool for water, nutrition and canopy management

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