Mulches & Groundcovers for Sustainable Vineyard Floor Management

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Outline

• Introduction
• Research purpose/objectives
• Experimental design
• Summary of results
• Conclusions & recommendations
Vineyard Floor Management Strategies

- **Cultivation**
  - Common in classic wine producing areas

- **Herbicides**
  - Commonly used under vines and in no-till systems
  - Problems include resistant weeds
  - Trunk splitting & cold hardiness issues (glyphosate)

- **Groundcovers & cover crops**
  - Protect and improve soil
  - Improve vineyard work environment
  - Provide habitat for beneficial organisms
  - \textit{Compete with vines?}

- **Mulches**
  - Prevent weed seed germination
  - Reduce evaporation
  - Improve soil structure & water infiltration
Sustainability

- Sustainable systems are environmentally sound, socially equitable, economically viable
Potential Benefits of Sustainable Vineyard Floor Management

Environmental:
• Less reliance on synthetic chemicals
• Protect and improve soil
• Habitat for beneficial organisms
• Reduce/eliminate problems with glyphosate

Economic:
• Reduce labor requirements (pruning, spraying, shoot positioning, etc.) by manipulating vine vigor
• Spend less $ on inputs (weed and disease sprays)

Social:
• Better work environment
• Neighbors
• Aesthetic appeal
Midwest “Grower Standard”

- Perennial sod alleyways
- Weed-free strip under vines

Pros:
- Permanent groundcover over 85-90% of soil
- Soil conservation
- Bare strip improves airflow

Cons:
- Herbicide issues
- Maintenance of weed-free strip may be unnecessary after vines are established
- Excess vine vigor
Research Site & Objectives

- Fox Run Vines in Brainard, NE
- ‘Marquette’ vines planted 2007
- Vineyard floor management study
  - Evaluate alternatives to glyphosate under vines
  - Reduce vegetative vigor with groundcovers

Photos courtesy of Fox Run Vines/Fox Run Farms
Experimental Design

- **3 alleyway (row middle) treatments:**
  - ‘Park’ Kentucky bluegrass
  - ‘Boreal’ creeping red fescue
  - Resident vegetation (orchardgrass)

- **5 under-trellis (in-row) treatments:**
  - ‘Boreal’ creeping red fescue
  - ‘Dalkeith’ subterranean clover non-sprayed control
  - Recycled crushed glass mulch
  - Dried distiller grains (DDGs)
  - Glyphosate (grower control)
Experimental Design

- 3 x 5 factorial design with ~4 replications
- 3 vines (24 feet) = experimental unit
  - Took data/measurements on middle vine
- Alleyway treatments = on both sides of vine rows
Experimental Design

8’ x 10’ vine spacing: 8’ between vines, 10’ between rows
Establishment of Research Plots

• Prepared groundcover plots (glyphosate)
• Seeded groundcovers into standing dead vegetation - September, 2010
  – Watered 3 times per week
• Reseeded groundcovers (hand-broadcast) - Spring, 2011
  – No watering
• Subterranean clover plots → non-sprayed control
• Crushed glass and DDGs applied in June 2011
“Novel” Mulching Materials

• DDGs
  – Co-product of ethanol fermentation process
  – Preemergence herbicide
  – Contains ~4% nitrogen
  – Applied ~1/3 lb per square foot
  – 50 pound bag covered 6 vines (48 ft x 3 ft wide)
  – Obtained from UNL feed mill

• Crushed glass mulch
  – Municipal recycled glass
  – Mixed colors
  – Applied ~3” thick
Maintenance of Research Plots

• Glyphosate in-row plots sprayed 2-3 times per season
• In-row groundcover plots mowed once per season
• Alleyways mowed as needed
• DDGs applied twice each season
• Crushed glass reapplied in March, 2013
Research Photos: 2011

22 April 2011

3 June 2011

8 August 2011

3 June 2011
Research Photos: 2011

21 June 2011

22 July 2011

8 August 2011

28 June 2011

22 July 2011

8 August 2011
Research Photos: 2011

8 August 2011
Measurements

- Weed % cover
- Soil temperature
- Solar radiation
  - Soil surface reflectance, canopy transmittance
- Soil & vine water status
- Vine vigor
  - Shoot length, leaf layer number, pruning weight
- Yield & clusters per vine
- Fruit composition
  - Berry size, Brix, pH, TA
Effects of groundcover and mulch treatments on in-row % weed cover on 3 dates in a SE Nebraska ‘Marquette’ vineyard. CG and DG had rating of 0 on September 7, 2012. CG = crushed glass; CRF = creeping red fescue; DG = dried distillers’ grain; SC = non-sprayed control.
Soil Temperature

• In general, mulches had higher soil temp; groundcovers had lower soil temp (compared to glyphosate)

Effects of in-row groundcover and mulch treatments on soil temperatures measured on 3 dates in a SE Nebraska ‘Marquette’ vineyard. CG = crushed glass mulch; CRF = creeping red fescue; DG = distillers’ grain; SC = non-sprayed control
Effects of in-row groundcover and mulch treatments on soil surface reflectance and canopy PAR (photosynthetically active radiation) transmittance in a SE Nebraska ‘Marquette’ vineyard. CG = crushed glass mulch; CRF = creeping red fescue; DG = distillers’ grain; SC = non-sprayed control.
Soil Water Content

• Alleyway treatment effects
  – BG < (CRF = control) for all dates in 2013 and 2 dates in 2012

• In-row treatment effects
  – DG conserved water; CG decreased soil moisture in 2013
  – CRF and SC decreased soil water on most dates

Effects of in-row mulch and groundcover treatments on soil water content in a SE Nebraska ‘Marquette’ vineyard, 2012 and 2013. CG = crushed glass mulch; CRF = creeping red fescue; DG = distillers’ grain; SC = non-sprayed control
Vine Water Potential

- Not affected by alleyway or in-row treatments

Mid-day stem $\Psi$ was not affected by in-row groundcover and mulch treatments ($\alpha=.05$) in a SE Nebraska ‘Marquette’ vineyard. CG = crushed glass mulch; CRF = creeping red fescue; DG = distillers’ grain; SC = non-sprayed control.
Vine Vigor

• Shoot length measurements
  – Marked 2 shoots per plant
  – Measured biweekly during shoot expansion

• Point quadrat canopy analysis
  – 3 transects per plant at veraison 2012 & 2013
  – Data used to compute leaf layer number (LLN)
  – Measures canopy density

• Dormant pruning weight
  – March 2012 & 2013
Shoot Length

• Not affected by alleyway or in-row treatments

Shoot lengths of ‘Marquette’ grapevines measured in 2012 and 2013 in southeast Nebraska. Vineyard floor treatment effects were not significant at $\alpha=0.05$. CG = crushed glass; CRF = creeping red fescue; DG = distillers’ grain; SC = non-sprayed control.
Leaf Layer Number

- Not affected by alleyway treatment
- In-row treatment effects:
  - Generally, mulches > groundcovers
  - CG = only treatment that differed from glyphosate

Effects of in-row groundcover and mulch treatments on mean leaf layer number (LLN) in a SE Nebraska ‘Marquette’ vineyard, 2012-2013. CG = crushed glass mulch; CRF = creeping red fescue; DG = distillers’ grain; SC = non-sprayed control
Pruning Weight

- In-row treatments did not affect pruning weights.
- Pruning weights affected by alleyway treatment in 2012 only

Effect of alleyway groundcover treatment on pruning weights for ‘Marquette’ grapevines in a SE Nebraska vineyard. Main effect of alleyway was statistically significant in 2012 but not in 2013 (P=0.1346). BG = Kentucky bluegrass; CRF = creeping red fescue; control = resident vegetation
Yield 2012

• Harvested August 3, 2012
• Yield and cluster counts not affected by treatments
  – Average yield 7.9 kg/vine
  – Average 112 clusters/vine
Yield 2013

- Harvested September 7, 2013
- Cluster counts not affected by treatments
  - Average 112 clusters/vine
- Alleyway and in-row treatment interaction for yield (anomaly?)

Effects of alleyway and in-row treatments on ‘Marquette’ yield in a SE Nebraska vineyard, 2013. BG = Kentucky bluegrass; CRF = creeping red fescue; control = resident vegetation; CG = crushed glass mulch; DG = distillers’ grain; SC = non-sprayed control
Fruit Composition: Berry Weight & Brix

• Treatment differences for berry weight and Brix in 2013 but not 2012

Effects of vineyard floor treatments on berry weight and Brix of ‘Marquette’ from a SE Nebraska vineyard, 2013. BG = Kentucky bluegrass; CRF = creeping red fescue; control = resident vegetation; CG = crushed glass mulch; DG = distillers’ grain; SC = non-sprayed control

Effects of alleyway (a) and in-row (i) treatments on 50 berry weight in 2013

In-row treatment effects on juice Brix in 2013
Fruit Composition: pH & TA

- pH was affected by in-row treatment
  - In general, mulches > groundcovers
  - DG > glyphosate in 2012
  - CG > glyphosate; CRF and SC < glyphosate in 2013
- None of the treatments affected TA
  - 2012 average TA = 1.04%
  - 2013 average TA = 0.77%

Effect of in-row treatments on ‘Marquette’ juice pH from a SE Nebraska vineyard, 2012 and 2013. CG = crushed glass mulch; CRF = creeping red fescue; DG = distillers’ grain; SC = non-sprayed control

<table>
<thead>
<tr>
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<th>2012 Average TA</th>
<th>2013 Average TA</th>
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<tbody>
<tr>
<td>2012</td>
<td>1.04%</td>
<td>0.77%</td>
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<tr>
<td>2013</td>
<td>0.77%</td>
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Effect of in-row treatment on juice pH in 2012

<table>
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<th>Treatment</th>
<th>Juice pH</th>
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<tbody>
<tr>
<td>CG</td>
<td>3.6</td>
</tr>
<tr>
<td>CRF</td>
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<td>DG</td>
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<tr>
<td>Glyphosate</td>
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<td>SC</td>
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Effect of in-row treatment on juice pH in 2013

<table>
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<th>Treatment</th>
<th>Juice pH</th>
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<tr>
<td>CRF</td>
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<tr>
<td>DG</td>
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<tr>
<td>Glyphosate</td>
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<tr>
<td>SC</td>
<td>3.9</td>
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Summary:
Alleyway Treatment Effects

• Affected soil moisture (BG < CRF and control) but NOT vine water potential
• Affected pruning weight in 2012 (BG and CRF > control) but NOT LLN or shoot length
• Did not conclusively affect yield, berry weight
• Did not affect fruit composition
Summary: In-row Treatment Effects

• CG, CRF, and DG controlled weeds
• Mulches increased soil temp (especially CG) while groundcovers decreased soil temp (especially CRF)
• Affected soil moisture but NOT vine water potential
• Affected LLN (CG had higher LLN than glyphosate) but not shoot length or pruning weight
Summary: In-row Treatment Effects

- No consistent effects on yield, cluster number, or berry weight
- CG had higher juice Brix than glyphosate in 2013
- Mulch treatments had higher juice pH than groundcovers, although effects were inconsistent compared to glyphosate
- No treatment effects on TA
Distillers’ Grain: Conclusions

• Potentially inexpensive; relatively easy to transport & apply
• Application timing is key
• Acceptable weed control with multiple applications
• Could be useful in newly established vineyards or low-fertility sites, especially near ethanol distillery or feed mill
Crushed Glass: Conclusions

• Relatively expensive and difficult to transport
  – $50/55 gallon barrel covers ~50 feet of row ($8/vine)
• Acceptable weed control lasted 2 seasons
• Impractical unless vineyard is near a crushing facility and source of waste glass
Glyphosate: Conclusions

• Good weed control
• Inexpensive, easy to apply
• Multiple applications necessary each season
• Potential problems:
  – Herbicide resistant weeds
  – Trunk splitting/cold injury due to overspray
Creeping Red Fescue: Conclusions

- Inexpensive seed
- Rapid establishment & good soil coverage
- Low maintenance (mow once/season)
- Consistent weed control (<10% weeds)
- Aesthetically pleasing
- Continuous vineyard floor coverage is a viable option for many Midwest growers
Non-sprayed Control: Conclusions

- No cost to establish
- Good soil coverage
- Low maintenance (mow once/season)
- Unkempt appearance
- Results of this research suggest yield, fruit quality, and vine balance were not negatively affected by in-row weeds
Recommendations

• Depend on management goals and vineyard site!
  – Conserve water?
  – Low maintenance?
  – Reduce vegetative vigor?

• In-row mulches could be a good solution for new vineyards

• In-row groundcovers performed well in this study, but should not be used until AFTER VINES ARE ESTABLISHED
Thank you!!

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