Cover Crops for Sustainable Cropping Systems in the Desert Southwest

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Kulbhushan Grover
Plant and Environmental Sciences
New Mexico State University,
Las Cruces, NM 88003
kgrover@nmsu.edu
(575)280-7663
Cover Crops

Mainly grown to:
- reduce soil erosion by covering the ground.
- add organic matter and nutrients to the soil.
Cover Crops:

- Grown between cash crop cycles.
- Intercropped with cash crops.
- Planted in the absence of cash crop.
Green Manures vs. Cover Crops vs. Catch Crops
Green Manures

Usually grown to:
• help maintain soil organic matter and
• increase nitrogen availability
Catch Crops

• Retrieve available nutrients still in the soil following a cash crop.
• Prevent nutrient leaching over the winter.
Why cover crops in the desert southwest?
Intensive agriculture has led to

- Soil erosion
- Poor soil fertility
- Very low soil organic matter
- Soils susceptible to drought
- Weed infestation
- Diseases
Cover crops can help

- Enhance mycorrhizal numbers
- Add N (legume)
- Add organic matter
- Suppress weeds
- Suppress nematodes
- Attract beneficial insects
- Reduce erosion
- Increase infiltration of water
- Decrease nutrient loss

Magdoff and Van Es, 2003
Benefits of Cover Crops

- Benefits from cover crop depend upon:
  - Productivity/biomass
  - Duration.
Organic Matter Buildup

- 5-yr study in CA
- Organic matter
  - Increased
  - 1.3 to 2.6 %
  - (in top 2 inch)
Why organic matter is important, particularly in desert soils?

Poor soils
low organic matter
Cover crops supply nutrient to the following crops

• N credit - legumes
# Legumes- Biological N fixation

<table>
<thead>
<tr>
<th>Legume</th>
<th>N fixed lb/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>195</td>
</tr>
<tr>
<td>Red clover</td>
<td>115</td>
</tr>
<tr>
<td>Cowpea</td>
<td>90</td>
</tr>
<tr>
<td>Pea</td>
<td>63</td>
</tr>
<tr>
<td>Common bean</td>
<td>41</td>
</tr>
</tbody>
</table>

[www.sare.org](http://www.sare.org)
Cover crops can reduce nutrient losses

• Nitrate leaching in the fall is a concern.
• Non-legume cover crops help reducing nitrate leaching by taking-up the extra N
  – Cereal rye
  – Wheat
  – Barley
  – Oats
  – Ryegrass
Cover crops supply other nutrients to the following crops

- Other nutrients
  - Phosphorus
    * Sudan grass
      - Deep root system
    * Lupins and Buckwheat
      - Secrete acids that solublize P
Cover Crops Enhance Mycorrhizal Fungi

- Help improve inoculation of the next crop with mycorrhizal fungi.
- Improves P availability.
Soil Aggregate Stability with Cover Crops

Grover et al., 2009
Cover crops help alleviate soil compaction
3 times higher Phosphorus in root holes than in bulk soil

White and Weil, 2011
Cover Crops help Improve Water Infiltration

- Live plants and residues increase water infiltration
- Compensate for the water use for their growth.
Cover Crops help Improve Water Infiltration

Blanco-Canqui et al., 2011
Cover crops increase diversity at the farm
Help reduce pest populations

Verticillium wilt in Chile

• Rotation with non-host plants is one of the main tools to avoid this problem
  – Wheat
  – Barley
  – Sorghum
  – Broccoli
  – Corn

http://www.ipm.ucdavis.edu/
Biofumigant cover crops

Biofumigant

- Bioactive plant and other organic materials
  - to aid in reducing populations of plant pests in the soil.
Cover Crops Help Suppress Weeds

**Buckwheat**
- Covered the ground within 15 days after planting (DAP).

**Pearl millet**
- Substantial biomass by 42 DAP
- Crowded out most weeds.
Choice of cover crops

Challenging in arid and semi-arid Southwest due to:

• Water availability
• Resource availability
• Management issues
• Lack of information
• Economics of cover crop utilization

Before growing cover crops, ask yourself some questions:

• Which type should I plant?

• When and how should I plant the crop?

• When should the crop be killed or incorporated into the soil?
While selecting a cover crop, consider this:

• What I want to accomplish?

• What are the soil conditions at my farm?

• What kind of climate do I have at my location?
While selecting a cover crop, consider what is your goal:

- Nitrogen or organic residue additions.
- Erosion control
- Soil fertility
- Soil compaction alleviation
- Weed suppression
While selecting a cover crop, consider:

• What are the best species for your climate?

• Will the cover crop use so much water that it harms the next crop?

• Are root diseases or plant-parasitic nematodes problems that you need to address?
Cover Crops tested in southwest New Mexico
Cover Crops tested in southwest New Mexico

- **Field history**: chile monoculture for several years
Cover Crops Tested

Pearl Millet
*Pennisetum glaucum*

Sorghum-sudan
*Sorghum bicolor*

Sorghum-sudan/lablab

Sesbania
*Sesbania exaltalta*
Cover Crops Tested

- Hairy vetch
  *Vicia villosa*

- Cowpea
  *Vigna unguiculata*

- LabLab
  *Lablab purpureus*

- Buckwheat
  *Fagopyrum esculentum*
## Cover Crops Tested

<table>
<thead>
<tr>
<th>First Planting Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 30(^{th}), 2012</td>
</tr>
</tbody>
</table>

- Sorghum-sudan
- Pearl millet
- Sorghum-sudan/lablab
- Sesbania
- Lablab
- Cowpea
- Hairy vetch
- Buckwheat

*Groundcherry* (*Physalis acutifolia*)
*Junglerice* (*Echinochloa colona*)
<table>
<thead>
<tr>
<th>Host:</th>
<th>Common Buckwheat <em>Fagopyrum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis and Recommendations</td>
<td></td>
</tr>
<tr>
<td>Primary Diagnosis:</td>
<td><em>Beet Curly Top Virus (BCTV)</em></td>
</tr>
<tr>
<td>Second Diagnosis:</td>
<td><em>Rhizoctonia sp./spp.</em></td>
</tr>
</tbody>
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<thead>
<tr>
<th>Host:</th>
<th>Hyacinth Bean <em>Lablab purpureus</em></th>
</tr>
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<tr>
<td>Diagnosis and Recommendations</td>
<td></td>
</tr>
<tr>
<td>Primary Diagnosis:</td>
<td><em>Beet Curly Top Virus (BCTV)</em></td>
</tr>
<tr>
<td>Second Diagnosis:</td>
<td><em>Pythium Damping Off Pythium sp./spp.</em></td>
</tr>
</tbody>
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<tr>
<th>Host:</th>
<th>Cowpea <em>Vigna unguiculata</em></th>
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<tr>
<td>Diagnosis and Recommendations</td>
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<tr>
<td>Primary Diagnosis:</td>
<td><em>Beet Curly Top Virus (BCTV)</em></td>
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<tr>
<th>Host:</th>
<th>Sesbania <em>Sesbania punicea</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis and Recommendations</td>
<td></td>
</tr>
<tr>
<td>Primary Diagnosis:</td>
<td><em>No Pathogen Found</em></td>
</tr>
</tbody>
</table>
45 days after planting, P = 0.05
Weed Biomass (1\textsuperscript{st} Planting Date)

45 days after planting, $P = 0.05$
Re-planting of Legumes

Sorghum-sudan
1st planted

Re-planted
Sesbania doing well after second planting
Buckwheat plot infested with weeds
Hairy vetch plot infested with ground cherry
Good weed suppression by Sesbania
Soil Moisture Pattern, 6 inches

Soil moisture content, %

Sorghum Sudan
Pearl Millet
Sorghum Sudan/lablab Mixture

Non-significant
Making cover crops an attractive economic option for growers to improve their economic bottom-line.
1st Cut Pearl Millet, 80 days after planting
Awaiting for baling
Pearl millet re-growing after the first cut
Pearl millet re-grown
Near the second cut
Cumulative Cover Crop Biomass

First cut: 80 days after planting   Second cut: 52 after planting
Cover Crop Mixtures
Sesbania

Sorghum

Sudangrass

Planted: August 7th, 2012
Sesbania
+
Pearl millet

Planted: August 7th, 2012
Cocktail Mix
(Sesbania + Sorghum
Sudangrass + Lablab +
Pearl millet + Hairy
vetch + Buckwheat)
Planted: August 7th, 2012
1. Adzuki bean/ Red bean
2. Pigeon pea, Tropical Green pea
3. Mung bean/ Green Gram
4. Guar/Clusterbean
5. Lima bean
6. Bush bean
7. Green bean/ Kidney bean
8. Fava bean, field bean, bell bean
9. Moth bean/ Turkish gram
10. Cowpeas
11. Lablab/ hyacinth bean
12. Tapery bean
13. Sesbania
14. Hairy vetch
15. Yellow sweet clover
Winter Cereals following Sesbania
Terminating winter cereal cover crop with roller-crimper
Chickling vetch
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Growth characteristics</th>
<th>Other notable characteristics</th>
<th>Seeding rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>Perennial</td>
<td>Cold tolerant, nitrogen-fixing legume.</td>
<td>Low shade tolerance; deep rooted; drought tolerant.</td>
<td>15-18 lb/ac</td>
</tr>
<tr>
<td>Annual grasses (wheat, barley, oats, annual ryegrass, triticale)</td>
<td>Winter annual</td>
<td>Includes. Cold tolerant; rapid growth rate, Inexpensive seeds.</td>
<td>Not good on sandy soils, high lime tolerance, low drought and low salinity tolerance, moderate moisture use.</td>
<td>60-120 lb/ac</td>
</tr>
<tr>
<td>Austrian winter peas</td>
<td>Winter annual</td>
<td>Moderately cold and drought tolerant, nitrogen-fixing legume.</td>
<td>Can provide high biomass, moisture efficient, can suppress weeds due to rapid growth in spring, low shade and traffic tolerance.</td>
<td>60-80 lb/ac</td>
</tr>
<tr>
<td>Brassicas (Mustards, turnips, Forage Radish)</td>
<td>Summer annual</td>
<td>Tap rooted, some are moderately cold tolerant, can be seeded in fall.</td>
<td>Mustard can act as bio-fumigant; radish and turnip can break soil compaction, low to high salinity tolerance depending on species, moderate to high drought tolerance.</td>
<td>5-12 lb/ac</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>Summer annual</td>
<td>Cold sensitive; rapid establishment and growth.</td>
<td>Moderate drought and shade tolerant; can suppress weeds, can do well in relatively poor soils, good for soil aggregation, can reseed if flowers mature.</td>
<td>50-60 lb/ac</td>
</tr>
<tr>
<td>Cowpeas</td>
<td>Summer annual</td>
<td>Cold sensitive, nitrogen-fixing legume.</td>
<td>Drought tolerant; can do well in relatively poor soils and can fix up to 150 lb N per acre.</td>
<td>50-100 lb/ac</td>
</tr>
<tr>
<td>Foxtail Millet</td>
<td>Summer annual</td>
<td>Short season, cold sensitive.</td>
<td>Drought tolerant; grows fast with adequate moisture.</td>
<td>15-20 lb/ac</td>
</tr>
<tr>
<td>Hairy vetch</td>
<td>Winter annual</td>
<td>Cold tolerant, nitrogen-fixing legume.</td>
<td>Moderate tolerance to soil lime, shade and drought; low salinity tolerance.</td>
<td>15-20 lb/ac</td>
</tr>
<tr>
<td>Lablab</td>
<td>Summer annual</td>
<td>Vining and spreading legume. “Rio Verde” lablab developed by Texas A&amp;M also has high nutritive value as forage.</td>
<td>Provides very good soil cover that can suppress weeds. Good nitrogen fixation.</td>
<td>50-60 lb/ac</td>
</tr>
<tr>
<td>Pearl millet</td>
<td>Summer annual</td>
<td>Deep rooted fast growing grass.</td>
<td>Drought tolerant and provide good soil cover that can suppress weed. requires less nutrients and water than sorghum-sudan</td>
<td>15-20 lb/ac</td>
</tr>
<tr>
<td>Red clover</td>
<td>Perennial</td>
<td>Short-lived, cold tolerant, nitrogen-fixing legume.</td>
<td>Moderate tolerance to soil lime, low drought and salinity tolerance, intolerant to shade.</td>
<td>20-28 lb/ac</td>
</tr>
<tr>
<td>Sesbania</td>
<td>Summer annual</td>
<td>Erect legume, with good nitrogen fixation and can establish well in weedy fields.</td>
<td>Grows very fast and attains up to 5 feet high in about 2 months. Great biomass potential</td>
<td>30-40 lb/ac</td>
</tr>
<tr>
<td>Sorghum–Sudangrass</td>
<td>Summer Annual</td>
<td>Cold sensitive, fast growing annual grass with good root system.</td>
<td>Drought tolerant, can suppress weeds.</td>
<td>15-40 lb/ac</td>
</tr>
<tr>
<td>Yellow Sweetclover</td>
<td>Annual or biennial</td>
<td>Cold tolerant, nitrogen-fixing legume, with strong tap roots.</td>
<td>High tolerance to soil lime; high drought tolerance; high salinity tolerance; intolerant to shade.</td>
<td>8 to 15 lb/ac</td>
</tr>
</tbody>
</table>
Cover Crop Termination

• Terminate the cover crop before or during soil preparation for next main crop.
  – At blooming- before seeds
  – Wait 1-2 weeks for next crop planting after killing the cover crop.
Drier Climates

• Delayed termination of a winter cover crop – may result in moisture deficiency for main summer crop.

• Kill the cover crop before it removes too much soil water.
Key issues to focus on in water limited environment:

• Water requirements of the cover crop - is the demand high or low?
• Drought tolerance of the cover crop - does the cover crop tolerate dry spells and to what extent?
• Is the cover crop easy to manage - watch out for tendency to become weeds
Key issues to focus on in water limited environment:

- Is the cover crop easy to manage? - would the cover crop die easily when sprayed or plowed down?
- How much residue can I get from this cover crop? - high residue or low residue?
- How much water do I have - does water economics justify putting in a cover crop in my situation?
- Possibility of harvesting about 70% and leaving 30% as residue?
Thank you!

Questions?