High Residue Farming under Irrigation

Workshop Digest

This publication summarizes speaker presentations from the 2010 High Residue Farming under Irrigation workshop. For more information, contact the WSU Extension office in Ephrata (509-754-2011 ext. 413, amcguire@wsu.edu).

Specific pesticides or uses of pesticides mentioned in this publication may not be labeled for use in Washington State. Always use registered pesticides according to their label.

Workshop Agenda

Top Ten Reasons Why to Consider High Residue Farming, Andy McGuire, WSU Extension
Residue Management at Harvest, Randal Taylor, Oklahoma State University
Weed Management Considerations in Reduced Tillage Systems, Andrew Kniss, University of Wyoming
High Residue Farming in the Treasure Valley - Lessons Learned, Steve Norberg, Oregon State University
No-till Drills and Planters, Randal Taylor, Oklahoma State University
Optimizing Weed Control in Roundup Ready corn, Andrew Kniss, University of Wyoming
Top Ten Reasons Why to Consider High Residue Farming

*Andy McGuire, WSU Extension*

A. Why are you interested in High Residue Farming (HRF)?
   1. To learn how to make HRF work
      i) It’s more than eliminating tillage
   2. Benefits for you
      i) Use these benefits to motivate you to learn the system. If you do not learn the system, you will not be successful at HRF.
      ii) Most of these benefits will save you money, $.
         (1) Assuming you maintain yields

B. Top 10 Reasons Why to Consider High Residue Farming
   1. Free up your time. $
      i) “How you spend your time is how you spend your life” Do you think you will regret not spending more time tilling fields?
      ii) Time=money: with the saved time you could farm more ground, manage crops that are more profitable, market your crops better, or go fishing.
   2. Reduce your labor needs and costs by reducing tillage passes. $
   3. Reduce your fuel costs. $
      ii) The production of the “easy” oil peaked in 2006. What is left is harder to get to and therefore more expensive.
      iii) The price of oil will increase as demand from developing nations and especially China, increase.
   4. Increase your double-cropping opportunities. $
      i) Dry beans, sweet corn, buckwheat, annual forage crops, silage corn
   5. Increase your soil’s ability to take water.
      i) Residue on soil surface intercepts water droplets and prevents surface crusting
      ii) Can eliminate dammer-diking, runoff, and water erosion
      iii) Improves the uniformity of chemigation
   6. Reduce or eliminate wind erosion in your fields.
      i) Residue mulch protects the soil from the wind
   7. Reduce your irrigation water use. $
      i) The residue reflects sunshine and reduces air movement
         (1) Reduces evaporation; takes the E out of ET
         (2) More water available for transpiration through crops
8. Increase your soil’s resistance to compaction.
   i) With tillage systems, you get stuck in the compaction-tillage cycle:
   ![Diagram showing compaction cycle]
   ii) HRF gives you a way out of this cycle
   ![Diagram showing HRF cycle]

9. Increase your soil’s organic matter nutrient bank.
   i) Leaving residue on the soil surface will build soil organic matter in the short- and long-term.
   ii) Our soils are naturally very low in soil organic matter, but with HRF we have the ability to increase soil organic matter
   iii) View the soil as a bank
       1. Will need to start out making deposits: additional nutrients are required, especially nitrogen, phosphorus, and sulfur.
       2. Eventually, you will be able to make regular withdrawals: because you are building soil organic matter, you will get to the point where the nutrients mineralized from the increased organic matter pool will become significant

10. Reduce your equipment needs.
    i) Depends on the crop and the rotation
    ii) Eliminates primary and secondary tillage operations
    iii) Use sales of unneeded equipment to offset the cost of any required new equipment

C. Pick one or a few of these reasons and use them as motivation to learn how to manage HRF systems successfully.
Residue Management at Harvest

Randal Taylor, Oklahoma State University

1) Residue management at harvest
   a) Crop Residue Produced per Bushel of Yield

<table>
<thead>
<tr>
<th>Crop</th>
<th>Lbs. of residue per ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>100</td>
</tr>
<tr>
<td>Corn</td>
<td>60</td>
</tr>
<tr>
<td>Sorghum</td>
<td>60</td>
</tr>
<tr>
<td>Soybeans</td>
<td>45</td>
</tr>
</tbody>
</table>

   i) High yielding, irrigated crops produce a large amount of residue

   b) Problems with non-uniform residue distribution
      i) Poor tillage and planting performance
         (1) Seeding depth is non-uniform
      ii) Volunteer seed concentration
      iii) Herbicide interception
      iv) Insulates soil surface
         (1) Cooler soils
         (2) Wetter soils
         (3) Delays or slows emergence
      v) Excess residue over seed furrow

   c) Challenges in spreading residue uniformly at harvest
      i) Increasing width of harvest equipment
      ii) Many combines have only straw Spreaders, not chaff Spreaders. They are different pieces of equipment.
      iii) Wind
d) Equipment for residue management
   i) Stripper headers
      (1) Combs up through wheat and strips off the grain

(2) Benefits
   (a) Leaves nearly all the stubble standing at close to its original height
   (b) Standing stubble does not have to be cut at planting
      (i) Planter flattens much of the residue at planting
   (c) Grain is essentially threshed from the standing small grain stubble at the header
      (i) Approximately 85% of the grain leaving the header has been threshed
      (ii) Very little straw enters the combine
      (iii) The combine becomes primarily a rethreshing and cleaning machine
      (iv) Improves the capacity of the combine
   (d) Studies conducted by Hill et al. (1985) show increased grain capacity, improved separation efficiency, decreased specific fuel consumption, reduced straw walker loss, and lessens the combine’s response to varying crop conditions.
   (e) Conserves soil moisture better than conventionally harvested stubble

(3) Challenges
(a) If stubble lodges, the benefits at planting are lost
(b) Finding a dealer (in the PNW)
(c) Cost of buying a new header

ii) Chaff spreaders
   (1) Recommended for both direct seeding and strip-till systems
   (2) Some new combines have OEM chaff spreaders
   (3) There are several manufacturers of after-market chaff spreaders
   (4) What do you need to know about chaff spreaders?
      (a) How much does it cost?
      (b) How far does it spread chaff?
      (c) Does it spread material uniformly?
      (d) How is the unit driven?
      (e) How does material get from the shoe to the spinner?
      (f) Is it user friendly?
         (i) Ease of spreader adjustment
         (ii) Ease of combine adjustment and inspection
   (5) Types
      (a) Mainly spinner spreaders, single or double
         (i) They do not spread uniformly, but they are much better than nothing
         (ii) It is difficult to throw chaff very far
      (b) Pneumatic
   (6) Costs, after market
      (a) Low end, $850, for 20’ width
      (b) High end, $2200, for wider spreading
      (c) $3000+, very high end
   (7) Partial list of dealers
      (a) J. B. Spreaders, Inc.
      (b) Dutch Industries
      (c) F/S Manufacturing
      (d) Agri-Tech
      (e) The Spreader, Inc.
      (f) Vittetoe, Inc.
      (g) The Crary Company
      (h) Fast-Lane Products
   (8) Takes power to run spreaders

iii) Chopping corn heads
   (1) Benefits
      (a) Improves residue decay
      (b) Reduces tire wear
      (c) Better conditions for HRF planting
   (2) Types
      (a) Flail chopper
(b) Rotary mower
(c) Snapping rolls
(d) See http://farmindustrynews.com/combines/9-new-stalk-chopping-corn-heads

2) Summary
   a) Uniform residue distribution makes everything work better in the system
   b) By going from a tillage system to a no-till system, you are exchanging one set of problems for
      another set of problems. Just like with tillage, you have to manage the problems in no-till to be
      successful.
   c) Given his 20+ years of experience, what he has seen, read, and heard, and given the benefits,
      and the problems with no-till farming, his conclusion is that he would be doing it (no-till) now
      if he were farming.

Weed Management Considerations in Reduced Tillage Systems

Andrew Kniss, University of Wyoming

1) For many weeds, residue management is secondary to
   a) Crop rotation
   b) Herbicide choices

2) However, changes in residue management will impact weeds:
   a) Changes the vertical distribution of weed seeds
      i) Most seed near or at surface
      ii) At first, because seeds are not buried, this can result in more weeds.
   b) Changes the weed species composition
      i) Many annual grasses disfavored by no-till, high residue systems because they prefer loose,
         tilled soils
      ii) Perennial weeds can be favored by no-till, high residue systems where their roots and
          rhizomes are not disturbed by tillage
iii) Most annual broadleaves will be similar in both systems

iv) There will be exceptions to all these rules: wild oats were ubiquitous across residue management systems (Thomas et al. 2004).

c) Changes in weed densities
i) Farmers may experience many more weeds early in transition to reduced tillage systems

3) Increased dependence on herbicides
a) Tillage vs. Herbicides
i) Fuel usage
   (1) Plow = 4.7 gal/A
   (2) Cultivator = 2.0 gal/A
   (3) Sprayer = 0.4 gal/A

b) Timing of herbicide applications
i) In conventional tillage systems, weed control is often limited to preemergence and in-crop management
ii) In HRF, you may need to consider weed control at other times of the year
   (1) Pre-plant
      (a) Early pre-plant (EPP), 15-45 days before planting
         (i) Ideal EPP herbicide
            1. Non-selective
            2. Highly effective
            3. No carryover effects
      (ii) Glyphosate and paraquat are commonly used

(b) Pre-plant (PP), stale seedbed
   (i) Almost a necessity in HRF
   (ii) Get seeds to germinate before crop is planted, and then kill them
   (iii) Irrigating early to get flush of weeds
   (iv) Weeds emerging with the crop are the most economically damaging
   (v) Deplete as much of weed seed bank as possible
   (vi) Kills first flush of weeds, which is usually the worst

(c) Read herbicide labels. Examples:
(i) **Banvel** requires 1” of precipitation (or irrigation) or 21 days between application and planting of some susceptible crops
(ii) **Select** requires 6 days before planting field corn, 1 month before planting many other grass crops
(iii) **Stinger** requires 10.5 months before planting sorghum and 18 months before millet; most other grass crops may be planted any time

(d) EPP vs. PP
   (i) EPP often provides more consistent control
      1. Better chance of moisture in rainfed systems, to activate herbicides
   (ii) EPP may eliminate the need for burndown herbicide application at planting
   (iii) EPP can minimize potential herbicide carryover problems in both the current year and the following.

iii) In crop applications
   (a) Preemergence (PRE)
   (b) Postemergence (POST)

(2) Early season weed control is critical
   (a) Most crops are poor competitors for first 4 to 8 weeks
   (b) Increased crop residues may slow early development of some crops even further
      (i) Reduced soil temperature
   (c) Increased crop residues may decrease weed emergence also
      (i) Many species require light to germinate

(3) Herbicide selection largely determined by the crop
   (a) Factors
      (i) Weed spectrum - **SCOUTING**
      (ii) Herbicide use in previous crop
          1. Resistance management
      (iii) Herbicide use in following crop
          1. Rotation interval
      (iv) **COST, $**

   (b) Crop competitiveness and pre-plant weed control will play a role in herbicide efficacy
iv) Post-harvest applications
   (1) Most effective time to control many perennial weeds

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roundup</td>
<td>1</td>
<td>87</td>
<td>70</td>
</tr>
<tr>
<td>Roundup</td>
<td>2</td>
<td>92</td>
<td>85</td>
</tr>
<tr>
<td>Landmaster</td>
<td>2.5</td>
<td>90</td>
<td>--</td>
</tr>
</tbody>
</table>

(2) Need adequate regrowth prior to herbicide application
   (a) Stressed, mowed, or cut weeds will not translocate herbicide well
(3) May require irrigation to stimulate regrowth

4) Residue-Herbicide interactions
   a) Will my soil-applied herbicide work with HRF?
      i) It depends…it is hard to generalize about this
   b) Crop residues affect these soil properties which then influence either herbicide-soil interactions or crop-weed interactions:
      i) Organic matter (carbon)
      ii) Physical characteristics
      iii) Soil moisture
      iv) Microbial activity
      v) pH
      vi) Enzyme activity
      vii) Fertility
   c) General principles:
      i) The more residue, the harder it is to get herbicide to the soil
      ii) The more residue, the more weeds are suppressed by the residue:

   iii) Under dry conditions, more herbicide is lost from residue than soil surface due to volatilization and photodegradation.
iv) Rainfall or irrigation immediately following herbicide application will minimize these losses

v) Some herbicides maintain effectiveness while on dry residue, others do not

vi) No-till systems may also increase herbicide leaching through the soil profile due to better water infiltration

5) Make full use of cultural weed control practices
   a) **Crop rotation** is key
      i) A well designed crop rotation will help control weed by:
         (1) Utilizing a range of planting dates
         (2) Utilizing a range of harvest dates
         (3) Utilizing diverse crops
         (a) Stature
         (b) Botanical group
         (c) A diverse crop rotation will lead to diverse weed control practices
            (i) Limit the buildup of any one problem species
            (ii) Delay or prevent herbicide resistant weeds
            (iii) Reduce the need for herbicides and tillage
(5) Allow for rotation of herbicide chemistries

b) Practices that allow crop to be more competitive:

i) Crop row spacing

![Row Spacing Diagram]

ii) Crop seeding density
(1) More crop plants early in the season = increased competition with weeds for limited resources
(2) Wheat seeding rate:
   (a) 40 lbs./A = 300,000 brome, 180,000 mustard (per acre)
   (b) 80 lbs./A = 90,000 brome, 80,000 mustard (per acre)

iii) Fertility management
(1) Fertilizer
   (a) Type and placement
   (b) Most responsive to nitrogen and phosphorus
   (c) Nitrogen placement in winter wheat
      (i) No nitrogen → 18 bu/A; 800 lbs./A brome
      (ii) Broadcast → 20 bu/A; 1,500 lbs./A brome
      (iii) Band → 30 bu/A; 850 lbs./A brome

6) Summary
   a) Species composition may change
   b) Consider weed control when the crop is absent (EPP, PH)
   c) Crop residue can aid in weed suppression
   d) Crop residue can reduce herbicide penetration
      i) Irrigation or granular applications may help
   e) Utilize cultural practices where possible
1) Farmer experiences
   a) Kenneth Jensen, strip-tilled corn
      i) Under center pivot
      ii) Corn after wheat on 22” row spacing
      iii) Schlagel strip-till machine with RTK guidance system
      iv) Operations eliminated using strip-tillage to go from wheat to corn:

      | Operation Eliminated | Cost, $ per acre |
      |----------------------|------------------|
      | Offset disking        | 14.00            |
      | Offset disking        | 14.00            |
      | Ground hog (cultivation) | 12.50         |
      | Spread fertilizer     | 7.50             |
      | Dammer-Diker          | 13.00            |
      | Total Savings         | 61.00            |

(1) How much **TIME** would you have if you could eliminate these operations on your farm?

v) System details, wheat harvest to corn planting
   (1) Uses chaff and straw spreaders on combine for wheat harvest

   (a) Do not confuse straw choppers with chaff spreaders.
   (2) Turbo-tills (Great Plains vertical tillage implement) the field twice
(b) Turbo-till results on 120-140 bu/ac wheat straw
   (i) One pass vs. two pass

   (c) May enhance residue decomposition
   (d) Sizes residue, especially where wheat had lodged

   (3) Irrigates
   (4) Applies glyphosate
   (5) Spring strip-tillage, 2-3 weeks before planting
   (6) Planter has Yetter row cleaners

vi) Strip-tilled corn, June 1, 2009, plants 40,000 seeds/ac

vii) Corn stand as influenced by strip-tillage in 2009 and 2010

<table>
<thead>
<tr>
<th></th>
<th>Strip-till</th>
<th>Conventional</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field 1 (2009)</td>
<td>42,000</td>
<td>38,500</td>
<td></td>
</tr>
<tr>
<td>Field 2 (2009)</td>
<td>39,000</td>
<td>38,000</td>
<td></td>
</tr>
<tr>
<td>Field 4 (2010)</td>
<td>45,344</td>
<td>44,003</td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>42,115</td>
<td>40,186</td>
<td>1,929</td>
</tr>
</tbody>
</table>
(1) Disking twice leaves more residue over the row than strip-tillage.

viii) Yield as influenced by strip-tillage in 2009-2010.

<table>
<thead>
<tr>
<th>Location</th>
<th>Tillage</th>
<th>Yield @ 15%, bu/ac</th>
<th>Moisture, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pivot 1 (2009)</td>
<td>Strip-tilled</td>
<td>247.4</td>
<td>27.0</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>244.9</td>
<td>23.6</td>
</tr>
<tr>
<td>Pivot 2 (2009)</td>
<td>Strip-tilled</td>
<td>248.7</td>
<td>30.3</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>254.7</td>
<td>27.6</td>
</tr>
<tr>
<td>Pivot 3 (2009)</td>
<td>Strip-tilled</td>
<td>272.3</td>
<td>25.7</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>273.7</td>
<td>25.9</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>239.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Average</td>
<td>Strip-tilled</td>
<td>254.1</td>
<td>26.4</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>253.2</td>
<td>24.9</td>
</tr>
<tr>
<td>Difference</td>
<td>Strip-tilled</td>
<td>0.9</td>
<td>1.5</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

(1) These are excellent yields for their region
(2) Maintained yield with strip-till system. Strip-tilled crops were slightly behind in maturity but savings from eliminating tillage favors the strip-till system.

b) Monty Heid, strip-tilled dry edible beans
(1) Schlagel strip till machine

ii) Dry bean yield as influenced by strip-tillage in 2010
(1) Strip-till: 2,418 lbs./ac; Conventional 2,253 lbs./ac, 7.3% more in the strip-tilled (not replicated)
(2) Corn silage yield as influenced by strip-tillage (2010)
(a) Strip-till 30.4 tons/ac; Conventional 31.7 tons/ac at 65% moisture

c) Crustbuster no-till drill
   i) Available for lease to farmers from Malheur SWCD
   ii) Used by 29 farmers on 2,266 acres in 2010
      (1) Drilling spring barley into corn (180 bu/ac) residue without tillage

(a) Barley yielded 2.5 tons/ac, similar to previous years
(b) Possible risk with this rotation
   (i) With small grains following corn, there is the potential for problems with
       fusarium head scab
   (ii) Use fungicide early, manage water well after head emergence
(2) Irrigated spring wheat drilled into alfalfa
   (a) Rill irrigated field
   (b) Alfalfa killed in fall, before last cutting
   (c) Planted in two directions
   (d) May have helped with salt problems in the field
   (e) Yielded 104 bu/ac compared to 70 bu/ac normally

(3) Gary Westcott, 2010 spring barley direct seeded into wheat residue
   (a) Effect of not having a chaff spreader:
      (b) Yielded 2.5 tons/ac
   (c) Lessons learned
      (i) Need GPS guidance on drill to figure out where you’ve planted in heavy residue
      (ii) Rill irrigated fields
          1. Residue burned off, direct seeded with drill

(4) Direct seeded oats into wheat stubble
   (a) Need to irrigate dry soils to soften them up before planting

(5) Ron Smith
   (a) Corn-on-corn, 30” row spacing
   (b) One pass strip-till plant system
       (i) Schlagel strip-till machine
(ii) Uses a rolling stalk chopper after harvest

2) Questions
   a) With the Schlagel, can you stay on the 22” rows with the planter?
      i) Coulters in back help hold the planter on course
   b) Does he guide the planter with a coulter?
      i) No, he uses GPS auto-steer on the tractor

No-till Drills and Planters

   Randal Taylor, Oklahoma State University

1) A high plains perspective
   a) No-till drills
      i) Two approaches
         (1) “Fluff-and-plant”
            (a) Coulters ahead of openers
               i) Could be a coulter cart in front of drill
               (ii) Coulters cut residue and till the soil ahead of the openers
               (iii) Requires additional down force (weight) for coulters
               (iv) Potential crusting if the right conditions exist
(b) Great Plains is the main manufacturer
(c) Using narrower coulters than in the past, to avoid creating clods
(d) Challenges
   (i) In wet conditions a compaction layer can be created
(2) “Slice-and-plant”
   (a) Single or double disk openers with no coulters
   (b) Disk openers slice the residue and soil to place seed in the slot
   (c) Slot may reopen in heavy soils if crop is drilled too wet and is not followed by a rain
   (d) Double disk drills work in both tilled and untilled conditions
   (e) Single disk drills work best in untilled conditions
   (f) Conventional drills can be used in untilled conditions, but they may not last very long because they are not built as heavy as true no-till drills
      (i) Use them as a transition tool, especially in lower residue conditions
(3) Which system is better?
(a) Depends on:
   (i) Crop
       1. Seed size
       2. Seedbed needs
   (ii) Residue conditions
       1. Heavy
       2. Light
   (iii) Soil
       1. Texture
       2. Moisture

(4) In 2003, he compared three drills, John Deere 1590, Great Plains 1510P, and a Sunflower 9412 (all 7.5” spacing), a corn planter (30” rows) and a Great Plains twin row planter.
   (a) Planted in good moisture in all 5 fields
   (b) Drills were operated by company reps.
   (c) Results
       (i) JD drill performed well across conditions
       (ii) Great Plains twin row and the corn planter did well in three of five fields.
       (iii) Yields did not differ except in one field where the corn planter was significantly greater

(5) 2005 drill study
   (a) Soybeans were drilled into corn stubble near Abilene, Kansas
   (b) Planted on May 25th
   (c) We used 3 drills (Deere 1590, GP 1510P, and Sunflower 9412) on 7.5” spacing, 1 drill (Crustbuster) on 10” spacing, and a planter (30”)
   (d) Four replications
   (e) Resulted in good stands with all the equipment, and no difference in yields

ii) Handling tough to cut residue
   (1) Wait until it is dry, later in the day

iii) Getting accurate depth control
   (1) “People are planting shallower than they think they are”
   (2) In general, depth control has been supplied by press wheels.
      (a) Longer swing arms means less consistent control over rolling terrain.
   (3) Single disk openers with gauge wheels near the seed tube offer some of the best depth control.
   (4) Parallel linkage systems also offer more consistent depth control.
   (5) Down force on the opener can dictate depth control in challenging seeding conditions.
      (a) Increasing down force does not always mean you can cut residue better.
   (6) Opener disk angle and operating speed can also affect depth control by creating upward forces on the seeding unit.
   (7) These forces could also affect seed-soil contact if press wheel pressure is reduced or they lose contact with the soil.
iv) Obtaining seed-to-soil contact
   (1) Single press wheel is the standard for tilled soil
       (a) May not be the best for untilled conditions
   (2) Single disk opener systems typically have multiple seed closing wheels
v) Hoe-type openers
   (1) In high plains, these are not as popular because they are high disturbance
   (2) The newer ones are better than the older versions
   (3) Planting speed is less than with disk drills, but the drills are usually wider
vi) Drill summary
   (1) No-till conditions are less forgiving at planting
   (2) The no-till drills that we have today are much better than their predecessors are and are
       approaching the precision of row crop planters.
   (3) Think about what you want to accomplish when considering no-till drills.

b) Row-crop planters
i) Results of several field experiments
   (1) Seed firmers had no effects of practical significance, but he still uses them
   (2) Row cleaners resulted in greater emergence, closer plant spacing, fewer skips, greater
       test weight, but no difference in yield
ii) Using one spiked closing wheel resulted in greater yields at the rainfed sight but not at the
    irrigated site.
iii) Lower planting speeds resulted in better precision in seeding
iv) Stand establishment criteria were not correlated with yield; a lot can happen between
    planting and harvest.
c) General recommendations
i) Adjustment and operation of the equipment is likely more critical than the specific
   equipment
   (1) Planter adjustment
       (a) Level the frame
       (b) Check down force – need heavy duty springs
       (c) Check depth setting
       (d) Check closing wheel down pressure
ii) Old planters can be upgraded to plant no-till inexpensively
iii) Find something that works the best across the most conditions found in your fields and stick
     to it.
1) Glyphosate properties
   a) Systemic; moves into roots
   b) No practical soil activity
   c) Foliar herbicide
      i) To be effective, a foliar herbicide must:
         (1) reach the plant
            (a) Challenges
               (i) Drift
               (ii) “canopy” effect: the shading of smaller plants by larger plants or standing residue
         (2) Be retained on the leaf
            (a) Plant morphology, upright vs. horizontal
            (b) Waxiness
               (i) Lambsquarters retains only 25% as much spray as redroot pigweed
               (ii) Surfactant increases spreading of droplet on leaf
               (iii) Check glyphosate product label to see if it recommends adding a surfactant, especially with generics
            (c) Special plant structures
               (i) Lambsquarters leaves are covered with structures that limit the contact between herbicide and leaf surface
            (d) Surfactants, and crop oils can help
         (3) Penetrate the leaf
            (a) Plant cuticle is a major barrier to penetration by foliar applied herbicides
               (i) Thickness and composition influenced by
               1. Age of plant
               2. Environment; dry stressed plants have thicker cuticle
         (4) Move to the site of action
         (5) Remain toxic long enough to kill the plant

2) Application factors
   a) Herbicide rate, apply glyphosate at the minimum recommended rate or greater!
      i) Target the most difficult to control weeds to avoid escapes
      ii) Sprayer calibration
         (1) Check for
            (a) Damaged nozzle
            (b) Clogged nozzle
            (c) Different nozzle size
            (d) Poor agitation
            (e) Boom height
         iii) Check your calculations
      iv) Weed size and density
         (1) Dense canopy reduces coverage
(3) **You must control the weeds early to prevent yield loss!**
(a) Most crops are highly susceptible to early season weed competition
(b) In most years, if weeds reach 3 to 4 inches in height, yield has already been lost

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![Early Season Weed Control Chart](chart1.png)

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(4) Just because you can control large weeds with glyphosate does not mean you should.

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![Early Season Weed Control Chart](chart2.png)

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![Another reason to manage early Chart](chart3.png)
v) Conditions
   (1) Dust, caused by driving too fast during spray application:
      
   (2) Weather
      (a) Rainfall
      (b) Humidity, high is better
      (c) Soil moisture, high is better
      (d) Temperature, warm, but not too hot
   (3) Healthy plants make better herbicide targets

3) Timing of weed emergence vs. herbicide application
   a) Weeds emerging after spray will not be killed
   b) Late season weed control
      i) If crop establishment and vigor is good, 2 applications of Roundup (or other glyphosate)
         may work well
      ii) However, what if:
         (1) Stand is thin
         (2) Diseases reduce leaf area
         (3) Hail damage occurs
         (4) Crop is in 30” rows
      iii) These conditions may require a residual herbicide with RR crops
         (1) Preemergence (probably the ideal time):
             (a) Allows delayed first POST application, decreasing the chance of needing additional
                 POST herbicides
         (2) Layby:
             (a) Adding a residual herbicide with or after the POST glyphosate to prevent late-season
                 weed problems
   c) Temptation will exist to rely solely on glyphosate
      i) Glyphosate has no residual activity
      ii) More than one application WILL BE REQUIRED!
         (1) Or a residual herbicide may be used in addition
         (2) Using a PRE herbicide will allow more flexibility
      iii) Don’t wait for ALL the weeds to emerge before first application
5) Ammonium sulfate (AMS)
   a) Mix in water before glyphosate is added, either dry or liquid forms.
   b) Addition of ammonium sulfate can help, especially with difficult to control weeds like lambsquarters and with hard water
   c) Increased glyphosate rate + AMS can give even better results
      i) Rate of glyphosate required to provide 95% control of lambsquarters WITHOUT AMS: 22 oz./A
      ii) Rate of glyphosate required to provide 95% control of lambsquarters WITH AMS: 12 oz./A
6) Hard water problems
   a) The glyphosate molecule is negatively charged, and has a very high affinity for hard water cations
      i) Calcium
      ii) Magnesium
   b) Ca and Mg in the spray water will bind to glyphosate making it unable to penetrate the plant cuticle
7) Recommendations
   a) If you have been successful with PRE herbicides in the past, consider using them in RR crops at reduced rates
      i) Early season competition reduces yield!
      ii) We cannot forget this even though we have an effective POST herbicide option
   b) First POST application should target weeds less than 4”
   c) Avoid spraying when there is heavy dew
   d) Avoid spraying in the evening
   e) Use application volumes of 10 to 15 gpa
   f) Use rates that target the most difficult to control weeds in the field
      i) Don’t skimp on the rate, but don’t over-apply
   g) ALWAYS put ammonium sulfate in the tank

NOTICE
Pesticides or uses of pesticides mentioned in this publication may not be registered for use in Washington State. Always use registered pesticides according to their label.

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