12 Foliar Feeding Ideas for Extra Yields

1. Reduce surface tension of spray to fully coat leaves.
2. Clean and soften the waxy leaf cuticle so nutrients can enter leaf.
3. Use surfactant with mild ionic bonding to carry nutrients into cells.
4. Reduce *internal* surface tension to speed sugars through phloem tubes.
5. Use only a *plant-based* surfactant which crops can metabolize.
6. Spray 15-20 gal. water per acre; medium droplet size to cut drift.
7. Spray during cool, calm morning or evening.
8. Use non-chlorinated water… structured and R.O. if possible.
9. Select nutrients based on sap test or tissue test.
10. Adjust pH as per product label.
11. Use flagged field strips to accurately measure yield response.
12. Surfactant should be *non-toxic* to plants, animals — and you.

By Erik and Jerry Carlson
Renewable Farming LLC
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Cedar Falls, IA 50613
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Why Foliar Feed?

• More control with less risk
• Lower overall nutrient inputs (31% to 99% of nitrogen metabolized, vs. 10% to 40% soil applied)
• Less nutrient leaching past the root system, reducing groundwater contamination
• Allows continuous adjustment of rates to meet seasonal needs.

Dr. Roch Gaussoin
University of Nebraska – Lincoln
rgaussoin1@unl.edu
• Foliar fertilization is by far the most effective way to apply secondary and trace elements. The readily-available nutrients are more easily utilized, because foliar absorption is a physical and chemical process and not a biological process as is the case with most granular fertilizers.

Dr. Roch Gaussoin
University of Nebraska – Lincoln
rgaussoin1@unl.edu
1. Use a colloidal micelle surfactant for a glossy coat on both sides of every leaf

**KQ-XRN in water only:** Droplets form. Water surface tension of 72 dynes is higher than surface tension of the leaf. High runoff. Less contact absorption area. Droplets exposed to evaporation.

**KQ-XRN in water plus WakeUP Summer:** Spray solution clear-coats entire leaf, both sides. Nutrient solution fully absorbed by the leaf in 10 to 20 minutes.
2. Temporarily lift waxy cuticle layer with WakeUP *Summer* in spray solution

- Waxy leaf coating on top and bottom
- Palisade cells with chlorophyll which build sugars

Temporarily softening carbon chains in the waxy leaf coat allows more nutrients to penetrate into palisade cells and become metabolized.
Applied nutrients need to penetrate through entire leaf surface, not just enter through the stomata, which cover only a fraction of the leaf.

This is why the waxy “chitin” layer must be temporarily softened and lifted. A colloidal micelle cleanser is the most effective means of doing this. Very few “surfactant” products create colloidal micelles in water.

This photo also shows bacteria living on the leaf surface. Some species such as the PPFMs exude growth promotants. This is why a little sugar in your nutrient spray can add a yield nudge; it feeds these leaf-dwelling bacteria.
Laser beam shining through a jug of concentrated WakeUP reflects from trillions of tiny colloids, which are negatively charged. These react in water to form “micelles” which become a:

1. Surfactant
2. Cleanser
3. Carrier
Properties of Water

slight negative charge

e\(^{-}\) of bonds spend more time around O atom than around H atoms...so a slight negative charge.

slight positive charge

Because of the slight charges, and the fact that “opposites attract,” water molecules organize themselves with hydrogen bonding.
3. Colloidal micelles ionically bond with nutrients, carrying them into plant cells for metabolism

Exterior negative charge temporarily bonds with nutrient elements. When the colloidal micelle encounters a leaf tubule, the micelle allows water molecules and nutrients to flow almost “single file” through the microtubules, which are about 1 nanometer in inside diameter. This transfer isn’t fully understood, but it’s most effective if the crop recognizes compounds as biologically friendly for nutrition.

Diameter of micelle is about 30 nanometers
A colloid with a strong negative charge creates a stable “micelle” of water molecules around it. These micelles repel each other and become very “slippery” with low surface tension. The strength of the bond is measured as the “Zeta Potential.” This micelle structure becomes a carrier of nutrient ions to the plant cell.
Microtubules, also called Ectodesmata - pores with a diameter of less than 1 nm. These pores are readily permeable to solutes such as urea (radii 0.44 nm), but not larger molecules such as synthetic chelates.

Source: Dr. Roch Gaussoin, University of Nebraska
Microtubules leading from cell wall to nucleus of the cell are the conduits of nutrient ions for cell metabolism.
“The rate of cuticular permeation decreases as hydration diameter of monovalent cations (size) increases.” (Translation: Bigger cations are harder to move through the leaf cuticle.)

“For divalent cations, increased hydration weakens charge strength and promotes greater permeation.” (Translation: More water makes it easier to move nutrient ions through the leaf cuticle and into plant metabolism.) Source: Dr. Roch Gaussoin, U. of Nebraska

WakeUP colloids are about 0.4 to 0.8 angstroms.
Nanometer: One billionth of a meter
Angstrom: One-tenth of a nanometer (0.1 nanometer)
Picometer: One trillionth of a meter
Speed of foliar-applied nutrient uptake

Data: University of Nebraska
WakeUP remains active inside the leaf, accelerating translocation of sugars and other nutrients out of the leaf through phloem tubes. WakeUP, a colloidal micelle, also reduces internal surface tension of plant sugars and becomes a ‘lubricant’ for nutrient transfer from leaves to roots, shoots and fruit.
We’ve seen faster nutrient translocation with WakeUP Summer in the spray solution every time we tissue tested after spraying with foliar nutrients.
Trace element content of corn at V3, 48 hours after foliar spraying with trace elements in three types of colloidal micelle surfactant / carriers

Absorption and translocation of manganese rose 200% with WakeUP Summer as carrier, compared to control. Zinc content rose almost 300%.

WakeUP Summer proved far more effective at micronutrient transfer than the old “SoySoap” in our tests.
Trace element content of winter wheat leaves 48 hours after foliar spray with trace elements in two formulations of WakeUP

Absorption and translocation of manganese rose 200% with WakeUP Fresh as carrier, almost 400% with WakeUP Summer as carrier, compared to no application.
With WakeUP, sugars move more rapidly to roots and new growth.

Sugar levels in corn roots remained 70% higher than controls almost 2 days after a foliar spray of WakeUP, SEA-90 and nitrogen as urea.

Research by agronomist Jim Porterfield, Martinsville, IL

95% of crop weight is carbon, hydrogen and oxygen from the air and water. These elements are first built by leaf photosynthesis, but must translocate to where they are used, such as the seed or fruit.
Pumping extra sugars and other nutrients to corn roots by spraying WakeUP Spring at late V1 to V2 stimulates mycorrhizae and beneficial microbes around the root. By V4, when corn is “setting” kernel rows, it will sense greater nutritional health.

Inoculating with mycorrhiza or beneficial microbes on seed or in-furrow multiplies the benefit by raising the population of helpful organisms to feed.

This root has a thick coating of mycorrhizal filaments which cling to soil particles. Compliments of Phil Pitzenberger, Greene, IA
Mobilize sugars to roots early! Feed the beneficial bacteria and mycorrhiza early, and you build a massive “earth pump” for greater nutrient and moisture circulation in your crop all season.
Accelerating sugars to roots with WakeUP Spring at V2 helps build a large, well-colonized root system early in the season, for robust circulation through xylem phloem systems in the crop. This helps crops keep growing through dry weather stress. Also... couple this “feeding” effect with microbial in-furrow inoculants for more synergy!

Untreated corn (above) was grown in a terrarium with the same soil as the treated corn. These roots are adequate in a season with good soil moisture. The biggest yield differences between untreated and treated crops typically show up after dry-weather stress.

Roots of corn treated with WakeUP (above) are 50% more massive, with roots reaching almost 3 ft. deep. A North Carolina State U. corn plot trial by agronomist Ron Heiniger found a 14-bu. gain with two WakeUP treatments.
**Fall-planted tillage radish:** WakeUP Spring alone as a foliar spray increased weight by 14%. This is an example of mobilizing sugars from leaves to roots — which in this case are the “fruit” of this cover crop.

WakeUP Spring also mobilized SEA-90: In combination, WakeUP and SEA-90 increased weight by 28% compared with the control.

*Research by Jim Porterfield, Illinois, fall 2012*
6. Apply 15-20 gal. per acre solution.

- *For glossy leaf coverage,* you need low surface tension. A fine mist is not needed, as droplets will spread across leaf surfaces. WakeUP reduces surface tension of water from 70 dynes to about 32 dynes.

- *A medium to coarse spray* reduces drift and evaporation loss. With low surface tension, spray droplets merge in mid-air to cut down on drift.

- *Turbodrop nozzles,* with a venturi action, create large drops filled with small bubbles that burst when they hit a leaf.

- Aerial spraying: Use maximum practical rate of solution per acre. Try to schedule for cool, quiet application time.

One ounce of WakeUP contains enough micelles to cover 4 acres
Sprayers that “fog” don’t necessarily mean improved coverage. Water vapor is the finest “mist” — and it forms dewdrops on soybean hairs. Sprays which fail to “clear coat” the leaf allow spray material to evaporate or wash off without absorption. Spraying with dew on leaves is highly effective with WakeUP Summer in the mix. Dew adds more water per acre, making the coating more dilute and thus easier to absorb.
A biologically based colloidal micelle can help absorb dew, too!

A heavy dew may be “worth” 1/10 inch of rain to a crop, especially if it’s absorbed rather than evaporated away.
Leaves are coated with dew. Normal surface tension of water causes beads on the leaves. This also indicates that not much moisture is absorbed as leaves shed rainfall and dew.

7. Time your spraying when leaf is cool and translocating sugars
Morning or evening spraying time is about equal for leaf absorption, if temps are cool. *We favor morning, when the leaf is starting to make sugars.*

**AM Spray vs. PM Spray**

<table>
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<tr>
<th>Elements</th>
<th>% Absorbed</th>
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<td>B</td>
<td>AM Spray</td>
</tr>
<tr>
<td>Ca</td>
<td>AM Spray</td>
</tr>
<tr>
<td>Cu</td>
<td>AM Spray</td>
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<tr>
<td>Fe</td>
<td>AM Spray</td>
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<td>Mg</td>
<td>AM Spray</td>
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<tr>
<td>Mn</td>
<td>AM Spray</td>
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<tr>
<td>NH4</td>
<td>AM Spray</td>
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<tr>
<td>NO3</td>
<td>AM Spray</td>
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<tr>
<td>P</td>
<td>AM Spray</td>
</tr>
<tr>
<td>Zn</td>
<td>AM Spray</td>
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</tbody>
</table>

**AM Spray = 52° F, PM Spray = 71° F**
8. Use clean, non-chlorinated water. If possible, use structured and reverse osmosis water for easy leaf penetration and cellular absorption. Add a pound or two of sugar to feed leaf PPFMs.
Reverse Osmosis systems remove chlorine, chemicals, salts — all of these can tie up nutrients or conflict with cell metabolism. Second best is filtered rainwater. Avoid chlorinated, fluoridated water from city or rural water treatment systems. Farm well water can vary widely.

We use the Pursanova structuring system in spray solutions when we test foliar nutrients. There are other structuring units available, but Pursanova has a dedication to agricultural applications.

- Pursanova treatment of water reduces surface tension by about 25%. However, it increases capillary action via xylem tubes, which is contrary to ordinary physics.

- Pursanova water, by itself, has shown increases in plant biological activity, such as faster seed germination.
Keith Schlapkohl, Stockton, IA uses foliar spray “stock” water which is first structured, then treated by reverse osmosis — and then structured again before mixing nutrients or herbicides. He cuts herbicide rates by 50% or more and still gets excellent control.

In 2012, Keith raised corn in the 230 bu. to 280 bu. range in a drought area. Non-GMO corn and soils with excellent biological activity. Keith adds WakeUP to all nutrient foliars, and he foliar sprays three to five times as he sees the crop needing it.
9. Sap testing: Breakthrough for Foliar Nutrient accuracy

Lab squeezes juice from leaf samples and reports 21 nutritional indicators. It’s like a blood test of readily available nutrients. In contrast, analysis of dried, ground-up leaf tissue is a post-mortem of all nutrients — stored and available for growth.

Sap testing reveals upcoming needs for growth, giving you at least a 2 week lead time to foliar feed before yield potential is lost.

Each analysis matches new leaves and older leaves. If older leaves are being “mined” for nutrients, that signals an upcoming need.
10. Adjust pH of spray solution as called for by product label. We prefer dry citric acid rather than ammonium sulfate (sulfer sometimes reacts and drops out).

11. Mark control strips with flags or GPS instruments to measure yield response when you harvest.

12. Any surfactant/carrier should be biologically based and non-toxic to crops, animals — and you.
Examples of foliar feeding results

One foliar feeding trip with zinc and manganese brightened the green color of soybeans in 2011. You can see the 18-row strips from the air. Treated strips yielded 11 bushels more.
6.8 bu. gain with 2 gal. per acre of slow release 28% N alone, 11.9 bu. gain after adding WakeUP to tank mix. *Almost an 80% increase in yield response.* This is a typical yield enhancement.
When six kinds of micronutrients were tank-mixed with WakeUP in this 2012 trial, four of the nutrient brands showed a synergistic yield response with WakeUP.
2104 beta test with lignin-based plant growth promoter

Av. 11 strips Lignition + WakeUP: 158.9 bushels
Av. 9 strips Lignition alone: 129.1 bushels
Av. 15 control strips: 126.7 bushels

Data: Renewable Farming LLC, Cedar Falls, IA
2015 corn plot trials with Lignition and WakeUP

8 control reps 144.07
6 reps with Lignition on seed plus in-furrow 157.17 (+13.09)
4 reps Lignition+ WakeUP, and foliar + WakeUP Summer 164.97 (+20.89)
4 reps Lignition foliar + WakeUP 164.41 (+20.34)
8 reps Lignition on seed alone 144.8 (+0.73)

Trials at Renewable Farming LLC,
Cedar Falls, IA
50613
Bob Streit asked us to test:
This is our 2015 test plot in the background. Erik’s son Blake Carlson in foreground.
**Tank mixed and sprayed with high-clearance Hagie sprayer July 18, 2015:**
1 quart/acre  Bio-Empruv
1 quart/acre  42PHI copper
WakeUP *Summer* on random plots at 5 ounces per acre
2015 field yield trial with Bio Empruv from Ken Hamilton
Bio Minerals Technologies

**Bio Empruv, 42PHI and WakeUP Summer**

<table>
<thead>
<tr>
<th>Plot</th>
<th>Lbs.</th>
<th>Moisture %</th>
<th>Test wt.</th>
<th>Row length</th>
<th>Area of acre</th>
<th>Yield at 15.5%</th>
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<td>15.6</td>
<td>58.5</td>
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*Note: Two damaged plots eliminated*

Average of six plots 193.67

Yield benefit, bushels/acre **11.16**

**Bio Empruv and 42PHI only**

<table>
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<tr>
<th>Plot</th>
<th>Lbs.</th>
<th>Moisture %</th>
<th>Test wt.</th>
<th>Row length</th>
<th>Area of acre</th>
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Average of six plots 185.71

Yield benefit, bushels/acre **3.20**

**Control plots**

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<th>Lbs.</th>
<th>Moisture %</th>
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<th>Area of acre</th>
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<td>139.03</td>
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Average of six plots 182.52

*Study by Renewable Farming LLC, Cedar Falls, IA 50613*
Late applied Goss' wilt test

Field: Southeast Roberta
Product applied August 26, 2014

### Goss foliar product sprayed by itself at recommended rate

<table>
<thead>
<tr>
<th>Strip No.</th>
<th>Feet in 3-row strip</th>
<th>Harvested area (acres or fraction of one acre)</th>
<th>Pounds harvested from strip</th>
<th>Moisture % at harvest</th>
<th>Test weight per bushel</th>
<th>Bu. per acre adjusted to 15.5% moisture</th>
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<tbody>
<tr>
<td>Treated</td>
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<td>310</td>
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<td>442</td>
<td>16.0%</td>
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<td>310</td>
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<td>384</td>
<td>15.9%</td>
<td>55.9</td>
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<td>Treated - control</td>
<td>0.1%</td>
<td>1</td>
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<tr>
<td>Treated</td>
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<td>548</td>
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<td>494</td>
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<td>0</td>
<td>18.02</td>
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Average treated: 16.77% 56.60 154.04
Average control: 16.53% 55.80 143.94
Difference: 0.23% 0.80 10.10

Note on above data: Strip 15 was eliminated as it did not receive in-furrow nutrients. All other strips were fertilized the same, had the same herbicide, etc.

### Goss foliar product sprayed tank-mixed with WakeUP Summer at recommended rate

<table>
<thead>
<tr>
<th>Strip No.</th>
<th>Feet in 3-row strip</th>
<th>Harvested area (acres or fraction of one acre)</th>
<th>Pounds harvested from strip</th>
<th>Moisture % at harvest</th>
<th>Test weight per bushel</th>
<th>Bu. per acre adjusted to 15.5% moisture</th>
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<tbody>
<tr>
<td>Treated</td>
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<td>0.053</td>
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<td>15.9%</td>
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<td>15.9%</td>
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</table>

Average treated: 16.10% 56.67 146.08
Average control: 16.33% 56.17 129.04
Difference: -0.23% -0.10 7.04

2014 late season trial:
Corn treated with Bio-Empruv, a biological to raise corn disease immunity:
10 bu. gain applied alone,
17 bu. gain with WakeUP
One of our field research surprises of 2013 was that tank-mixing three ounces of WakeUP Spring per acre, in-furrow with AgriEnergy Resources’ biological SP-1, nudged corn yields about 8 bu. per acre beyond benefits of SP-1 alone.

This points to a need for additional replicated field tests.

We know from many tissue tests and yield checks that WakeUP enhances absorption and translocation of NPK and trace nutrients when applied as foliar sprays.

Farmers also tell us they see yield gains by adding two or three ounces per acre of WakeUP Spring with NPK and traces applied in-furrow or row support. Thus we recommend using WakeUP Spring with starter and side-dress nutrients.

Until now, we’ve had very little data for WakeUP tank-mixed with biological products applied as seed treatment or in-furrow.

**This in-furrow field trial completed 24 strip plots** of six 30-in. rows, alternating across a four-acre field. This gave us:

- Six replications of the recommended 1-gal. per acre rate of SP-1 alone, applied in-furrow with water,
- Six replications of the same rate and solution of SP-1, plus three ounces per acre of WakeUP; and
- Twelve control strips with no in-furrow SP-1 or WakeUP.

The planter was set for a population of 34,000. We planted Prairie Hybrids Seeds 2730, a 102-day non-traited hybrid.

The field had 100 units of N broadcast in early spring as ammonium sulfate, plus a ton of gypsum (Power Lime from BRT) and a ton of local ag lime.

Just before tasseling, the field was uniformly foliar-fed with 4 gal. per acre of Kugler 2075 in 20 gal. of water, with WakeUP as the surfactant/mobilizer in this foliar feeding. (The fertilizer rate should have been only 2 gal. per acre, as we saw some leaf burn. This plot was beside our front driveway, and some of our
AgriEnergy Accelerator alone

243.7

AgriEnergy Accelerator with WakeUP Summer

256.7

WakeUP Summer made AgriEnergy Accelerator even more effective

13 bu. nudge in corn yield for AgriEnergy Accelerator with WakeUP

2013 field trial by AgriEnergy Resources. Average of three replications each
New growth and vanishing chlorosis in 11 days followed three foliar sprays.  

**July 16:** 2 quarts Way Ahead 7X (plus 2.5 lbs. dextrose and 8 oz WakeUP.  

**July 17:** 5 oz. WakeUP, 2.5 lbs. dextrose, 2 quarts Prudent Presto Red, 0.5 quart black humate, 0.5 broad spectrum micronutrient mix from DiHoMa in South Carolina.  

**July 18:** 2 quarts Verity VM Balance, 2.5 lbs. dextrose, 1 quart 42phi ZN Mn, 1 qt. urea solution (23% N).  
Sprayed about 7 a.m. with a light dew, temps in mid 70s.  
This border strip was intended as a special “intensive treatment” patch.  
No leaf burn was observed.
Foliars on drought beans: By Aug. 18, visual differences showed up as seen from the air. The photo washes out much of the contrast that you’d see live from a powered parachute.
SPAD reading, untreated

SPAD reading, foliar fed
Soybean yields raised 27%
By foliars — in drought season

These beans had 1.8 in. of rain in July and August. This strip averaged 35.7 bu. per acre. The combine monitor rose to 48 bu. in some areas.
2013: Rescue a severe potassium deficiency with K-sulfate provided by Ken Musselman, AgriEnergy Resources. Sprayed alternating six-row strips of soybeans.
2013: On Oct. 15, sprayed strips remain healthier. Whiteflies invaded the untreated strips.
Foliar feeding every other six rows resulted in an average 8-bu. gain in foliar-fed strips. There was a consistent yield increase in every foliar-fed strip. This represents four spraying trips.
Northwest Iowa farmer report, fall 2015:

In a strip without in-furrow nutrition, corn yield dropped 30 to 40 bushels.

The yellow strip on the left edge of the field indicates sixteen 30-inch rows without an in-furrow mix, which was a blend of:

16 ounces of a microbial stimulant called **Generate**, from Agnition. ($8 per acre)

20 grams per acre of a beta-test plant growth stimulant we're experimenting with, called **Lignition**. (About $1.50 per acre; retail price not established yet)

3 ounces of **WakeUP Spring**. ($2.50 per acre)

2 gallons of liquid 9-18-9 **starter fertilizer**. ($8 per acre)

Average yield on 151 acres: 189.3 bu.
In 2015, Rod Smith of Northumberland County in northeast England raised world-record wheat: 245 bu. per acre. He foliar fed the crop four times and kept it growing and filling.
Thank you!

Erik and Jerry