

The Science & Usage of Controlled Release Fertilizers in Seedling Production Systems

Southern Forestry Association

July 10, 2017

Myrtle Beach, SC



Agenda

Brief Review of SFA Trials

Controlled Release Fertilizer VS. Slow Release Fertilizer

How Polyon Works

Custom Formulations

New Technologies/Opportunities

Harrell's

Questions and Discussion

Trialed Product

- 16-5-11, 12-14 month Polyon
- 100% Polyon Coated
- 80% release within 12-14 months
- Rate of 8# and 16# per CY used.
- Comparing CRF vs. Typical "Nutrient Loading" (International Paper Co. 2001)

16-5-11

12-14 Month Polyon
Pine Seedling Fertilizer

Average Media Temperatures	60°F	70°F	80°F	90°F
Longevity in Months	16-18	14-16	12-14	10-12

Application Rates

Incorporation

Uniformly mix (incorporate) Custom Nursery Fertilizer into potting media at following rates using trials and grower experience to obtain optimum performance. The addition of dolomitic lime-stone, additional micronutrients or other media amendments may be needed.

POUNDS PER CUBIC YARD			
Low	Medium	High	
10	15	20	

Topdressing - Rates Per Container

Uniformly apply product away from the base of plant.

(gallons)	Low	Medium	High
Trade G (g)	16	20	24
1 (g)	24	29	36
2 (g)	58	70	86
3 (g)	103	126	153
5 (g)	139	169	206

Harrell's
Growing a Better World®

GUARANTEED ANALYSIS

Total Nitrogen (N)	16.0000%
8.9600% Nitrate Nitrogen	
7.0400% Ammoniacal Nitrogen	
Available Phosphate (P ₂ O ₅)	6.0000%
Soluble Potash (K ₂ O)	11.0000%
Magnesium (Mg)	0.9000%
0.9000% Water Soluble Magnesium (Mg)	
Sulfur (S)	1.8800%
1.8800% Combined Sulfur (S)	
Iron (Fe)	0.4800%
0.4800% Water Soluble Iron (Fe)	
Manganese (Mn)	0.2100%
0.2100% Water Soluble Manganese (Mn)	
Molybdenum (Mo)	0.0100%
Zinc (Zn)	0.0600%
0.0600% Water Soluble Zinc (Zn)	

Derived From: Ammonium Nitrate, Ammonium Phosphate, Molybdo Oxide, Potassium Nitrate, Ferrous Sulfate, Magnesium Sulfate, Manganese Sulfate, Zinc Sulfate

* 14.4% coated slow release Nitrogen(N), 4.6% coated slow release available Phosphate(P₂O₅) and 9.9% coated slow release Soluble Potash (K₂O)

WARNING - The application of fertilizing materials containing Molybdenum(Mo) may result in forage crops containing levels of Molybdenum(Mo) which are toxic to ruminant animals.

F352 Density - 75 lb/cu. ft.

Directions for Use

Information regarding the contents and levels of metals in this product is available on the Internet at: <http://www.aspfco.org/metals.html>

FOR USE ONLY BY PROFESSIONAL APPLICATORS AND COMMERCIAL GROWERS
Apply fertilizer in accordance with best management practices established by your State University or Extension Service. Observe any State or Local fertilizer regulations pertaining to fertilizer content, application rate, or timing of application specific to your locale. Do not apply near water, storm drains, or drainage ditches. Do not apply if heavy rain is expected. Apply this product only to turfgrass areas and sweep any product that lands on hard surfaces back onto the treated area. For information on the components in this fertilizer, write to Harrell's, LLC at the address below. Include the inventory # or Batch # printed on the product label.

CONVERSION TABLE

Rounded Measure	Gram
1 teaspoon (tsp)	7.1
1 tablespoon (tbs.)	22.0
1/4 cup	61.4
1/2 cup	141.5
†The gram weights are approximate.	
Actual weight in your measuring should be determined for the fertilizer being applied.	

Harrell's SPOON SIZE RATE

Spoon Size	Grams
1	10
2	15
3	20
4	26
5	38
6	54
7	70
8	88

The GREEN color of the POLYON® capsule, POLYON® and POLYON NPK® are registered trademarks of Koch Agronomic Services, LLC.

1707-5001 031707

Net Wt. 50 LBS. (22.7 KG)



Warning

Dust may cause Serious Eye Damage
Skin, Eye and Respiratory Tract Irritant. Harmful if swallowed.

Precautionary Statements: Wear safety glasses with side shields or goggles when handling product. Avoid breathing dust. Wash face, hands and exposed skin thoroughly after handling. Do not eat, drink or use tobacco products when using this product.



First Aid

If In Eyes: Flush with water for 15 minutes. Call a doctor for treatment advice if irritation persists.
If on Skin: Wash thoroughly with soap and water. Launder clothing before reuse.
If Inhaled: Remove affected person from source of exposure. Call 911 if breathing is difficult.
If Ingested: Do not induce vomiting. Get medical attention.
Have the product label with you when calling a doctor or going for treatment.

MANUFACTURED FOR HARRELL'S, LLC PO BOX 807 LAKELAND, FL 33802 (863) 687-2774 (800) 282 8007

Exciting Results!

- Visually, much greener with the CRF than the typical methodology
- 6x more “juice” in the soil at out-planting than with the control.

	Polygon	Multicote	Control
RCD mm	5.5 A	5.8 A	4.5 B
Foliar N%	2	2	1.9
Media Ammonia N ppm	51.1	51.8	11.2
Media Nitrate N ppm	61.2	56	9.4



Release Curve

Estimated Nutrient Release

16-5-11

Harrell's
Growing a Better World®

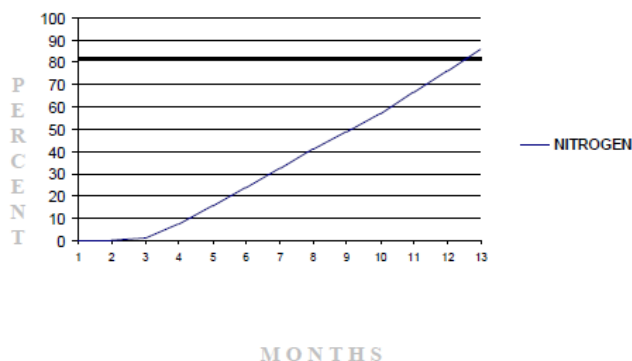
Pine Seedling Fertilizer
Polyon PLUS 12-14 month

Customer: AU/SFA Trials
Location: Charleston, SC
Application/Growing Method: Container Grown

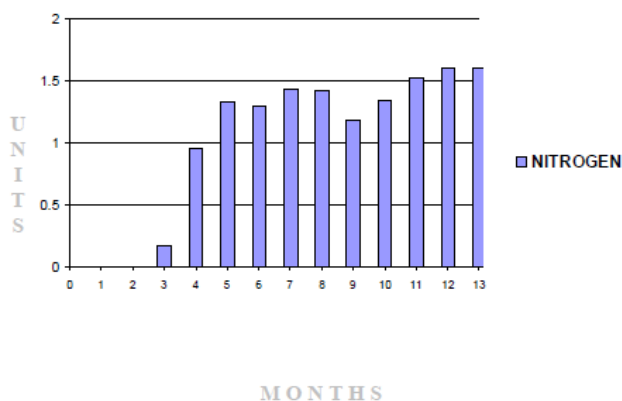
Application Date: 5/1/2017

Longevity (Months): 12-14

Cumulative Release of Nutrients (%) by Month



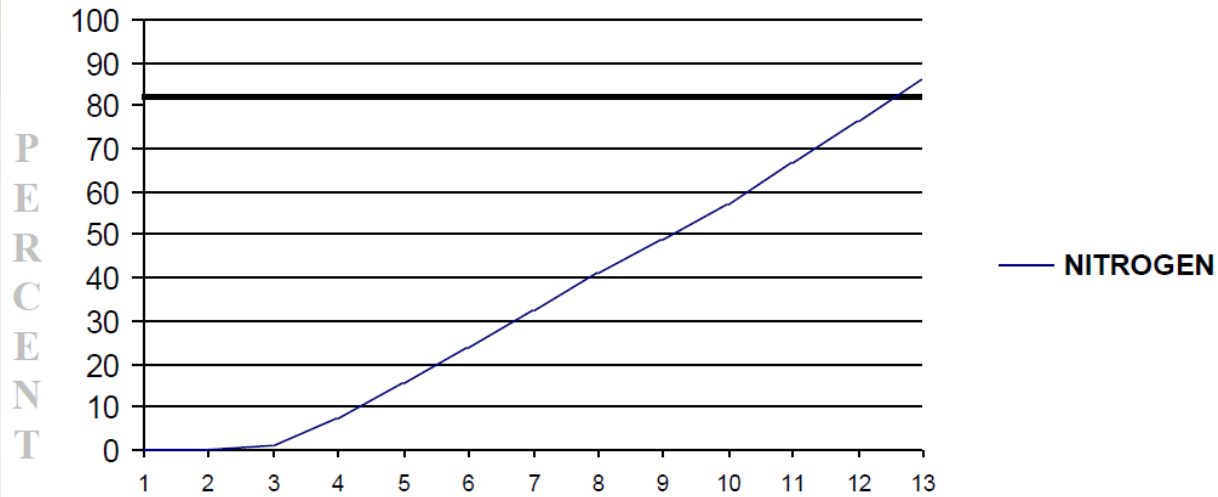
Actual Units of Nutrients Released by Month



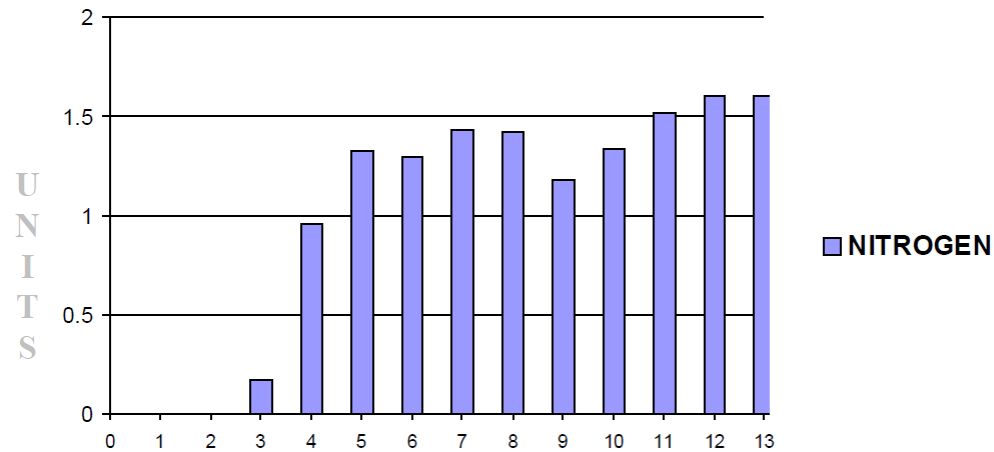
Temperatures

Month	Avg. Temp (F°)
January	48.38
February	50.9
March	57.74
April	65.3
May	72.68
June	78.8
July	81.68
August	80.96
September	76.64
October	67.82
November	59.54
December	52.16

Cumulative Release of Nutrients (%) by Month



Actual Units of Nutrients Released by Month



How'd we build this?

AUBHOR1
Auburn Horticultural Dept/Aubu
CustoMix® Mobile 2012
Data: 7/6/17
No Messages
Version 1.16 - June 1, 2017

Finished Goods
Formulation

Loc: SYLACAUGA
Program:
A/P/C: P
Quote #: 1707-5001

n-p-k 16 - 5.9 - 11.7 %org 0 Remaining NPK 0 - 0 - 0
Minors: 0.9Mg 1.88S 0.49Fe 0.21Mn 0.01Mo 0.06Zn
CMix: CEAEDD

Over Formulate

Ton Formula

O	Inv #	Description	Pounds	IVCode	MXCode	t/n	n/n	a/n	w/s	wis	apa	k20
	R167	16-5-11+Poly	2000.00	CEAEDD	CEAEDD	16	8.96	7.04	0	0	5.9	11.7

Totals
2000
16
8.96
7.04
0
0
5.9
11.7

New Quote

Inv #:
Elem:
(P.A.U): U
Amount:
Rem lbs: 0
Reminder

Raw Product Inquiry

Inv #	Description
R048	Muriate Of Potash - Granular
R048-H	Muriate Of Potash - Granular Hocking Use
R050	Sulphate Of Potash - Granular
R051	Sulphate Of Potash - Mini
R053	Polyon K-Mag 0-0-18
R054	38 5-0-0 Polyon
R055	41-0-0 Polyon Nursery
R056	Polyon 40-0-0
R057	Standard SPM
R057-H	Sulpomag Standard Hocking Only
R058	Premium SPM (GR.)
R059	Sodium Molybdate
R063	Techmangum
R065	Manganese Sulphate, Mini Prilled
R066	Granusol Iron 50% Iron Sucrate
R068	Copper Sulphate

Record: 1 of 212
No Filter

Double Click

Location/application info

AUBHOR1

Auburn Horticultural Dept/Aubu

CustoMix® Mobile 2012

Data: 7/6/17

No Messages

Version 1.16 - June 1, 2017

Finished Goods

Formulation

Quit

Pricing Info

Cust Quote Info

Tag Info

Fly Sheet Info

Custograph Info

Overhead Info

Formula Screen

Save Quote

PlaceOrder

Custograph Nursery

Switch to Turf

Location:

Charleston, SC

Athens, GA

Atlanta, GA

Auburn, AL

Aurora, OR

Baltimore, MD

Beaverton, OR

Bellingham, WA

Birmingham, AL

Boise, ID

Bonsall, CA

Boring, OR

Bridgeton, NJ

Bristol, TN

Brownsville, TX

Bushnell, FL

Carbondale, IL

Average

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

Container:

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

SYLACAU

Application Date:

5/1/2017

Longevity (Months):

12

Logo:

Harrell's Standard

mp F*:

% Override:

(10-10%, -10=-10%)

n/Growing Method:

Container Grown

FP Per Container:

A Custom Label is formulated

16-5-11

12-14 Month Polyon

Pine Seedling Fertilizer

Average Media Temperatures	60°F	70°F	80°F	90°F
Longevity in Months	16-18	14-16	12-14	10-12

Application Rates

Incorporation

Uniformly mix (incorporate) Custom Nursery Fertilizer into potting media at following rates using trials and grower experience to obtain optimum performance. The addition of dolomitic lime-stone, additional micronutrients or other media amendments may be needed.

POUNDS PER CUBIC YARD			
Low	Medium	High	
10	15	20	

Topdressing - Rates Per Container

Uniformly apply product away from the base of plant.

(gallons)	Low	Medium	High
Trade G (g)	16	20	24
1 (g)	24	29	36
2 (g)	58	70	86
3 (g)	103	126	153
5 (g)	139	169	206

Harrell's

Growing a Better World®

QUARANTEED ANALYSIS	
Total Nitrogen (N).....	16.0000%
8.9600% Nitrate Nitrogen	
7.0400% Ammoniacal Nitrogen	
Available Phosphate (P ₂ O ₅).....	6.0000%
Soluble Potash (K ₂ O).....	11.0000%
Magnesium (Mg).....	0.9000%
0.9000% Water Soluble Magnesium (Mg)	
Sulfur (S).....	1.8000%
1.8000% Combined Sulfur (S)	
Iron (Fe).....	0.4800%
0.4800% Water Soluble Iron (Fe)	
Manganese (Mn).....	0.2100%
0.2100% Water Soluble Manganese (Mn)	
Molybdenum (Mo).....	0.0100%
Zinc (Zn).....	0.0600%
0.0600% Water Soluble Zinc (Zn)	

Derived From: Ammonium Nitrate, Ammonium Phosphate, Molybdo Oxide, Potassium Nitrate, Ferrous Sulfate, Magnesium Sulfate, Manganese Sulfate, Zinc Sulfate

* 14.4% coated slow release Nitrogen(N), 4.6% coated slow release available Phosphate(P₂O₅), and 9.9% coated slow release Soluble Potash (K₂O)

WARNING - The application of fertilizing materials containing Molybdenum(Mo) may result in forage crops containing levels of Molybdenum(Mo) which are toxic to ruminant animals.

F352 Density - 75 lb/cu. ft.

Directions for Use

Information regarding the contents and levels of metals in this product is available on the internet at: <http://www.aapfo.org/metals.html>

FOR USE ONLY BY PROFESSIONAL APPLICATORS AND COMMERCIAL GROWERS
Apply fertilizer in accordance with best management practices established by your State University or Extension Service. Observe any State or Local fertilizer regulations pertaining to fertilizer content, application rates, or timing of application specific to your locale. Do not apply near water, storm drains, or drainage ditches. Do not apply if heavy rain is expected. Apply this product only to turf/garden areas and sweep any product that lands on hard surfaces back onto the treated area. For information on the components in this fertilizer, write to Harrell's, LLC at the address below. Include the inventory # or Batch # printed on the product label.

CONVERSION TABLE		Harrell's SPOON SIZE/RATE	
Rounded Measure	Gram	Spoon Size	Grams
1 teaspoon (tsp)	7.1	1	10
1 tablespoon (tbs.)	22.0	2	15
1/4 cup	61.4	3	20
1/2 cup	141.5	4	26
†The gram weights are approximate.		5	38
Actual weight in your measuring should be determined for the fertilizer being applied.		6	54
		7	70
		8	88

The GREEN color of the POLYON® capsule, POLYON® and POLYON NPK® are registered trademarks of Koch Agronomic Services, LLC.

1707-5001 031707

Net Wt. 50 LBS. (22.7 KG)



Warning

**Dust may cause Serious Eye Damage
Skin, Eye and Respiratory Tract Irritant. Harmful if swallowed.**



First Aid

If in Eyes: Flush with water for 15 minutes. Call a doctor for treatment advice if irritation persists.
If on Skin: Wash thoroughly with soap and water. Launder clothing before reuse.
If Inhaled: Remove affected person from source of exposure. Call 911 if breathing is difficult.
If Ingested: Do not induce vomiting. Get medical attention.
Have the product label with you when calling a doctor or going for treatment.

Precautionary Statements: Wear safety glasses with side shields or goggles when handling product. Avoid breathing dust. Wash face, hands and exposed skin thoroughly after handling. Do not eat, drink or use tobacco products when using this product.

MANUFACTURED FOR HARRELL'S, LLC PO BOX 807 LAKELAND, FL 33802 (863) 687-2774 (800) 282 8007



Photo Credit: Ryan Nadel

Controlled Release Fertilizers VS Slow Release Fertilizers



Controlled Release $\neq$ Slow Release

SRFs	CRFs
Natural Organics	Resin Coated
Synthetic Organics	Polymer Coated
Sulfur Coated	

Slow Release Fertilizers (SRF)

- Have “Unavailable” nutrients
- Are less efficient than CRFs
- Release mechanisms are not controlled



SRF Cont..

SRF Release via:

- Hydrolysis (IBDU)
- Mineralization (Nitroform)
- Catastrophic Release (PCSCU)



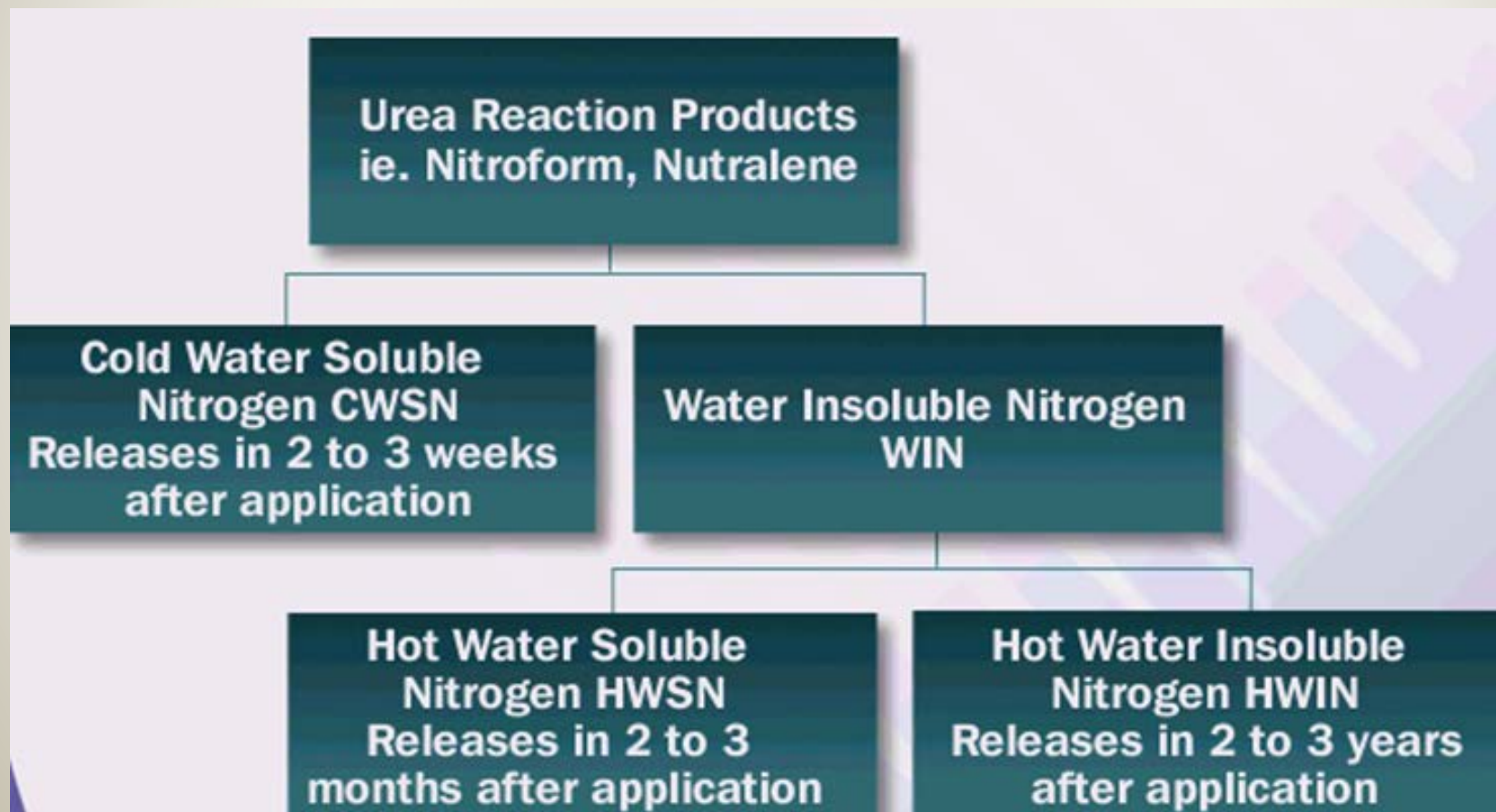
Hydrolysis

Isobutylidene Diurea Products (IBDU)



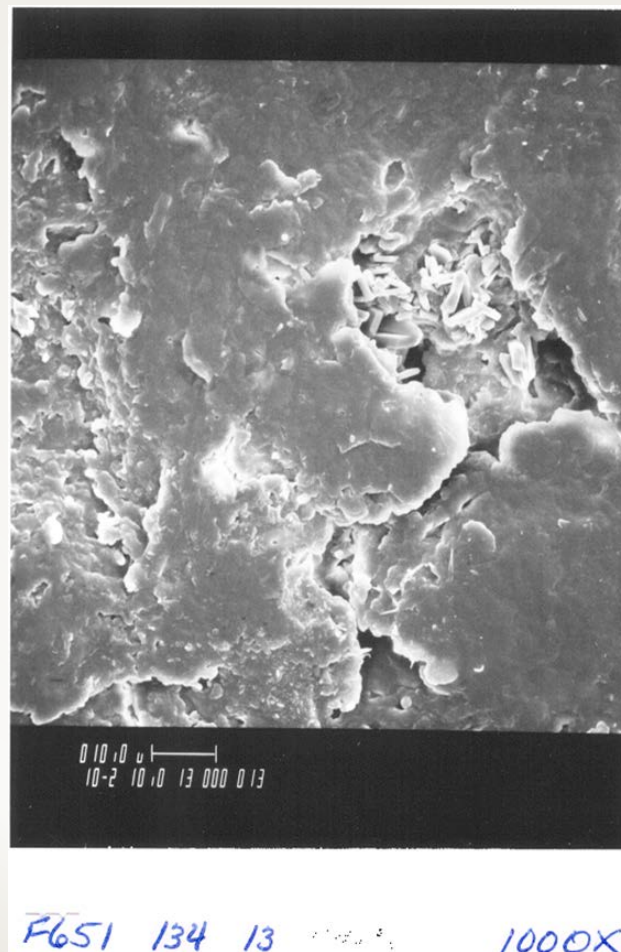
Mineralization

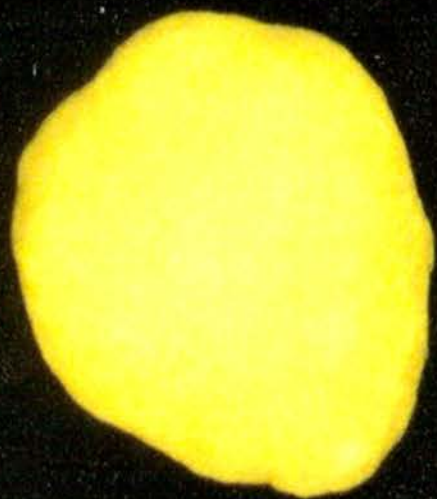
Nitroform/Blue-Chip (38-0-0)



Catastrophic Release

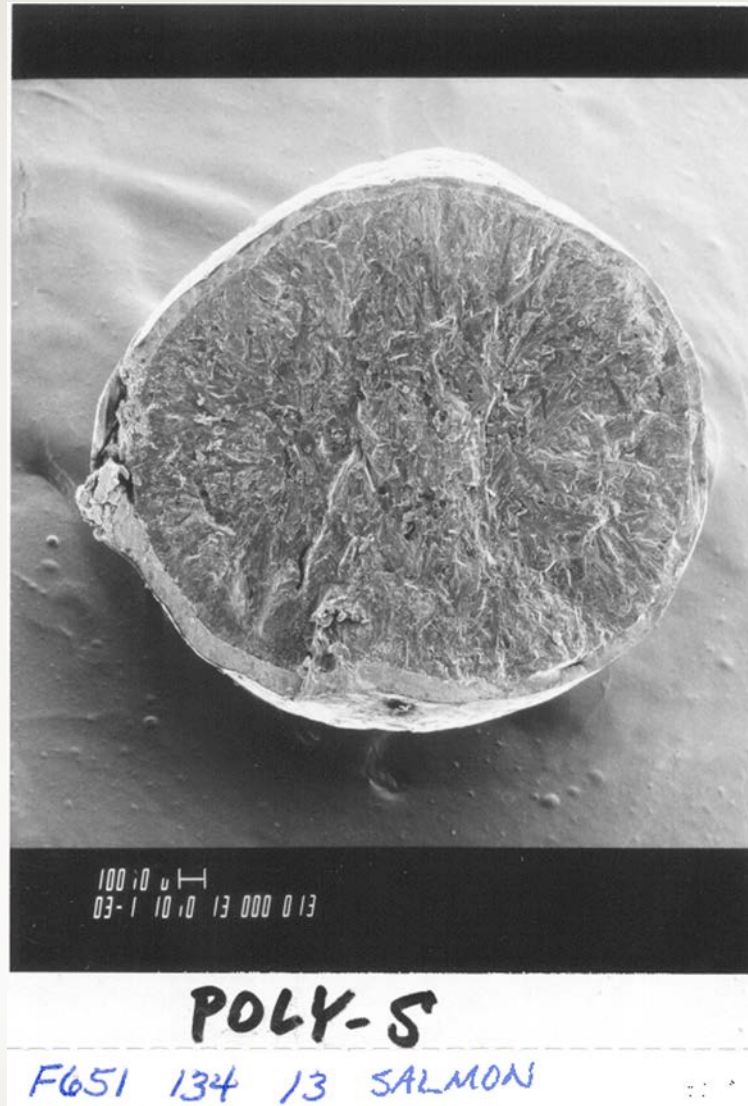
Polymer Coated Sulfur Coated Urea











So, what are CRF's?



CRF Definition:

Conventional water soluble fertilizer materials (substrates) are given a protective coating or encapsulation (water insoluble, semipermeable or impermeable with pores) that controls water penetration and the rate of nutrient dissolution and nutrient release.

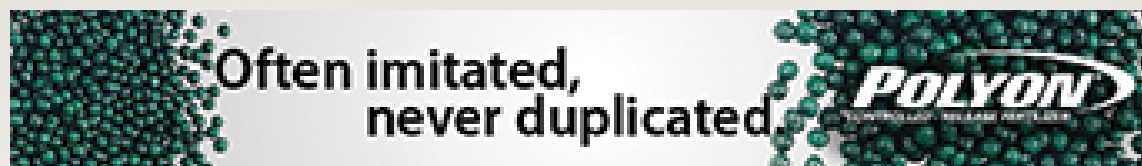


Polygon Controlled Release Fertilizer

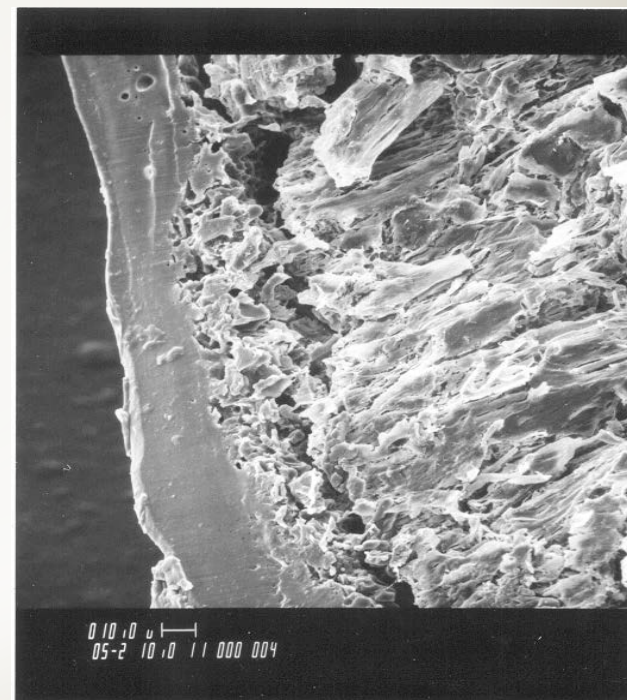




- Launched in 1992/1995 by Pursell Technologies (AL)
 - “How to feed pine seedlings for 1-2 years..”
- Currently manufactured by Koch Agronomics (USA)
- Formulated & Distributed in US by Harrell’s
 - Golf, Nursery, Sports Turf, Landscape, Specialty Ag
- True polymer coated product (polyurethane)
- Polymer coating is created by the reaction of Polyol with Diisothiocyanate



- The polyurethane coating of Polyon is reacted with and to the fertilizer substrate (bonded)
- Release curves based on 86 F



Link



polyon fertilizer



manufacture of *POLYON* fertilizers



polyon fertilizer



manufacture of *POLYON* fertilizers

Monomer A



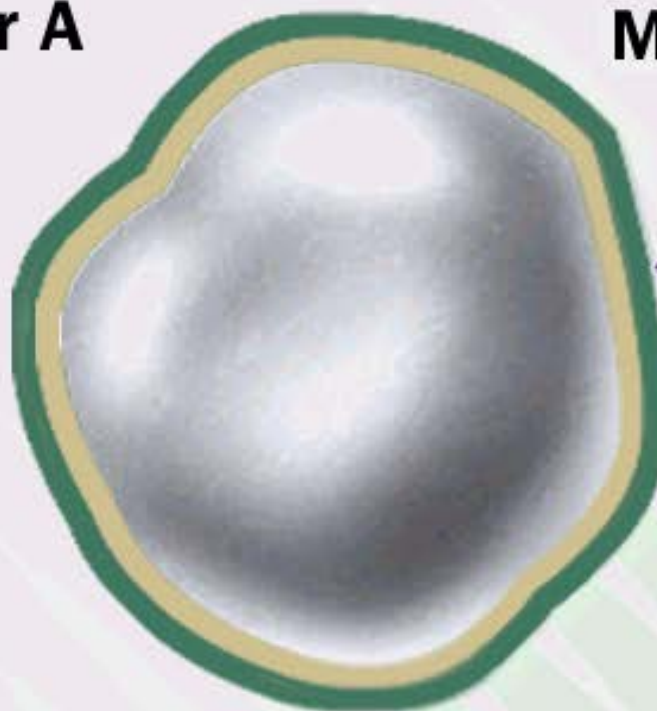
polyon fertilizer



manufacture of *POLYON* fertilizers

Monomer A

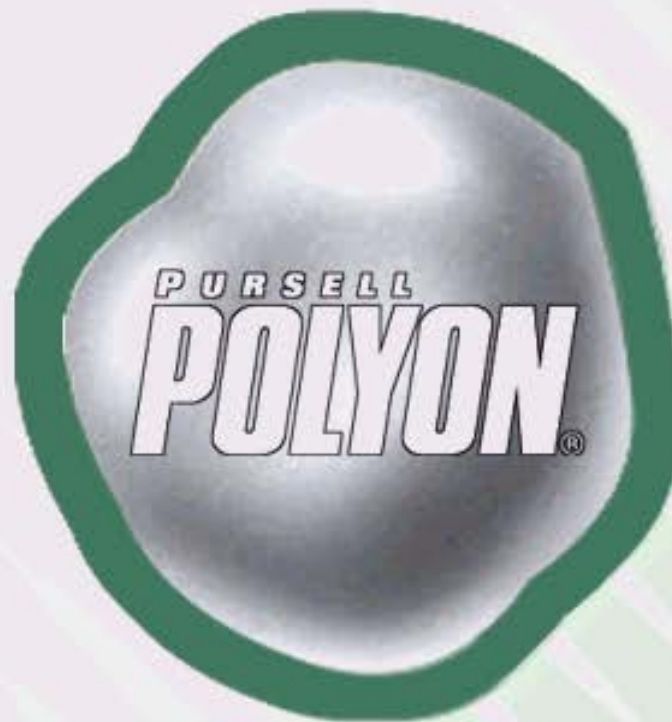
Monomer B

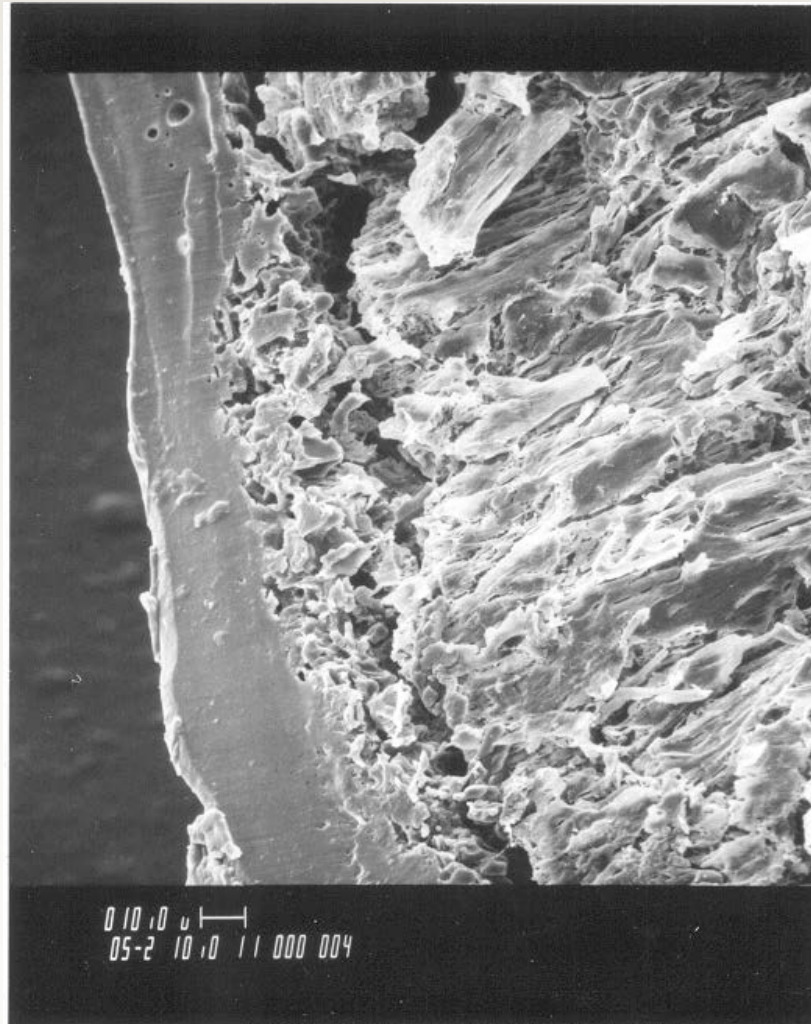


polyon fertilizer



manufacture of *POLYON* fertilizers





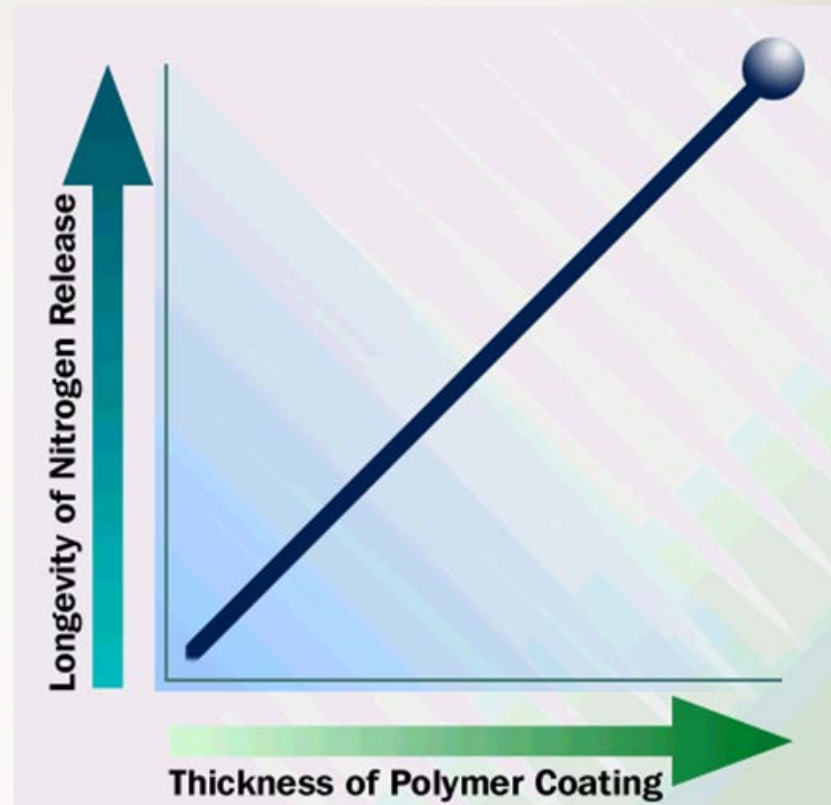
5 Factors affecting CRF Performance

- 1) Coating
- 2) Temperature
- 3) Moisture
- 4) Coating substrate
- 5) Growers



Factor 1: Coating

- Coating = CONTROL
- Can be manipulated



Factor 1: Coating

- Coating = CONTROL
- Can be manipulated
- Coating Porosity
 - “openness” of the coating for nutrient passage
- Critical to maintain coating integrity



Coating Durability and Integrity



Coating Durability Test Procedures

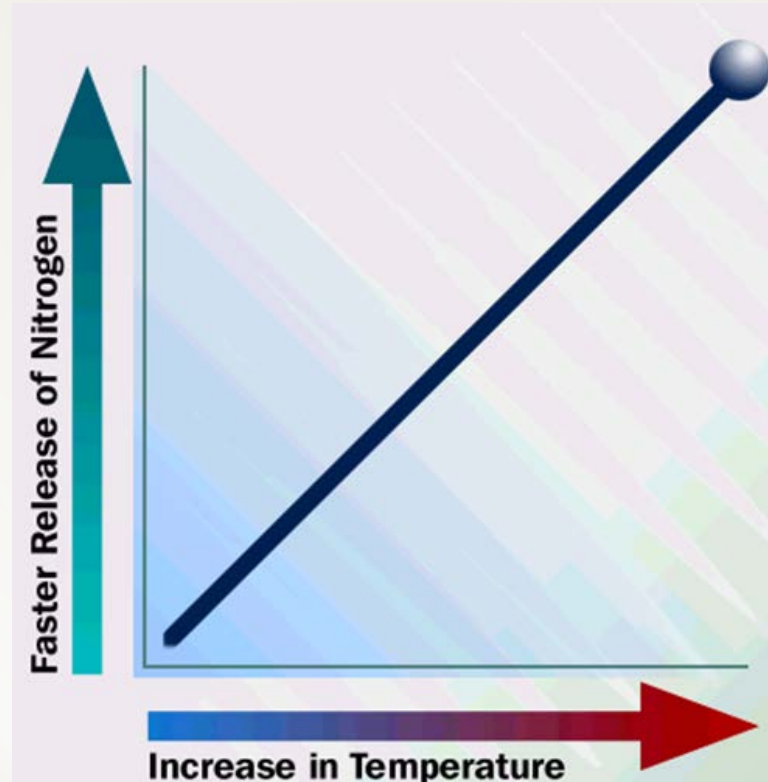


20 ft 3 x's



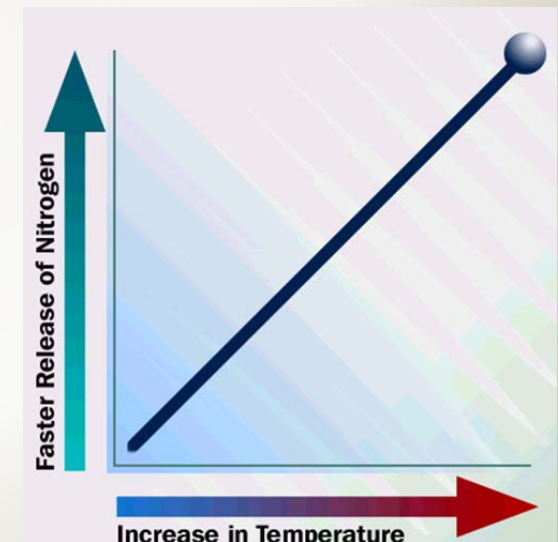
6 ft 5 x's

Factor 2: Temperature

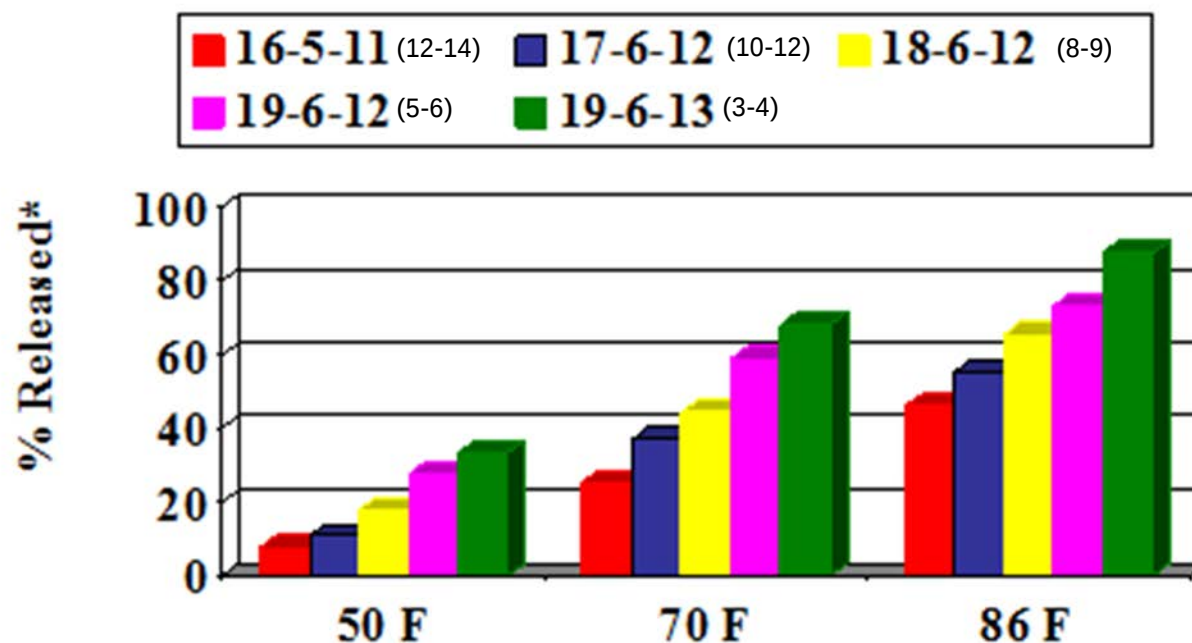


Temperature, cont.

- Product longevities based on release data at a given temperature
 - 86 F for Polyon
 - 78 F for Multicote (based on K)
 - 77 F for Nutricote
 - 70 F for Osmocote



Effect of Temperature on Polyon NPK Release



* Release at 22 weeks

Factor 3: Moisture

- Initiates the CRF release mechanisms
- CRF activation is dependent on moisture but much lower than the wilting point.
 - only need a little bit of moisture to start the release process
 - You can have a plant that is super dry and not getting enough water, but that is still enough moisture to keep the fertilizer activated.



Factor 4: Coating substrate

- Prill vs Granule
- Shape (angular vs. round)
- Surface Smoothness
- Particle Size
- Water Solubility (NPK)



Factor 5: Growers

- Application rate, timing, method
- **Growing Media**
 - Bark
 - Peat
 - Native Soils
 - Sand
 - Other Amendments?



Growers, cont.

- **Irrigation**
 - Type, Source, Quality, Frequency
- **Quality Control Issues**
 - Salts/EC Monitoring
 - Water Monitoring
 - Substrate Testing
 - Plant Tissue Testing



5 Factors affecting CRF Performance: All are important

- 1) Coating
- 2) Temperature
- 3) Moisture
- 4) Coating substrate
- 5) Growers

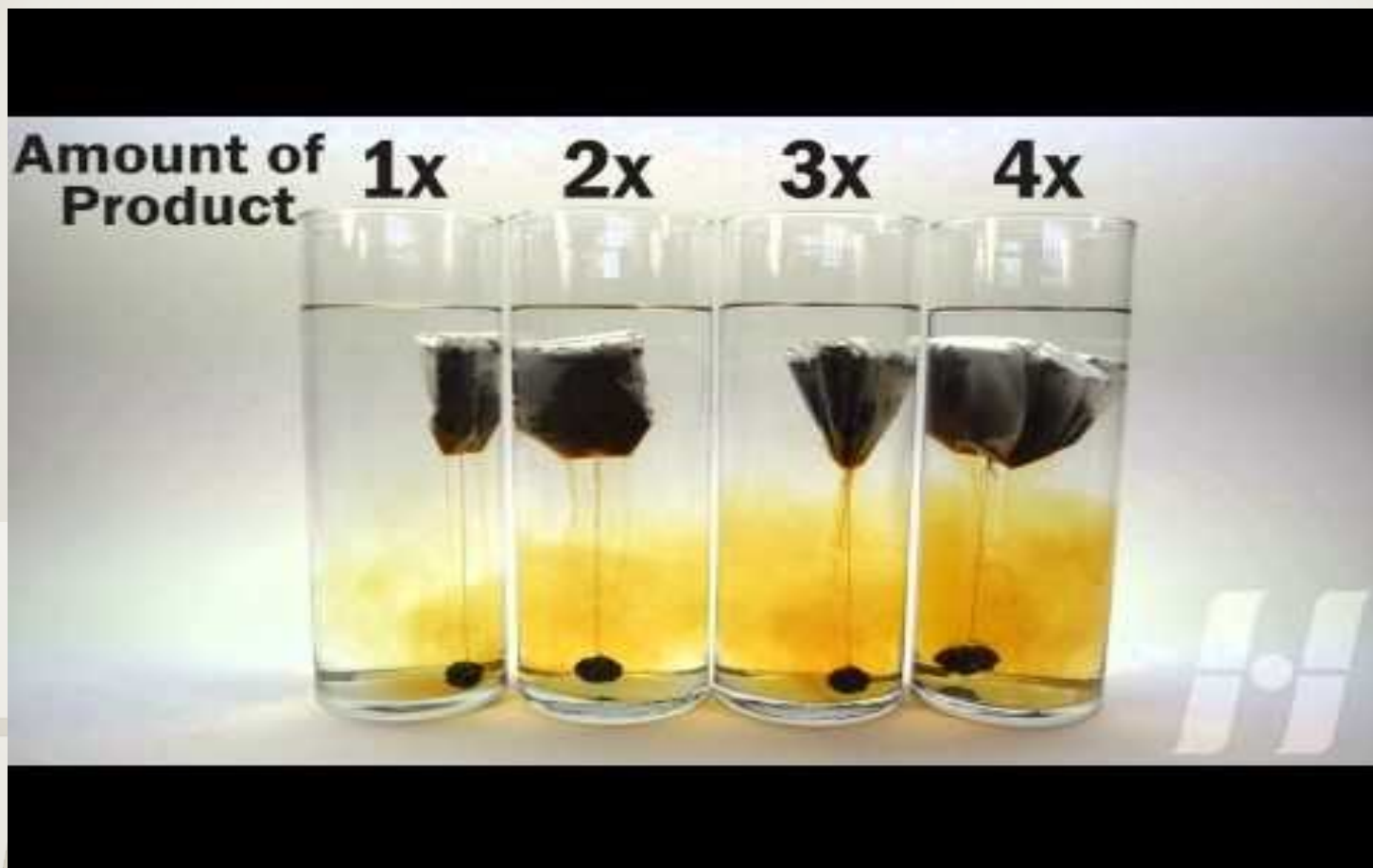


5 Factors affecting CRF Performance: All are important

- 1) Coating**
- 2) Temperature**
- 3) Moisture**
- 4) Coating substrate
- 5) Growers



Coating, Temp, Moisture: Like Sweet Tea



Harrell's Customizes Polyon to YOUR Needs



Harrell's Customizes Polyon to YOUR needs

- Custom formulate with Polyon (+ over 300 other raw materials)
 - Over 60k ton/yr all made 1-2 ton at a time.
- Base the finished product off of individual needs/location of customer
 - Customix
 - Custograph
- Direct sales and support





New Technologies/Opportunities

The “Sparging” Process



“Sparge?”

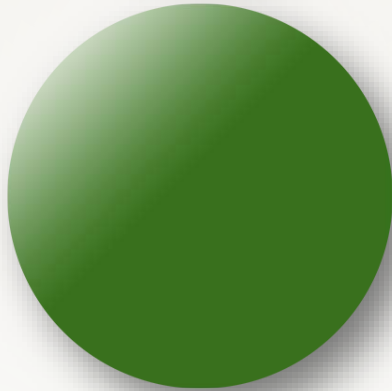
What does that mean?

- Harrell’s can include a plant protectant such as an insecticide or herbicide directly on our fertilizer granules during the manufacturing process.
- This allows your fertilizer to do extra work so you don’t have to.
- We call the addition of the plant protectant *sparging*.



How does the Sparging Process Work?

- Your Harrell's representative starts the process by formulating your fertilizer with the addition of the protectant.
- During manufacturing, the fertilizer prills start out like any other – just a granule of nutrient.



For example, here's a single Polyon fertilizer prill.

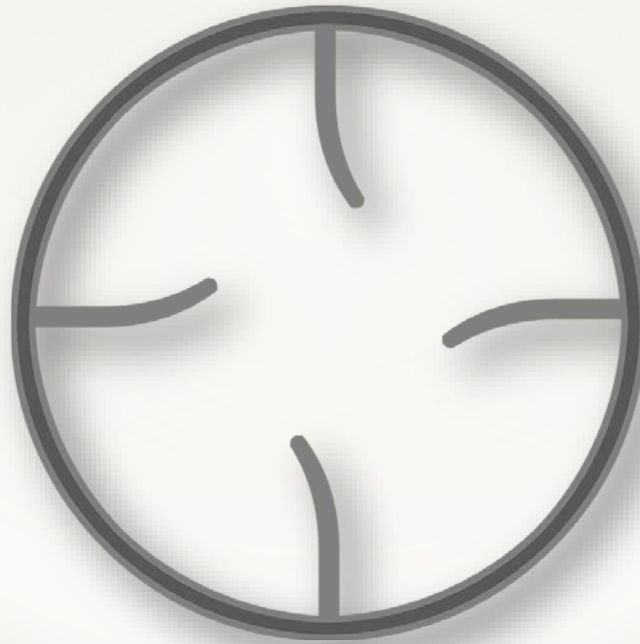
Quality Control & State-of-the-Art Equipment

- The sparging procedure happens in a large, rotary drum mixer designed specifically for this process.
- Harrell's has multiple drums in place to prevent unintentional cross contamination.
- A Quality Control Technician is on staff to monitor the entire process, and every batch is sampled to ensure accuracy.
- Pesticide on fertilizer loading rates are verified by laboratory analysis.



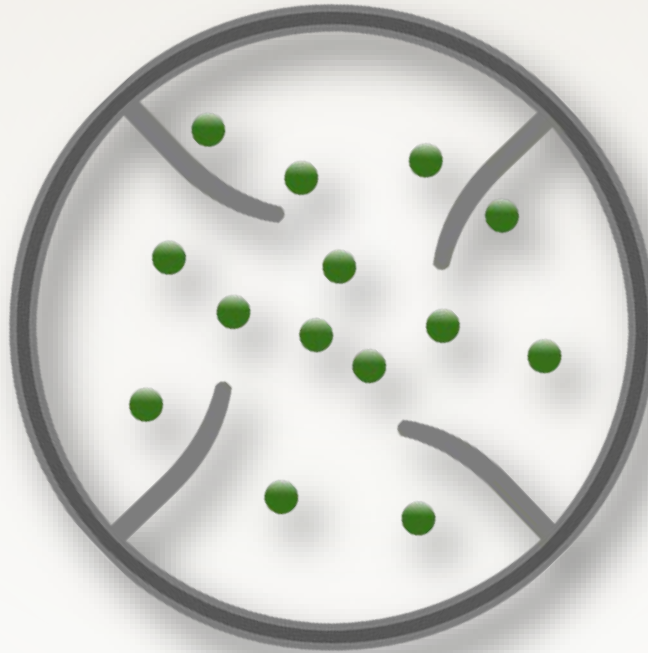
The Mixer

- The interior of the mixer has several malleable paddles that agitate the fertilizer and plant protectant as the mixer rotates without causing any damage to the prills.



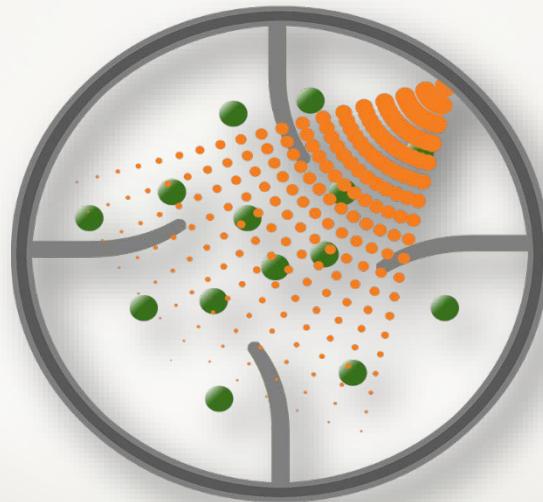
Fertilizer is Added

- The process begins with adding fertilizer to the mixer.



Plant Protectant is Added

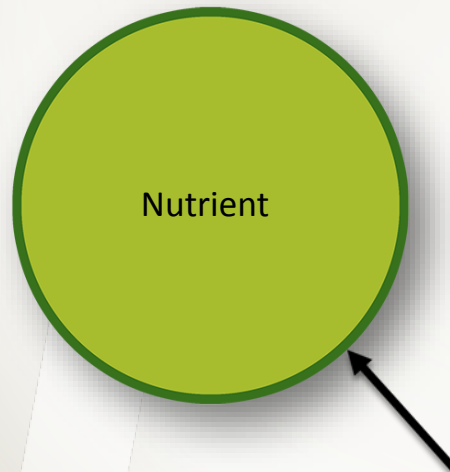
- The amount of protectant needed for the batch is calculated precisely and then added to the mixer, where it is sprayed inside as everything continues rotating.
- The paddles keep the fertilizer prills moving, so the spray makes direct contact with the surface of each granule.
- After the protectant has been added, the drum continues rotating for several additional minutes to ensure each prill has been properly coated.



The Result

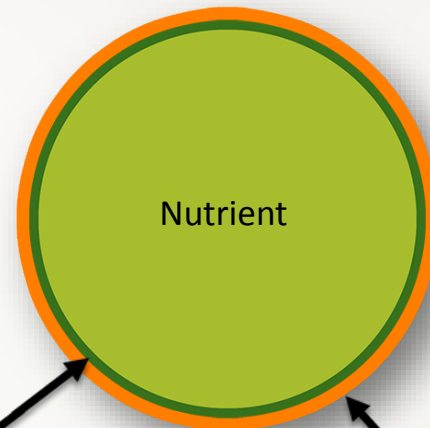
- Fertilizer with an evenly-applied plant protectant is the result of this process.
- Here's a look at a standard Polyon granule and a sparged granule.

Standard Polyon Granule



Polyon Coating

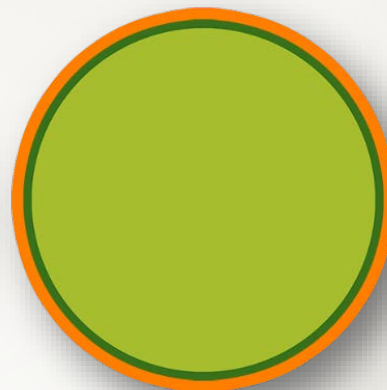
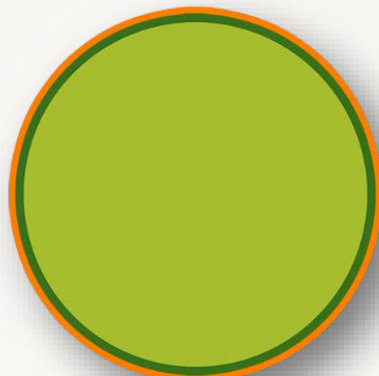
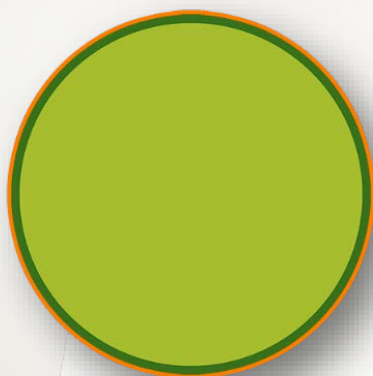
Sparged Polyon Granule



Sparge Coating

We Sparge to your Specifications

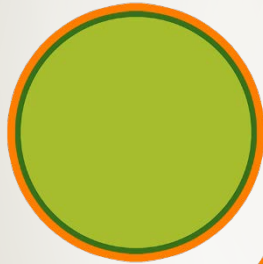
- We can control the amount of plant protectant applied to the fertilizer.
- Your Harrell's representative can specify the necessary quantity of protectant based on your needs and label recommendations.



Sparging with Talstar

(Fire Ant Quarantine Approved)

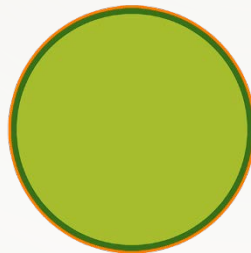
- Talstar is pound-for-pound in the fertilizer bag. This means that if you put 10 pounds of fertilizer in your media, you are also putting 10 pounds of Talstar in your media.



0.2% Talstar with 10 pounds of fertilizer =
10 pounds of Talstar in your media.



When we drop the concentration to 0.096, the 10 pounds of fertilizer is the equivalent of 5 pounds of Talstar 0.2% since the dosage is half.



Dropping to 0.069% Talstar, when you put 10 pounds of fertilizer it's like putting 3.5 pounds of Talstar.

**Finally, remember, we are here
to help you succeed**



Success through:

- Customer Service (direct sales)
- IPM programs and solutions (insect/disease/weeds)
 - Monthly learning modules (www.harrells.com/education)
- Full-line chemical distributor (BASF, Syngenta, Bayer, etc.)
- Manufacture our own adjuvant line (pH buffer, surfactant, liquid fertilizers)
- Best water-soluble line in the world (sourced from Netherlands)
- POLYON

BRAIN TEASER TIME



True or False:

Applying any sulfur or sulfate-based fertilizers will lower the pH of soil/media.

FALSE



pH stands for...

Potential Hydrogen

Meaning Hydrogen is needed in order for a the pH to be affected.

Where's the hydrogen in sulfur (S) or sulfate (SO₄)?



Sulfur and PH

*The answer comes from chemistry (Oxidation)

- The conversion of elemental sulfur to sulfate creates acidity
- The sulfate ion is **NOT acidic**
 - Potassium sulfate is not acidic
 - Magnesium sulfate is not acidic
 - Calcium sulfate is not acidic
 - Sul-po-mag (K-mag) is not acidic
 - Ammonium sulfate is acidic
 - Because of the ammonia (NH_4), not because of the sulfate

Best way to lower pH:

- Drench 3lbs/100 gal of ammonium sulfate (21-7-7)
- Topdress with granular sulfur (and water in)
- Can use flowable or powdered S, but watch salts
 - Realize this process will likely need repeating several times



Questions? Comments?

Kyle Creamer

Harrell's LLC

615-668-8467

kcream@harrells.com

www.harrells.com

