

Slow-Release and Controlled-Release Fertilizers: An Overview of the Market Today[©]

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Keywords: Organic, synthetic, resin coated, polymer coated, fertilizer release characteristics, cost analysis

INTRODUCTION

Commercially available slow-release fertilizers (SRFs) are different than controlled-release fertilizers (CRFs). They differ in coating materials, characteristics of fertilizer release, longevity as influenced by temperature, hydrolysis and/or microbial activity - and unit cost compared to actual usage/longevity cost in a commercial, production setting (Fig. 1). Unit cost is not the only deciding economic factor.

SLOW-RELEASE FERTILIZERS (SRFS)

The different SRFs on the market today are (1) natural organic products, such as Nature Safe <https://www.naturesafe.com/> and other true organic compounds; (2) synthetic organic products, such as Nitroform Blue-Chip <https://kochturf.com/Products/SlowRelease/Nitroform/> and IBDU- Isobutylidenediurea; these break down through hydrolysis and mineralization (Figs. 2 and 3). There are also polymer coated sulfur coated urea products (PCSCU) such as Poly-S <https://icl-sf.com/uk-en/technologies/poly-s/> and XCU[®] <https://www.greenindustrypros.com/lawn-care-renovation/product/10156380/koch-agronomic-services-kas-xcu-slowrelease-fertilizer> - which release via what is known as “catastrophic

release” (ruptures, cracks, fractures in the coating)

<https://www.harrells.com/blog/understanding-nitrogen-sources> (Fig. 4).

In summary, SRF’s have no “controlled release” mechanism (Fig. 5). They are also less efficient and are not ideal as the sole source of a fertility program. However, they are great additions in a more balanced approach to complement CRF’s.

CONTROLLED-RELEASE FERTILIZERS (CRFS)

CRF’s are classified into two different groups based on their coating: resin coated (coating comes from plant origins) or polymer coated (synthetic coating) (Fig. 6).

Osmocote[®] is the only true resin¹ coated product on the market today. It was seen as the “pioneer” of the CRF market. It was developed based on a floor varnish used in the 1940s (Fig. 7). It is manufactured by ICL <https://www.iclfertilizers.com/> and releases through the process of osmosis (Fig 8). The prills swell when water enters and once it swells - it cannot contract. Fissures form in the coating, and the water/nutrient solution then exits the prills. The longevity of Osmocote[®] is based on the coating thickness at an average temperature of 21°C (70°F). Higher temperatures and physical damage to the prills will speed up the fertilizer release.

There are a number of polymer coated² CRFs (Fig. 9). An example is Nutricote[®], which is manufactured by JCAM in Japan <http://www.jcam-agri.co.jp/> (Fig. 10). JCAM creates the raw and finished product in Japan and then ships it to the USA where Florikan[®] <https://www.florikan.com/about> is the exclusive distributor. Nutricote[®] is unique in that the longevity is not based on the coating thickness; rather, it is the ratio of two polymers (with

¹ A resin is “any of numerous clear to translucent yellow or brown solid, or semi-solid substance of plant origin (organic or natural) such as copal, rosin, and amber used principally in lacquers, varnishes, inks, adhesives, synthetic plastics, and pharmaceuticals”.

² Polymer coated includes coating with “any of numerous synthetic compounds of usually high molecular weight, consisting of up to millions of repeated linked units, each a relatively light and simple molecule.”

different release times) that coat the prills. This determines the fertilizer release period. The release pores of the polymers can close in cooler temperatures. The release mechanisms is via the solute concentration gradient of the two polymers coating the prill (Fig. 11). The longevity of Nutricote[®] is based on an average temperature of 25°C (77°F).

Polyon[®] is the other major CRF in the market today. It is manufactured by Koch Agronomic Services in the USA <http://kochagronomicservices.com/> and is exclusively distributed by Harrell's <https://www.harrells.com/>. Polyon[®] is custom blended and sold directly to the end user. The longevity of Polyon[®] is related to the coating thickness of the two monomers incorporated with polyurethane (Fig. 12). Polyon[®] also releases via the solute concentration gradient, and its longevity is based on 30°C (86°F).

Other CRF products mentioned briefly are similar in characteristics to Polyon[®] (Fig.13).

These are, as follows:

- GAL-Xe^{ONE}[®] —formerly known as “Florikote[®]” that is owned by Simplot <http://simplotgalxeone.com/> and sold nationwide. Release longevities are based on 38°C (100°F)
- Multicote[®]—Manufactured by Haifa in Israel. Release longevity is based on 21°C (70°F). Its availability is based on temperature and potassium release, not nitrogen.
- Plantacot[®] —longevity is based on 21°C (70°F).
- Duration[®]—Former Agrium product, but now is part of Koch Agronomic Sciences technology. Release data is based on 20°C (68°F).
- Purkote[®] —a new product from Pursell that is still under evaluation. Release data is based on 30°C (86°F).

SUMMARY

I encouraged IPPS members to compare more than cost when looking at different CRF products. For instance, a \$10 per 50lb bag difference in pricing only equates to \$0.04 difference per 3-gal container (assuming the analysis and longevities are the same) (Figs.14 and 15). Also, be careful to check the temperatures in which the longevities are determined. A “4 month” CRF product based on release data at 21°C (70°F) - is reduced to a “2 month” product at 30°C (86°F).

**Slow Release Fertilizers (SRF) are Not Controlled
Release Fertilizers (CRF)**

- One difference is in the coating characteristics.

Slow Release	Controlled Release
Natural Organics	Resin Coated
Synthetic Organics	Polymer Coated
Polymer Coated Sulfur Coated Urea - PCSCU	

Figure 1. Slow release fertilizers (SRF) differ from controlled release fertilizers (CRF) in coating characteristics.

Slow Release Fertilizers (SRF)

Slow Release	Product example	Released via
Natural Organics	Milorganite, Nature Safe	Microbial Action
Synthetic Organics	IBDU	Hydrolysis
Synthetic Organics	Nitroform, Nutralene	Mineralization
Polymer Coated Sulfur Coated Urea - PCSCU	Poly-S, XCU [®]	Catastrophic, rupture

Figure 2. Examples of slow release fertilizer (SRF) products and their release mechanism.

Synthetic Organic—Nitroform

☐ Broken down thru mineralization

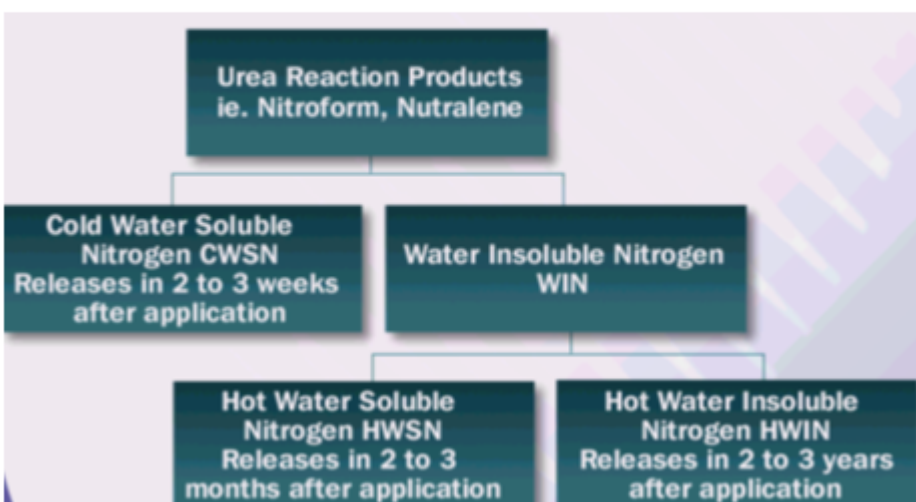
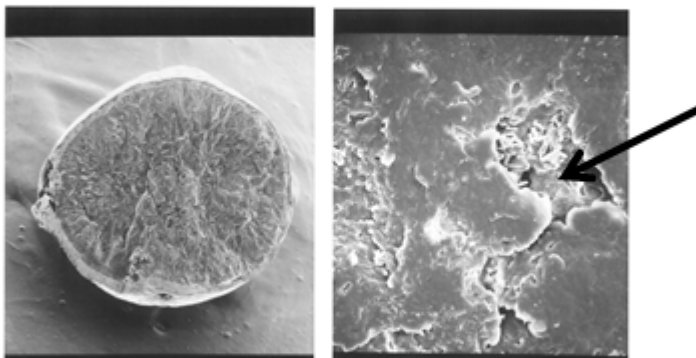


Figure 3. Fertilizer in Nitroform SRF is released through mineralization.

Polymer Coated Sulfur Coated Urea - Poly S/XCU®

□ Broken down by catastrophic release, rupture



Sulfur coated urea particle (left) and rupture on the surface of the layers coating the urea fertilizer substrate (right, arrow), due to increase osmotic pressure, enabling fertilizer release.

Figure 4. Fertilizer in sulfur coated urea is dispensed via catastrophic release via the rupture/fissure in the polymer coated layers.

Summary of Slow Release Fertilizer (SRF) Characteristics

- The release mechanisms are NOT controlled.
- Not all nutrients are “available”.
- Good as a part of a total fertility program, but not for overall use.
- Slow Release Fertilizers are less efficient.

Figure 5. Four characteristics of slow release fertilizers (SRF).

Controlled Release Fertilizers

“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.”

Association of American Plant Food Controls Officials
(AAPFCO)

Figure 6. The definition of a controlled release fertilizer (CRF).

Resin Coated Controlled Release Fertilizer- CRF

- Example, Osmocote®, Manufactured by ICL <https://iclsf.com/global-en/explore/nursery-stock-perennials-pot-bedding-plants/slow-release-fertilizers/>.
- Coating based on a floor varnish used in the mid 1940s.
- “Pioneer” of the CRF market.



Figure 7. Osmocote® is an example of a resin coated, controlled release fertilizers (CRF).

So how does the nutrient get out of the prill?

- The prills swell from water intake; once it expands, it cannot contract.
- Fissures form in the coating.
- And the nutrient/water solution exits.
- Longevity is based on release data at 21°C (70°F) avg. temp and is affected by the coating thickness.
- Example, Osmocote®.



Figure 8. How does the fertilizer get out of an Osmocote® prill?

Examples of Polymer coated CRF's

- Nutricote®
- Polyon®
- GAL-Xe^{ONE}®
- Multicote®
- Basacote®
- Plantacote®
- Surfkote/XRT®
- Purkote®
- Duration®

Figure 9. Examples of commercial, polymer coated CRFs.

Polymer Coated Fertilizer - Nutricote®

- Manufactured by JCAM in Japan.
- JCAM creates the raw/finished product in house in Japan.
- Exclusively provided by Florikan in the USA.
- Polyolefin polymer coating.
- Coating: Created with a blend of two polymers: polyethylene (PE) and ethylene vinyl acetate (EVA)
 - PE and EVA are blended together and dissolved in a chlorinated solvent.
 - Talc/silica are then added as a parting agent.
 - Matrix is then sprayed on the substrate.



Figure 10. Polymer coated, Nutricote® CRF.

Coating & Release - Nutricote®

- Unique: Coating thickness does not equal control longevity... the ratio of PE to EVA controls the release longevity.
- Example:
 - PE : EVA ratio = 1:1 = 98 day release
 - PE : EVA ratio = 1:0 = 1,300 day release
- Release pores can close in cooler temperatures.
- Release mechanism is via solute concentration gradient/

ORIKAN®

18-6-8 **NUTRICOTE® TOTAL**

2 - STAGE

LONGEVITY / RELEASE - UP TO: **180 Days**
avg soil temperature of 77°F

FOR PROFESSIONAL USE ONLY

GUARANTEED ANALYSIS		APPLICATION RATES	
TOP-DRESS RATES - GRAMS PER CONTAINER			
18% Nitrogen (N)*	6%	TYPE	180 DAYS
9.7% Ammoniacal Nitrogen			

CAUTION:
KEEP OUT OF THE REACH OF CHILDREN
HARMFUL IF SWALLOWED.

Figure 11. Coating and release characteristics of Nutricote® controlled release fertilizer (CRF).

Polymer coated fertilizer - POLYON®

- Release mechanism is via solute concentration gradient permeation.
- Product longevities are based on release data at 30°C (86°F) avg. temperature.

19-4-8

Product # 300933, a 5-6 month fertilizer with 300933

Average Media Temperatures	60 F	70 F	80 F	90 F
Longevity in Months	8-9	7-8	5-6	3-4

Benefits

- Nutrient release not affected by media type or pH level
- Nutrient release not affected by moisture level or microbial activity
- Each particle is individually coated for consistent effective nutrient release



GUARANTEED ANALYSIS

Total Nitrogen (N)	19.000%
8.000% Nitrate Nitrogen	
8.000% Ammoniacal Nitrogen	
8.000% Urea Nitrogen	
Available Phosphate (P ₂ O ₅)	4.000%
Soluble Potash (K ₂ O)	4.000%
Magnesium (Mg)	1.000%
0.000% Water Soluble Magnesium (Mg)	
Borax (B)	0.050%
4.700% Combined Sulfur (S)	
Copper (Cu)	0.140%
0.140% Water Soluble Copper (Cu)	
Iron (Fe)	0.100%



Figure 12. Polymer coated Polyon® controlled release fertilizer (CRF).

Other Examples - Polymer Coated Fertilizers

- ❑ **Gal-Xe One**[®] Simplot. Formerly “Florikote [®]”. Now Nationwide. Polyurethane coating. Release coating based on 38°C (100°F)
- ❑ **Multicote**[®] Haifa product (Israel). Coating created from polyurethane and polyether polyol. Longevity based on 21°C (70°F).
- ❑ **Basacote**[®] Currently only in European market.
- ❑ **Plantacote**[®] Polyurethane coating based on polyether polyol. Release data based on 21°C (70°F).
- ❑ **Surfkote/XRT**[®] Used primarily in turf or as a starter charge. Short release period.
- ❑ **Purkote**[®] Pursell’s, polyurethane coated CRF, similar to POLYON. Release data at 30°C (86°F), but not proven.

Figure 13. Other commercial examples of polymer coated controlled release fertilizers (CRFs).

Cost Analysis

Brand X Fertilizer (8-9 month) \$55.00/50lb

		Rate in Grams					
BRAND X 8 month	Size (Gallons)	Low	\$/pot	Med	\$/pot	High	\$/pot
\$55.00	1	11	\$0.027	13	\$0.031	16	\$0.039
	2	26	\$0.063	31	\$0.075	38	\$0.092
	3	46	\$0.111	56	\$0.136	68	\$0.165
	5	62	\$0.150	75	\$0.182	92	\$0.223
	7	91	\$0.220	112	\$0.271	136	\$0.330
	10	114	\$0.276	139	\$0.337	170	\$0.412
	15	128	\$0.310	156	\$0.378	191	\$0.463
	20	160	\$0.388	195	\$0.472	238	\$0.577

Brand Y Fertilizer (8-9 month) \$45.00/50lb

		Rate in Grams					
BRAND Y 8 month	Size (Gallons)	Low	\$/pot	Med	\$/pot	High	\$/pot
\$45.00	1	11	\$0.020	13	\$0.024	16	\$0.030
	2	26	\$0.048	31	\$0.057	38	\$0.070
	3	46	\$0.085	56	\$0.104	68	\$0.126
	5	62	\$0.115	75	\$0.139	92	\$0.170
	7	91	\$0.168	112	\$0.207	136	\$0.252
	10	114	\$0.211	139	\$0.257	170	\$0.315
	15	128	\$0.237	156	\$0.289	191	\$0.353

Figure 14. Cost analysis of a CRFs based on unit prices

Cost Analysis

- Brand Y Fertilizer (8-9 month) \$45.00/50lb.
- Brand X Fertilizer (8-9 month) \$55.00/50lb.

Take Home Message

- \$10/bag difference between Brand Y & X.
- On a 3 gal pot the difference is only \$0.04.
- Remember to compare more than price.
- A 4-month product at 21°C (70°F) is equivalent to a 2-month product at 30°C (86°F).

Figure 15. Factors in selecting a CRF should not be based just on the unit price – but rather the usage/ longevity cost under local, commercial production conditions.