Clarus™ PRO

PROFESSIONAL LANDSCAPE FERTILIZER

16-2-3 *Technical Summary*

We make organic matter.®

www.nutrientsplus.com

Conventional

Slow Release Fertilizers

Compared To

Clarus™ PRO Screamin' Green® 16-2-3

A Basis For Classifying

The Five Sources Of Nitrogen

Contained In 16-2-3

Background

Urea formaldehyde (UF) is the standard for 'slow release fertilizer'. UF and UF related technology are classified and patented according to their fractions of water insoluble nitrogen (WIN) and respective solubility. Two organic sources, biosolids and composted poultry manure, also contain WIN. However, instead of these sources being compared to UF and their valuable quality of possessing WIN, industry has had a tendency to generalize organic rate of release as a negative characteristic when referring to them as "slow to respond".

Diminishing the organic category in this way creates unnecessary roadblocks for market acceptance. It is counterproductive to the modern manager accountable for serious budgetary responsibilities who cannot afford expensive, synthetically manufactured, slow release fertilizers particularly when organic nutrients can be recycled cost effectively.

An objective evaluation recognizes the activity of biosolids matches similarly to that of the synthetic fractions of UF and more specifically, it has a longer delivery period of activity. The activity of Clarus™ PRO's particular form of composted poultry manure matches similarly to another UF WIN fraction that is conducive in a range that is slow but not as slow as the longest ranges of UF and biosolid fractions.

Together, these two sources essentially replicate UF's range of activity. There are historical and technical reasons why the two distinct organic fractions have not been combined previously. Utilizing modern processing methods, both are now available to be mixed. Again, the combined mixture offers extended periods of activity closely resembling that found in standard UF formulations. By adding in three other conventional sources with their respective periods of release within the shorter ranges (quickest, quick and slowly available) a customized finished product is produced.

It is fair to state UF's entire fractional range of slow release activity is contained within each reacted granule whereas, with the two organic sources, the range is derived by blending the materials, albeit, they remain separate ingredients. This should not matter. UF's spectrum of activity is limited to the longer range and is therefore blended with other conventional sources to provide a more customized performance. Both finished products (three conventional nitrogen sources in 16 2 3 combined with two organic sources for their respective WIN fractions and conventional) results in no practical difference with respect to their final blending and overall performance.

Classifying fractions of WIN from both organic sources on the basis used for synthetic UF formulations will benefit the industry.

A caveat remains. The two organic fractions of WIN are delivered to soils embodied in a complex of organic matter. UF is not. In the absence of these substances less biochemical reactivity results and the mineralization of nitrogen to plant available form is diminished.

The delivery of WIN embodied within self-contained sources of energy that gets used towards ensuring its conversion into a more available form is a more efficient methodology. Adding to this effect and supported by the results of bioassays[1], the presence of naturally derived beneficial microbes in the particular form of composted poultry manure used when making the mix (of five nitrogen sources) will further enhance the product's performance.[2]

The benefits from the direct uptake of simple organic substances are also known. Auxins and humates are examples. They are known plant growth regulators with many benefits such as suppression of diseases and increased drought tolerance.

While not the purpose of this report, an objective comparison would also have to include these merits of WIN complexed in organic matter but not provided by UF.

[1] Soil Food Web, Port Jefferson, NY, 2003

[2] Ervin, Erik, Ph.D. Virginia Tech, "Budgeting organic matter into programs with fertilizers containing natural and organic ingredients for sustained functionality with reduced nitrogen inputs on cool and warm-season turfgrasses" 2008

SET STANDARD FOR CLASSIFYING TYPICAL SLOW RELEASE FERTILIZER

The basis for U.S. Patent 6936681, "Slow Release Nitrogen Fertilizer", utilizes a slow release particulate urea-formaldehyde polymer. The polymer is useful as a fertilizer for enhancing the extended delivery needed for plant development and growth.

The polymer used binds synthetic compounds to retard release of plant available fertilizer materials to the soil. It contains nitrogen but the polymer merely binds fertilizer materials without substantially supplying nitrogen to the plant. The nitrogen sources in this composition are usually ammonium salts or inorganic nitrates. The polymer source is purchased in the form of a resin. In the process of making slow release nitrogen, variations in reaction time and temperature as well as a specific drying period will cause resulting variations of binding strength and thus, the rate at which the newly formed compound supplies nitrogen to the soil. Urea-formaldehyde (UF) polymer is sold under many trade names but most commercial references include Methylene Urea, Nitroform®, and Nutralene®.

The element Carbon (C) plays a major role in the finished product. It is the essential element from the polymer to chemically bind with nitrogen. Increasing the number of carbons combining with nitrogen adds length to carbon chains and complexity to the compound. With extensive processing, plastics form and are known for their longevity when disposed of and resistance to breakdown in the environment can be over a prolonged period.

Numerous examples of nitrogen binding with carbon exist and in many cases, *naturally*. Two such sources are biosolids and composted poultry manure.

FERTILIZER MATERIAL ACTIVITY INDEX

Nitrogen from biosolids and composted poultry manure as a fertilizer material is derived slowly like UF and the basis for determining the rate could be the same:

UF is comprised of three fractions of nitrogen based on solubility[1]:

Fraction I, or the cold water-soluble N (CWSN), is the portion that is soluble in water at 20 to 25° C (68 to 77° F). This fraction consists of unreacted urea, methylene diurea and dimethylene triurea.

Fraction II is the portion of cold water insoluble N (CWIN) that is hot water-soluble N (HWSN). This portion will dissolve a pH 7.5 buffered phosphate solution in 30 minutes at 98 to 100° C (208 to 212° F), and includes trimethylene tetraurea and tetramethylene pentaurea.

Fraction III, or the hot water insoluble N (HWIN), is that portion that does not dissolve in the hot water-soluble fraction. It is composed of pentamethylene hexaurea and longer chain molecules.

1. The activity index (AI) was defined by Katy and Fassbader (1966) as the percentage of CWIN that is HWSN. Specifically: [(CWIN – HWIN) / CWIN] x 100
2. It is assured that this portion of the CWIN fraction will become available over a growing season.

[1] http://www.turf.uiuc.edu/hort436/Lec%2011.stm

BASIS FOR CLASSIFYING BIOSOLIDS & COMPOSTED POULTRY MANURE LIKE UF

As with the supply of nitrogen to soil from UF, biosolids and composted poultry manure require mineralization and nitrification for nitrogen to be supplied. However, rather than the rate by which these processes occur being dependent on the molecular size of the methylene ureas (the rate decreasing with the increasing carbon chain-length of any particular methylene urea) rate is particularly dependent on how they are complexed within naturally occurring organic substances such as proteins, amino acids and enzymes.

Ultimately, such organic nitrogen converts to the same nitrogen plant food forms, ammonium and nitrate, as when derived from methylene urea. Throughout the digestion of organic matter in soils a myriad of biochemical reactions occur. Solubility is one such measure. Biosolids commonly contain 90% water insoluble nitrogen (WIN). Further, the activity index is low. A specific process for composting poultry manure yields a fertilizer material at least 50% WIN with fractions having a much higher activity index than biosolids.[2]

The following tables best illustrate the basis for classifying biosolids and composted poultry manure like UF.

[2] Unique to a specific method of processing layer manure.

MIXING CONVENTIONAL & NATURAL ORGANIC FERTILIZER MATERIALS OPTIMIZES N DELIVERY

Table 1 gives a molecular weight distribution of methylene ureas that may be found in a UF fertilizer.

Utilizing biosolids and a particular composted poultry manure a similar result can be accomplished by first considering how a biosolid breakdown might appear (table 2) and the poultry manure might appear (table 3) if the appropriate tests were performed for obtaining their actual breakdown. Without such testing we can rely on estimated values based on general product knowledge. Collectively, these tables offer how 16-2-3 works when mixing both together (table 4) and with conventional sources of nitrogen (table 5).

Table 1. Distribution of methylene urea polymers in a typical ureaform.

	Distribution	Mole wt.	WSN†	AI‡	Nitrification	
	%		%		%	wk
Methylene diurea	10	132	34	100	92	6-8
Dimethylene triurea	15	204	25	98	90	8-12
Trimethylene tetraurea	40	276	16	60	80	10-15
Tetramethylene pentaurea	25	348	10	35	50	12-24
Pentamethylene hexaurea	10	421	4	30	20	24-32

† Water-soluble N.
‡ Activity index = [(CWIN – HWIN)/CWIN] x 100.

Table 2. Estimated distribution of organic compounds in a typical biosolid.

	Distribution	Wt.	WSN†	AI‡	Nitrification	
	%		%		%	wk
Biosolid WSN fraction	10				100	2-3
Biosolid CWIN fraction	10				90	3-8
Biosolid HWSN fraction	70				50	8-12
Biosolid HWIN fraction	10				30	12-24

† Water-soluble N.
‡ Activity index = [(CWIN – HWIN)/CWIN] x 100.

Table 3. Estimated distribution of organic compounds in a particular poultry manure. [1]

	Distribution	Wt.	WSN†	AI‡	Nitrification	
	%		%		%	wk
Poultry Manure WSN fraction	50				100	2-3
Poultry Manure CWIN fraction	35				90	3-8
Poultry Manure HWSN fraction	10				50	8-12
Poultry Manure HWIN fraction	5				30	12-24

† Water-soluble N.
‡ Activity index = [(CWIN – HWIN)/CWIN] x 100.

Table 4. Estimated composite when biosolids and poultry manure fertilizer materials are blended.

	Distribution	Wt.	WSN†	AI‡	Nitrification	
	%		%		%	wk
PM/Biosolid-complexed WSN fraction	20				100	2-3
PM/Biosolid-complexed CWIN fraction	15				90	3-8
PM/Biosolid-complexed HWSN fraction	60				50	8-12
PM/Biosolid-complexed HWIN fraction	5				30	12-24

† Water-soluble N.
‡ Activity index = [(CWIN – HWIN)/CWIN] x 100.

Table 5. Five sources of N from conventional & natural-organic fertilizer materials in 16-2-3.

	Total	N	Actual		WSN	AI	Nitrification	
	Lbs	%	Lbs	%	%		%	wk
Urea + WSN OM fractions	YYY	XX	YYY	20	100	--	100	2-3
Ammonium Sulfate + WSN OM fractions	YYY	XX	YYY	20	100	--	100	3-4
Sulfur Coated Urea + CWIN OM fractions	YYY	XX	YYY	45	90+	--	100	4-6
PM/Biosolid-complexed HWSN fraction	YYY	XX	YYY	10	50	TBD	90	8-12
PM/Biosolid-complexed HWSN fraction	YYY	XX	YYY	05	10	TBD	50	12-24
	2000		320					

XY = Proprietary values

Before the advent of synthetic sources, fertilizer materials were all from natural and organic sources. Since 1950 their use declined due to the availability of synthetic fertilizers supplying higher concentrations of essential nutrients in granular form that made applications easier and more cost effective such as urea and ammonium sulfate. Fifty years later, improved methods for processing natural and organic fertilizer materials are being used to the extent they can be readily mixed with synthetic sources. The nitrogen supplied to the soil is comparable to reacted N sources as long as they are stable (physically, chemically and biologically) and compatible for mixing in blends.

[1] Unique to a specific method of processing layer manure.