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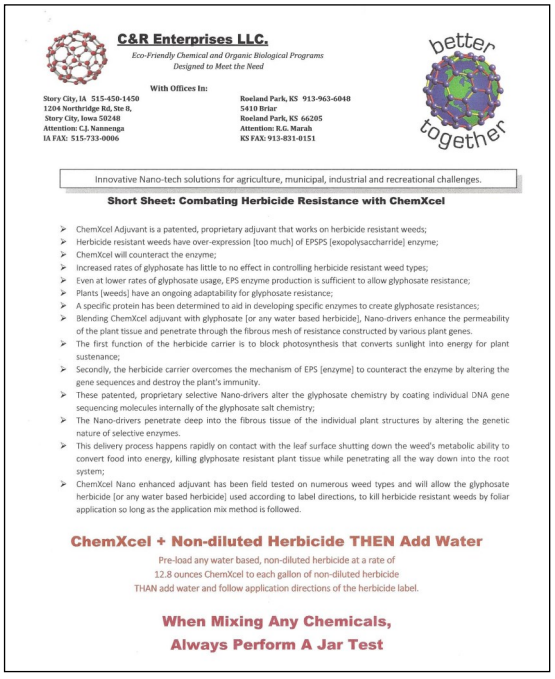
Adjuvants Alone Won't Solve Glyphosate Resistance

Adjuvants are very useful products which are used to enhance the activity of postemergence herbicides. Numerous adjuvant products from very reliable distributors are marketed annually and provide a true value to growers seeking to optimize herbicide performance. However, since the adjuvant industry is not regulated as stringently as the pesticide industry, we occasionally run into products that create a lot of attention because of extravagant claims made by the manufacturer or distributor.

Nanotechnology is a new and exciting area of research and product development in numerous sectors. Agrochemicals, including adjuvants, are being developed with nanotechnology and may very well have substantial benefits. However, during our winter grower meeting season, we began to hear rumblings about certain "nano" adjuvants and how they provided the answers for control of herbicide-resistant weeds. Our concern grew after reviewing the marketing material that inaccurately describes the underlying mechanisms of herbicide resistance and the suggestion that the only necessary action to control glyphosate-resistant weeds was to apply glyphosate with the nano adjuvant. The nano adjuvants purportedly would overcome resistance mechanisms and by promoting higher levels of herbicide penetration into the plant. No scientific evidence exists that would suggest weed resistance to glyphosate is simply a lack of foliar absorption. Nonetheless, we were getting phone calls about their utility and were hearing claims that there was university data to support their claims. However, we at Purdue University had not worked with these compounds, nor were we aware of university data supporting their use.

Below is a copy of the "technical" data information provided by the distributors for two nano adjuvants, one of these was being marketed in Northern Indiana. A number of interesting claims are made on these documents, which you can read below.



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Innovative Nano-tech solutions for agriculture, municipal, industrial and recreational challenges.

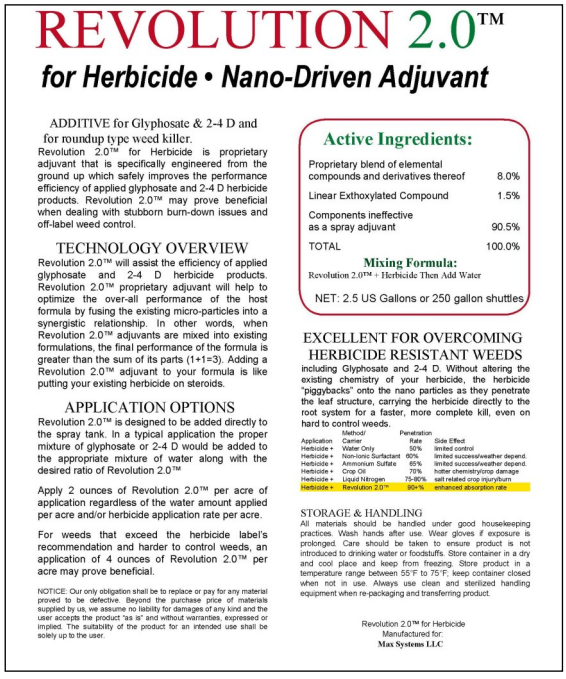
Short Sheet: Combating Herbicide Resistance with ChemXcel

- ChemXcel Adjuvant is a patented, proprietary adjuvant that works on herbicide resistant weeds;
- Herbicide resistant weeds have over-expression [too much] of EPSPS [exopolysaccharride] enzyme;
- ChemXcel will counteract the enzyme;
- Increased rates of glyphosate has little to no effect in controlling herbicide resistant weed types;
- Even at lower rates of glyphosate usage, EPS enzyme production is sufficient to allow glyphosate resistance;
- Plants [weeds] have an ongoing adaptability for glyphosate resistance;
- A specific protein has been determined to aid in developing specific enzymes to create glyphosate resistances;
- Blending ChemXcel adjuvant with glyphosate [or any water based herbicide], Nano-drivers enhance the permeability of the plant tissue and penetrate through the fibrous mesh of resistance constructed by various plant genes.
- The first function of the herbicide carrier is to block photosynthesis that converts sunlight into energy for plant sustenance;
- Secondly, the herbicide carrier overcomes the mechanism of EPS [enzyme] to counteract the enzyme by altering the gene sequences and destroy the plant's immunity.
- These patented, proprietary selective Nano-drivers alter the glyphosate chemistry by coating individual DNA gene sequencing molecules internally of the glyphosate salt chemistry;
- The Nano-drivers penetrate deep into the fibrous tissue of the individual plant structures by altering the genetic nature of selective enzymes.
- This delivery process happens rapidly on contact with the leaf surface shutting down the weed's metabolic ability to convert food into energy, killing glyphosate resistant plant tissue while penetrating all the way down into the root system;
- ChemXcel Nano enhanced adjuvant has been field tested on numerous weed types and will allow the glyphosate herbicide [or any water based herbicide] used according to label directions, to kill herbicide resistant weeds by foliar application so long as the application mix method is followed.

ChemXcel + Non-diluted Herbicide THEN Add Water

Pre-load any water based, non-diluted herbicide at a rate of
12.8 ounces ChemXcel to each gallon of non-diluted herbicide
THAN add water and follow application directions of the herbicide label.

When Mixing Any Chemicals,
Always Perform A Jar Test



REVOLUTION 2.0™

for Herbicide • Nano-Driven Adjuvant

ADDITIVE for Glyphosate & 2-4 D and for roundup type weed killer.

Revolution 2.0™ for Herbicide is proprietary adjuvant that is specifically engineered from the ground up which safely improves the performance efficiency of applied glyphosate and 2-4 D herbicide products. Revolution 2.0™ may prove beneficial when dealing with stubborn burn-down issues and off-label weed control.

TECHNOLOGY OVERVIEW

Revolution 2.0™ will assist the efficiency of applied glyphosate and 2-4 D herbicide products. Revolution 2.0™ proprietary adjuvant will help to optimize the over-all performance of the host formula by fusing the existing micro-particles into a synergistic relationship. In other words, when Revolution 2.0™ adjuvants are mixed into existing formulations, the final performance of the formula is greater than the sum of its parts (1+1=3). Adding a Revolution 2.0™ adjuvant to your formula is like putting your existing herbicide on steroids.

APPLICATION OPTIONS

Revolution 2.0™ is designed to be added directly to the spray tank. In a typical application the proper mixture of glyphosate or 2-4 D would be added to the appropriate mixture of water along with the desired ratio of Revolution 2.0™

Apply 2 ounces of Revolution 2.0™ per acre of application regardless of the water amount applied per acre and/or herbicide application rate per acre.

For weeds that exceed the herbicide label's recommendation and harder to control weeds, an application of 4 ounces of Revolution 2.0™ per acre may prove beneficial.

NOTICE: Our only obligation shall be to replace or pay for any material proved to be defective. Beyond the purchase price of materials supplied by us, we assume no liability for damages of any kind and the user accepts the product "as is" and without warranties, expressed or implied. The suitability of the product for an intended use shall be solely up to the user.

Active Ingredients:

Proprietary blend of elemental compounds and derivatives thereof	8.0%
Linear Exthoxylated Compound	1.5%
Components ineffective as a spray adjuvant	90.5%
TOTAL	100.0%

Mixing Formula:
Revolution 2.0™ + Herbicide Then Add Water

NET: 2.5 US Gallons or 250 gallon shuttles

EXCELLENT FOR OVERCOMING HERBICIDE RESISTANT WEEDS

including Glyphosate and 2-4 D. Without altering the existing chemistry of your herbicide, the herbicide "piggybacks" onto the nano particles as they penetrate the leaf structure, carrying the herbicide directly to the root system for a faster, more complete kill, even on hard to control weeds.

Application	Method/ Carrier	Penetration Rate	Side Effect
Herbicide +	Water Only	50%	limited control
Herbicide +	Non-Ionic Surfactant	60%	limited success/weather depend.
Herbicide +	Ammonium Sulfate	65%	limited success/weather depend.
Herbicide +	Crop Oil	70%	hotter chemistry/crop damage
Herbicide +	Liquid Nitrogen	75-80%	salt related crop injury/burn
Herbicide +	Revolution 2.0™	90+%	enhanced absorption rate

STORAGE & HANDLING

All materials should be handled under good housekeeping practices. Wash hands after use. Wear gloves if exposure is prolonged. Care should be taken to ensure product is not introduced to drinking water or foodstuffs. Store container in a dry and cool place and keep from freezing. Store product in a temperature range between 55°F to 75°F; keep container closed when not in use. Always use clean and sterilized handling equipment when re-packaging and transferring product.

Revolution 2.0™ for Herbicide
Manufactured for:
Max Systems LLC

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Find the latest weed management information and tools from Purdue:
https://ag.purdue.edu/btny/weedscience

PURDUE EXTENSION WEED SCIENCE

Purdue Nanotechnology Adjuvant Research Results

In an effort to learn more about the utility of these adjuvants, we conducted a study at a site in Indiana with glyphosate-resistant Palmer amaranth and wanted to share the results in this article. Dr. Young has also collaborated with a number of other weed scientists throughout the Midwest to conduct similar trials and we will share the results as they come available.

Our trial was on glyphosate-resistant Palmer amaranth with a population of about 95% resistant:5% susceptible. Control with glyphosate alone was 13.8%. There was a 5% increase in activity with one of these adjuvants at 27 DAT compared to glyphosate alone, but that only raised the level of control to 18% which is still well below commercially acceptable levels. In other words, the nano adjuvants tested did not solve weed resistance to glyphosate.

Adjuvants are critical components of making effective herbicide applications to control our most problematic weeds. However, the simple addition of an adjuvant to resolve weed resistance to herbicides does not exist. Be critical of any marketing claims that sound too good to be true, because most of the time they are.

Table 1. **Control of Glyphosate-Resistant Palmer amaranth with Glyphosate plus Adjuvant Using Nanotechnology Twelve Mile, IN**

Herbicide	Rate	Herbicide Efficacy 27 Days after Treatment [a]
		---------- % Control ----------
Roundup PowerMax	22 fl oz/A	13.8 b
Roundup PowerMax AMS	22 fl oz/A 8.5 lb/100gal	13.8 b
NanoRevolution 2.0	4 fl oz/A	0 c
ChemXcel	4 fl oz/A	0 c
Roundup PowerMax NanoRevolution 2.0	22 fl oz/A 4 fl oz/A	18.3 a
Roundup PowerMax ChemXcel	22 fl oz/A 4 fl oz/A	15.0 ab

[a] Means followed by the same letter are not statistically different.

Purdue Nanotechnology Adjuvant Research Results

PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

July 13, 2015

Control of Glyphosate-Resistant Palmer amaranth with Glyphosate plus Adjuvant using Nanotechnology.
27 Days After Treatment at Twelve Mile, Indiana.

PURDUE EXTENSION WEED SCIENCE

UNTREATED

Roundup PowerMax - 22 fl oz/A

Roundup PowerMax - 22 fl oz/A
AMS - 8.5 lb/A

Roundup PowerMax - 22 fl oz/A
ChemXcel - 4 fl oz/A

Roundup PowerMax - 22 fl oz/A
NanoRevolution 2.0 - 4 fl oz/A

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