

## YEA!<sup>®</sup> for Improved Potato Emergence and Yields

James C. Linden

&

Richard J. Stoner

Department of Chemical Engineering  
Colorado State University  
Fort Collins, CO 80523

Founder & President  
AgriHouse, Inc  
Berthoud, CO 80513

Potato Grower Magazine published “Throw Out Tradition -Take a Giant Leap”, in January 1997, describing an advanced potato technology for minituber seed encapsulation. The encapsulation matrix was developed and tested by the authors and Dr. Ken Knutson, Professor Emeritus of the Colorado State University Cooperative Extension Service and former manager of Colorado’s potato seed certification program. Later that same year, NASA successfully tested a liquid version of matrix aboard the space shuttle and Mir space station. In 2001, the researchers were granted a patent for their Tuber Planting System Comprising of Chitin and Chitosan. Recently, AgriHouse, Inc. received a Certificate of Registration from the Colorado Department of Agriculture for its proprietary YEA!<sup>®</sup> Yield Enhancing Agent™. Stoner, founder and President of AgriHouse, states, “Over 10 years of greenhouse and field trial on many crops, including potatoes, enabled his company to receive the plant amendment certification for commercial agriculture”.

This proprietary elicitor, YEA!<sup>®</sup> Yield Enhancing Agent, has been shown to improve minituber emergence and harvest yields with more number ones, compared to non-treated minitubers. YEA!<sup>®</sup> does not appear to be a systemic agent in plants, but instead causes receptors on the cell surface to initiate molecular level signal transduction processes. For example, induction of  $\beta$ -1,3-glucanase in treated seeds is known to be associated with improvement in emergence rates, increased growth and yields (1).

As a result of signal transduction, plants will produce various secondary metabolites that are useful in interactions with the environment. Various biotic and abiotic elicitors can enhance secondary metabolite production (2), and it is the interplay of these secondary metabolites that enables the now-alerted plant to better overcome biotic and abiotic (environmental) stresses. While some elicitors stimulate defense responses in the plant, other elicitors induce plant growth responses that result in increased dry weight biomass, root size and stem caliper, bloom and harvest yields (3).

As an organic patented material derived from exoskeletons of crustaceans, YEA!<sup>®</sup> is considered an elicitor. Elicitors provide the external stimuli that trigger the changes in the plant cells, which lead to a cascade of reactions and production of secondary metabolites, ultimately helping the plant overcome stress factors. Elicitors are stimuli of biotic and abiotic types. For example, the latter are represented by natural stresses to the plant from touch, shear forces (wind), temperature shocks and osmotic stresses. Biotic elicitors

include glucan polymers, glycoproteins, low molecular weight organic acids, fungal xylanases, segments of bacterial flagella or cell wall materials that alert the plant to the likelihood of potential pathogen attack. High affinity binding sites have been characterized for oligo- $\beta$ -glucosides, such as oligochitins, oligochitosans, yeast N-glycan and  $\beta$ -1, 4-linked galacturonate oligomers (4). The stimuli are perceived by receptors on the plant cells, which lead to activation of secondary messengers that transmit signals into the cell through signal transduction pathways that ultimately results in gene expression and the biochemical changes that benefit the plant. Interplay of the signaling molecules also regulates entire pathways by factors, which include polyamines, calcium, jasmonates, salicylates, nitric oxide and ethylene (5).

Since 1995 the authors conducted numerous potato experiments under controlled conditions at Colorado State University and a field site in Wyoming. Results showed YEA!<sup>®</sup> to increase emergence (c.f. Figure 1) and increase daughter tubers (c.f. Table 2). In both of these experiments YEA!<sup>®</sup> was applied at rate of 1.25 mL per liter to minitubers, from which results showed a 28 percent increase in Russet Burbank minituber numbers in YEA!<sup>®</sup> treatments compared to controls (c.f. Figure 2).

In 1997, Dr. Gary Franc from the University of Wyoming was asked by BioServe Space Technologies to evaluate wheat plants that had returned after many months from the Mir space station. BioServe is a NASA Commercial Center in the Department of Aeronautical Engineering on the campus of the University of Colorado, Boulder, Colorado. Upon Dr. Franc's recommendation, YEA!<sup>®</sup> was selected for testing aboard NASA's space shuttle and the Mir space station. Concurrent tests were also conducted at Kennedy Space Center and Colorado State University under the direction of the authors. Data showed this unique elicitor induced elevated  $\beta$ -1,3-glucanase enzyme activity and that this activity was associated with increased emergence and yields.

The elicitor has been applied to Russet Burbank minitubers as both a seed treatment and irrigation treatment with statistically significant results indicating better tuber yields than controls. Also, controlled studies comparing YEA!<sup>®</sup> with chitin and chitosan treated Russet Burbank minitubers resulted in a 47 percent increase in minituber yield ( $P= 0.05$ ) over the controls and chitin and chitosan treatments, as seen in Table 3.

Field and greenhouse studies have shown that the elicitor has no phytotoxic effect on tuber hypocotyl emergence and tuber set. In fact, these growth parameters are enhanced with the application of the elicitor preparation. The use of YEA!<sup>®</sup> in some regimen during the life cycle of plants has positive effects resulting in

- increased seed viability
- earlier sprouting
- more rapid growth
- greater yields
- higher quality produce

The ability of the proprietary elicitor to amend plant growth characteristics by means of

signal transduction processes makes YEA!<sup>®</sup> a unique plant amendment that differs from other types of elicitors and treatments, including chitin and chitosan. Furthermore, YEA!<sup>®</sup> Yield Enhancing Agent is not a growth regulator. Growth regulators and plant hormones includes auxins, gibberillic acid, cytokinins and ethylene. Some of these agents are known to enhance and promote growth as well as to alter plant differentiation that changes tissue morphology.

As a non-systemic agent in plants YEA!<sup>®</sup> impacts receptors on the cell surface and initiates molecular level signal transduction processes. YEA!<sup>®</sup> Yield Enhancing Agent naturally activates the signal transduction pathways in a wide and diverse range of species and cultivars that includes beans, corn, tomatoes as well as many other vegetables and flowers. During the last 13 years it has been proven to significantly increase seed germination and sprouting under laboratory and field conditions. Scientists and growers across North American, Mexico, Europe, Asia and India have reported the ability of YEA!<sup>®</sup> to increase early emergence, biomass and harvest yields. By incorporating YEA!<sup>®</sup> into seed treatments and field applications by side dressing, drip system, flood irrigation and overhead sprays growers can improve the crop condition, resulting in higher quality yields and improved shelf life. Growers can benefit significantly from multiple applications of YEA!<sup>®</sup> Yield Enhancing Agent anytime during the plant's life cycle.

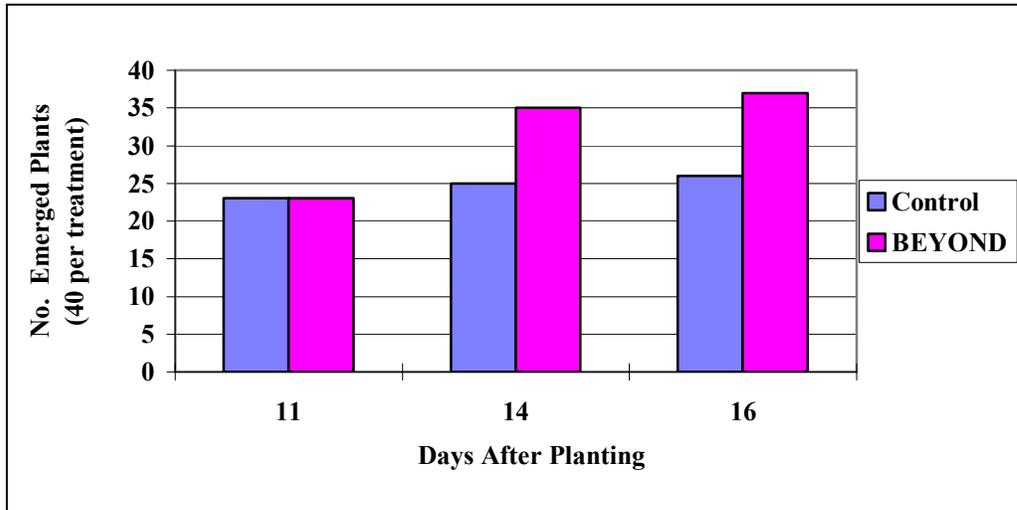
Authors note: Research on the elicitor, YEA!<sup>®</sup> Yield Enhancing Agent, was carried out under the test names 'YEA!<sup>®</sup>' and 'BEYOND' and 'ODC'. YEA!<sup>®</sup> Yield Enhancing Agent is EPA registered (# 83729-1) and approved for organic use. YEA! Yield Enhancing Agent is manufactured by AgriHouse Inc., Berthoud, Colorado USA <http://www.agrihouse.com/>.

For more information about YEA!<sup>®</sup> please visit <http://www.yearcrops.com/>

### **BIBLIOGRAPHY**

1. Linden, J., Stoner, R., Knutson, K. Gardner-Hughes, C. Organic Disease Control Elicitors, Agro Food Industry Hi-Te (p12-15 Oct 2000).
2. Linden, J.C. Phisalaphong, M. Oligosaccharides potentiate methyl jasmonate-induced production of paclitaxel in *Taxus canadensis*, Plant Science, 2000. 158 (1/2): 41-51.
3. Stoner, R. J. II, Stoner, R. J. Sr., Linden, J. C., Knutson, K. W., Kreisher, J. H. 2001. Tuber Planting System Comprising Chitin or Chitosan. US Patent 6,193,988.
4. Taiz, L. Plant Physiology. Sunderland, MA: Sinauer Associates, Inc., 2002.
5. Buchanan, B.B., Gruissem, W. and Jones, R.L. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Rockville, MD: 2000.

**Figure 1. Results of 1995 Greenhouse Potato Emergence Study Using Russet Burbank Minitubers (YEA!<sup>®</sup> test name: BEYOND)**



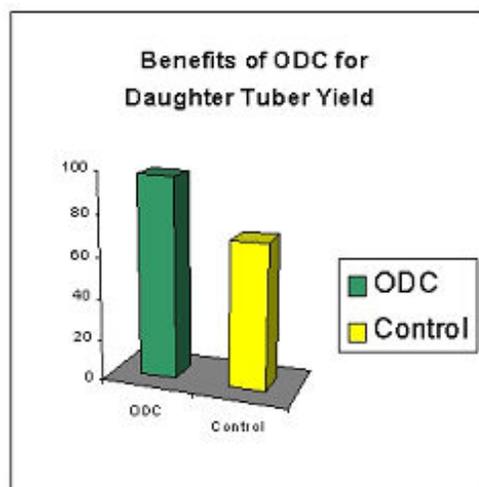
Significant differences ( $P=0.05$ ) begin to appear two weeks after planting and treatment with YEA!.

**Table 1. 1995 Greenhouse Evaluation of Effect of Elicitors on Tuber Number from Russet Burbank Study Colorado State University**

Treatments:	Average Tuber Number
Control	5.6b
YEA!	7.6a

Values followed by different letters are statistically different at  $P=0.05$

**Figure 2.  
1999 GREENHOUSE STUDY OF THE ELICITOR YEA! (ODC) ON RUSSET BURBANK MINITUBERS GROWN IN STERILE SOIL TO INCREASE YIELDS**



The elicitor YEA! (test name: ODC) treated plants had a 28 percent increase in daughter tuber yields over the control group (\*Values are statistically different at P=0.01).

**Table 2 Yield data on Russet Burbank harvest comparing YEA! to chitin and chitosan treatments**

Treatments	Control	Chitin	Chitosan	YEA!
Total number of tubers	40 b	38 b	40 b	61 a

P=0.05

YEA! was statistically significant with 47 percent increase over the control and chitin and Chitosan side-dress treatments. Study plots were located at the University of Wyoming Research and Extension Center, Torrington, WY.

# YEA!® Yield Enhancing Agent

## Agricultural Use

When used as directed on this label, YEA!® can boost seed germination and vitality, stimulate emergence and sprouting, enhance plant vigor, promote growth, suppress diseases and pathogens, activate plant resistances to environment stress and disease pressures, including the suppression of parasitic nematodes, increase crop yields, and improve crop quality.

For use as a seed treatment on corn, soybeans, potatoes, vegetables, herbs, grains, legumes, fruit and citrus trees.

### Active Ingredient:

Chitosan ..... 0.25%  
 Other Ingredients ..... 99.75%  
 TOTAL ..... 100.00%

Product contains 0.021 lb (0.01 kg) of chitosan / gallon

## KEEP OUT OF THE REACH OF CHILDREN

### CAUTION

SEE SIDE PANEL FOR PRECAUTIONARY STATEMENTS

FIRST AID	
<b>If in eyes</b>	<ul style="list-style-type: none"> <li>Hold eye open and rinse slowly and gently with water for 15 – 20 minutes.</li> <li>Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li> <li>Call a poison control center or doctor for treatment advice.</li> </ul>
<b>If on skin or clothing</b>	<ul style="list-style-type: none"> <li>Take off contaminated clothing.</li> <li>Rinse skin immediately with plenty of water for 15 – 20 minutes.</li> <li>Call a poison control center or doctor for treatment advice.</li> </ul>
<b>If swallowed</b>	<ul style="list-style-type: none"> <li>Call poison control center or doctor immediately for treatment advice.</li> <li>Have person sip a glass of water if able to swallow.</li> <li>Do not induce vomiting unless told to do so by the poison control center or doctor.</li> <li>Do not give anything by mouth to an unconscious person.</li> </ul>
<b>If inhaled</b>	<ul style="list-style-type: none"> <li>Move person to fresh air</li> <li>If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.</li> <li>Call a poison control center or doctor for further treatment advice.</li> </ul>
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.	

### MANUFACTURED BY:

**Contents:**  
 AgriHouse, Inc.  
 307 Welch Ave  
 Berthoud, Colorado 80513

EPA Reg. No.: 83729-1  
 EPA Est. No.: 83729

Batch code:

### PRECAUTIONARY STATEMENTS

**Hazards to Humans and Domestic Animals – CAUTION:** Causes moderate eye irritation. Avoid contact with eyes. Wash thoroughly with soap and water after handling.

### ENVIRONMENTAL HAZARDS

Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment wash waters.

### PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear: Long-sleeved shirt, long pants, waterproof gloves, protective eyewear, and shoes plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

### DIRECTIONS FOR USE

It is a violation of federal laws to use this product in a manner inconsistent with its labeling.

To prevent contamination of the dilute solution of YEA!® by possible pesticide or other chemical residues in the spraying equipment, use dedicated equipment, or be sure that the equipment is thoroughly clean before use.

### For Agricultural Use:

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

### Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry intervals (REI). The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard. Do not allow worker entry into treated areas until sprays have dried. PPE requirements for early entry to treated areas (that is permitted under the Worker Protection Standard and that involves contact with anything has been treated, such as plants, soil or water) is: coveralls, waterproof gloves that and shoes plus socks.

### GENERAL INSTRUCTIONS

Shake before using. For best results use pH neutral (pH 6.9 to 7.0) mix water. Follow specific crop instructions for dilution rates and application usage. Do not apply within three days of harvesting.

### SPECIFIC CROP INSTRUCTIONS

**Seed Treatment for True Seed Crops:** Mix 20 ml into 1 gallon. Apply directly to seeds. Allow to dry or plant soaked seeds within 60 hours after applying.

**Potato Seed Treatment Applications:** Pre-dip potatoes prior to planting Mix rate: 1 pint into 10 to 50 gallons or more:

### Storage and Disposal

Do not contaminate water, food or feed by storage or disposal.

**Pesticide Storage:** Store in original container in a cool, dry place, away from sunlight and out of the reach of children and pets. Do not reuse container. **Pesticide Disposal:** Wastes resulting from use of this product may be disposed of on site or at an approved waste disposal facility. **Container Disposal:** Unrefillable container. Do not reuse or refill this container. Offer for recycling, if available. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. An empty container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed. Completely empty contents into formulation equipment. Then offer for recycling or reconditioning or, dispose of container in a manner approved by state and local authorities.

### WARRANTY

AgriHouse Inc. warrants that this product conforms to the chemical description on the label and is reasonable fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Patented & Patents Pending