AGROVIVE™

R3Plant™ RECOVERY

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EXECUTIVE SUMMARY

Hail damage to soybeans is a major contributor to soybean crop losses and crop insurance claims from these losses. Soybean plants typically grow from the tips of the shoots (Apical Growth). When hail hits the soybean plants, it breaks off the growing tops of shoots and stems. In the process, it breaks apical dominance causing the plant to form multiple lateral (side or meristematic) shoots. These numerous new shoots produce few full size pods that reach maturity, thus resulting in dramatically reduced yields. The failure of such soybean crops to produce even moderate yields due to this damage is the basis for extensive insurance claims.

R3Plant™ is a microbial-based biostimulant product from Agrovive™ that in multiple field studies has demonstrated the consistent ability to promote regrowth of hail-damaged soybeans. R3Plant™ stimulates a regeneration of the original damaged stalk at the wound, resulting in normal soybean plant branching and canopy formation. This regrowth allows for soybean yields that have greatly improved yields over untreated crops. The product offers a unique opportunity to increase crop yields following hail damage, and also to influence crop insurance claims and losses. The value of soybeans harvested from R3Plant™ treated soybeans after hail damage have exceeded the caps set for soybean crop insurance payouts as established by USDA Risk Management Agency.

Benefits of this product include reduced yield loss, increased return on investment by soybean growers, as well as reduced payout and greater profits to insurance providers and insurance underwriters. Confirmation of the benefits of R3Plant™ under actual grower field conditions would undoubtedly lead to the routine use of this product to 1) reduce the number of crop loss claims, 2) increase the financial return to growers from larger yields, as compared to payments from insurance claims, and 3) soybean growers may be able to obtain lower cost hail insurance by reducing the risk of crop loss from hail damage.

R3Plant™ offers a real opportunity to reduce the risk from hail damage and thus improve profitability for both growers and crop insurers. To confirm the reliability of R3Plant™ on soybean regrowth and yield improvement from hail damage the following pilot project is proposed.

OBJECTIVE OF PROPOSED PILOT PROJECT

To evaluate the application of R3Plant™ on soybean crop recovery and yield improvement following simulated and naturally occurring hail damage at two stages of crop maturity. The simulated crop damage will be targeted to soybean crops one week before and one week after local mandatory replant date as established by insurance industry standards. The study area will simulate damage by using a string “weed eater” starting at the top of the plant and damaging it to just above the first node. The untreated damaged plot will allow for the normal broken apical dominance effect (multiple branches) to regrow starting at the last available node on the plant stem.

PRODUCT DESCRIPTION:
WHAT IS A BIOSTIMULANT?

A biostimulant is any biological organism or product produced by a living organism that is applied to or inoculated into a plant, or the environment around a plant, that elicits a desired response. Humans have harnessed these living interactions for centuries both intentionally and naturally to provide food and domesticate crops across the globe. Plants require microorganisms and their byproducts to provide nutrition from the soil that is in a form or state that the plant cannot naturally transport or consume.

Nitrogen Fixation is a prime example of microbial organisms contributing directly to the production of grain in a plant. Rhizobia are necessary to promote the yield of nodule forming legumes and symbiotic plants by supplying extra nitrogen directly to the plant for conversion into proteins and other essential building blocks of life.

Mycorrhizal organisms form vast networks to allow the transport of nutrients throughout the soils and to connect plants in a manner that is closely akin to computer networks sharing information that allows us all to prosper and be informed about the world around us.

Symbiotic organisms can be found on the surface and within the plants themselves, and much like our own micro-and-gut biome, can facilitate and help regulate our critical systems. The plants' microbiome is necessary to carry out everyday functions like pH regulation and photosynthesis.

These organisms have been under attack for most of the last century by practices and products that did not recognize the need for, or the abundance of these symbiotic organisms. We have now recognized that the loss of these naturally occurring and diverse organisms has been a hindrance to the full realization of genetic advancements and modern farming practice potentials.

Most farmers and industry insiders have seen fields that have exhibited some of the same effects as R3Plant™ in the "wild" although in a less systematic and fragmented fashion. We have just begun to understand the interactions and relationships that can allow plants to recover from damage. The product tested as part of this pilot will make sure the microbes necessary for systemic recovery are in the plant at time of seeding. The maintenance and support of these bacteria will be critical to the success of this pilot. Plants that have successful inoculation and such microbes have not been killed due to chemistry inconsistent with their survival, will demonstrate their effect of damage induced regulation on plant growth and yield.

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BENEFITS TO THE PLAN

R3Plant™ Microbes were selected to allow a legume to recover from traumatic damage by re-establishing apical dominance.

1. A proprietary group of bacteria have been harnessed allowing a legume to restore growth from a damaged stem wound, thus allowing apical dominance to reestablish in the stem for further growth from the original stem.
2. The use of these bacteria was partnered with the SoyFX seed coating product, that responds to stress hormones being produced by all the remaining plants in the field and permits the plant to recover a full canopy and potentially greater yield than if the plant had not been damaged.
3. Reactive Oxygen Species (ROS) microbes are contained in the microbial mixture in a supporting role to assist in the movement of nutrients from the large root mass to the emerging plant tissues.
4. pH regulating systems facilitated by the microbes allow the plant to regulate the daily cycle of rest during daylight. This can include the inability to transfer electrons in critical processes to allow the plants to mature faster with the bank of nutrition stored in the roots.
5. The plants are able to regenerate lost tissues faster due to the large bank of nutrition available in the root mass and establish a yield that has greater potential than a replanted seed that has to establish new roots and accumulate the necessary nutrient sink to fill beans with the limited remaining time until killing frost.

MORPHOLOGICAL RESPONSE

1. Treated plants will regrow from the stem wound rather than making new lateral branches become the new stem and forcing the nutrition and water through the restricted vascularization not meant to pass that much material.
2. The biggest impact of the product if applied as a seed coat is the ability to recover and stimulate growth when the crop is damaged, but not destroyed.
3. The use of B-Pryme is recommended to feed the rapid regrowth of the plant once a canopy has begun to form.

DATA ANALYTICS DESCRIPTION

Data from this pilot project will be used to determine what conditions are necessary to recreate lost tissues and to allow full or mostly full recovery from damage. This can be derived from data correlation to yield as determined in the final grain testing.

We will also be evaluating seed treat recovery as a general prophylactic seed treatment. We will be determining what effect the product has when applied to the seed on final yield loss and claim losses to the industry, including what percentage justifies replanting of the crop. We will rely heavily on the adjustors and insurance industry insiders to evaluate this portion of the program. We will also rely on the insurance industry to determine loss rating and claim impact on all levels of the industry allowing new actuarial tables to be produced and implemented that may be able to share prophylactic application to the seed as an overall risk reduction. This information will help determine if this product will result in a symbiotic relationship with the insurance industry resulting in them providing support to the farmer to implement this program?

Evaluation of a foliar application to a hail damaged field may also be included in this program to evaluate the efficacy of spraying the product on the remaining stems of a field that was not inoculated as seed rather than planting new seed potentially saving the seed industry capital that is allocated to current risk models.

Economic Models should be developed to analyze the data generated to determine if a cost sharing program between multiple stakeholders such as the seed industry, insurance industry, farmers and Ag retailers, should be developed and implemented.

Additionally, nutritional tissue tests should be taken to develop a projection of the necessary nutrition needed to supplement and support the regrowth and improved yields of the damaged plants.

DATA FROM HISTORIC TRIALS

The following is data from the last two years using the R3Plant™ Product under real and simulated hail events.

2017

We provided several thousand acres of product for use in South Dakota after a hail event in Hamlin and Codington Counties. The results were monitored by the farm operators and only anecdotal yield results were provided.

This year provided Agrovive with a baseline of data that the yields exceed the insured payout for the acres treated.

The result of this trial was that we discovered under normal circumstances a plant treated with R3Plant™ after a hail event caused the plant to regrow from the scar callus rather than from the node below the damage which is how the plant would have normally responded. This is significant as this is the only product known that promotes this method of regrowth.

Typical regrowth from a damage event to a soybean plant is by loss of apical dominance, which is what happens when you remove the top growing material and the lower branches grow to replace the plants typical upward growth from the tip. See Figure 1.

This was the first use of the product post damage and the mechanism for regrowth was the focus rather than harvest and yield data in South Dakota.

FIGURE 1. Soybean plant illustrating regrowth from scar callus rather than node.

2018

The last year of trial was utilized to determine yield effect and regulation of biochemical processes in the plants under hail event stress.

The trials utilized a cutting effect of both "mower" style sharp edge rapid excision technique and a "weed eater" string brush cutter method to simulate damage and to determine if an ROS stress response associated with a true hail event had an effect on plant regrowth.

The plants cut by "clean" excision did not grow back and proved the effect of an ROS stress response signal in the plant to impact the regrowth using R3Plant™ product.

The plants cut by "weed eater" cutting method caused an ROS signaling stress response that better simulated actual hail damage caused a regrowth response from the scar callus on the soybean plants.

The yields attained by the cut then treated plants were in excess of the uncut untreated plants on both trials in South Dakota.

The first field was cut with a string brush cutter the second week of July 2018. See Figure 2. This field was located in South Eastern South Dakota and had excess moisture. The plants were cut to within 3.5 inches of the ground. The lowest node was all that was left of the plants. The first field was sampled in multiple locations within the field and samples were then averaged with 5 replicated samples per segment. The untreated and left uncut control had an average result of 65.7 bushels per acre. The uncut treated plants had an average yield result of 67.24 and 64.67 in each of the two test areas. The cut and treated area had an average estimated yield of 69.23 which is an increase of 3.53 bushels per acre when compared to the untreated an uncut area of the field. This is a astonishing recovery of the plants.

The second field was also located in South Eastern South Dakota in an area with excess moisture. See Figure 3.

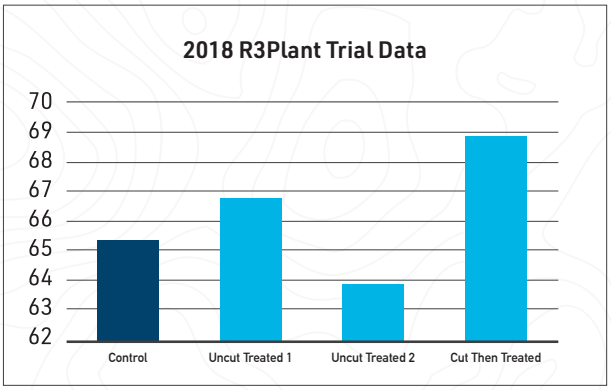

FIGURE 2 2018 Field 1 R3Plant data in Bushels Per Acre Simulated Damage

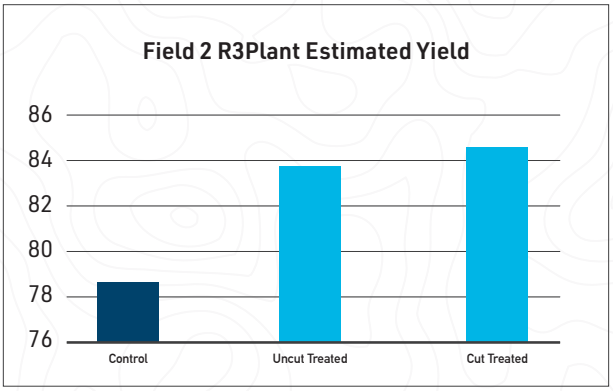

FIGURE 3 Field 2 R3Plant data in Bushels Per Acre Simulated Damage

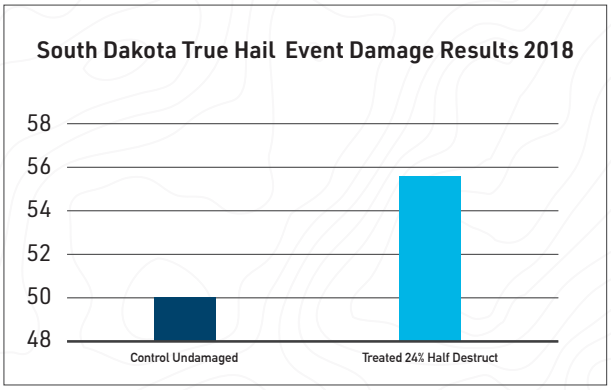

FIGURE 4 South Dakota "true" hail

The field was cut with a stringed brush cutter to within 3.5 inches of the ground leaving only the lowest node on the stem on the plant. The field was then treated after the destruction event. The cut area was treated with R3Plant™ and a corresponding uncut area was treated with R3Plant™ at the same time. The majority of the field was left uncut and untreated. The control area which was uncut and untreated had a sampled yield of 79.44 bushels per acre, which was a yield that was consistent with the historical yield of the field. The uncut treated area of the field had a sampled yield of 84.51 bushels per acre which demonstrated that the product by itself is effective at causing an increase in overall yield. The cut and then treated portion of the field had a sampled yield of 85.25 bushel per acre. This result in the destruct and treated portion of the field shows that the product is effective in plant regeneration and yield stabilization following a destructive event resulting in loss of nearly the entire stem and foliage of the plant.

We were given a unique opportunity to monitor real world results in Central South Dakota in a field we were conducting a large-scale early application trial on. The field had been foliar treated with an early application soybean product that contained the R3Plant™ bacteria. The field was hit on one half by a hailstorm that was assessed at 24% loss post harvest. We were fortunate in that our trial was on the half impacted by the storm and the control was not impacted by the localized hail event. The historic yield of the field is 57 bushel per acre. The samples were derived by mechanical combine harvest at the end of the season and are true representation of the yield of the field studied.

The control section of the field had an average yield determined by weigh wagon of 50.93 bushels per acre. The early foliar treated section of the field, which was damaged but not destroyed by the hail event had an average of 56.37 bushels per acre by true weight and measured by mechanical combine harvest. This was a 5.44 bushel per acre increase over control in the field with an assessed loss of 24% left as determined by insurance adjustor after harvest. See Figure 4.

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SOIL TESTING

Soil and tissue testing for all essential nutrients can be provided to you and your agronomist at a reduced cost through the Agrovive™ Lab Testing Program. Your Agrovive™ dealer can assist your agronomist to obtain all essential nutrients to meet the needs of your crop.

Soil and tissue test results will help your agronomist to determine the nutritional needs of your crop, and how best to provide these nutrients to maximize your yields and profitability.