

BiOWiSH[®] Crop Liquid

Evaluation of BiOWiSH[®] Crop Liquid on Yield in Winter Wheat -- Year 3

Executive Summary

BiOWiSH Technologies, Inc. engaged Helena Agri-Enterprises, LLC as a third-party Contract Research Organization (CRO) to conduct a study to determine the effects of BiOWiSH[®] Crop Liquid on winter wheat production in Oregon. The results reported in this study are from the 3rd year of wheat trials in the area. The study compared 2 treatments:

- A common regional fertilizer program as the control (Control)
- The same fertilizer program with BiOWiSH[®] Crop Liquid added (Control + BiOWiSH[®] Crop Liquid)

The study determined that the Control + BiOWiSH[®] Crop Liquid program increased yield in winter wheat which led to higher profit.

Background

About BiOWiSH[®] Crop Liquid

BiOWiSH[®] Crop Liquid is a microbial additive that can be coated onto dry fertilizer or mixed with liquid fertilizers to create an enhanced efficiency fertilizer with industry-leading shelf life, and consistent results across a broad range of operating conditions and environments, all at a low cost to farmers. BiOWiSH[®] Crop Liquid enhances native microbial activity in the soil and root development, increasing nutrient availability and improving plant vigor. BiOWiSH[®] Crop Liquid is proven to enhance the effects of applied fertilizers by optimizing yield potential and soil productivity.

About Helena Chemical Company

Helena Agri-Enterprises is a leading provider of crop production and crop protection products in the United States and worldwide. Headquartered in the USA, the company has been in the agronomic products supply business for more than 50 years and has expanded their contract research services over the last decade. As an independent CRO, Helena R&D is a team of highly trained and experienced study directors, field researchers, and support staff. They are one of several independent CROs that BiOWiSH Technologies, Inc. works with to independently evaluate our agronomy products.

Objectives

The objective of this research study was to determine the efficacy of BiOWiSH[®] Crop Liquid on winter wheat production, grown under irrigation, when added to a fertility program common to the production area in Central Oregon. The focus was on BiOWiSH[®] Crop Liquid's impact on plant vigor, yield of winter wheat, grain quality, and the grower economics.

Implementation Program

Helena R&D conducted this trial at a research site located near Culver, OR. The trial design was a completely randomized block design with 4 replicates per treatment. Each replicate plot measured 5 ft wide by 25 ft long (1.5 m by 7.6 m). 'WB528' winter wheat was planted using a precision Great Plains planter and planted at the rate of 120 lb/ac (134.5 kg/ha).

BiOWiSH[®] Crop Liquid



- Optimizes yield potential
- Increases nutrient availability
- Enhances root development
- Improves plant vigor
- Enhances native microbial activity in the soil
- Improves soil productivity

Available Sizes

- 50 gal/190 L
- 264 gal/1000 L

BiOWiSH® Crop Liquid was added to the fertilizer program and mixed with water for application. Pre-plant fertilizer was broadcast over the trial area at a rate of 450 lb/ac (504.4 kg/ha) with a 40-0-0 plus 5.5% Sulfur composite fertilizer and incorporated into the soil within 72 hours after application. Starter fertilizer applications were applied to each individual plot using a CO₂ backpack sprayer, calibrated to deliver the liquid fertilizer blends in-furrow at the appropriate rates for each treatment. Starter fertilizer treatments, application rates, and timings are shown below in Table 1. Pest and disease management techniques were implemented on site when required.

Table 1. Fertilizer Treatments and Application Timings

| Treatment | Fertilizer (applied in furrow at planting) | Rate gal/ac [L/ha] |
|----------------------------------|---|--------------------------|
| Control (Grower Practice) | UAN 32% N | 9.0 [84.2] |
| | Nucleus®* 0-0-21 | 2.0 [18.7] |
| | Nucleus® O-Phos 8-24-0 | 5.0 [46.8] |
| | Kickstand®* 0-0-0-7 Zn | 0.25 [2.3] |
| | Water | 5 [46.8] |
| | UAN 32% N | 9.0 [84.2] |
| Control + BiOWiSH® Crop Liquid** | Nucleus®* 0-0-21 | 2.0 [18.7] |
| | Nucleus® O-Phos 8-24-0 | 5.0 [46.8] |
| | Kickstand®* 0-0-0-7 Zn | 0.25 [2.3] |
| | Water | 5 [46.8] |

*Nucleus®, and Kickstand® are registered trademarks of Helena Holding Company.

**BiOWiSH® Crop Liquid added at manufacturer's recommended rate.

The following evaluations were made in order to determine the effects of BiOWiSH® Crop Liquid enhanced fertilizer on winter wheat production. For crop vigor, a 0-5 scale was used (0 = low vigor and 5 = high vigor), for crop color, a 0-10 scale was used (0 = no color and 10 = dark green), plant height (cm), and relative chlorophyll content was measured using an electronic SPAD reader. To measure leaf tissue levels of nutrients, 50 representative leaf samples were collected at flag leaf stage and composited for each treatment. Along with yield measurements, grain test weight and percent protein were measured. Yield data and local commodity crop pricing were used to calculate net income and profit change.

Results

Plant Health

In season evaluations of crop vigor, color, plant height, and chlorophyll assessments were similar between treatments. Table 2 represents the data point nearest to the harvest.

Table 2. Plant Health

| Treatment | Crop Vigor Rating | Color Rating | Plant Height in [cm] | SPAD (%) |
|--------------------------------|-------------------|--------------|----------------------|----------|
| Control | 5 | 5 | 36.3 [92.2] | 53.58 |
| Control + BiOWiSH® Crop Liquid | 5 | 5 | 36.0 [91.4] | 54.65 |

In season leaf tissue analysis showed similar nutrient levels between treatments which were at acceptable levels (Table 3).

Table 3. Leaf Tissue Nutrient Levels

| Treatment | Nitrogen % | Phosphorus % | Potassium % |
|--------------------------------|------------|--------------|-------------|
| Control | 4.07 | 0.47 | 3.25 |
| Control + BiOWiSH® Crop Liquid | 4.37 | 0.43 | 2.54 |

Yield and Quality

Analysis of wheat yield showed that the BiOWiSH® treatment resulted in an increase of 14.1 bu/ac (948 kg/ha) which equates to a 10.7% increase over the standard grower practice program. Percent grain protein and grain test weight had similar levels across treatments. (Table 4).

Table 4. Winter Wheat Yield

| Treatment | Yield bu/ac [MT/ha]* | Test Weight** | Protein % |
|-----------------------------------|----------------------------|---------------|--------------|
| Control | 131.3 [8.77] | 59.15 | 11.1 |
| Control + BiOWiSH® Crop Liquid | 145.4 [9.71] | 59.98 | 10.8 |

*An average test weight was used for conversion from bu/ac to MT/ha

**Notes 1lb = 1.12 kg

Economic Analysis

Economic analysis data is shown in Table 5. Based upon the average yield increase of 10.7% in the Control + BiOWiSH® Crop Liquid, net income increased by 12%, resulting in an increased profit of \$69 USD/ac (\$171 USD/ha).

Table 5. Economic Effects of BiOWiSH® Crop Liquid Enhanced Fertilizer Application in Winter Wheat

| Treatments | Grain Yield* bu/ac [MT/ha] | Yield Increase % | Net Income** USD/ac [USD/ha] | Net Income Gain % | Profit Change*** USD/ac [USD/ha] |
|-----------------------------------|----------------------------------|------------------------|------------------------------------|-------------------------|--|
| Control | 131.3 [8.77] | - | \$580 [\$1,433] | - | - |
| Control + BiOWiSH® Crop Liquid | 145.4 [9.71] | 10.7 | \$649 [\$1,604] | 12 | \$69 [\$171] |

*Calculations for conversions between imperial and metric units are based on the original source data; slight rounding differences may occur within reported publication values; an average test weight was used for conversion from bu/ac to MT/ha

**Net income gain is the crop value minus the fertility program cost. It does not account for non-fertility expenses.

***Profit change is the difference between net income of the respective program and the Control.

Conclusion

This study demonstrates the addition of BiOWiSH® Crop Liquid to the common fertility program improved winter wheat yield by 10.7%. BiOWiSH® Crop Liquid treatment increased net profit over the Control treatment by \$69 USD/ac (\$171 USD/ha). Evaluations of crop vigor, color, plant height, and chlorophyll assessments were similar between treatments. In addition, the percent grain protein and grain test weight had similar levels across treatments. The ability of BiOWiSH® Crop Liquid enhanced fertilizer to improve wheat production offers a significant return on investment opportunity to the grower.



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