

BiOWiSH® Crop Liquid

Evaluation of BiOWiSH® Crop Liquid in Spring Wheat



Executive Summary

BiOWiSH Technologies, Inc. engaged Helena R&D as a third-party Contract Research Organization (CRO) to conduct a study to determine the effects of BiOWiSH® Crop Liquid on wheat production.

The trial compared three treatments:

- A regional standard fertility program (Control)
- The same fertilizer program with BiOWiSH® Crop Liquid added (Control + BiOWiSH® Crop Liquid)
- N Optimized Fertility Program + BiOWiSH® Crop Liquid

The study determined that the BiOWiSH® treatments optimized both soil conditions for greater root mass and yield potential by improved nutrient uptake. In this trial, a 7.2% yield increase was observed for the Control + BiOWiSH® Crop Liquid Treatment, and a 1.7% yield increase for the N Optimized + BiOWiSH® Crop Liquid treatment, which led to higher profit.

Background

About BiOWiSH Technologies

Headquartered in Cincinnati, Ohio, BiOWiSH Technologies, Inc. is a global provider of biotechnology solutions. As a leader in the agricultural market, we help farmers increase crop production sustainably, safely, and cost effectively. Our revolutionary BiOWiSH® Crop Liquid is a blend of proprietary microbial cultures that can be coated onto dry fertilizer or mixed with liquid fertilizers to create an enhanced efficiency fertilizer. BiOWiSH® endophytic *Bacillus* deliver soil nutrients to crops through the rhizophagy cycle creating a symbiotic relationship between the plant and soil microbes. This helps farmers achieve consistent results across a broad range of operating conditions, climates, and environments. By unifying nature and science, BiOWiSH reinvents the way food is grown. For more information, visit biowishtech.com.

BiOWiSH® Crop Liquid



- Optimizes yield potential by improved nutrient uptake
- Increases nutrient use efficiency and supports nutrient uptake
- Optimizes soil conditions for greater root mass
- Improves soil conditions for increased plant vigor
- Enhances beneficial microbes in the rhizosphere

Available Size

- 264 gal/1000 L

About Helena Agri-Enterprises, LLC

Helena Agri-Enterprises, LLC 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 its 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, manufactured in the USA by BiOWiSH Technologies, Inc. on wheat production when added to a fertility program common to the production area in central Oregon. Additional focus was also placed on BiOWiSH® Crop Liquid's impact to grower economics. In this trial, the common regional wheat fertility program (Control) was compared to the same fertilizer program with BiOWiSH® Crop Liquid added and an N Optimized Fertility Program + BiOWiSH® Crop Liquid.

Implementation Program

The study was a randomized complete block design with four replications. The Control plots were treated with the standard grower program of 280 lbs/acre of urea. Alturas spring wheat cultivar was planted on Day 0. Urea treatments (see Table 1) were applied on a research site in Madras, Oregon on Day 1, and irrigation began on Day 3. The trial began on April 21 and the crop was harvested at maturity in August.

Table 1. Fertilizer Treatments and Application Timings

Treatment	Post-Plant Fertilization Program	Rate lbs/acre [kg/ha]	Application Phase
Control	Urea (46-0-0)	280 [314]	Post-plant
Control + Crop Liquid	BiOWiSH® Crop Liquid Coated Urea (46-0-0)	280 [314]	Post-plant
N Optimized Fertility Program + BiOWiSH® Crop Liquid	BiOWiSH® Crop Liquid Coated Urea (46-0-0)	240 [269]	Post-plant

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

Results

- Both BiOWiSH® treatments optimized yield potential by improved nutrient uptake
- BiOWiSH® treated plants optimized soil conditions for greater root and foilar biomass
- All three treatments had similar grain protein
- Soil nutrients were maintained across all treatments

Soil Nutrients

Figure 1 shows the post-harvest Soil Health Calculation for the Control and the two BiOWiSH® treatments. The Soil Health Calculation looks at the balance of soil carbon, nitrogen, and their relationship to microbial activity. This number represents the overall health of the soil.

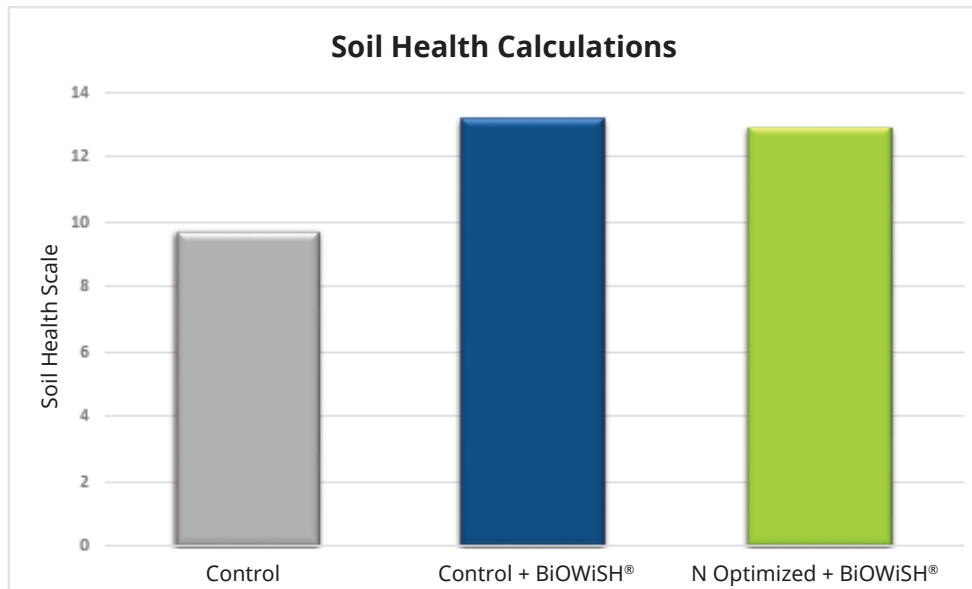


Figure 1: Soil Health values range from 0 to 25. A value below 7 indicates changes or adjustments are needed.

The soil health calculation for the Control legs (Standard Grower Practice) was 9.7. The Control + BiOWiSH® Crop Liquid and N Optimized Fertility Program + BiOWiSH® Crop Liquid treatments had soil health ratings of 13.2 and 12.6, respectively.

In general, higher yield removes a greater amount of soil nutrients from the soil. When this happens, the growers need to bump up their fertilizer application in the following year. In this study (see Table 2), it was observed that **yield increase in the BiOWiSH® Treatments did not deplete soil nitrogen or other nutrients.**

Table 2. Post Harvest

Treatment	Nitrate Nitrogen (ppm)	Phosphorus (ppm)	Potassium (ppm)
Control	7	16	349
Control + BiOWiSH® Crop Liquid	10	18	394
N Optimized Fertility Program + BiOWiSH® Crop Liquid	11	21	405

**Post-harvest available soil macro-nutrients.*

Plant Vigor

The Control + BiOWiSH® treatment resulted in 86% higher root biomass. The N Optimized Fertility Program + BiOWiSH® showed a 24% increase in root biomass. In both cases the spring wheat BiOWiSH® treatments developed larger roots, indicating improved soil conditions for increased plant vigor.

Table 3. Root Mass

Treatment	Root Biomass oz [g]	Increase (%)
Control	0.56 [15.8]	-
Control + BiOWiSH® Crop Liquid	1.04 [29.4]	86.1%
N Optimized Fertility Program + BiOWiSH® Crop Liquid	0.70 [19.6]	24.1%

Table 4. Foliar Mass

Treatment	Foliar Biomass oz [g]	Increase (%)
Control	2.14 [60.6]	-
Control + BiOWiSH® Crop Liquid	2.24 [63.6]	4.8%
N Optimized Fertility Program + BiOWiSH® Crop Liquid	2.21 [62.8]	3.5%

Table 5. Grain Protein Percent

Treatment	Grain Protein (%)
Control	10.0%
Control + BiOWiSH® Crop Liquid	10.0%
N Optimized Fertility Program + BiOWiSH® Crop Liquid	10.0%

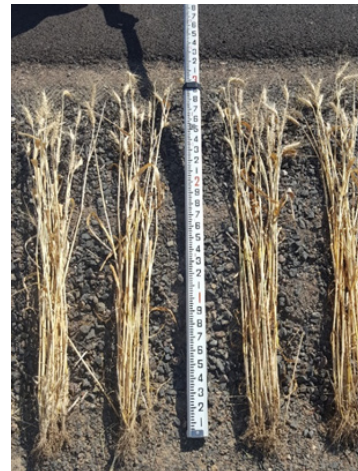
Yield Parameters

The Control + BiOWiSH® optimized yield potential by improved nutrient uptake over the standard grower practice by 7.2%. In addition, even with a 15% reduction in fertilizer for the N Optimized Fertility Program, the BiOWiSH® treatment out-performed the Control by 1.7%.

Table 6. Yield Parameters

Treatment	Yield tons/acre [MT/ha]	Yield Increase (%)
Control	2.93 [6.57]	-
Control + BiOWiSH® Crop Liquid	3.14 [7.04]	7.2%
N Optimized Fertility Program + BiOWiSH® Crop Liquid	2.98 [6.68]	1.7%

Yield results are shown visually in the images below and graphically in Figures 2a and 2b.



Control (left) and Control + BiOWiSH® (right)

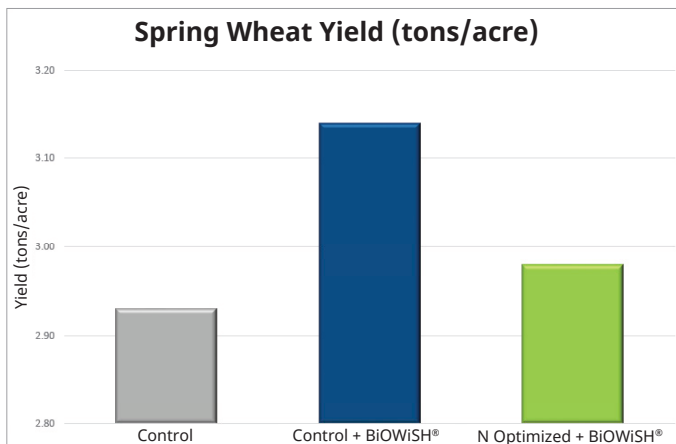


Figure 2a: Yield (tons/acre) Results

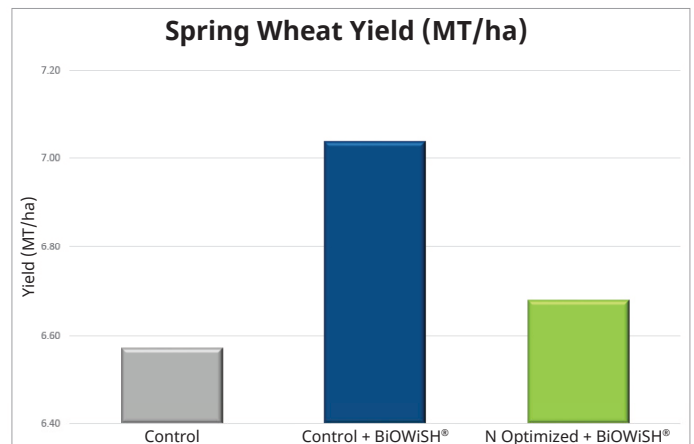


Figure 2b: Yield (MT/ha) Results

Economics

Economic analysis data is shown in Table 7. The Control + BiOWiSH® Crop Liquid exhibited the best results based upon crop and input cost values at the time of the study. Based upon the average yield increase of 7.2%, net income increased by 8.0%, resulting in an increased profit of \$27.63 USD/acre (\$68.28 USD/ha). The N Optimized Fertility Program + BiOWiSH® Crop Liquid showed that net income increased by 4.0%, resulting in an increased profit of \$14.53 USD/acre (\$35.90 USD/ha) based upon crop and input cost values at the time of the study.

Table 6. Yield and Economics

Treatment	Grain Yield tons/acre [MT/ha]	Grain Yield Increase tons/acre [MT/ha]	Yield Increase (%)	Net Income USD/acre [USD/ha]	Profit Change USD/acre [USD/ha]
Control	2.93 [6.57]	-	-	329.84 [815.05]	-
Control + BiOWiSH® Crop Liquid	3.14 [7.04]	0.21 [0.47]	7.2	357.47 [883.33]	27.63 [68.28]
N Optimized Fertility Program + BiOWiSH® Crop Liquid	2.98 [6.68]	0.05 [0.11]	1.7	344.37 [850.96]	14.53 [35.90]

*Calculations for conversions between imperial and metric units are based on the original source data; slight rounding differences may occur within reported publication values.

**Net income 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

BiOWiSH® endophytic *Bacillus* deliver soil nutrients to crops through the rhizophagy cycle creating a symbiotic relationship between the plant and soil microbes. Together, the cycle improved soil conditions for increased plant vigor in this study. More importantly, the BiOWiSH® treatments in this study were able to maintain protein content in the wheat. The highest revenue increase came from adding BiOWiSH® to the standard practice of 280 lbs/acre urea, resulting in a \$27.63 increase in profit per acre (\$68.28 USD/ha) compared to the standard practice without BiOWiSH®.

Optimizing the grower standard nitrogen fertility allowed for a fertility program cost equal to the Control. With the equal cost, the N Optimized Fertility Program + BiOWiSH® Crop Liquid treatment further optimized yield potential by improved nutrient uptake. The spring wheat revenue was \$14.53 higher per acre (\$35.90 USD/ha) than the standard practice, meaning that the \$14.53 increase was profit.

Overall, BiOWiSH® Crop Liquid treatments achieved higher profits in this study via optimized yield potential by improved nutrient uptake.



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