BiOWiSH® TECHNOLOGIES

Research Study

BiOWiSH® Crop Liquid

Evaluation of BiOWiSH® Crop Liquid on Growth and Yield of Leaf Lettuce

Executive Summary

BiOWiSH Technologies, Inc. engaged a U.S. private third-party contract research organization (CRO) to conduct a study to determine the efficacy of BiOWiSH® Crop Liquid for leaf lettuce production in the San Joaquin Valley area in California, USA. The trial used the regional standard fertilizer program as the control and compared it to the same fertilizer program with BiOWiSH® Crop Liquid added. The study determined that coating grower standard fertilizer with BiOWiSH® Crop Liquid increased plant vigor, plant height, and yield, leading to higher net income.

Objectives

The objective of this study was to determine the effects of BiOWiSH® Crop Liquid on growth and yield of leaf lettuce grown under field conditions near Fresno, California.

Background

The U.S. private third-party contract research organization (CRO) that conducted this trial is a team of highly trained and experienced study directors, field researchers, and support staff with diverse backgrounds in agronomy study management. They are one of several independent CROs that BiOWiSH Technologies, Inc. works with to independently evaluate our agronomy products.

BiOWiSH® Crop Liquid is a microbial biostimulant 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 stimulates native microbial activity and promotes root development, increasing nutrient uptake and improving plant vigor. BiOWiSH® Crop Technology is proven to enhance the effects of applied fertilizers by increasing yield and soil health.

BiOWiSH® Crop Liquid

- Improves crop yields
- Increases nutrient availability
- Enhances root development
- Improves plant vigor
- Stimulates native microbial activity in the soil
- Improves soil health

Available Sizes

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

Implementation Program

The study was conducted on leaf lettuce (*Lactuca sativa*, var. crispa - Cutting Lettuce Variety: Green Star Pelleted) on a research field near Fresno, California in sandy soil. The treatments were organized as a randomized complete block design with 10 replications. The field site was rototilled and disked prior to planting. Plot size was 1.5 m [5 ft] x 6.1 m [20 ft] (9.3 m^2 or 100 ft^2). Seeds were planted into two 76 cm [30 inch] rows at 15 cm [6 inch] seed spacing.

Two fertilizer treatments were used in the study: **Control**, which was a grower standard fertility program that included NPK 20-20-20, and **Control + BiOWiSH® Crop Liquid** which was coated onto the NPK 20-20-20 according to the BiOWiSH® Crop Liquid label recommendations. The fertilizers were broadcast side-dress at planting, 3, 5, and 7 weeks after planting, respectively. The Control program was chosen because it was the most common best management practice used by growers in the region, as defined by the independent third-party CRO. The details of each treatment program are defined below:

Treatment Name	Fertilization Program	Rate	Application Timing
Control	NPK 20-20-20	214 kg/ha [200 lb/ac.]	At planting, 3, 5, and 7 weeks after planting
Control + BiOWiSH® Crop Liquid	NPK 20-20-20 coated with BiOWiSH® Crop Liquid	214 kg/ha [200 lb/ac.]	At planting, 3, 5, and 7 weeks after planting

The following characteristics were evaluated to determine the effects of BiOWiSH® Crop Liquid on leaf lettuce production:

1. **Plant Health:** measured using a visual vigor rating of 0-5 at 30 days after planting (DAP).
2. **Plant Growth:** measured as plant height at 30 DAP.
3. **Plant Leaf Nutrient Composition:** measured by independent laboratory using leaf tissue collected mid-season.
4. **Yield:** measured as the weight of total marketable leaf yield in mT/ha [tons/ac.].
5. **Economics:** an economic evaluation of the different fertilizer programs was performed based upon current market data for farmers in the San Joaquin Valley of California.

Results

Plant Health and Growth

Plant health and growth measurements revealed that the Control + BiOWiSH® Crop Liquid treatment increased vigor (11%) and height (1.8%) compared to the Control treatment.

Treatment	**Plant Vigor** (0-5 Scale)	**Plant Growth** (Height, cm)
Control	3.6	3.88 cm [1.52 inches]
BiOWiSH® Crop Liquid	4.0	3.95 cm [1.56 inches]

Plant Leaf Nutrient Analysis

The Control + BiOWiSH® Crop Liquid treatment showed increased yield while maintaining adequate to high plant nutrient levels.

Treatment	**Nitrogen** (%)	**Phosphorus** (%)	**Potassium** (%)
Control	6.22	0.79	4.86
Control + BiOWiSH® Crop Liquid	6.35	0.85	4.63

Yield Parameters and Economics

Yield parameter measurements revealed that the Control + BiOWiSH® Crop Liquid treatment increased leaf lettuce yield by 12.1%.

Economic analysis revealed that the Control + BiOWiSH® Crop Liquid treatment resulted in a significant increase in net income, resulting in an increase in profit of $1,182 USD/ha [$483 USD/ac.] compared to the Control program.

Treatment	Total Marketable Leaf Yield	Marketable Leaf Yield Increase (%)	Net Income*	Profit Change**
Control	14.16 mT/ha [6.32 tons/ac.]	-	$9,756 USD/ha [$3,946 USD/ac.]	
Control + BiOWiSH® Crop Liquid	15.88 mT/ha [7.08 tons/ac.]	12.1	$10,938 USD/ha [$4,427 USD/ac.]	$1,182 USD/ha [$479 USD/ac.]

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 and does not account for non-fertility expenses.*

***Profit change is the difference between the respective program and the control.*

Conclusion

BiOWiSH® Crop Liquid coated NPK 20-20-20 fertilizer increased plant vigor (11.0%), plant height (1.8%), and total marketable leaf weight (12.1%) in lettuce. These increases resulted in an increased profit of $1,182 USD/ha [$479 USD/ac.]. The ability of BiOWiSH® Crop Liquid to improve leaf lettuce production offers a significant return on investment opportunity to the grower.

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