BiOWiSH® TECHNOLOGIES

Research Study

BiOWiSH® Crop Liquid

Evaluation of BiOWiSH® Crop Liquid on Yield and Quality in Walnuts – Year 1

Executive Summary

BiOWiSH Technologies, Inc. engaged Helena R&D as a third-party Contract Research Organization (CRO) to conduct a 3-year study to determine the effects of BiOWiSH® Crop Liquid on walnut production. The results reported in this study are from year one of the trial. The trial compared two treatments:

- A 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 several growth, yield, and quality parameters in walnuts which led to higher profit.

Background

About BiOWiSH® Crop Liquid

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 Liquid is proven to enhance the effects of applied fertilizers by increasing yield and soil health.

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 effects of BiOWiSH® Crop Liquid technology, manufactured in the USA by BiOWiSH Technologies, Inc, on walnut production when added to a fertility program common to the production area in central California. The focus was on BiOWiSH® Crop Liquid's impact on soil nutrients, plant vigor, in-shell and nut meat yield, nut grading quality, and the grower economics.

In this trial, the common regional walnut fertility program included a commodity inorganic fertilizer, a proprietary liquid potassium fertilizer (Nucleus® 0-0-21), and a liquid humic acid product (Hydra-Hume®). This program was compared to the same program with BiOWiSH® Crop Liquid.

Implementation Program

The 3rd party CRO conducted the trial on a commercial farm near Live Oak, CA. Pest and disease management techniques were implemented on site when required. The trial site used 7-year-old Howard trees managed in two large blocks which were randomly assigned to treatments. The size of each block was 550 ft (168.7 m) x 792 ft (291.4 m) which was equivalent to 10 acres (4.05 ha) per treatment.

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

All evaluations were conducted on marked trees and included leaf color, tree vigor, new shoot growth, in-shell yield, nut meat yield, and USDA grades for nut color and size. The evaluations were used to perform an economic analysis between the treatments.

Representative composite soil samples were obtained from each block to evaluate soil nutrient levels and a leaf tissue sample composited from all marked trees in each treatment was collected to evaluate tissue levels of nutrients. Two fertilizer applications were injected through an irrigation system at a volume of 41 gal/ac for each application. The 2 treatments and application timings are shown below in Table 1.

In this trial, a standard walnut fertility program included UAN-32%, a proprietary liquid potassium fertilizer (Nucleus® 0-0-21), used to deliver potassium to the root zone for quick and efficient potassium uptake, and a liquid humic acid product (Hydra-Hume®), used as a fertilizer efficiency aid to help farmers get more use from the fertilizer they apply. Two fertilizer applications were injected through an irrigation system at the volume indicated in Table 1, which details the 2 treatments, fertilizers, and application timings.

*Table 1. Fertilizer Treatments and Application Timings.**

Treatment	Fertilizer	First Application in June	Second Application in July (21 days after first application)
Control**	UAN-32%	28 gal/ac (261.9 L/ha)	28 gal/ac (261.9 L/ha)
	Nucleus® 0-0-21	6 gal/ac (56.1 L/ha)	6 gal/ac (56.1 L/ha)
	Hydra-Hume®	1 gal/ac (9.3 L/ha)	1 gal/ac (9.3 L/ha)
	Water	6 gal/ac (56.1L/ha)	6 gal/ac (56.1L/ha)
Control + BiOWiSH® Crop Liquid***	UAN-32%	28 gal/ac (261.9 L/ha)	28 gal/ac (261.9 L/ha)
	Nucleus® 0-0-21	6 gal/ac (56.1 L/ha)	6 gal/ac (56.1 L/ha)
	Hydra-Hume®	1 gal/ac (9.3 L/ha)	1 gal/ac (9.3 L/ha)
	BiOWiSH® Crop Liquid	Labeled Rate***	Labeled Rate***
	Water	6 gal/ac (56.1 L/ha)	6 gal/ac (56.1 L/ha)

**Nucleus® and Hydra-Hume® are registered product names of Helena AgriEnterprises.*
***For the Control treatment, untreated UAN 32%, liquid Nucleus® 0-0-21, and liquid Hydra-Hume® were mixed with water to a final volume of 41 gal/ac (383.5 L/ha). This fertilizer solution was then applied through the irrigation dripper line to the appropriate 10-acre block at each application, respectively.*
****For the Control + BiOWiSH® Crop Liquid treatment, UAN 32%, liquid Nucleus® 0-0-21, and liquid Hydra-Hume® were mixed with BiOWiSH® Crop Liquid according to BiOWiSH® Crop Liquid label recommendations then mixed with water to a final volume of 41 gal/ac (383.5 L/ha). This fertilizer solution was then applied through the irrigation dripper line to the appropriate 10-acre block at each application timing, respectively.*

The following evaluations were made in order to determine the effects of the BiOWiSH® Crop Liquid on walnut production. Visual evaluations for plant health were conducted on July 20th and August 16th. This involved rating each tree for leaf color on a 0-10 scale (0 = Pale Yellow – 10 = Dark Green), tree vigor on a 0-5 scale (0 = Poor – 5 = Excellent) and percentage of shoots showing new growth.

At harvest, all shaken walnuts per tree were raked, collected, and weighed. This data was used to calculate in-shell walnut yields. A 100-nut sample was collected from each tree and stored in a freezer until processing ("crack out"). First, in-shell weights were obtained, then nuts were sized in-shell according to the official USDA size grades for walnuts, including, baby, medium, large, and jumbo (number per 100 nuts) and used to calculate the yield of walnuts within each USDA size class. Walnuts were then cracked and meats were graded for color according to official USDA color grades of extra light, light, light amber, and amber (number per 100 nuts). The meats were then weighed and used to calculate overall meat yield per acre. Fifty leaves were collected from each treatment block on July 20th and sent to an accredited third-party laboratory for plant tissue analysis. Yield data and current commodity prices were used to calculate net income and profit change.

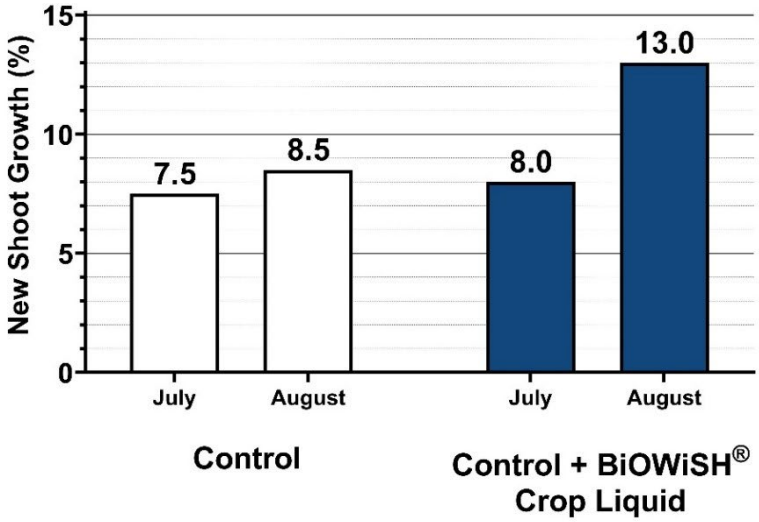
Results

Tree Health and Growth

Analysis of tree health (leaf color and tree vigor), evaluated once in July and again in August, showed both the Control and the Control Program + BiOWiSH® Crop Liquid maintained similar leaf color and tree vigor. Across both treatments and time points, leaf color averaged 7.4 out of 10 whereas vigor averaged 4.6 out of 5, indicating excellent tree health.

New shoot growth evaluations were also carried out, once in July and again in August. Data indicated that the Control + BiOWiSH® Crop Liquid treated trees showed a significantly higher percentage of new shoot growth in August (see Figure 1).

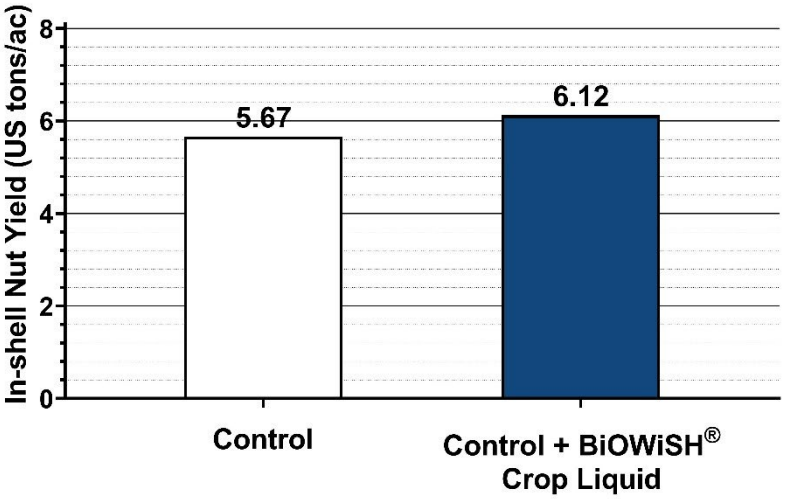
Figure 1. Effect of BiOWiSH® Crop Liquid on New Shoot Growth in Walnut Trees



Yield Parameters

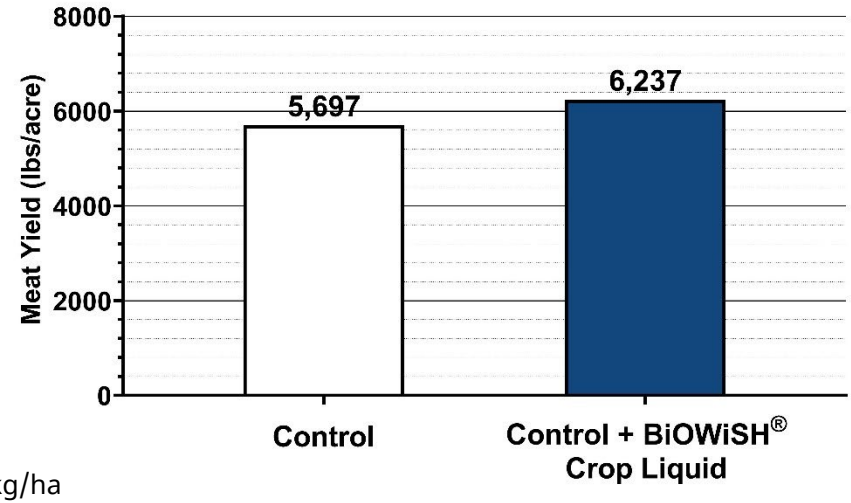
Analysis of walnut yield parameters showed an increase in in-shell nut yield (7.9%) and an increase in nut meat yield (9.5%) in the Control + BiOWiSH® Crop Liquid (see Figures 2 and 3, respectively).

Figure 2. Effect of BiOWiSH® Crop Liquid on In-Shell Yield of Walnuts



Note: 1 US Ton/ac = 2.2 metric tons/ha

Figure 3. Effect of BiOWiSH® Crop Liquid on Nut Meat Yield in Walnuts

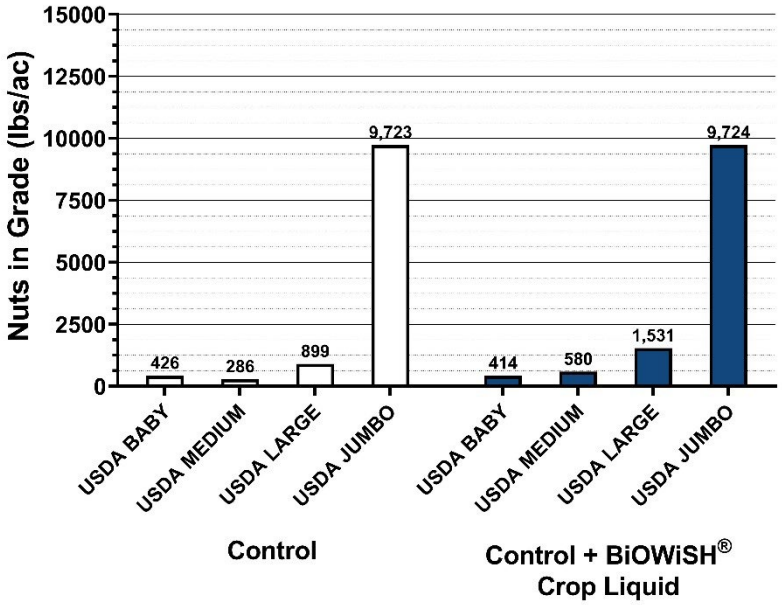


Note: 1 lb/ac = 1.1 kg/ha

USDA Quality and Color Grades

Analysis of USDA quality grades indicated that the Control + BiOWiSH® Crop Liquid treatment program had greater yields of USDA Medium, USDA Large, and USDA Jumbo, with lower yields of USDA Baby (Figure 4).

Figure 4. Effect of BiOWiSH® Crop Liquid on USDA Quality Grades in Walnuts



Analysis of USDA Color Grade showed no differences between treatments and across treatments, showed that more than 85% of nut meats showed the highest color rating of USDA Extra Light (data not shown).

Laboratory Leaf Tissue Analysis

Laboratory leaf tissue analysis showed both the Control and Control + BiOWiSH® Crop Liquid treated trees had comparable levels of nitrogen, phosphorus, potassium, and micro-nutrients that are known to promote plant vigor and yield.

Table 2. In-season Laboratory Leaf Tissue Analysis

Treatments	N %	P %	K %	Ca %	Mg %
Control	2.60	0.16	1.47	2.41	0.63
Control + BiOWiSH® Crop Liquid	2.56	0.14	1.08	2.61	0.70

Laboratory Soil Analysis

Post-harvest laboratory soil analysis from triplicate soil samples for each treatment showed both the Control and Control + BiOWiSH® Crop Liquid treatment fields had comparable levels and ratings of nitrogen, phosphorus, potassium, magnesium, calcium, and organic matter.

Table 3. Post-Harvest Laboratory Soil Analysis

Treatments	N ppm	P Weak Bray, ppm	P Strong Bray, ppm	K ppm	Mg ppm	Ca ppm	OM %
Control	4	29	56	235	308	1178	1.3
Control + BiOWiSH® Crop Liquid	3	28	54	215	292	1174	1.3

Economic Analysis

Economic analysis data is shown in Table 4. Based upon the average yield increase (7.9%) in the Control + BiOWiSH® Crop Liquid treated blocks, net income increased by 7.4%, resulting in a profit change of $1070 USD/acre ($2641 USD/ha).

*Table 4. Effect of BiOWiSH® Crop Liquid on Economic Performance in Walnuts**

Treatments	**In-shell Yield** US tons/acre [MT/ha]	**Yield Increase** %	**Net Income*** USD/acre [USD/ha]	**Net Income Gain** %	**Profit Change**** USD/acre [USD/ha]
Control	5.67 [12.71]	-	$13,488 [$33,334]	-	-
Control + BiOWiSH® Crop Liquid	6.12 [13.72]	7.9%	$14,558 [$35,975]	7.4%	$1070 [$2641]

**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 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

In this large-block commercial research trial, BiOWiSH® Crop Liquid increased new shoot growth, yield of USDA size grades of medium, large, and jumbo walnuts, overall in-shell walnut yield, and nut meat yield when compared to the Control Program, respectively.

The addition of BiOWiSH® Crop Liquid was proven to increase nutrient use efficiency by performing a mass balance of fertilizer inputs, leaf tissue analysis, post-harvest soil analysis, and nutrient offtake. The BiOWiSH® Crop Liquid treatment had the same nutrient inputs as the Control treatment and was able to maintain similar leaf tissue and soil analysis nutrient levels with more yield or crop offtake (nutrient offtake).

The tree health, soil nutrient availability, and yield factors interacted to increase net income by 7.4% and increased profit by $1070 USD/acre ($2641 USD/ha) in the Control + BiOWiSH® Crop Liquid treatment. Overall, the study indicates that BiOWiSH® Crop Liquid is a useful addition to a walnut program and offers a significant return on investment opportunity to the grower.

Contact us:
agronomy@biowishtech.com
+1 312 572 6700
biowishtech.com