

BiOWiSH® Crop Liquid

Evaluation of BiOWiSH® Crop Liquid on Yield and Quality in Walnuts – Year 3



Executive Summary

BiOWiSH Technologies engaged Helena Agri-Enterprises, LLC as a third-party Contract Research Organization (CRO) to conduct a three-year study to determine the effects of BiOWiSH® Crop Liquid when added to fertilizer to create an Enhanced Efficiency Fertilizer (EEF) for walnut production. The results reported in this study are from year three of the trial.

The trial compared two treatments:

- Control, Standard Regional Fertility Program
- Control + BiOWiSH® Crop Liquid

The study determined that the addition of BiOWiSH® Crop Liquid optimized yield potential by improved nutrient uptake, resulting in a 18.3% in-shell yield increase for the Control + BiOWiSH® Fertility Program, which led to higher profit. The study also demonstrated consistency of BiOWiSH® Crop Liquid, as the data and performance trends were similar in the first and second years of the study.

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 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 third-year research study was to determine the efficacy of BiOWiSH® Crop Liquid, in different years on walnut production when added to a fertilizer to create an Enhanced Efficiency Fertilizer (EEF) compared to the standard regional Control fertility program common to the production area in central California. The evaluation focused on leaf color, plant vigor, new shoot growth, in-shell and nut meat yield, nut grading quality, and grower economics.

In this trial, the standard 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 Control + BiOWiSH® program.

Implementation Program

The third-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 consisted of ten-year-old trees of the walnut cultivar 'Howard' managed in two large blocks, which were randomly assigned to treatments. The size of each block was 696 ft (212.1 m) x 1018 ft (310.3 m), which is equivalent to 17.5 acres (7.1 ha) per treatment.

In this trial, the standard walnut fertility program included CAN-17, UAN-32, Nucleus® 0-0-21 (used to deliver potassium to the root zone for quick and efficient potassium uptake), a liquid 7-25-5 fertilizer, a liquid 3-0-8 fertilizer, and Hydra-Hume® (used as a fertilizer efficiency aid to help farmers get more use from the fertilizer they apply). Three fertilizer applications were injected through an irrigation system at the volume indicated in Table 1, which details the two treatments, fertilizers, and application timings.

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

Table 1. Treatments, Fertilizers, and Application Timings

Treatment	Fertilizer	First Application In April During Leaf-Out gal/acre [L/ha]	First Application In April During Leaf-Out qt/acre [L/ha]
Control	CAN-17	31 [290]	-
	3-0-8	-	1 [2.3]
Control + BiOWiSH® Crop Liquid	CAN-17	31 [290]	-
	3-0-8	-	1 [2.3]
	BiOWiSH®	Labeled Rate	

Treatment	Fertilizer	Second Application In May During Growth Stage gal/acre [L/ha]	Second Application In May During Growth Stage qt/acre [L/ha]
Control	UAN-32%	18.75 [175.4]	-
	Nucleus® 0-0-21	4 [37.4]	-
	3-0-8	-	1 [2.3]
	7-25-5	4 [37.4]	-
	Humic Acid	1 [9.4]	-
	Water	4 [37.4]	-
	Control + BiOWiSH® Crop Liquid	UAN-32%	18.75 [175.4]
Control + BiOWiSH® Crop Liquid	Nucleus® 0-0-21	4 [37.4]	-
	3-0-8	-	1 [2.3]
	7-25-5	4 [37.4]	-
	Humic Acid	1 [9.4]	-
	Water	4 [37.4]	-

Treatment	Fertilizer	Third Application In June During Growth Stage gal/acre [L/ha]	Third Application In June During Growth Stage qt/acre [L/ha]
Control	UAN-32%	18.75 [175.4]	-
	Nucleus® 0-0-21	4 [37.4]	-
	3-0-8	-	1 [2.3]
	7-25-5	4 [37.4]	-
	Humic Acid	1 [9.3]	-
	Water	4 [37.4]	-
Control + BiOWiSH® Crop Liquid	UAN-32%	18.75 [175.4]	-
	Nucleus® 0-0-21	4 [37.4]	-
	3-0-8	-	1 [2.3]
	7-25-5	4 [37.4]	-
	Humic Acid	1 [9.3]	-
	Water	4 [37.4]	-

*Nucleus® and Hydra-Hume® are registered product names of Helena Agri-Enterprises.

**For the Control treatment, untreated nitrogen (CAN-17 or UAN-32%), 3-0-8, 7-25-5, 0-0-21, and(or) humic acid liquid were mixed with water to the volumes indicated in the table. This fertilizer solution was then applied through the irrigation dripper line to the appropriate 17.5-acre block at each application, respectively.

***BiOWiSH® Crop Liquid used at manufacturer's recommended rate. For the Control + BiOWiSH® Crop Liquid treatment, untreated nitrogen (CAN-17 or UAN-32%), 3-0-8, 7-25-5, 0-0-21, and (or) humic acid liquid were mixed with BiOWiSH® Crop Liquid according to label recommendations then mixed with water to the final volume indicated in the table above. This fertilizer solution was applied through the irrigation dripper line to the appropriate 17.5-acre block at each application, 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 six times between May 3 and July 22. 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 official USDA size grades for walnuts and used to calculate the yield of walnuts within each USDA size class.

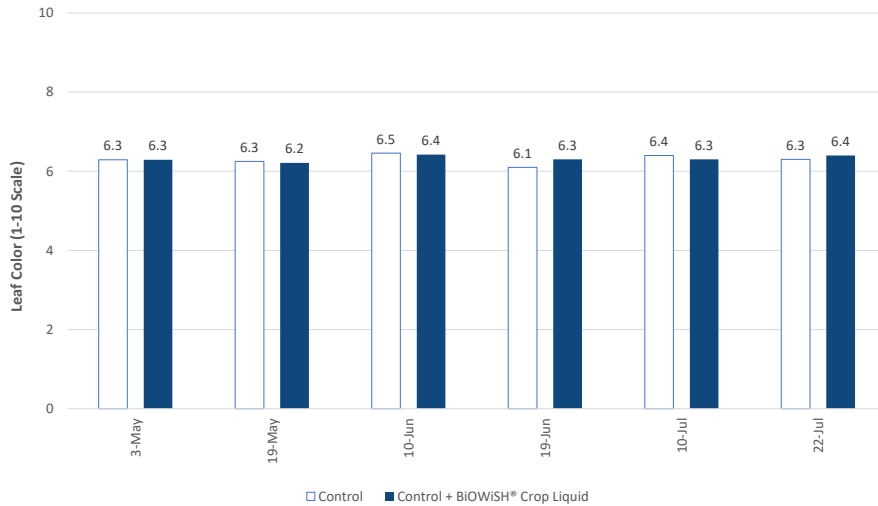
Size classes for walnuts include baby, medium, large, and jumbo (number per 100 nuts). Walnuts were then cracked and meats were graded for color according to official USDA color grades of extra light, light, light amber, and amber (number per 100 nuts). Finally, the meats were weighed and used to calculate overall meat yield per acre. Yield data and current commodity prices were used to calculate net income and profit change.

Results

Leaf Color

Analysis of leaf color, evaluated six times between May and July, suggested that color ratings were similar for the Control + BiOWiSH® treatment compared to the Control.

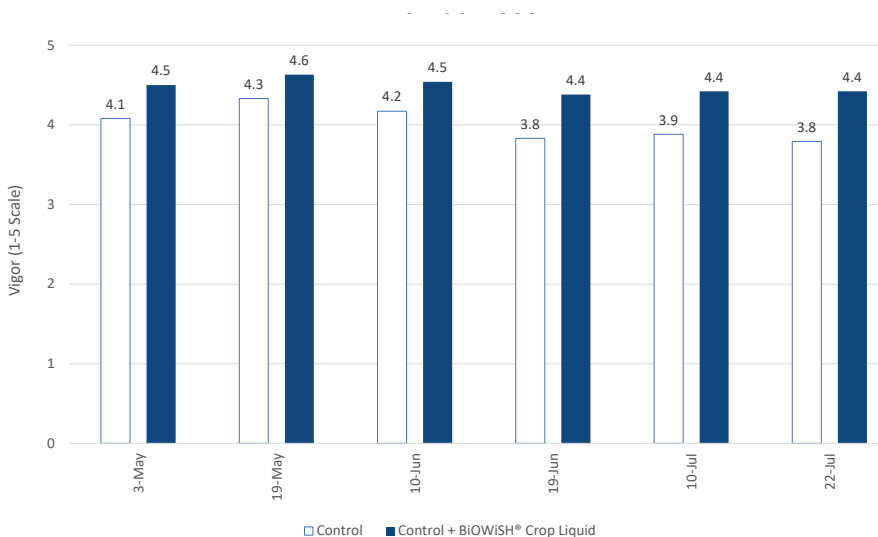
Figure 1. Effect of BiOWiSH® Crop Liquid on Leaf Color in Walnut Trees



Tree Vigor

Analysis of tree vigor, evaluated six times between May and July, suggested that vigor ratings were higher for the Control + BiOWiSH® treatment at each of the six time points evaluated.

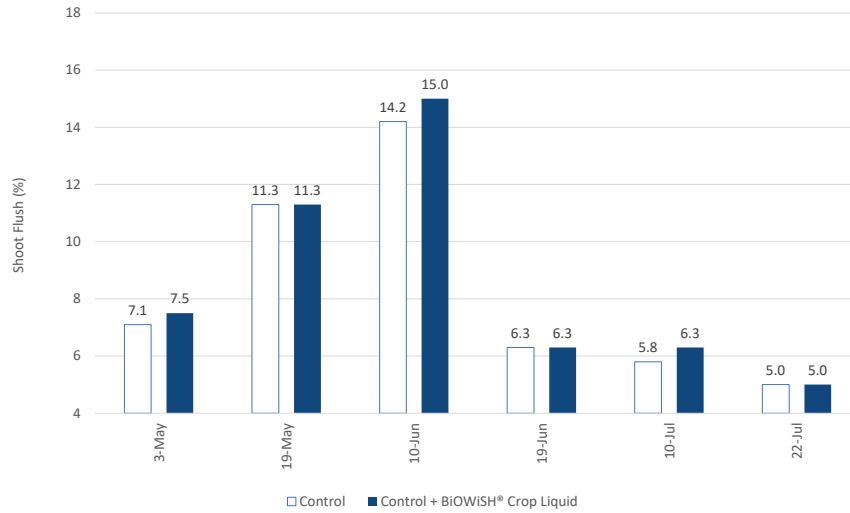
Figure 2. Effect of BiOWiSH® Crop Liquid on Tree Vigor in Walnut Trees



New Shoot Growth

Analysis of new shoot growth, evaluated six times between May and July, suggested that the percentage of shoots showing new growth was higher for the Control + BiOWiSH® treatment compared to Control at three of the six time points evaluated.

Figure 3. Effect of BiOWiSH® Crop Liquid on New Shoot Growth in Walnut Trees

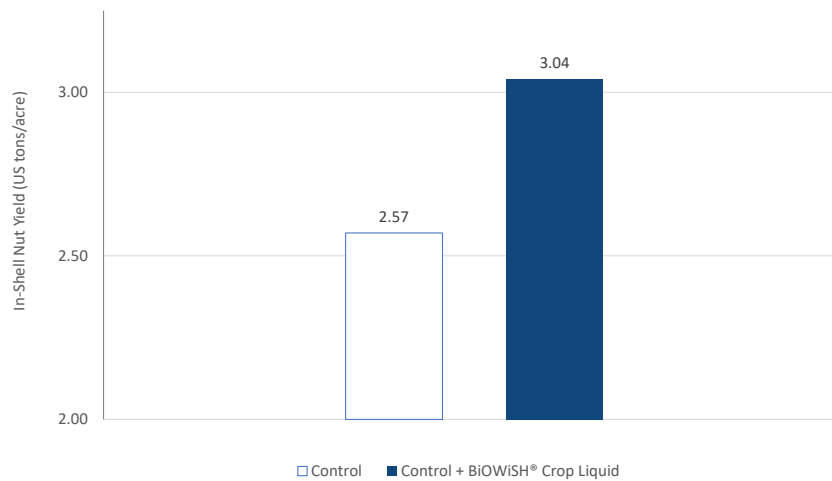


Yield Parameters

In-Shell Nut Yield

Analysis of walnut yield parameters showed an increase of in-shell nut yield (18.4%, Figure 4) in the Control + BiOWiSH® treatment when compared to the Control.

Figure 4. Effect of BiOWiSH® Crop Liquid on In-Shell Yield in Walnut Trees



Nut Meat Yield

Analysis of walnut yield parameters showed an increase of nut meat yield (24.3%, Figure 5) in the Control + BiOWiSH® treatment when compared to the Control.

Figure 5. Effect of BiOWiSH® Crop Liquid on Nut Meat Yield in Walnut Trees

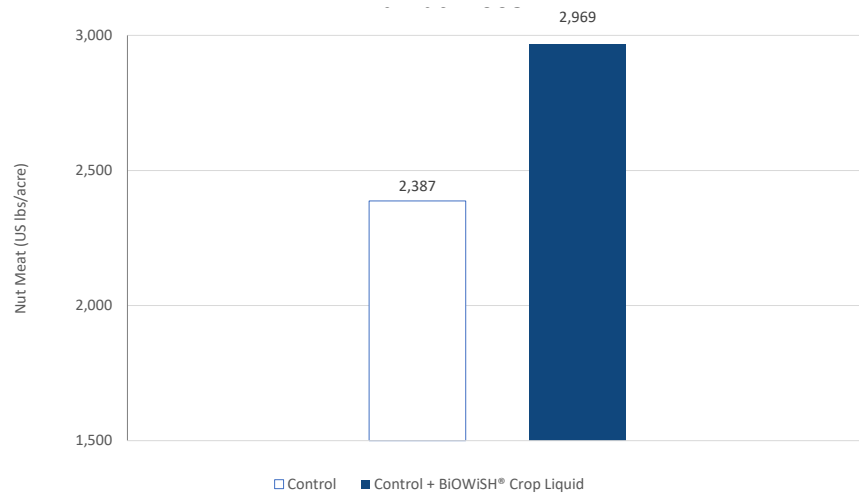
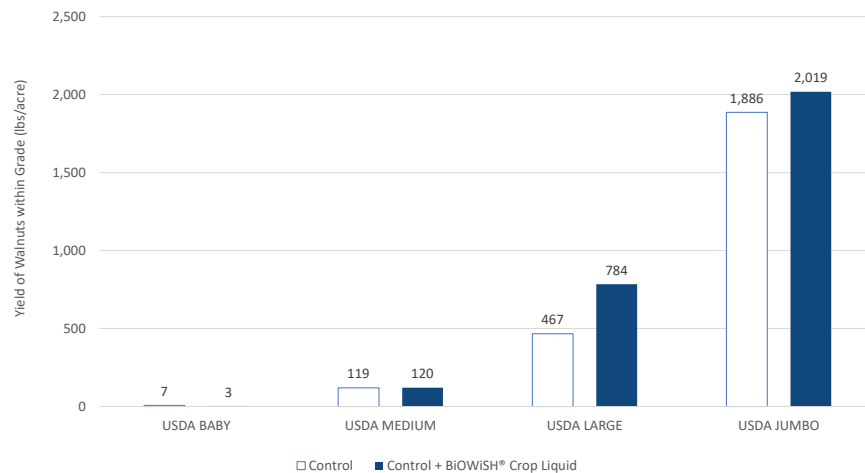


Figure 6. Effect of BiOWiSH® Crop Liquid on USDA Grade Size in Walnuts

Analysis of USDA quality grades suggested that the Control + BiOWiSH® treatment program had greater yields within USDA large and jumbo.



Analysis of USDA nut meat color grades showed that nut meat color were similar across all grades when comparing the Control and Control + BiOWiSH® treatment.

Economic Analysis

When added to the Control, BiOWiSH® enhanced fertilizer showed an in-shell yield increase of 18.3%, resulting in an increased profit of \$995 USD/acre (\$2,459 USD/ha).

Table 2. Effect of BiOWiSH® Crop Liquid on Economic Performance in Walnuts (In-Shell Yield)

Treatment	In-shell Yield tons/acre [MT/ha]	Yield Increase tons/acre [MT/ha]	Yield Increase (%)	Net Income USD/acre [USD/ha]	Profit Change USD/acre [USD/ha]
Control	2.57 [5.76]	-	-	5,439 [13,440]	-
Control + BiOWiSH® Crop Liquid	3.04 [6.81]	0.47 [1.05]	18.3	6,434 [15,899]	995 [2,459]

*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

BiOWiSH® endophytic *Bacillus* deliver soil nutrients to crops through the rhizophagy cycle creating a symbiotic relationship between the plant and soil microbes. This enabled optimized yield potential by improved nutrient uptake, which led to an increase of 18.3% for in-shell nut meat yields across all grade sizes. The increase in yield led to a profit change of \$995 USD/acre (\$2,459 USD/ha).

The overall yields were smaller than previous years in this study, but the BiOWiSH® treatment gained a higher percent yield increase in year three, indicating an even greater plant response. Overall, this three-year study indicates that BiOWiSH® Crop Liquid improves soil conditions for increased plant vigor, and is a useful addition to a walnut fertility program.



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