

BiOWiSH[®] Crop Liquid

Evaluation of BiOWiSH[®] Crop Liquid on Yield and Quality in Pistachios

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 pistachio production located in California. The study compared 2 treatments:

- A common regional fertilizer program (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 and maintained general quality parameters in pistachio production 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 objectives of this research study were to evaluate the addition of BiOWiSH[®] Crop Liquid to the grower's practice fertility program and to measure impacts on soil nutrient availability, tree vigor, yield, nut grading quality, and grower economics.

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

Implementation Program

This study was conducted on a 10-year-old, well managed and uniform pistachio orchard located in Chowchilla, CA. This site is within a high yielding production zone for pistachios in Madera County. The variety of the pistachios was 'Golden Hills' which is a standard variety in California. This study was set up as a non-randomized, strip plot trial design. Each strip plot contained 12-mature 'Golden Hills' pistachio trees and was down a single row that had a unique riser or injection manifold to make applications through.

The irrigation system in this grower's field utilized a fanjet system that irrigated or wet the soil out to the edge of the canopy of each row or about 50% of the soil surface. Applications were made using a CO₂ propelled injection manifold that was connected to a 3-gallon (11.36 L) stainless steel tank containing treatments to be applied. The CO₂ injection manifold was set at 12 psi. Applications began after a 2 hour pre-wetting period and the treatments were applied for a period of 15 minutes so as to ensure even distribution. The treatments were set with a minimum of a 4 hour irrigation period following the applications to ensure the products were incorporated into the root zone of the crop.

In this study, the focus comparison was the grower's standard fertility program versus the grower standard fertilizer + BiOWiSH® Crop Liquid added at the manufacturer's recommendation to the fertilizer blend at the Helena facility. In this trial, the grower's standard program included KTS (Potassium Thiosulfate (0-0-25-17), UAN-32%, and a liquid humic acid product (Hydra-Hume®). Five applications were made in season (May through July).

Table.1 Fertilizer Treatments and Application Timings.

Treatment	Fertilizer	Rate gal/ac [L/ha]	Number of Applications & Timing		
			May	June	July
Control (Grower Practice)	KTS*	10 [93.5]	2	1	2
	Hydra-Hume®**	1 [9.35]	2	1	2
	UAN 32% N	14.08 [131.7]	2	1	2
Control + BiOWiSH® Crop Liquid	KTS	10 [93.5]	2	1	2
	Hydra-Hume®	1 [9.35]	2	1	2
	UAN 32% N	14.08 [131.7]	2	1	2

*KTS = Potassium Thiosulfate (0-0-25-17)

**Hydra-Hume® is a registered trademark of Helena Holding Company

This study monitored the efficacy of BiOWiSH® Crop Liquid enhanced fertilizer through soil nutrient availability, tree health, yield, and overall nut quality. For soil health and mass balance effects, soil samples were collected prior to treatment application and again post-harvest. All in-season evaluations were made on the 12 trees from the grower and the BiOWiSH® Crop Liquid enhanced fertilizer treated strips.

Tree health was measured by conducting visual analysis of crop color (0-10 scale, 0 = chlorotic and 10 = dark green), vigor (0-5 scale, 0 = dead and 5 = robust with maximum growth potential), shoot length (inches), and percent foliar flush or percent of canopy with new growth (0-100%).

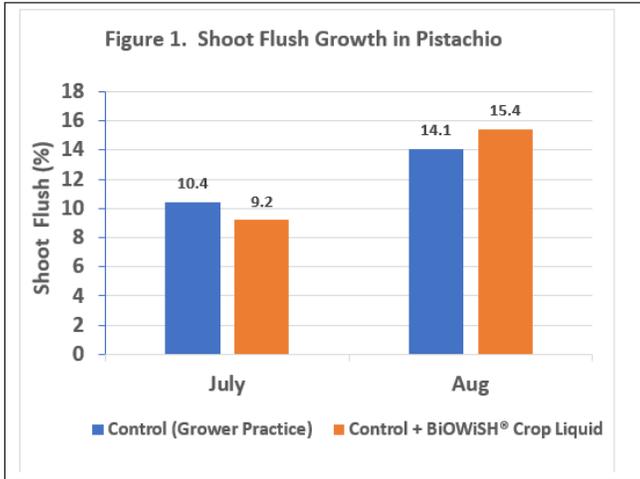
Yield data was collected by shaking trees and weighing the total fresh weight of the crop from the 12 trees from each plot. A sub sample of 100 nuts was collected from each plot for crack-out analysis. Crack-out analysis included a process of measuring total weight of the 100 nut subsample with hulls and then a re-weighing of the subsamples once hulled weight was taken to determine in-shell yield in pounds per acre. The USDA quality parameters of number of blanks and non-split shells were counted of the 100 nut subsample and presented on a percent basis. Sizing was determined by counting the number of nuts in 1 ounce.

Results

Tree Health

No phytotoxicity was observed in this study as a result of the applied treatments.

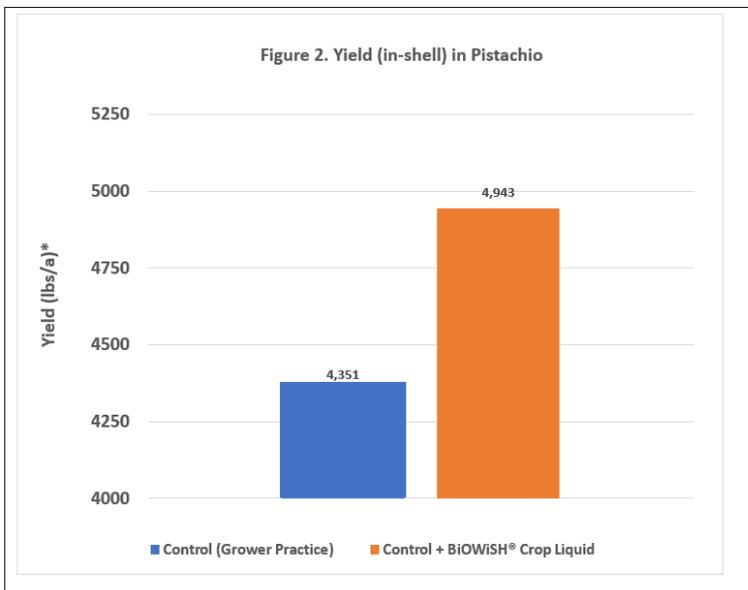
Evaluations of tree health parameters showed there were no differences between treatments in crop color and vigor. In-season shoot growth was also similar between treatments. Shoot flush observations are presented in Figure 1. August shoot flush measurements showed a trend for an increase with the BiOWiSH® Crop Liquid enhanced fertilizer program.



Yield Parameters

Yield data showed that including BiOWiSH® Crop Liquid as part of the fertilizer program resulted in a 592 lb/ac (663.5 kg/ha) increase over the Control program. The added production equates to a 13.6% increase in overall yield. Nuts per ounce stayed about the same with the Control showing 12.8 nuts/oz and the BiOWiSH® treatment showing 12.7. The BiOWiSH® treatment showed a 0.5% increase in blanks from 0.3% (Control) to 0.8%. The percentage of non-split nuts increased from 3.6% for the Control to 4.6% for the BiOWiSH® treatment.

Quality parameters for both treatments were similar. Both treatments graded as US No. 1 as per USDA grading guidelines.



*Note: 1lb/ac = 1.12 kg/ha

Laboratory Soil Analysis:

Pre-treatment and post-harvest laboratory soil analysis from composite soil samples for each treatment block showed that the Control and Control + BiOWiSH® Crop Liquid treatments had comparable levels and ratings of major nutrients, organic matter, and pH effects. (Tables 2 and 3)

Table 2. Pre-Treatment Laboratory Soil Analysis

Treatment	Sample Timing	Nitrate-N ppm	Phosphorus ppm	K ppm	Mg ppm	Ca ppm	OM %	pH
Control (Grower Practice)	Pre-treatment	9	125	537	124	1158	1.4	6.1
	Rating*	-	VH	VH	M	M	VL	-
Control + BiOWiSH® Crop Liquid	Pre-treatment	8	103	504	108	1131	1.3	6.1
	Rating	-	VH	VH	M	M	VL	-

*Ratings levels are based on ranges selected by the specific testing lab and are only valid for comparisons among tests analyzed by this specific lab

Table 3. Post-Harvest Laboratory Soil Analysis

Treatment	Sample Timing	Nitrate-N ppm	Phosphorus ppm	K ppm	Mg ppm	Ca ppm	OM %	pH
Control (Grower Practice)	Post-Harvest	5	96	495	104	890	1.5	5.3
	Rating*	-	VH	VH	M	L	VL	-
Control + BiOWiSH® Crop Liquid	Post-Harvest	5	114	562	121	1202	1.2	5.6
	Rating	-	VH	VH	M	M	VL	-

*Ratings levels are based on ranges selected by the specific testing lab and are only valid for comparisons among tests analyzed by this specific lab

Economic Analysis:

Economic analysis data is shown in Table 4. Based upon the yield increase (13.6%) in the Control + BiOWiSH® Crop Liquid treated trees profit increased by \$1,717 USD/ac (\$4,243 USD/ha).

Table 4. Economic Effects of BiOWiSH® Crop Liquid Enhanced Fertilizer Applications in Pistachio

Treatment	Yield* (in-shell) lbs/ac [kg/ha]	Yield Increase lbs/ac [kg/ha]	Yield Increase %	Net Income** USD/ac [USD/ha]	Net Income Gain %	Profit Change*** USD/ac [USD/ha]
Control	4,351	-	-	\$12,332	-	-
	[4,877]	-	-	[\$30,473]	-	-
Control + BiOWiSH®	4,943	592	13.6	\$14,049	14	\$1,717
	[5,540]	[663]	-	[\$34,716]	-	[\$4,243]

*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 commercial research trial, BiOWiSH® Crop Liquid enhanced fertilizer increased in-shell yield by 13.6% when compared to the Control Program. The BiOWiSH® treatment had the same nutrient inputs as the Control treatment while maintaining similar soil analysis nutrient levels with more yield. There were no differences in crop color or tree vigor between the treatments, however a trend towards increased shoot flush for the BiOWiSH treatment was reported. Nuts from both treatments graded as US No.1 per USDA grading guidelines.

The tree health, soil nutrient availability, and yield factors interacted to increase net income by 14% with a realized profit of \$1,717 USD/ac (\$4,243 USD/ha) with the Control + BiOWiSH® Crop Liquid program. Overall, the study indicates that BiOWiSH® Crop Liquid enhanced fertilizer is a useful addition to a pistachio program and offers a significant return on investment opportunity to the grower.



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