

## BiOWiSH<sup>®</sup> Crop Liquid

### Evaluation of BiOWiSH<sup>®</sup> Crop Liquid on Yield and Quality in Almonds

#### 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<sup>®</sup> Crop Liquid on almond production located in California's South Valley. The study compared 2 treatments:

- A regional fertilizer program as the control (Control)
- The same fertilizer program with BiOWiSH<sup>®</sup> Crop Liquid added (Control + BiOWiSH<sup>®</sup> Crop Liquid)

The study determined that the Control + BiOWiSH<sup>®</sup> Crop Liquid program increased yield and general quality parameters in almonds which led to higher profit.

#### Background

##### About BiOWiSH<sup>®</sup> Crop Liquid

BiOWiSH<sup>®</sup> 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<sup>®</sup> Crop Liquid enhances native microbial activity in the soil and root development, increasing nutrient availability and improving plant vigor. BiOWiSH<sup>®</sup> 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 agronomy products.

#### Objectives

The objective of this almond research study was to determine the potential of BiOWiSH<sup>®</sup> Crop Liquid to increase yield and quality. The focus was on BiOWiSH<sup>®</sup> Crop Liquid's impact on soil nutrients, plant vigor, yield, grading quality, and grower economics.

### BiOWiSH<sup>®</sup> 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 in a 15-year-old almond orchard located in Wasco, CA. This site is in an area of high productivity for almonds in Kern County, California. Treatments were applied to blocks that were approximately 75 acres (30.4 ha) and 0.25 mile (0.4 km) apart. Treatment blocks had similar soil conditions with the same variety and planting time. The variety of the almonds monitored in this study was 'Nonpareil.' Applications were made using grower drip application equipment. In this study, the main focus comparison was the grower's standard fertility program versus the grower standard fertilizer + BiOWiSH® Crop Liquid, which was added at the manufacturer's recommended rate. Pest and disease management were implemented on site when required.

In this trial, the grower's standard program included UAN-32%, and a liquid humic acid product (Hydra-Hume®). BiOWiSH® Crop Liquid was added to the fertilizer by the fertilizer supplier to create an enhanced efficiency fertilizer. Three applications were made in season approximately one month apart. In addition, a post-harvest application was made in September.

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

Treatment	Fertilizer	Rate gal/ac [L/ha]	Timing			
			March	April	May	September
Control (Grower Practice)	UAN 32% N	14.0 [131]	x	x		x
	Hydra-Hume®**	1.0 [9.35]	x	x	x	x
Control + BiOWiSH® Crop Liquid*	UAN 32% N	9.0 [84.2]			x	
	UAN 32% N	14.0 [131]	x	x		x
	Hydra-Hume®**	1.0 [9.35]	x	x	x	x
	UAN 32% N	9.0 [84.2]			x	

\*BiOWiSH® Crop Liquid was added at the manufacturer's recommended rate

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

This study primarily monitored the efficacy of BiOWiSH® Crop Liquid enhanced fertilizer through soil nutrient levels, tree health, yield, and overall quality. For soil analysis and nutrient comparisons, soil samples were collected prior to the fertilizer treatment application and again post-harvest. All in season tree health evaluations were made on 12 randomly selected trees from the Control treatment block and at the BiOWiSH® Crop Liquid treated block. Selected trees were marked with flagging tape to maintain their identity throughout the growing season.

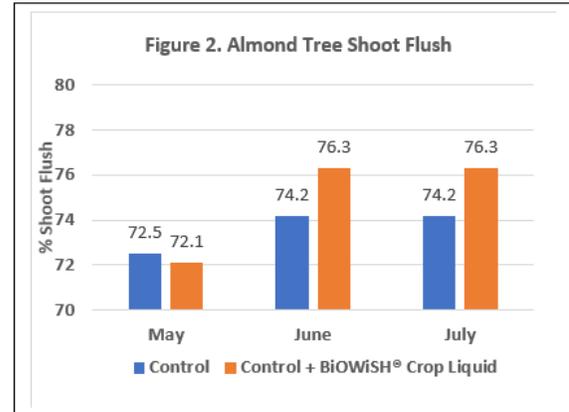
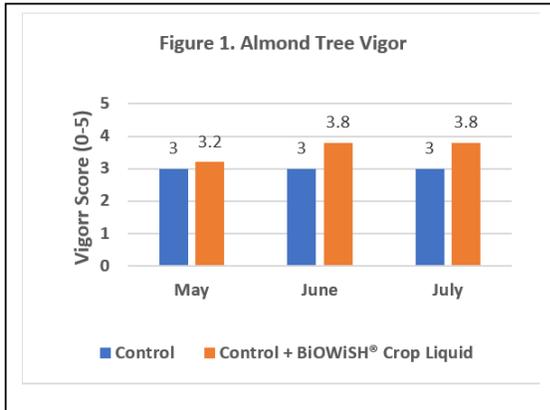
Tree health was measured by conducting visual analysis of crop color (0-10 scale, 0 = chlorotic and 10 = dark green), vigor (0-5 scale, 0 = dead and 5 = robust with maximum growth potential), shoot length (inches), and percent foliar flush or percent of canopy with new growth (0-100%). Nut set was monitored by marking off a limb in a cardinal direction and counting the number of nuts set on each limb. This information was then used to calculate percentage of nut set.

Yield data was collected by hand harvest from the 12 trees in both the standard grower block and the BiOWiSH® Crop Liquid treated block. Additionally, a grab sample was taken from each tree during harvest to provide a rough 2.5 lb (1.1 kg) composite sample from each treatment. The sample, was then processed through a mini huller/sheller to obtain total sample weight, total nut weight, doubles per sample, and weight per 100 nuts. These data sets were subsequently used to calculate meat pound per acre, percent doubles, and nuts per ounce by treatment.

## Results

### Tree Vigor

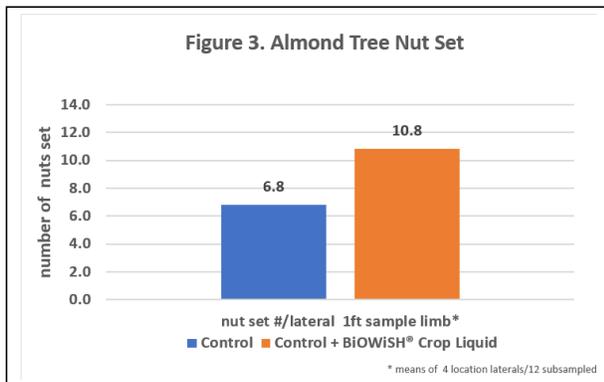
No phytotoxicity was observed in this study as a result of the applied treatments. Evaluations of tree vigor during the season showed a slight increase in vigor and percent shoot flush in trees sampled in the treated BiOWiSH® Crop Liquid (Figures 1 and 2). There were no noticeable differences in shoot length between treatments.



Tree color stayed consistent between the BiOWiSH® treatment and the grower standard, both earning scores of 5 during the assessment period.

### Yield Parameters

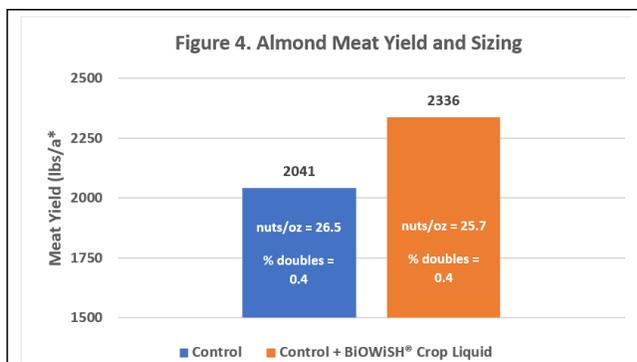
BiOWiSH® Crop Liquid enhanced fertilizer treated trees showed an increase in the number of nuts set per lateral foot of sample limbs as shown in Figure 3.



\*Note: 1 ft = 0.3 m

BiOWiSH® Crop Liquid enhanced fertilizer treated trees yielded a calculated meat weight per tree of 23 pounds (26 kg) which corresponds to yield of 2,336 lb/ac (2,618 kg/ha). The grower standard trees yielded 20 pounds per tree (22 kg) which calculates to 2,041 lb/ac (2,288 kg/ha). The grower practice with BiOWiSH® Crop Liquid resulted in a 295 lb/ac (331 kg/ha) increase in yield. A 14% advantage that resulted in an increased profit per acre of \$609 USD [\$1,505 USD/ha].

Percent of doubles were the same for both the BiOWiSH® treatment and the grower standard at 0.4%. Nut size showed an increase in the BiOWiSH® treatment with 25.7 nuts per ounce (28.35 g) as compared to the grower standard of 26.5 nuts per ounce (28.35 g). (Figure 4.)



\*Note: 1 lb/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 treatment blocks had comparable levels and ratings of major nutrients and organic matter (Tables 2 and 3). Higher yields and more tree vigor require higher nutrient use efficiency or availability, therefore a similar pre-treatment to post-harvest nutrient level with higher yield and improved vigor illustrates the addition of BiOWiSH® increased nutrient use efficiency.

**Table 2. Pre-Treatment Laboratory Soil Analysis**

Treatment	Sample Timing	Nitrate Nitrogen ppm	Phosphorus ppm weak bray	K ppm	Mg ppm	Ca ppm	OM %
Control (Grower Practice)	Pre-treatment	21	30	183	213	2829	1.4
	Rating*	-	H	H	H	H	VL
Control + BiOWiSH® Crop Liquid	Pre-treatment	28	32	144	297	2401	1.5
	Rating	-	VH	M	VH	H	VL

\*Note these 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 Nitrogen ppm	Phosphorus ppm weak bray	K ppm	Mg ppm	Ca ppm	OM %
Control (Grower Practice)	Post-harvest	6	26	160	263	2690	1.4
	Rating*	-	H	M	VH	H	VL
Control + BiOWiSH® Crop Liquid	Post-harvest	12	35	161	324	2176	1.3
	Rating	-	VH	M	VH	M	VL

\*Note these 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 average yield increase of 14% in the Control + BiOWiSH® Crop Liquid treated block, net income increased by 15%, resulting in an increase in profit of \$609 USD/acre (\$1505 USD/ha).

Treatment	Yield* (meat weight) 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	2,041	-	-	\$4,162	-	-
	[2,288]	-	-	[\$10,284]	-	-
Control + BiOWiSH®	2,336	295	14	\$4,771	15	\$609
	[2,618]	[331]	-	[\$11,789]	-	[\$1,505]

\*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.

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## Conclusion

In this large-block commercial research trial, the addition of BiOWiSH® Crop Liquid to the grower practice increased vigor, shoot flush, nut set, as well as nut meat yield 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. The tree health, soil nutrient availability, and yield factors interacted to increase net income by 15% with a realized profit of \$609 USD/acre (\$1505 USD/ha) with the Control + BiOWiSH® Crop Liquid program. Overall, the study indicates that BiOWiSH® Crop Liquid is a useful addition to an almond program and offers a significant return on investment opportunity to the grower.



BiOWiSH® is a registered trademark of BiOWiSH Technologies International, Inc.

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