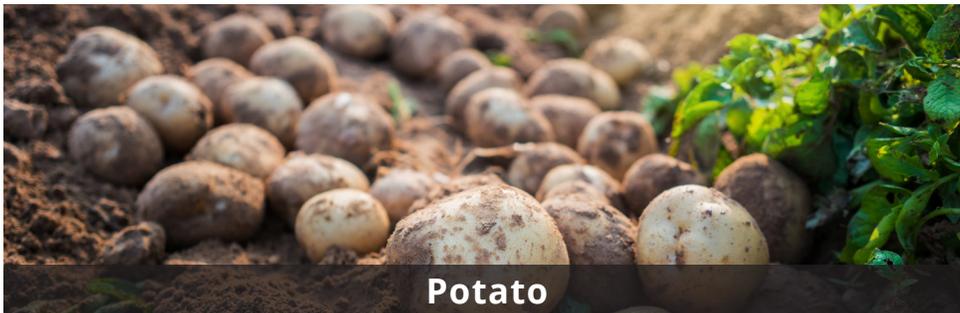


## BiOWiSH® Crop Liquid

### Evaluation of BiOWiSH® Crop Liquid Enhanced Fertilizer on Potato Production



#### Executive Summary

BiOWiSH Technologies, Inc. engaged North Dakota State University as a third-party Contract Research Organization (CRO) to conduct a study to determine the effects of BiOWiSH® Crop Liquid coated fertilizer on potato production in eastern North Dakota (USA).

The trial compared two treatments:

- Control (Grower Standard Practice)
- Control + BiOWiSH® Crop Liquid

In this study, the Control + BiOWiSH® Crop Liquid treatment was observed to have a marketable yield of 7 cwt/acre (0.88 MT/ha) higher than the Control treatment.

#### 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 a new class of 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](http://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 Sizes

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

## About North Dakota State University

North Dakota State University is distinctive as a student-focused, land-grant, research university. The mission of NDSU Agricultural Affairs is to educate students with interests in agriculture, food systems, and natural resources; to foster North Dakota communities as vital economic and social units through the formation of partnerships that educate the public in agriculture, life, and environmental disciplines; to provide creative, cost-effective solutions to current problems; and to pursue all relevant fundamental and applied research. As an independent CRO, the NDSU research team is made up 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 purpose of this study was to evaluate soil nutrients and plant vigor, collect yield, and define the farmers' economic benefit on potato production using Controlled Release Polymer Coated (CRPC) Urea coated with BiOWiSH® Crop Liquid.

The combination of the data is intended to determine whether the addition of BiOWiSH® Crop Liquid as a fertilizer enhancement can economically increase potato crop production while helping to improve soil conditions for improved plant vigor.

## Implementation Program

In this trial, the standard regional fertility program for potatoes consisted of a liquid application of 10-34-0 at a rate of 25 gal/acre (233.8 L/ha) followed by a solid application of CRPC Urea applied at a rate of 450 lbs/acre (504.4 kg/ha), which is the most common fertilizing practice in the region. This Control program was compared to a program which included the addition of BiOWiSH® Crop Liquid coated onto the CRPC Urea.

The trial consisted of two treatments with five replicates in a randomized complete block design. At the trial site, the potato cultivar 'Umatilla Russet' was planted in accordance with local practices. The crop was irrigated. The banded application of 10-34-0 at 25 gal/acre (233.8 L/ha) occurred at planting, while the CRPC Urea application of 450 lbs/acre (504.4 kg/ha) was made at hilling prior to emergence. There was no significant disease or pest pressure at the trial location.

Table 1. Application Table

Treatment	Fertilizer	Application Rate	Application Phase
Control	10-34-0	25 gal/acre [233.8 L/ha]	At Planting
	CRPC Urea 44-0-0	450 lbs/acre [504.4 kg/ha]	At Hilling
Control + BiOWiSH® Crop Liquid	10-34-0	25 gal/acre [233.8 L/ha]	At Planting
	CRPC Urea 44-0-0	450 lbs/acre [504.4 kg/ha]	At Hilling

\*BiOWiSH® Crop Liquid Fertilizer Enhancement was added at manufacturer's recommended rate.

## Results

### Stand Count and Vigor Data

The table below contains the trial's assessment for stand count and vigor. Stand count was taken approximately five weeks after planting by counting every emerged plant and dividing by the number planted, while vigor scores were rated from 0 (indicating a dead plant) to 5 (indicating extreme vigor). The values were similar or higher for the Control + BiOWiSH® Crop Liquid treatment relative to the Control.

Table 2. Stand Count and Vigor

Treatment	Stand Count	Vigor
Control	84	2.6
Control + BiOWiSH® Crop Liquid	84	2.8

### Yield

The yield distribution in hundredweight (cwt) per acre of harvested potatoes by size class is presented below. The values on the heavier end of this distribution, as well as total marketable yield, were higher for the Control + BiOWiSH® Crop Liquid treatment, indicating optimized yield potential by improved nutrient uptake.

Table 3. Yield by Potato Size Class

Treatment	Yield by Size Class					Total Yield	Marketable Yield	Percent Yield by Weight	
	<3 oz	3-6 oz	6-10 oz	10-14 oz	>14 oz			>6 oz	>10 oz
			cwt/acre [MT/ha]				cwt/acre [MT/ha]	%	%
Control	72 [9.04]	138 [17.32]	68 [8.54]	13 [1.63]	0 [0]	291 [36.53]	219 [27.49]	27.8	4.5
Control + BiOWiSH® Crop Liquid	71 [8.91]	132 [16.57]	76 [9.54]	14 [1.76]	4 [0.50]	297 [37.28]	226 [28.37]	31.6	6.1

\*Assuming conversion of 17.857 cwt per US ton, followed by conversion from US ton/acre to MT/ha.

\*\*Calculations for conversions between imperial and metric units are based on the original source data; slight rounding differences may occur within reported publication values.

## Economics

Economic data on marketable potato yield from the study is presented in the table below. The Control + BiOWiSH® Crop Liquid treatment had a profit change of \$68 USD/acre (\$167 USD/ha) greater than the Control.

Table 4. Farmer Economics Table on Marketable Potato Yield

Treatment	Marketable Yield cwt/acre [MT/ha]	Marketable Yield Increase cwt/acre [MT/ha]	Marketable Yield Increase (%)	Net Income USD/acre [USD/ha]	Profit Change USD/acre [USD/ha]
Control	219 [27.49]	-	-	1,927 [4,762]	-
Control + BiOWiSH® Crop Liquid	226 [28.37]	7 [0.88]	3.2	1,995 [4,929]	68 [167]

\*Assuming conversion of 17.857 cwt per US ton, followed by conversion from US ton/acre to MT/ha.

\*\*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. It does not account for non-fertility expenses.

\*\*\*\*Profit change is the difference between net income of the respective program and the Control.

## Soil Analysis

The table below contains soil data with each soil parameter measured mid-season and post-harvest by bulking soil samples from all individual replicates in a treatment. Values were similar or higher for the Control + BiOWiSH® Crop Liquid treatment relative to the Control.

Table 5. Soil Analysis Table

Treatment	Sample Timing	Nitrate-N ppm	Phosphorus ppm	Potassium ppm	OM %	pH
Control	Mid-Season	18	86	110	1.5	7.4
	Post-Harvest	14	88	110	1.5	7.3
Post-Harvest Percentage of Mid-Season Value		78%	102%	100%	100%	99%
Treatment	Sample Timing	Nitrate-N ppm	Phosphorus ppm	Potassium ppm	OM %	pH
Control + BiOWiSH® Crop Liquid	Mid-Season	14	88	110	1.5	7.3
	Post-Harvest	14	93	116	1.5	7.2
Post-Harvest Percentage of Mid-Season Value		100%	106%	105%	100%	99%

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## Conclusion

BiOWiSH® endophytic *Bacillus* deliver soil nutrients to crops through the rhizophagy cycle creating a symbiotic relationship between the plant and soil microbes. BiOWiSH® Crop Liquid, when added to a standard fertility program, optimized potato marketable yield potential to 226 cwt/acre (28.37 MT/ha) from 219 cwt/acre (27.49 MT/ha) by improved nutrient uptake. This overall increase of 7 cwt/acre (0.88 MT/ha) over the Control increased profit to the grower by \$68 USD/acre (\$167 USD/ha).

In plant production systems the absence of required nutrients to support high crop yield can have a negative impact on plant vigor and post-harvest soil nutrients. This issue can be avoided if a best management practice adequately accounts for the nutrient mass balance throughout the life cycle of the plant and for future growing seasons.

In this study the mid-season soil nutrients were similar with added fertilizer nutrient inputs being the same. However, the post-harvest soil results in Table 5 illustrate that the BiOWiSH® fertilizer enhancement increased nutrient use efficiency and supported nutrient uptake. This enables BiOWiSH® coated CRPC Urea to optimize yield potential by improved nutrient uptake and improves soil conditions for increased plant vigor overall.



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