BiOWiSH® TECHNOLOGIES

Research Study

BiOWiSH® Crop Liquid

Evaluation of BiOWiSH® Crop Liquid on Late Rice Production in China

Executive Summary

BiOWiSH Technologies engaged China Agricultural University and Hunan Agricultural University to evaluate the effects of BiOWiSH® Crop Liquid coated onto urea to create an Enhanced Efficiency Fertilizer (EEF) for late rice production in China.

The trial compared four treatments:

- Control, Standard Urea Fertility Program
- Control + Urease Inhibitor
- Control + Nitrification Inhibitor
- Control + BiOWiSH® Crop Liquid

Rice is the second largest crop after maize in China. Over-fertilization in rice paddy fields is a universal issue in southern China, which causes agricultural non-point pollution in air, water, and soil. Enhanced efficiency fertilizers are good options to reduce the fertilizer application rate and increase nutrient efficiency.

The results of this study indicate that urea coated with BiOWiSH® Crop Liquid optimized yield potential by improved nutrient uptake. The BiOWiSH® treatment resulted in a 10.6% yield increase over all other treatments, which resulted in higher profit.

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

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.

About China Agricultural University and Hunan Agricultural
China Agricultural University and Hunan Agricultural University are public research universities in China, specializing in advanced agricultural education. China is a large agricultural country with a vast number of distinct soil types and production environments. Agriculture plays a strategic role in the development of the national economy.

Objectives

The objective of this trial was to evaluate BiOWiSH® Crop Liquid coated onto urea 46-0-0 to create an enhanced Efficiency Fertilizer (EEF) for rice production in China, compared to the Control and other fertilizer enhancements such as inhibitors, recommended by local experts. The focus of this study was rice biomass and yield, Nitrogen Use Efficiency and economics.

Implementation Program

The study was conducted on late rice (variety name: Xiang Wan Xian12) in Heshan District, Yiyang City, Hunan Province, China. The trial had four treatments. Each treatment had three replicates arranged in a randomized complete block design (RCBD) in a plot size of 30m^2 (322.92 sq ft). Each plot was isolated with plastic film and drainage ditches were built between the replications. Rice seedlings were transplanted 30 days after seeding, with a planting population of 250,000 holes/ha (101,174 holes/acre) and two seedlings per hole. There were two applications of fertilizer at planting and tillering stages. Pest, disease, and weed control were implemented on site when required.

Data collected included agronomic traits, nitrogen content in whole plant, biomass yield, grain yield, and 1000-grain weight. These data points were then used to calculate Nitrogen Use Efficiency, plot yield, net income, and profit change.

Table 1. Treatments, Fertilizers, and Application timings

Treatment	Fertilizer	Application Rate kg/ha [lbs/acre]	Application Timing
Control	Urea	95 [85]	Preplant
	Urea	63 [56]	Sidedress
Control + Urease Inhibitor	Urea	95 [85]	Preplant
	Urea	63 [56]	Sidedress
Control + Nitrification Inhibitor	Urea	95 [85]	Preplant
	Urea	63 [56]	Sidedress
Control + BiOWiSH® Crop Liquid	Urea	95 [85]	Preplant
	Urea	63 [56]	Sidedress

**BiOWiSH® Crop Liquid used at manufacturer's recommended rate.*

Results

Plant Agronomic Trait Data

Table 2 illustrates plant agronomic trait parameters that contribute to yield performance. Ten plants per replicate were collected for a total of thirty plants per treatment to evaluate the agronomic trait data. The Control + BiOWiSH® treatment scored at the top of the list in almost all plant agronomic trait data including plant height, panicle length, effective panicle per plant, seed setting rate, and 1000-grain weight.

Table 2. Plant Agronomic Trait Data for Late Rice

Treatment	Plant Height cm [in]	Pancile Length cm [in]	Effective Panicle per Plant	Grain Number per Panicle	Seed Setting Rate %	1000-Grain Weight g [oz]
Control	90 [35.4]	23 [9.1]	15.5	113.7	79.3	25.9 [0.91]
Control + Urease Inhibitor	87 [34.3]	25 [9.8]	15.8	115.3	79.3	26.1 [0.92]
Control + Nitrification Inhibitor	82 [32.3]	24 [9.5]	16.3	113.5	79.2	26.2 [0.92]
Control + BiOWiSH® Crop Liquid	90 [35.4]	25 [9.8]	16.9	112.5	81.6	27.1 [0.96]

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

***1 US ton/ac = 2.24 MT/ha*

Grain and Biomass Yield
Each replicate was fully harvested and combined for each treatment to determine per treatment fields. The study showed that the Control + BiOWiSH® treatment has higher grain yield than the Control and inhibitor treatments. The BiOWiSH® treatment also achieved higher biomass yield compared with other treatments, indicating improved soil conditions for increased plant vigor.

Table 3. Grain and Biomass Yield

Treatment	Grain Yield MT/ha [tons/acre]	Grain Yield Increase MT/ha [tons/acre]	Grain Yield Increase (%)	Biomass Yield MT/ha [tons/acre]	Biomass Yield over Control (%)
Control	8.06 [3.60]	-	-	14.79 [6.60]	-
Control + Urease Inhibitor	8.11 [3.62]	0.05 [0.02]	0.6	15.16 [6.76]	2.5
Control + Nitrification Inhibitor	8.50 [3.79]	0.44 [0.20]	5.5	15.77 [7.03]	6.6
Control + BiOWiSH® Crop Liquid	8.91 [3.97]	0.85 [0.38]	10.6	18.60 [8.30]	25.8

Nitrogen Uptake
Harvest samples were collected from each plot to test the nitrogen (N) content in plant. The plant samples were treated with H_2SO_4-H_2O_2, then tested with the Kjeldahl method. The study showed that the Control + BiOWiSH® treatment accumulated the highest N content in plant. The high N content in the rice panicle indicated that BiOWiSH® treatment increased nutrient use efficiency and supported nutrient uptake.

Table 4. Nitrogen Accumulation in Rice Path

Treatment	Total N Plant Accumulation kg/ha [lbs/acre]	N Content over Control in Stalk %	N Content over Control in Leaf %	N Content over Control in Panicle %
Control	153.28 [136.75]	-	-	-
Control + Urease Inhibitor	156.08 [139.25]	-4.4	1.8	3.9
Control + Nitrification Inhibitor	163.33 [145.72]	-6.7	10.1	8.9
Control + BiOWiSH® Crop Liquid	171.86 [153.33]	-0.5	7.9	18.8

Nitrogen Use Efficiency
The formula for calculating the utilization efficiency of N fertilizer is as follows:

- N recovery efficiency (NRE) (%) = (N accumulation in the shoot - N accumulation in the shoot from no urea application plot) / N application rate x 100%
- N agronomic efficiency (NAE) = (yield in the N application plot - yield in no N application plot)/applied nitrogen rate
- N physiological efficiency (NPE) = (yield in the N application plot - yield in no N application control plot)/(N accumulation in the shoot - N accumulation in the shoot from no urea
- N partial factor productivity (NPFP) = plot yield/N application rate

The study showed the Control + BiOWiSH® treatment achieved higher Nitrogen Use Efficiency than other treatments, in each calculation method.

Table 5. Nitrogen Use Efficiency

Treatment	NRE %	NAE %	NPE %	NPFP %
Control	27.2	9.3	34.9	51.2
Control + Urease Inhibitor	29.0	9.6	35.5	51.5
Control + Nitrification Inhibitor	33.6	12.1	35.6	54.0
Control + BiOWiSH® Crop Liquid	39.0	14.7	38.8	56.6

Economics
When added to the Control fertilizer, BiOWiSH® Crop Liquid showed a yield increase of 10.6%, resulting in an increased profit of $289 USD/ha ($117 USD/acre) over the Control.

Table 6. Yield and Economics

Treatment	**Yield** MT/ha [tons/acre]	**Yield Increase** MT/ha [tons/acre]	**Yield Increase** (%)	**Net Income** USD/ha [USD/acre]	**Profit Change** USD/ha [USD/acre]
Control	8.06 [3.60]	-	-	2557 [1035]	-
Control + Urease Inhibitor	8.11 [3.62]	0.05 [0.02]	0.6	2555 [1034]	-2 [-1]
Control + Nitrification Inhibitor	8.50 [3.79]	0.44 [0.20]	5.5	2697 [1091]	140 [56]
Control + BiOWiSH® Crop Liquid	8.91 [3.97]	0.85 [0.38]	10.6	2846 [1152]	289 [117]

**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.*

Conclusion

BiOWiSH® endophytic *Bacillus* deliver soil nutrients to crops through the rhizophagy cycle creating a symbiotic relationship between the plant and soil microbes. Together, the cycle improved soil conditions for increased plant vigor in this study. As a result, urea coated with BiOWiSH® Crop Liquid increased nutrient use efficiency and supported nutrient uptake for rice in Hunan Province, China, resulting in an increased profit of $289 USD/ha ($117 USD/acre) over the Control.

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