# MIDTERM STATUS

## DESERT CONTROL & THE UNIVERSITY OF ARIZONA FIELD TRIALS OF LIQUID NATURAL CLAY

DESERT CONTROL | THE UNIVERSITY OF ARIZONA

# TABLE OF CONTENTS

Desert Control and the University of Arizona's Yuma County Cooperative Extension (YCCE) initiated a collaborative effort in 2022, exploring the potential of Liquid Natural Clay (LNC) to enhance soil quality and reduce water usage in desert conditions while growing high-value crops. A multi-year field validation program was initiated, including different LNC formulations and different crops.

This midterm status report outlines some of the key findings from the five first seasons running from spring 2022 to spring 2024.

In spring 2022, Desert Control initiated trials in Arizona's Yuma Mesa area, marking the first application of Liquid Natural Clay (LNC) in the United States. This project aimed to explore the potential benefits of LNC in enhancing water conservation and crop yield in sandy soils growing vegetable row crops while assessing the longevity of LNC's effects over an anticipated five-year period.

The trials employed various formulas of LNC across multiple crop seasons, each with distinct irrigation strategies and water deficit levels. The project started with water conservation experiments, focusing on watermelon and bell peppers under reduced irrigation scenarios. The objective was to evaluate yield outcomes under 20% and 50% less irrigation, highlighting the ability of LNC to sustain crops with lower water inputs.

The project continued into spring and fall 2023, applying LNC under standard farming practices to assess its effect on crop yield without irrigation limitations. Watermelon and cotton were evaluated in the spring, while romaine lettuce and iceberg lettuce were evaluated in the fall.

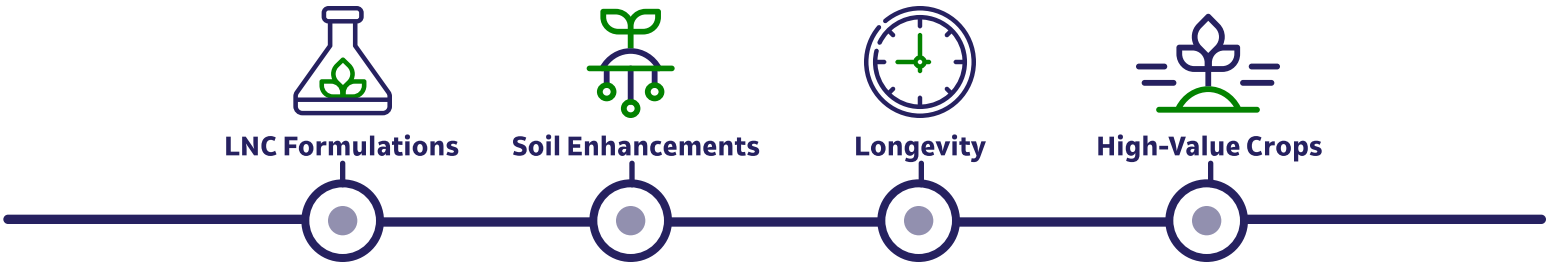
Overall, the trials aimed to provide critical insights into the role of LNC in improving agricultural sustainability in arid regions, offering a promising solution for water conservation while enhancing crop yield in challenging soil conditions. Due to positive outcomes and opportunity for diversification of approaches to enhance farming integration, monitoring and testing will continue through the full five-year partnership to evaluate the long-term benefits and durability of LNC in agricultural applications.

| Season | Crop 1 | Crop 2 | Objective & Testing Factor |
|---|---|---|---|
| Spring 2022 | Watermelon | Bell pepper | Yield under less irrigation: 20% vs 50% less irrigation |
| Fall 2022 | Romaine lettuce | Celery | Yield under reduced frequency irrigation: MAD 30% vs MAD 50% irrigation |
| Spring 2023 | Watermelon | Cotton | Yield under standard farming practice: full irrigation |
| Fall 2023 | Romaine Lettuce | Iceberg lettuce* | Yield under standard farming practice: full irrigation |
| Spring 2024 | Watermelon | Cantaloupe | Yield under standard farming practice: full irrigation |

*Fall 2023, the cotton-defoliant chemical used at the end of the prior growing season severely hindered iceberg lettuce growth and, therefore, iceberg lettuce season was terminated without data collection.

The project started with three primary areas of focus and a fourth was more recently added due to the significant economic impact opportunity:

- **Screening LNC Formulations:** Identify LNC formulations suitable for arable sandy soils in the southwest region of the United States.
- **Quantifying Soil Enhancements:** Measure improvements in soil quality and productivity.
- **Evaluating Longevity:** Assess the long-term efficacy of LNC.
- **Growing high-value crops on marginal lands:** Achieving high yields and meeting market specifications for commercial crop production on lower value soils.



Before plot establishment, soil samples were collected and assessed for soil texture and water-holding capacity. The soil texture was 95% sand and less than 2% clay. The field was laser leveled and tilled, and plots were marked in 7 X 45 ft dimensions. Residual nutrients and organic matter in the soils were minimal, as no farming or irrigation was previously conducted on this plot (Fig.1).


*Figure 1.* Aerial images for the field (a) before planting and (b) after planting.

LNC treatments were applied as three different formulas, A, B, and D; allowing C labeled plots to be used as “Control” plots. LNC treatments differed in both their application rates (where A had lowest rate and D highest) and formula compositions (Table. 1). After LNC was applied, plots were rototilled, and one vegetable growing soil bed (7 X 45 ft) was shaped within each plot, consistent with local commercial farming practices.

**Soil water Retention**

LNC treatments A, B, and D increased the amount of water held in the soil between field capacity and wilting point (ΔW) by 26%, 92%, and 75%, respectively, compared to the control.

These observations suggest that the LNC-treated sandy soils have the potential to hold more water, which might keep that water available in the root zone for more extended periods compared to untreated sandy soils.

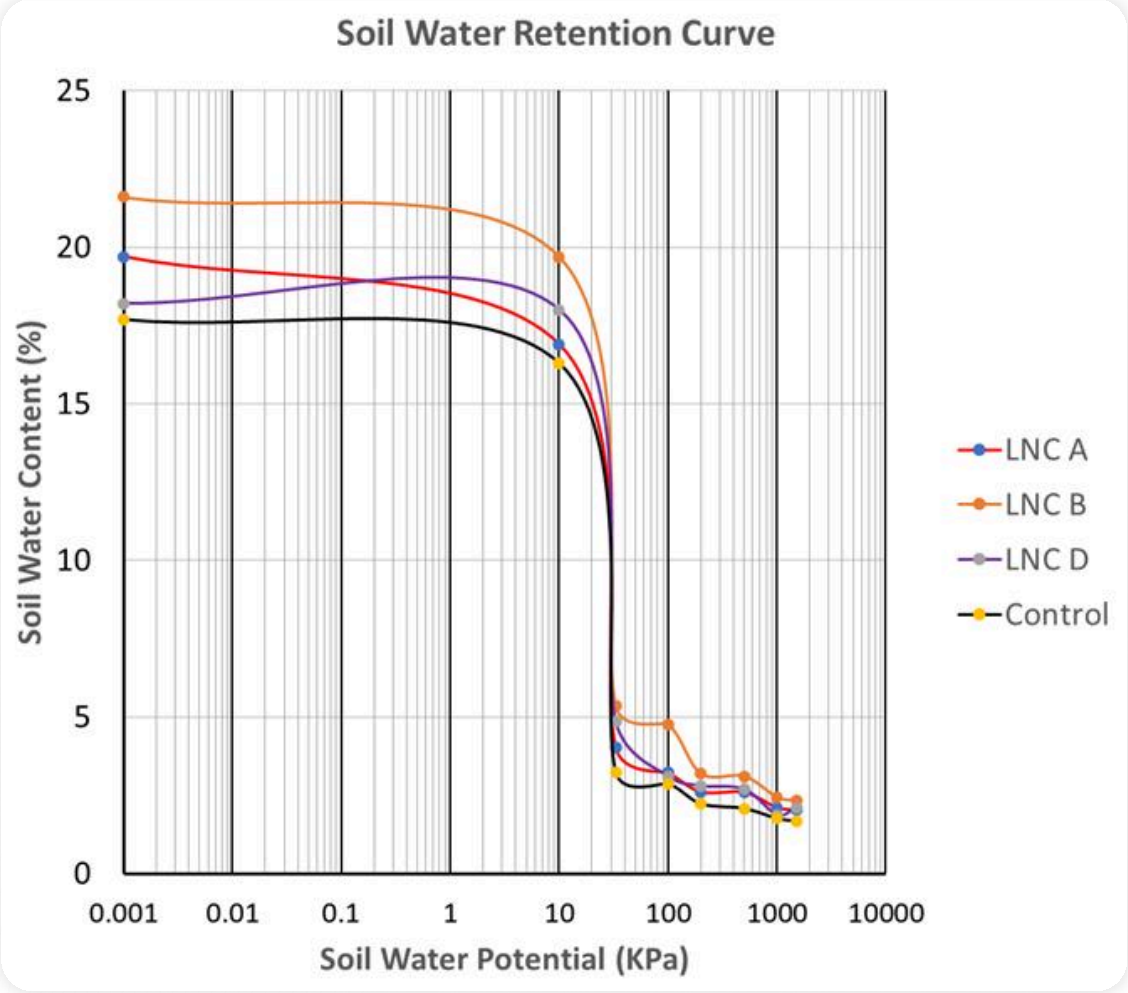



*Figure 2.* Water retention curve for LNC treatments and control.

**Cation exchange capacity**

The application of LNC formulations A, B, and D has yielded notable enhancements in the Cation Exchange Capacity (CEC) of the soil. CEC increased from a baseline value of 3.88 in the control to 4.34, 5.32, and 4.58 in groups A, B, and D, respectively—representing a 12%, 37%, and 18% relative improvement, as illustrated in Figure 3.

The increased CEC values signify an improved capacity of the soil to retain cations, particularly those of the essential nutrients (fertilizers) necessary for plant growth.

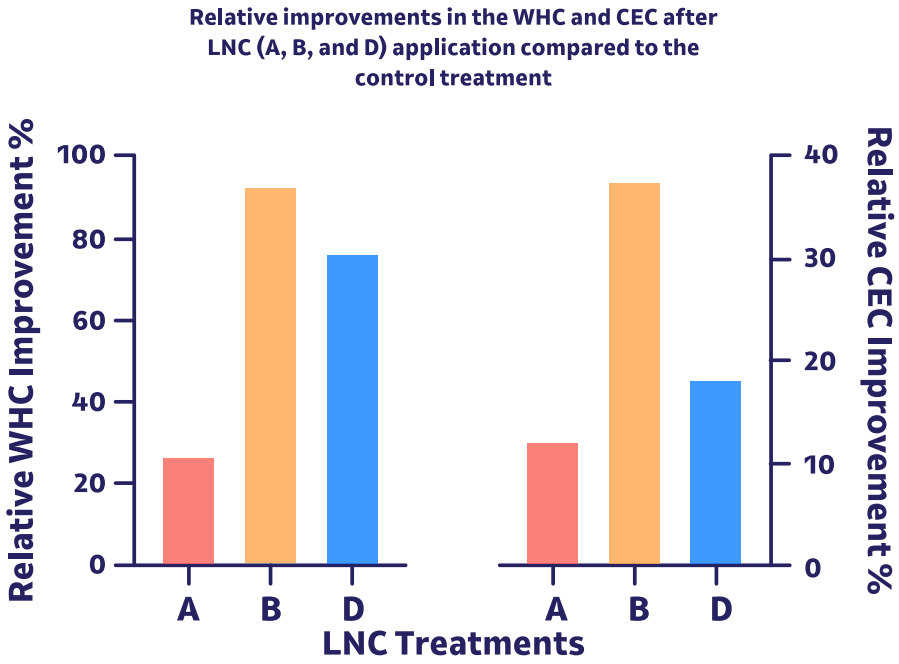



*Figure 3.* Water holding capacity and cation exchange capacity.

**Watermelons:**

- Required LNC adjustments in amounts and formulation to fit the soil profile and maximize the LNC effectiveness.
- With 50% less irrigation amounts , two LNC formulas showed larger fruit size.

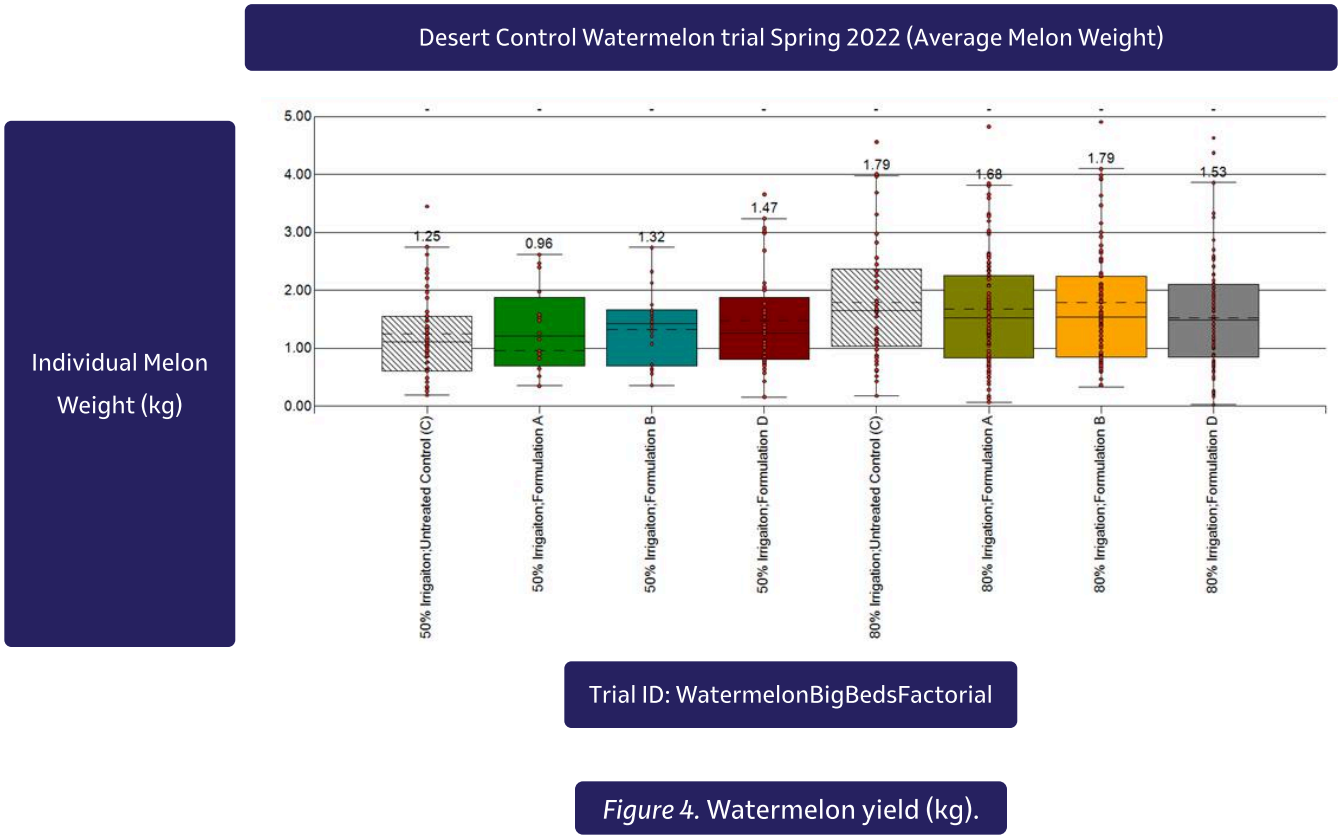



*Figure 4.* Watermelon yield (kg).

**Bell peppers:**

- The planting date was late in the season as temperatures become extreme for growing. Therefore, all pepper plants suffered from excessive heat during the summer months.
- However, LNC showed higher marketable fruit sizes compared to control, specifically under high water stress.

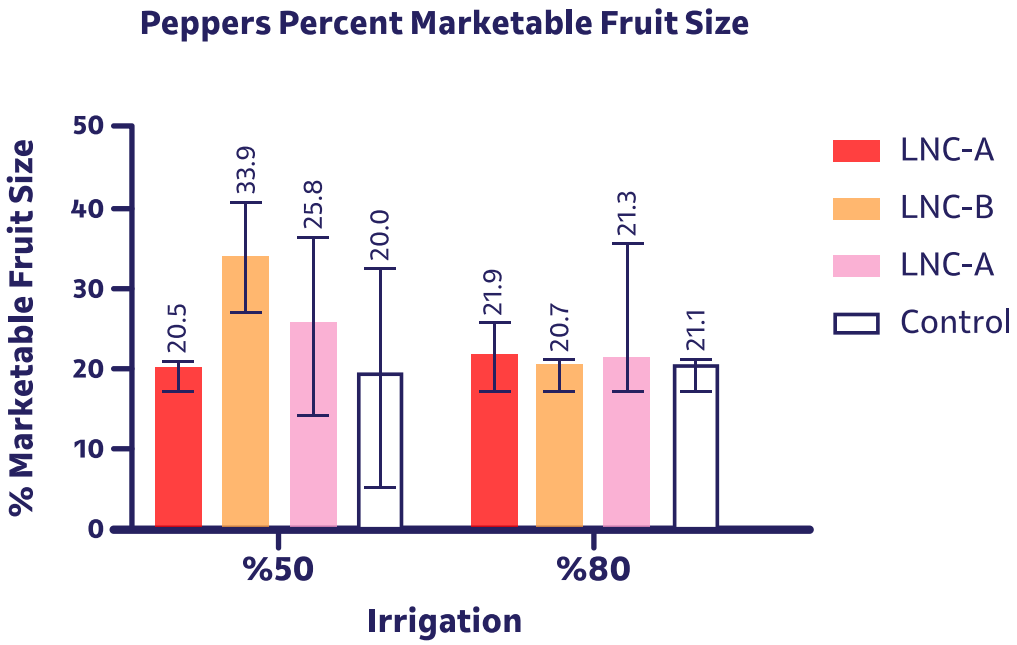



Figure 5. Bell peppers fruit size.

**Lettuce:**

At reduced frequency irrigation, applying water every 3 vs every 2 days, average yield values for LNC treated plots increased by 21% to 54% relative to the control plots.

This indicates that growers using LNC could allow more days between irrigation events compared to the increased irrigation frequencies typically necessitated by sandy soil farming.

The results indicate that LNC treated soils held more water between irrigation events, suggesting reduced water loss to deep percolation beyond the root zone and increased resilience to drought conditions. Additionally, by allowing more days between irrigation events, irrigation-related labor costs may reduce significantly.

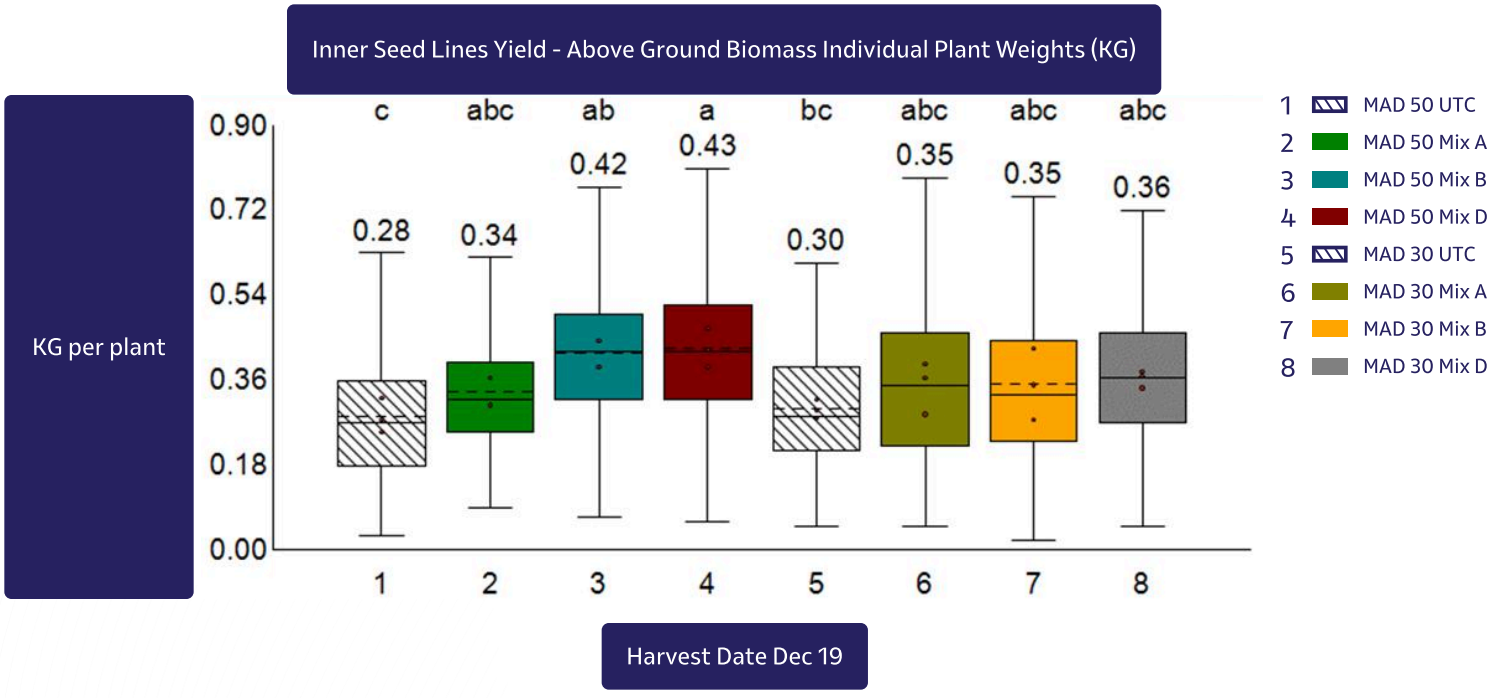



Figure 6. Lettuce yields.

**Celery:**

- Celery is a challenging crop to grow in the lower desert region due to high water requirements of the traditional marshland crop that prefers consistent moisture.
- LNC-D showed 56% higher yield (kg) compared to control for the MAD 30% irrigation regime.
- LNC-A & B appeared to improve yield but was not significantly different from control.
- No significant variation was seen under the MAD 50% reduced frequency irrigation for celery.

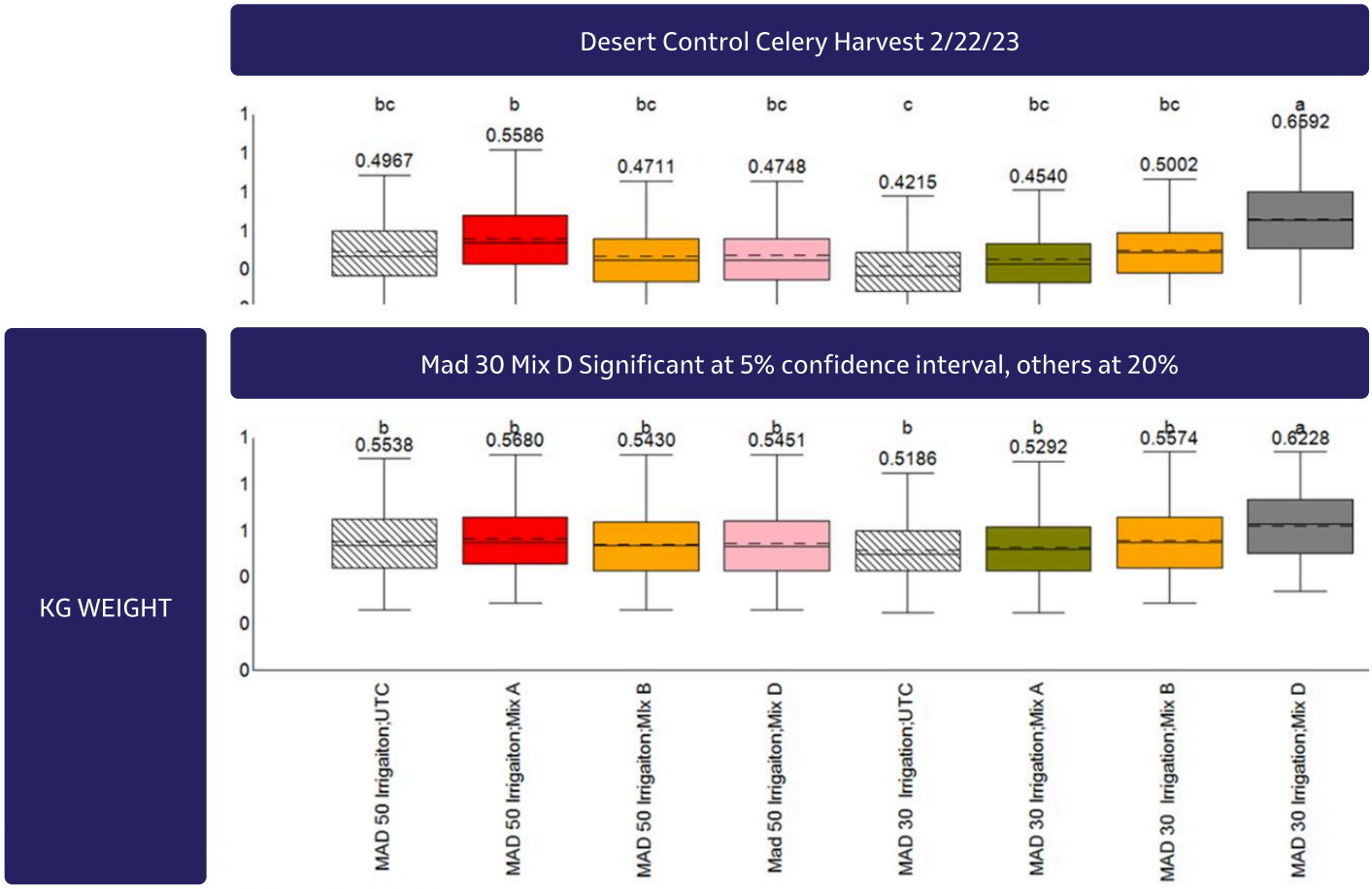



Figure 7. Celery yield.

**Watermelons:**

- All LNC treatments (A, B, and D) show an increase in median fruit weight compared to the control, although differences were not significant.
- LNC-A (Mix A) appears to have the most substantial impact, followed by LNC-B (Mix B) and LNC-D (Mix D).

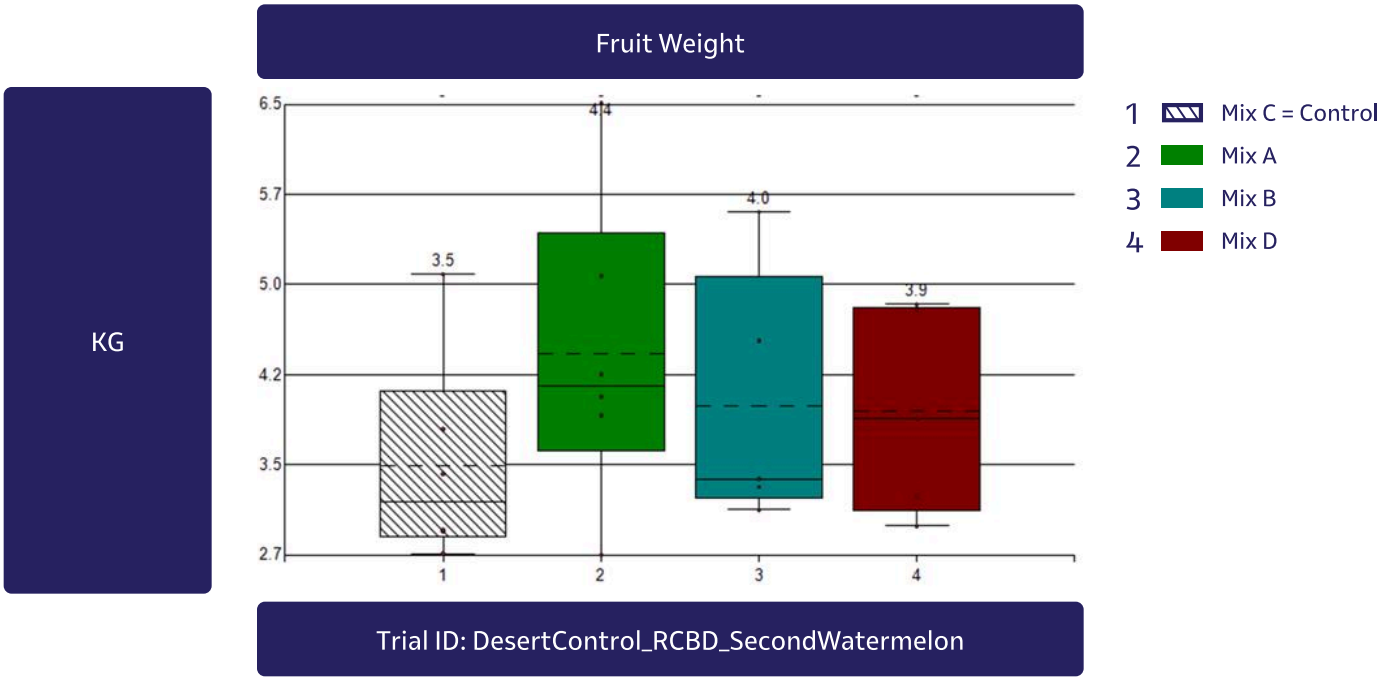



*Figure 8.* Watermelon Yield Data.

**Cotton:**

- LNC-B showed a 32% higher yield compared to the control.
- LNC-A and D yields were less than or equal to the control.

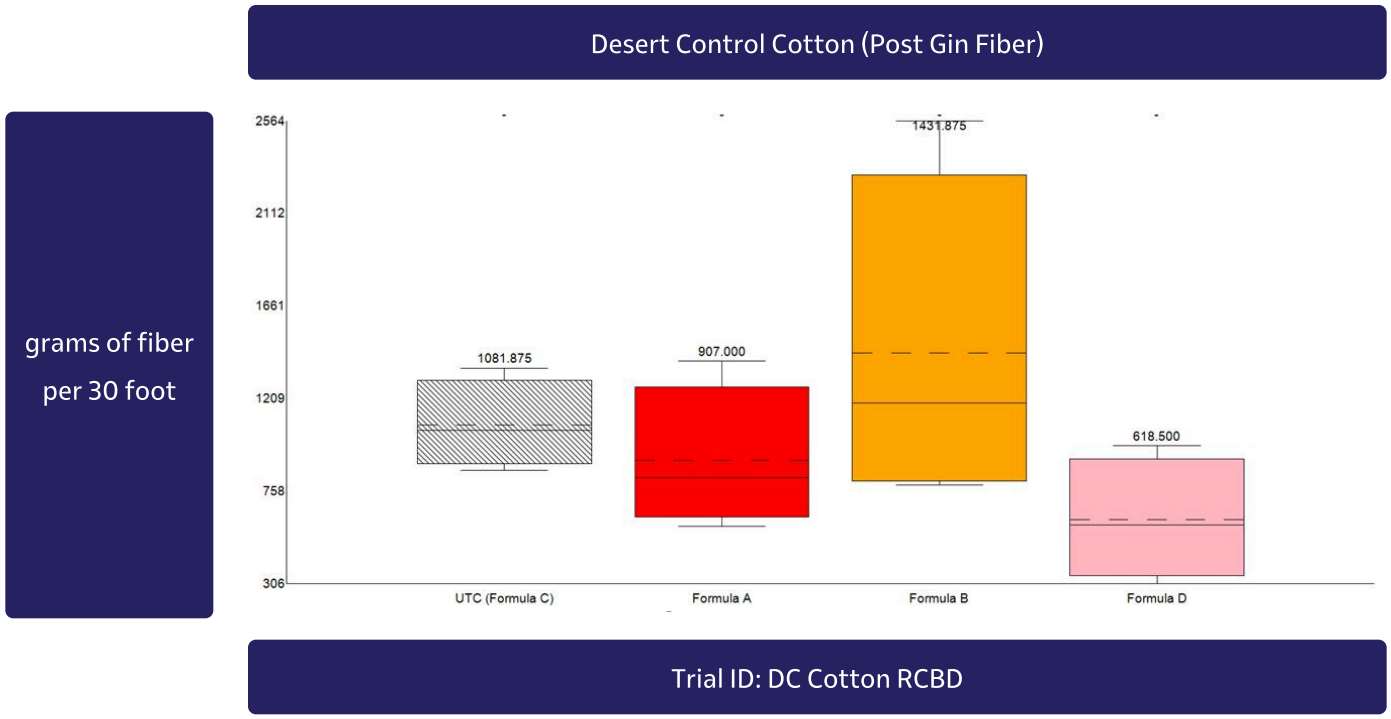



*Figure 9.* Cotton yield data.

**Romaine Lettuce:**

Compost was added this season as a treatment to simulate farming practices used on some farms and to evaluate the interaction between LNC and compost, as well as their potential effects on crop yield. Prior to direct seeding of the lettuce, green waste compost was applied to half of the field. Irrigation remained uniform across all treatments.

**Key Findings:**

- The treatments with compost generally showed higher harvested lettuce head weights compared to no-compost treatments.
- The control/ No-compost treatment had the lowest average yield at 0.91 lb, while LNC-D showed the highest yield (1.18 lb) nearly matching some compost treatments.
- LNC-A and LNC-B produced similar yields whether compost was used or not, suggesting that the mix itself might influence results more than the compost does.

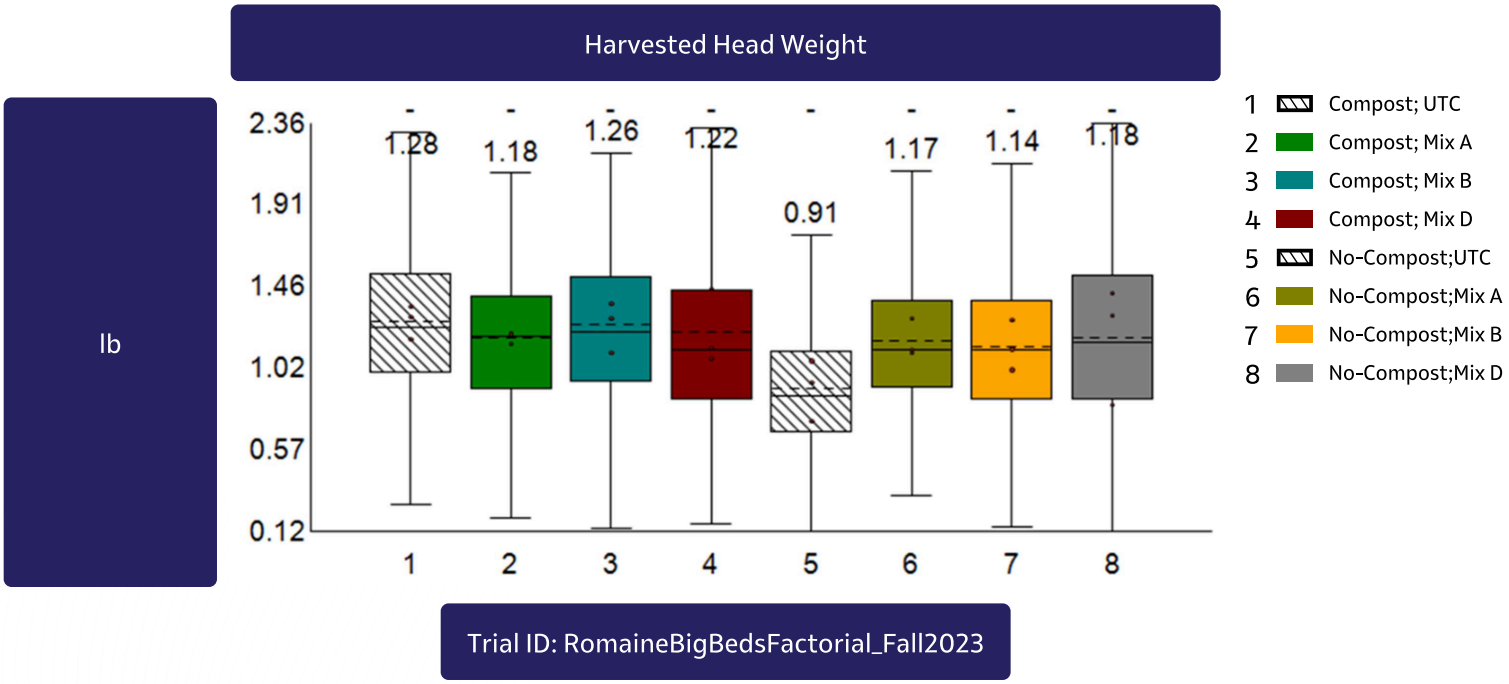



*Figure 10.* Romaine lettuce yield data.

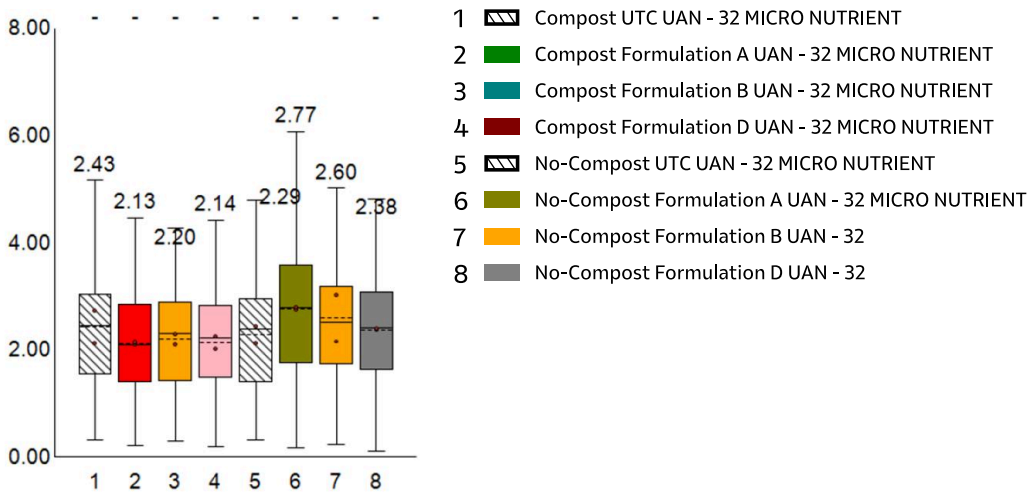
**Cantaloupe:**

No further compost was applied for this season, but some parts of the field had residual compost from the previous lettuce crop. This provided a chance to see whether compost had any residual effects.

**Key Findings:**

- On average the no-compost plots yielded slightly higher, suggesting minimal residual effects from compost application from the prior season.
- No-Compost plots with LNC-A and LNC-B treatments showed the highest average weight per melon. Although differences were not significant, this indicates LNC's potential in boosting crop yields even for sandy soils without compost addition.

LB/Melon




Trial ID: DesertControlCantaloupeFactorial

*Figure 11.* Cantaloupe standardized yield (lb/melon).

Watermelon was planted; however, the seedlings were weak, and an extended period of low nighttime temperatures in February 2024, lasting nearly three weeks, caused significant transplant shock. As a result, we experienced substantial losses from the watermelon transplants, and consequently, we were not able to collect enough data for watermelon trials.

**Field Days:**

Two events were hosted to educate local growers and researchers about LNC and share research findings.

| Date | Title | Location |
|---|---|---|
| 06/16/2022 | Desert Control Field Day Yuma AZ Trial | Yuma Mesa Station |
| 12/05/2022 | Liquid Natural Clay (LNC) to Improve Sandy Soils in Yuma-Mesa for Locally | Yuma Mesa Station |

**Workshops and Seminars:**

Additional sessions were conducted to engage with the agricultural community and disseminate knowledge. Frequent community engagement has been critical to increasing mutual understanding and gaining trust with growers experiencing LNC for the first time.

| Date | Title | Location |
|---|---|---|
| 06/16/2022 | Liquid Natural Clay to Combat Desertification and Improve Soil Quality | Desert Ag Research Symposium, Yuma Az |
| 09/05/2023 | Irrigation Efficiency Workshop for Commercial Farming | University of Arizona, Maricopa Ag Center, Maricopa, AZ |
| 10/17/2023 | From Sand to Hope | United States Committee on Irrigation & Drainage 2023 Conference, Fort Collins, Colorado |
| 11/30/2023 | Liquid Natural Clay (LNC) for Irrigated Sandy Soils | 34th Annual Fall Desert Crops Workshop. Imperial CA, |
| 12/05/2023 | Liquid Natural Clay (LNC) for Irrigated Sandy Soils | University of Arizona, Maricopa Ag Center, Maricopa, AZ |

As stated above, LNC treatments A, B, and D increased the amount of water held in the soil between field capacity and wilting point (ΔW) by 26%, 92%, and 75%, respectively, suggesting that LNC-treated sandy soils have the potential to hold more water. This is important to commercial farming as sandy soils require much greater irrigation inputs due to the lack of water holding capacity. Low water holding capacity limits growers to crops such as date palms, forage, and citrus, preventing these growers from growing many of the highest value crops the market demands.

Farmlands with higher water holding capacity and the ability to sustain higher value crops generally provide the greatest economic value. This is reflected in comparisons of property values and the cost to rent farmland. For example, different farmlands within a few kilometers of each other can have similar climate, water access, labor resources and supporting infrastructure, but the land with higher water holding capacity would demand farming rents four times greater than the sandy soil farmland. Land value for farming where the difference is mainly in soil texture can be attributed to the revenue generating potential of growing higher value crops in one soil type compared to the other.

Therefore, a significant focus of our upcoming agricultural studies will be looking at the opportunity to help growers produce high value crops from low value land. This may provide higher profit margins for growers by reducing farmland rent costs, open more land for being viable to high value commercial crops, and provide growers with more diversity of choice in what they grow to meet market demands and adapt to changing environmental conditions.

Other practical considerations are the safety and efficacy of LNC shown across multiple trials, with multiple formulations. No increase in crop disease was noted in any of the trials. LNC has been shown to be safe in applications prior to and during planting of different vegetable crops and permanent crops. Application to mature permanent crops has also been safely demonstrated in citrus, dates and viticulture. The broad safety and efficacy profile has been notable.

During the period of these trials, appropriate information was submitted to the Organic Materials Review Institute who granted Organic certification to LNC in compliance with the US Department of Agriculture's National Organic Program and has since renewed that certification. Organic farming at commercial scale is growing fast due to market demand but these operations have limited few tools to improve soil health and yields while maintaining strict organic compliance. LNC could be an important new tool for these growers.

Different formulations of LNC have demonstrated varying levels of efficacy with different crops, including its impact on cation exchange capacity. This requires further study to optimize formulations. In agriculture, more CEC improvement is considered best, in almost all cases. Yet, as we carry our findings into our research in the golf and landscaping markets, where increases in CEC are not considered desirable, refining our LNC formulations that increase water holding capacity without significantly increasing CEC is of value. Further, this market is likely to be of particular interest as such users typically pay water prices exceeding those of agricultural users, while social pressures to conserve water are often higher.

**Continuing Research:**

- **Further crop cycles:** are planned with a mixture of additional crops and trial replications to further validate positive findings. Trial methods may be adjusted further to better match commercial growing practices.
- **Long-Term Monitoring:** Conduct ongoing soil quality assessments to understand long-term efficacy and impacts.

**Outreach Expansion:**

- **More Field Days:** The Company and the University will host additional field days to reach a broader audience of growers.
- **Publications and Reports:** Desert Control and the University of Arizona will collaborate on detailed reports and scientific publications to document findings and share them with the broader scientific community. A manuscript, written for intended release by the University of Arizona Agriculture Extension Service, is undergoing peer review in preparation for potential publication as more data becomes available.

**Collaboration Enhancement:**

The encouraging findings from our collaboration with the University of Arizona have positioned Desert Control well to introduce new trials focusing on different LNC formulations, crops, soil profiles and application methods and to extend partnerships with other research institutions and agricultural stakeholders.

Field trials by Desert Control and the University of Arizona revealed the potential of Liquid Natural Clay to improve sandy soils. The use of LNC showed notable benefits in water retention and crop yields, crucial for enhancing sandy soils that typically struggle with such issues.

**Key Findings:**

1. **Water-Holding Capacity:** LNC treatments significantly boosted the soil's ability to retain water. For example, Treatment B enhanced the water holding capacity by 92%, which could allow farmers to decrease irrigation volume and/or frequency. The greatest economic impact opportunity may be in allowing farmers to grow very different, higher value crops in soils that traditionally could not support such practices. *See Figure 3.*
2. **Cation Exchange Capacity:** All LNC formulations improved the soil's ability to retain essential nutrients. Most significantly, Treatment B increased the cation exchange capacity by 37%, leading to better nutrient availability for plants. This also indicates the potential for less loss of expensive nutrient inputs to sub-soil leaching or leaching to aquifers and rivers. *See Figure 3.*
3. **Crop Yields:** Various crops like watermelons, bell peppers, lettuce, celery, cotton, and romaine lettuce showed higher yields with LNC treatment compared to control plots with some variation on which LNC formulation performed best for the different crops.

1. **Objectives and KPIs:** Gain a common understanding of the treatment goals based on the location-specific soil and water conditions, as well as planned crop cycles. Agree on what success looks like and how results will be measured. The optimal soil improvement solution is then prescribed with a tailored LNC formulation.

2. **Application Methods:** A plan is made for the most efficient application method, which is generally done through existing irrigation systems, although other options are available. Soil preparation may be needed in advance or in conjunction with the LNC application. Farming practices will influence application depth, for example, fields under high-frequency or deeper tillage may require more LNC or supplemental applications sooner. Feedback from professional growers is crucial to adjusting LNC formulations and/or application methods for the best outcomes.

3. **Irrigation Management:** If water saving is one of the objectives, soil moisture sensors can be installed for monitoring to provide data for advising on irrigation amounts and frequencies, allowing for savings on water costs and associated irrigation operational costs.

4. **Long-Term Monitoring and Adaptation:** Additional to soil moisture monitoring, Desert Control can also set up plans for periodic soil analysis, as well as crop performance evaluation, to assess soil and plant health.

5. **Organic farming:** LNC is certified organic by the Organic Materials Review Institute (OMRI). Organic growers can use LNC to help improve water efficiency, nutrient efficiency, soil performance and crop yields while complying with organic standards.

Although LNC makes sandy soils better for farming, it's crucial to understand that other factors also affect crop yields. The crops being cultivated, weather, and farming techniques all significantly impact final yields. Crop rotation, efficient irrigation, good soil preparation, and pest management are just a few of the numerous techniques that affect output. Furthermore, crop performance can be greatly impacted by seasonal fluctuations and local climate variables.

**Disclaimer related to forward-looking statements**

This report contains forward-looking information and statements relating to the business, performance, and items that may be interpreted to impact the results of Desert Control and/or the industry and markets in which Desert Control operates.

Forward-looking statements are statements that are not historical facts and may be identified by words such as “may”, “potential”, “aims”, “anticipates”, “believes”, “estimates”, “expects”, “foresees”, “intends”, “plans”, “predicts”, “projects”, “targets”, and similar expressions. Such forward looking statements are based on current expectations, estimates, and projections, reflect current views concerning future events, and are subject to risks, uncertainties, and assumptions, and may be subject to change without notice. Forward-looking statements are not guaranteeing any future performance, and risks, uncertainties, and other important factors could cause the actual business, performance, results, or the industry and markets in which Desert Control operates in, to differ materially from the statements expressed or implied in this release by such forward-looking statements.

No representation is made that any of these forward-looking statements or forecasts will come to pass or that any forecasted performance, capacities, or results will be achieved, and you are cautioned not to place any undue reliance on any forward-looking statements.

**Acknowledgment**

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