RainDrops Irrigation Trial
Conducted for WaterMax LLC.

Quade Agricultural Consulting
Lemoore, CA
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Introduction

Almonds are a very popular crop in California. With just over 800,000 acres planted, they represent a very large part of California agriculture. Due to an increase in demand for the product overseas, the amount of acres being planted is growing every year. This increase in demand has driven prices up to record levels and has kept them high for the last few years. This price increase has encouraged growers and managers to begin experimenting and deviating from what is considered normal when planting almonds resulting in orchards being grown in marginal soils, at a super high density and in areas where water is scarce. The threat of water reductions came true in 2008 when water allocations were cut dramatically to nearly 5% on the west side of the San Joaquin Valley. This not only hurt almond production but also required many to use salty ground water as well as remove some orchards due to water rationing. The effects of drastic deficit irrigation and salty ground water are still very evident today.

Almonds are a crop that unlike pistachios, cannot tolerate a high amount of water stress for long periods before permanent or near permanent damage occurs. This is why careful water management is not only key to achieving maximum yield, but it also insures a long and productive life for your orchard.

Hull Rot Information

Hull Rot is a fungal disease that affects almonds; especially the nonpareil variety. Nonpareil is the most common variety planted in California and is the highest priced among all varieties of almonds. Hull rot starts in the newly opened hulls of the almond nut during the period of hull split and later attacks the shoots at the point where the nut is attached. This results in the death of the shoot can sometimes spread and kill more parts of the branch. This killing of the shoot is what creates the issue since the actual fungal growth on the outside of the nut is of little consequence. When the fungus grows into the vascular system, it cuts off all nutrient flow to the outer part of the limb inducing death. This will kill good fruitwood and limit yields for years to come.

Since hull rot is contained deep inside the newly splitting hull of the almond where sprays cannot penetrate, there are no available fungicides to treat this disease. The only proven practice is water reduction or deficit irrigation. This will lower the humidity inside the canopy as well as within the splitting hull of the nut, drastically reducing the incidence of hull rot.
Extensive research has been done on this subject and all researchers concur that inducing a 50% deficit irrigation schedule combined with extended irrigation intervals is your best plan for reducing hull rot. Using this strategy, the percentage of hull rot infection is reduced by 50 to 75% over previous years where irrigation was not curtailed (information from University of California Research Study on Hull Rot).

For this trial, three fields were selected that were in different locations but were very similar in both design and management. All three have had incidences of hull rot in the past and therefore irrigation applications are reduced beginning at hull split. Within each block, we setup two water application rates: 100% applied water and 50% applied water. The term applied water was used to signify the amount of water actually applied to the field since we were already cutting water based on ET needs. The 100% applied water treatments received the same amount of water that the rest of the block received while the 50% applied water treatments received half of that. The reduction was created by altering the drip line to make it apply half of the water it normally applies. This method is detailed in the materials and methods section further in the paper. By reducing the applied water by 50%, the actual reduction in applied water from ET demand was closer to 25% or in other words, the tree was receiving 25% of the water it was needing at that time. Applying water at this reduced rate for any length of time will have catastrophic effects on tree health during the present as well as lasting effects long into the future. Creating a scenario that is more severe than typically seen gave us the opportunity to see how far the trees can be pushed before the drought stress had a significant effect on tree health. It also gave insight as to how well RainDrops would work under severe drought conditions.

This period of deficit irrigation is a needed practice in almond production but it can have lasting effects. During this time, developing buds are still in need of water and nutrients. Reducing or cutting water at hull split does reduce hull rot but it also lowers yield potential for next years crop due to the slowing of bud development and affect on overall tree health. Using RainDrops reduced the amount of stress on the tree at this time which would have a positive effect on future crop yields.
Stress / Yield Relationship

Almonds, or any perennial crop, are different than annual crops because what is done this year can have a lasting effect. Irrigation management can affect an orchard and its yield for years or even decades to come. Once the crop is created and the nuts are completely filled, the tree continues to grow but the energy is now put into developing next years fruit buds. Because of this continued growth, it is very important to keep irrigation and fertility active up until the point where trees go dormant in the winter. This is why inducing water stress during hull split creates an issue for farm managers and growers. What is being done to harvest this years crop can have a drastic effect on future production. This is a concept that is hard for many to grasp.

Stress of any kind will harm or limit plant growth to some degree. However the kind and level of stress vary depending on plant type, growth stage, age etc. Through careful irrigation management, the stress placed on an almond tree during hull split will limit the spread of hull rot while not stressing the tree enough to hurt next years crop production. If excessive water is applied, hull rot will be uncontrolled and the bud wood dies thus reducing the potential for future crop yield. If not managed correctly, hull rot will kill enough substantial wood that the orchard will become more and more financially deficient over time.

Behaviors of Water in the Soil

When water is added to the soil, it moves into the profile and takes up the space between the soil particles. When the water reaches a saturated state, most of the air is dispersed and replaced by water. This is common after an irrigation. At this time, water is easily retrieved by the plant because less suction pressure is needed to get the water from the soil. As more and more was is consumed by the plant, the soil becomes unsaturated. This stage represents a good mixture of air and water within the profile and is considered the most conducive to crop growth. Eventually, if water is not added, the soil will become very dry and enter a stage called vapour. In this stage, only a thin layer of water is left, like a coating on the soil particles. This layer is called vapour. This thin layer of water is held tightly by the particles and cannot be consumed by the plant because the plant cannot exert enough suction pressure to pull it from the particles. This pressure is measured in centibars. During this stage of vapour, if water is not applied soon, tree stress will become more intense and permanent damage will occur.

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The use of RainDrops affected each of these stages. Adding RainDrops to the irrigation water enabled the soil to hold more water within the profile during the saturated stage resulting in soil that would get wetter compared to the use of water with no RainDrops added. RainDrops also slowed the progression from the saturated to the vapour stage. In the vapour stage, evidence showed that moisture was more available to the plant. Thus yielding less stress to the plant had RainDrops was not used.

Application of RainDrops to Other Crops

Translating to other crops, especially annual crops like cotton or tomatoes, RainDrops would be beneficial as it can reduce the stress that occurs during water reductions as well as high temperatures. All plants, with few exceptions, are fundamentally the same in that they use water and adjust to heat stress. When a plant is running out of water or when temperatures are high, the plant will shut down certain growth processes and divert any water uptake to cooling it leaves. Leaf cooling happens even when there is sufficient moisture present in the soil. When the temperature goes above 95 degrees, that heat will raise the temperature around the leaf and the tree can’t keep growing and cool itself at the same time. So to survive, it reduces or shuts down growth and concentrates on keeping cool. At this point, water is still being used but the efficiency is much less as little to no growth is occurring. A good example would be a cotton crop on a calm, hot day. Outside the field, the humidity is tolerable but once you take a few steps inside the field, the humidity can become very uncomfortable. This increase in humidity is due to the plant consuming water for both transpiration and leaf cooling but during very high temperature, most of this water is for cooling. This will continue until the water in the profile is gone at which time, wilting occurs.
The addition of RainDrops proved to excel in both drought and well watered situations. Based on pressure bomb data that is discusses later in the report, the RainDrops treatments consistently reflected lower stress than the treatments with just water. This indicates that the RainDrops product makes more water available to the plant under reduced soil moisture conditions as well as in well waters situations. All of that considered, RainDrops would be a good addition to any irrigation program on all agricultural crops in other states or countries.

Materials

For this trial, we used several different pieces of equipment to measure the effects of RainDrops on both soil moisture and tree stress. All of the instrument data collected was converted into stress readings and are covered in the results section. All sensing and logging materials were sourced from Irrometer located in southern California.

Sensors

Watermark soil moisture sensors were were placed in the soil at the desired depths of 12, 24 and 36 inches and then attached to two wires that lead up to the logger box. The sensor, powered by the logger box, measured the resistance of the electrical signal. Based on the resistance, a soil moisture reading was calculated and then recorded by the logger box. The amount of resistance through the sensor was directly dependent on how much moisture was in the surrounding soil volume. The more moisture in the soil, the less resistance. The less moisture in the soil, the more resistance.
Switches

The switches chosen were used to signal irrigation events, record start and end dates as well as total irrigation system run time; all of which are based on irrigation system pressure. These switches relay a signal to the logger box that was created when the pressure switch read a line pressure taken from the actual drip lines in the field. This gave an accurate historical record of the past irrigation events. This was important when looking at the soil moisture data collected from the sensors and evaluating the effects of RainDrops.

Logger Box

The logger box was also supplied by the Irrometer Company and was designed for use with the above-mentioned sensors and switches. This box not only provided the electrical current needed to measure the resistance of the sensor, but it also had a digital display that could be read in real time for current soil moisture measurements. This box logged or stored the data retrieved every 15 minutes providing a record of what the soil moisture was then, how dry it got, how wet it got and how effective the irrigation events were over the past period of time since the last data retrieval. The box also came with software called Water Graph. This software took all of the information mentioned above and converted it into graph form to provide a visual representation of the data the logger box collected.
Data Shuttle

A data shuttle was used to retrieve the data that was collected by the logger box and then transfer it to the Water Graph software. The shuttle was a small black box that took the data from the box and put it onto a memory card where it is ready to be transferred into the software.

Pressure Bomb

A pressure bomb is a relatively old tool that was once used primarily in cotton but is now being used more and more in higher value crops due to its specific measurements and its consistency. It works by applying pressure to a complete leaf blade and forcing the moisture in the leaf back up through the stem of the leaf. The graphic on the right displays this. The amount of pressure required to force the water back through the stem of the leaf is read in bars; the universal unit of pressure measurement around the world. The higher the bars, the drier the leaf is and the more stress the plant is under. This measurement uses the plants own natural defenses against water stress to measure the exact stress the plant is under. When a plant recognizes that water is lacking and the soil is getting drier, it begins to ration the water that is left by slowing down or shutting down important growth processes completely. These actions slow or stop growth in order leaves some water in supply during times of drought. Essentially, the plant is rationing water as it senses its supply is running low. However, at some point the water is gone and death will occur. As this gradual slowing of growth begins, less and less water is taken up into the leaves where it would be used for leaf cooling, photosynthesis and cell development. As the water content of the leaf is reduced, the pressure needed from the pressure bomb to push that water up and out of the stem is increased. Therefore, using the
bomb you create pressure on the leaf and the higher the pressure, the less water in the leaf and the more stress the plant is under at that time.

Chemical Injector and Emitter Plugs

To apply the RainDrops efficiently and automatically, the drip line of the RainDrops treatments were fitted with an EZ-FLO injector that is designed to work under the normal pressures of a drip system. This injector works by the person first filling a pressure tank with the product to be applied. Then, when the system is turned on, the water pressure fills the tank with water and forces the product into the drip line. This tank was attached at the “T” on each of the two treatment rows at each location. RainDrops was then metered out at the specified rate covered in the next section. The entire line was treated using this method and the rate of product was adjusted accordingly based on the acreage it covered. Using this setup, different rows were able to be segregated by the different treatments rather than sectioning the field off into ½ or ¼ section blocks.

To keep the water application as efficiently distributed as possible for the 50% applied water treatment, emitter plugs were used. For the length of eight to ten trees, every other emitter was manually plugged which achieved the 50% application rate. These plugs were used instead of electric valves for three reasons. First the introduction of a valve opens the trial up to mechanical errors due to broken equipment. Using plugs eliminated moving parts and was more reliable. Second, by plugging every other emitter we only treated an area big enough for the trial and not a complete line. Third, a valve would have shut the entire line off and possibly compromised trees that were not being evaluated within the trial.
Methods

The trial began July 1, 2011 and lasted 8 weeks, ending August 15, 2011. This timeframe was chosen due to the timing of hull split and the need to deficit irrigate in an attempt to limit hull rot. Three locations or replications were set up: Site 1, Site 2 and Site 3. Three sites were needed to create replication which ensures that the results are genuine and not influenced by other variables which can occur and influence the outcome at one specific site. 50% RainDrops, 50% Control, 100% RainDrops and 100% Control were the four treatments in the trial. To ensure consistency, each treatment was only placed on the Nonpareil variety and in only mature blocks.

The RainDrops product was injected a total of five times throughout the course of the trial. The trial began with a pre-load application of 20 oz per acre the first week followed by three applications of 16 oz per acre every other week. RainDrops was then injected one last time during the eighth week at a final rate of 20 oz per acre. This last application was applied during the last irrigation before water was completely shut off for harvest. For the duration of the trial, continuous soil moisture readings were taken every 15 minutes along with weekly pressure bomb readings from each individual treatment in each location.

<table>
<thead>
<tr>
<th>Week Number</th>
<th>Injection Rate Per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20 oz.</td>
</tr>
<tr>
<td>2</td>
<td>16 oz.</td>
</tr>
<tr>
<td>3</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>16 oz.</td>
</tr>
<tr>
<td>5</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>16 oz.</td>
</tr>
<tr>
<td>7</td>
<td>None</td>
</tr>
<tr>
<td>8</td>
<td>20 oz.</td>
</tr>
</tbody>
</table>

| 88 oz. Total Per Acre |
Site layout

Each site, while in different locations, was set up identically to avoid any design influences that may affect the trial. Each block was mature and was irrigated using a double line drip irrigation system. As previously mentioned, only the Nonpareil variety was used for this trial. Four rows in total were selected, one for each treatment:

-50% applied water with RainDrops
-50% applied water without RainDrops (Control)
-100%-applied water with RainDrops
-100%-applied water without RainDrops (Control)

At each of the rows or treatments, three (3) sensors were placed at depths of 12, 24 and 36 inches, all well within the root zone of almonds. This totaled twelve (12) sensors at each site. Each treatment was conducted on an individual row consisting of only the Nonpareil variety, adjacent to each other but with one row of almonds between them to act as a buffer. The buffer row was not included in the trial and was only used to segregate the individual treatments. Although, the buffer between and on either side of each treatment was under the same applied water scenario. This ensured that the treatments were not supplemented by water being applied to the rows outside the trial.

One logger box was used to record both of the 50% applied water treatments while another logger box was used to record both 100% applied water treatments. This totaled two boxes per site. A pressure switch was then attached to each drip line on each treatment and then fed into the logger box. This switch signaled the logger box when the system was pressurized. This is important as it confirmed that we had constant pressure during the trial.

In each 50% treatment location, emitter plugs were attached to the drip line to block off individual emitters in an alternating pattern along the row for a length of 8 - 10 trees. This achieved the 50% applied water outcome while still maintaining a fairly uniform water application along the tree row. This helped eliminate any influence from applying the water in a fashion that the root system is not accustomed to. It must be noted that the term “applied water” is used frequently. This term signifies the actual amount of water applied as opposed to what is required by the crop. During this time of hull split, water is reduced from what would normally be needed to satisfy the crop in an attempt to reduce hull split. 100% applied water is
roughly 75% of the Evapotranspiration rate or ET and 50% applied water is roughly 25% of the Evapotranspiration rate during this time of year. Both are a significant cutback, however, 50% is considered a severe cutback from the crop needs at that time.

Pressure bombing the individual treatments was done by selecting average leaves, similar in size, shape and color, from each treatment. Multiple leaves (at least 4) were taken from each treatment and an average pressure bomb reading was calculated and recorded. Due to the profound effect that sunlight intensity has on pressure bomb readings, leaves from each treatment were picked and tested during the same hour each time. This time was roughly between noon and 1 o’clock because this is when sunlight intensity is just right for evaluating plant stress. Taken any later than this, the readings become very unreliable and therefore not very accurate.

Site Descriptions

Site 1 - Site 1 is located south east of Huron, CA. The almond block is a combination of 50% Nonpareil, 25% Aldrich and 25% Monterey varieties and is 7 years old. The block is made up of four different soils: Kimberlina Sandy Loam, Milham Sandy Loam, Westhaven Sandy Loam and Cerini Clay Loam. The almonds are on double line drip irrigation with an application rate of 0.5 in/hr.

Site 2 - Site 2 is located north west of Huron, CA. The almond block is a combination of 50% Nonpareil and 50% Monterey varieties and is 5 years old. The soil in this block is a very sandy loam and much more lightly textured compared to the soil in site 1. It is made up of two soils: Polvadero Sandy Loam and Wasco Sandy Loam. These almonds are on double line drip irrigation with an application rate of 0.5 in/hr.

Site 3 - Site 3 is located just south of Firebaugh, CA. The almond block is a combination of 33% Nonpareil, 33% Wood Colony and 33% Monterey and is 6 years old. The soil in this block is a very heavy clay loam that is much heavier than the previous two soils. This field has only one soil: Cerini Clay Loam. The almonds are on double line drip irrigation with an application rate of 0.8 in/hr.

Although these three sites were similar with respect to tree variety, age and irrigation systems design, the vastly different soils gave us the opportunity to not only test RainDrops but also see how it performed on a variety of different soil textures.

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Individual Site Results

Over the course of the study, it became evident that RainDrops does have a positive effect on soil moisture in both the 50% and 100% applied water treatments as well as the pressure bomb readings. In all cases where RainDrops was used, moisture was held longer in the soil and when rewetted, it went deeper and got wetter than using water alone. The pressure bomb data also showed positive results in both the 50% and 100% RainDrops treatments yielding reduced pressure bomb readings over the course of the trial. In the soil moisture graphs there are two lines which represent the average soil moisture through the profile as measured by the three sensors in each treatment over the course of the whole trial. The Red line is representative of the RainDrops treatments and the Blue line represents the control or water only treatments. Each site has two graphs, one for the 50% applied water treatments and one for the 100% applied water treatment.

The graph containing the pressure bomb data represents the readings collected throughout the trial on a weekly basis. To read this graph, the higher the pressure bomb reading, the more stress the tree is under due to reduced irrigation.

The results from each individual location or site is presented on the following pages.
Site 1 – Soil Moisture Results

50% Applied Water

In the above graphs, it is evident that the RainDrops treatment line (Red) is above the Control treatment line (Blue). Looking at the Y axis, the higher on the graph you go, the lower the centibar readings or the more moisture you have in the soil at that time. Centibars are used to describe the amount of suction pressure that is exerted by the plant to pull the moisture out of the soil and into the plant. The drier the soil is, the more suction pressure that is needed to get the moisture that is present. The wetter the soil, the less suction pressure needed to get the moisture that is present. The above graph demonstrates that when using RainDrops, not only did the soil retain more moisture but is also refilled faster and was wetter than the control treatment or water only as indicated by the lower centibar readings.
The graph above shows the pressure bomb readings taken during the trial. The legend on the bottom gives the color line with the corresponding treatment as well as the dates each readings were taken. The numbers on the left are the pressure readings for each date. Throughout the course of the trial, it became clear that both RainDrops treatments, 50% applied water and 100% applied water, yielded lower pressure bomb readings than that of water alone. It must also be noted that while there were positive results in the 100% applied water section, the most significant difference was in the 50% applied water treatment where RainDrops had the most impact. This provided more proof that RainDrops is beneficial in reducing stress on crops under drought conditions.
Site 2 – Soil Moisture Results

50% Applied Water

[Graph showing soil moisture results for 50% applied water]

100% Applied Water

[Graph showing soil moisture results for 100% applied water]

This graph shows the same results as site 1 but it also gives additional results. In the 50% applied water graph, the RainDrops stayed wetter up until the time water was cut off from the trees for harvest and the soil moisture evened out between the two. When water was then reapplied, RainDrops got wetter and stayed wetter. In the 100% applied water treatments, it is noted that the RainDrops did not get as wet as just water after the driest period. However, the graph shows that the RainDrops held the moisture more evenly during those dry periods. This indicates that the RainDrops still retained more of the moisture that was applied over using water only.
The pressure bomb readings here show that there is still a very significant change when using RainDrops. The 50% applied water without RainDrops peaked at 36 centibars while the 50% applied water with RainDrops peaked at 29 centibars. That is a 20% reduction in pressure bomb readings over plain irrigation water. The 50% RainDrops treatments was more closely aligned with each of the 100% applied water treatments.
At site 3, differences were more noticeable compared to the other sites. The 50% water treatment showed that RainDrops actually had a drier profile compared to the control treatment. After careful investigation, it was found to be related to drip line movement during harvest and lower emitter flow which is explained below. This soil moisture data reflected the opposite of what the pressure bomb data gave. The pressure bomb data is similar to the other sites in showing that RainDrops gave us a lower pressure bomb reading compared to water alone.

The reason for the drier profile with the RainDrops 50% applied water treatment was purely cultural and mechanical. First, as can be seen in the following photos on page 21, when the grower began to prepare for harvest, he pulled the drip lines up onto the berm to keep the
line out of the way of the sweepers. When this was done, the 50% RainDrops drip line was pulled about 1.5 feet away from the sensors. However, the anchors which held the control treatment drip line stayed in place right above the sensors. This distance affected the readings of the soil moisture sensors because the wet area was moved to a different location. The sensors were then located on the outer edge of the wet area resulting in readings that were significantly drier than they would have been if they were in the wet area under the feeding drip line. It was surprising that the sensors read that much moisture being that far from the drip line. This is more evidence RainDrops aided in soil moisture retention and movement since water alone would have yielded much drier numbers. Due to this equipment malfunction and not the performance of RainDrops, the data in this set was not used in the final analysis of RainDrops. Pictures and descriptions of the treatment in question follow on the next page.

Second, there was also a problem with emitter flow. A system evaluation was conducted on each of the trials and on this particular 50% applied water RainDrops location, the emitters put out less water that the 50% applied water Control treatment at this location. The 50% applied water RainDrops drip line emitters put out an average of 250 mL of water in 5 minutes but the 50% applied water Control treatment drip line put out an average of 310 mL of water in 5 minutes. This is a reduction of 20% in water flow over the length of the trial for the 50% applied water RainDrops treatment in comparison to the 50% applied water Control treatment. A 20% reduction in the amount of water applied is very substantial. The soil would be expected to be much drier but with the addition of RainDrops, it was only marginally drier than the 50% applied water Control treatment.
This picture is of the 50% Control Treatment sensor location. The sensors are placed underground, right beneath the feeding drip line is right above it. The line on the bottom does not conduct any water since it is there to only protect the wires that go from the sensors to the logger box above.

This picture is of the 50% RainDrops Treatment sensor location. This location shows the sensors on the bottom with the protective drip line. Note that the protective line was slightly disrupted, exposing the bright green sensor wires that are barely noticeable. The feeding drip line was pulled up on to the berm during harvest preparation thus moving it over a foot away from the sensors.
The pressure bomb readings above show that each of the 100% water treatments were similar until about July 27, 2011 when the RainDrops Control treatment reached 25 bars. This similarity between readings is the cause of two factors. This grower irrigates in a different fashion as he runs near full ET amounts of water, only reducing water right before shaking where water is then cut off completely at which time the pressure bomb readings go up for the Control treatments. The soil here is also very heavy clay. This heavy soil will retain more moisture and take longer to dry out compared to lighter, sandy soils. According to the graph, the 50% applied water RainDrops treatment had pressure bombs reading below the 100% applied water Control treatment. This pressure bomb data conflicts with the soil moisture data in this one particular site due to the accidental drip line adjustment made during harvest preparation. As can be seen in the graph, the soil moisture sensors may have been compromised during the trial, but the RainDrops was still being injected into the root zone where it continued to work in the soil and lower stress on the trees.
Average Trial Results

The previous results pages focused on individual site results. The following pages give the results of the average pressure bomb and soil moisture data are listed on the following pages and show that RainDrops is a valuable product not only for times when water is limited but also in times when water is abundant.

Average Overall Pressure Bomb Readings

This graph shows the average pressure bomb data for the whole trial. Lower numbers indicate less stress on the plant and the readings are on the left side of the graph. The Green represents the Control treatment or water alone and the Blue represents the RainDrops treatment. RainDrops averaged 20% lower pressure bomb readings when only applying 50% of the applied water and 13% lower pressure bomb readings when applying 100% of the applied water. This indicates that RainDrops is beneficial in both drought and normal irrigation situations.
The graph above shows the results with the Green bar being the control treatment and the Blue being the RainDrops treatment. The centibar readings are on the left side of the graph and as with the pressure bomb, the lower the numbers, the more moisture available for plant growth. Soil moisture shows good results with the use of RainDrops. The 50% applied water RainDrops treatment resulted in 27% lower centibar readings. That was nearly a 30% gain in soil moisture. The 100% RainDrops treatment resulted in an average of a 35% decrease in centibar readings over water alone. That was a 35% increase in soil moisture over using water alone.
Conclusions

After evaluating all the benefits and seeing the results of the trial, our overall opinion of RainDrops is very favorable for use in almonds, and other crops, during periods that would result in drought stress. These times would include hull split, harvest, extended irrigation intervals or any other time when water applications are reduced and stress is created. RainDrops also excelled when the crops water needs were met and the crop was under little to no stress making it just as valuable when water reductions are not in place.

Throughout this trial, RainDrops was tested and yielded positive results during hull split and the resulting stress that is created. It became evident that the benefits of using RainDrops during irrigation are:

- Increased moisture holding capacity
- Increase in soil moisture retention
- Increased water penetration; especially when irrigating very dry soils
- Lower overall plant stress levels during various soil moisture situations
- More consistent wetting and drying patterns
- Increase in overall plant viability
- Ability to expand irrigation intervals
- Increase in overall irrigation system efficiency
- Deeper soil profile maintenance throughout the season

In conclusion, it is our opinion that RainDrops is a very good product that fills a need during almond hull split. It also has a place in the agricultural market regardless of the location or irrigation method. Its relatively low cost, ease of use, safety and compatibility makes it an excellent choice for any irrigation need. Throughout the trial, it proved beneficial in both lowering crop stress and enabling the soil to increase its water holding capacity and retain more moisture in the soil profile over longer periods of time. It is for these reasons that we would recommend this product to a grower for use during almond hull split to reduce crop stress, overcome other water related stress situations or to increase the overall crop and water use efficiency.

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Supporting Information

The following pages, we have included more general information about the trial and the locations. This information is not related directly to the execution of the trial but is included here to provide supporting and background information on the trial locations and other benefits that became clear during the trial.

The above picture is of a tree that is in one location of the 50% control part of the trial where RainDrops is not being applied. Notice the amount of split that took place. This is much more advanced than other areas of the block. The increased amount of stress is causing split to occur much faster. Also, the tree visibly looks much drier with leaves hanging very low. The leaves also exhibit a rubber like appearance and feel that is seen under severe drought situations. Tree defoliation is also beginning.

Here was the 50% part of the trial in the same location but with the RainDrops added. Notice that the split is much less than the control treatment above. It is hard to notice from these pictures but the entire length of this row that is being treated with the RainDrops is splitting at a much slower rate compared to the control. This is good as it is just one more indication that the RainDrops product alleviates stress under low water conditions. This area is much closer to the 100% water applied treatment in regards to split progression. Even under a very significant reduction in water, it was not able that the tree was under substantial stress when comparing it to the 100% applied water treatments.