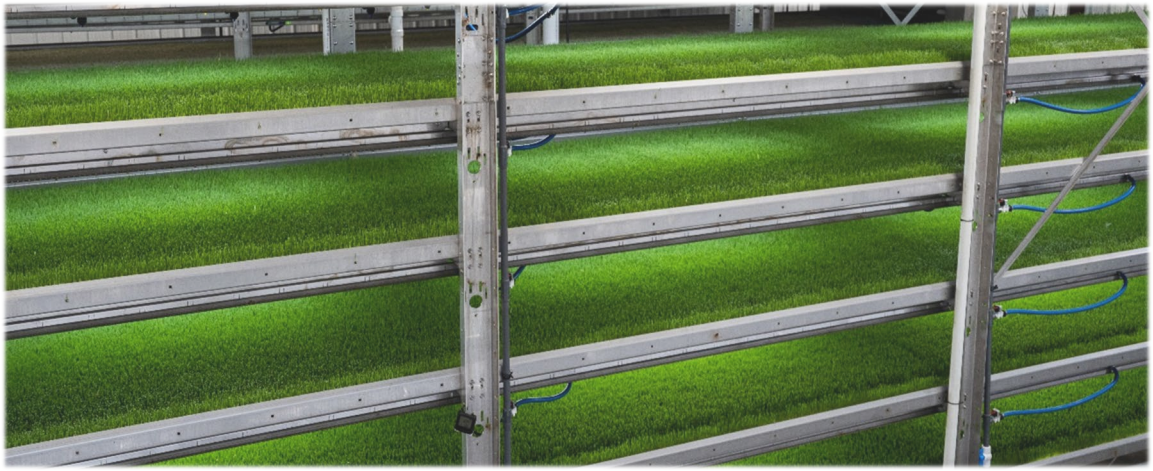
hydrogreen
NUTRITION TECHNOLOGY

A DIVISION OF CUBICFARM SYSTEMS CORP.

HydroGreen Producer Education

Crop Training

SEED TO SUPER FEED IN ONLY 6 DAYS



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V 1.1

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System Safety

Safety is our number one priority here at HydroGreen. Please follow all procedures listed below and in the owner's manual to ensure that you are safe and prevent injury when using the HydroGreen System.

1. Read the entire owner's manual prior to operating the HydroGreen System.
2. Do not reach into the system during harvest and seed out to prevent injury.
3. Always use the Lock-Out-Tag-Out procedure when performing maintenance on the machine.
4. Be cautious around all moving parts when they are in motion.
5. Read and understand all safety procedures.
6. Wear safety glasses when operating the system.
7. Wear ear protection when harvesting the machine.
8. Use caution walking near the system as the floor could be wet.
9. Use hydrogen peroxide safe handling procedures: Refer to Section 8 in the Hydrogen Peroxide SDS.

Before operating your new HydroGreen Growing System, please read the owner's manual in its entirety and follow all instructions! Restrict the use of your HydroGreen system to users who have read, understand, and can follow all operating instructions, precautions, and safety rules. HydroGreen Global Technologies is concerned about the safety of the operator and anyone else who could come in contact with the HydroGreen Grow System. The HydroGreen Grow System is designed and manufactured with built-in safety features to protect both operators and service technicians.

Before starting your system, verify that the warning labels pictured in this manual are in place as indicated, and are both legible and clearly visible.

Please contact HydroGreen if replacement labels are needed.

Growing Sprouted Grains

The Goal

The HydroGreen DGS and GLS systems are designed specifically around small grains. The grain density, nutritional value, consistent performance, ease of use and availability are highest with wheat and barley. The goal of HydroGreen Feed producers is to grow a fresh healthy crop that meets production requirements while being nutrient dense and free from disease or problems.

The expectation is that we achieve the following:

Expectations for HydroGreen Feed		
Item	**Wheat**	**Barley**
Seed to Feed Ratio	1:4	1:5
Dry Matter Percentage	22%	19%
Total Sugars	>28	>25

We can find success in this goal by making educated decisions in key focus areas.

The key areas of focus are:

1. Grain Selection
2. Grain Density
3. Environmental Conditions
4. Water Schedule
5. Crop Troubleshooting

As you go through this manual you will learn how to grow a high quality HydroGreen feed that meets your requirements. Please contact HydroGreen Support Staff if you have any questions or if you need any further assistance with your crop.

HydroGreen Support Staff
Email: HGinfo@hydrogreenglobal.com
Phone: +1 605-277-7271

Grain Selection

As mentioned previously, wheat and barley are the recommended grain types for use on HydroGreen DGS and GLS systems. Both grain types absorb water quickly, have a high density on a square foot basis, and are readily available where DGS and GLS systems are installed.

Discovery

Grain selection for use in HydroGreen DGS and GLS systems is based on several factors. Daily grain quantity requirements must be determined first. HydroGreen will then provide producers with a list of top performing varieties. Afterwards, the producer and HydroGreen team should determine what grain is readily available to assess the economics of the grain purchase and logistics of obtaining it. It is recommended that 2-3 readily available, grain varieties are found. Once found, the Variety Screening process will begin.

Variety Screening

Steps:

1. Obtain a sample of each variety, 6 lbs minimum.
2. Fill out a Sample Submission Form (see appendix) for each variety.
3. Seal each seed sample, with its submission form, in a zip locked bag.
4. Place samples and the submission forms in a box.
5. Send package to the following address:

   HydroGreen Research
   47172 Haylie Street
   Sioux Falls, SD 57107

The HydroGreen R&D Team will then test each sample for germination percentage, vigor, and performance. This process will take approximately one week from the date of delivery. At the completion of these tests, results and a complete nutritional analysis of each variety will be returned to the producer via email.

It is recommended that grain is tested at least a month in advance of start-up or switching grain varieties. This way we can ensure peak system performance.

Continued Support

After systems have been installed and are functioning, producers must provide regular communication on crop performance and system operations to receive full HydroGreen support. HydroGreen customer support staff will provide regular support to evaluate crop production, system performance, and continued customer education/training. As grain variety availability changes, producers must collaborate with grain suppliers and HydroGreen R&D Team to review alternative options and evaluate new varieties.

Key Performance Factors

Germination Percentage

Grain with germination percentage less than 95% will still absorb water but will not sprout. This leads to soaked, rotting grain, poor crop performance and feed quality.

Purity

Grain with purity less than 97% will have reduced feed nutrition values and inconsistent crop performance.

Foreign Material

Any Foreign Material (FM) in sourced grain will have a negative impact on crop performance and system cleanliness. FM includes weed seed, chaff, stems, dirt, stones, and other seeds. Having excessive FM on the DGS or GLS system will lead to decreased total grain density per square foot, plug drains, contaminated water, mold growth, and increased insect pressure. This ultimately leads to poor crop growth.

Disease and Insects

Disease and insect issues from field production can carry over to HydroGreen crop production and negatively impact feed quality. Insect damaged grain will likely have poor or no germination as well as disease issues. Disease

issues in field produced grain can potentially lead to dangerous levels of vomitoxin if fed in high quantities to livestock. Cleaning grain will help reduce the levels of both insect and disease damage.

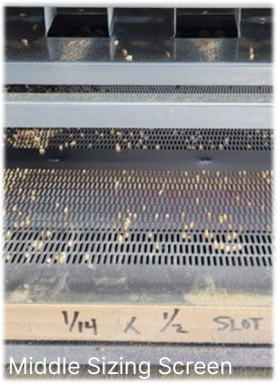
Grain Cleanliness

Cleaning grain prior to adding it to a DGS or GLS system will add to the crop quality and performance. Commercial grade grain cleaners improve quality by grading the grain to a specific size, removing most FM, disease/insect damaged kernels and dust.

Commercial grain cleaners that accompany most DGS and GLS systems have 3 levels of cleaning screens as well as dust collection. The top scalping screen typically removes larger material from the grain including hulls, sticks/stems, oversized FM. Level 2 and 3 have sizing screens that grade off light material (FM), smaller kernels, damaged and diseased kernels, dust, and insects. Screen sizes can be changed out based on the size of the grain being graded. Customers must work with HydroGreen R&D on proper grain grading and screen selections.

Customer and HydroGreen personnel should complete a new form and collect a representative sample of the grain that will be sourced and/or used in the DGS/GLS system. Failure to collect samples, complete sample form and submit to HydroGreen R&D for testing prior to grain purchase and delivery to customer site may result in unsatisfactory crop production and lowered expectations due to multiple unknown variables previously mentioned.

Top Scalp Screen



Middle Sizing Screen

Grain Density

The goal for HydroGreen producers is to maximize the conversion of complex sugars to simple and the value of how that specific product delivers to the ruminant fermentation processes. By maximizing the mobilization of carbohydrates and minimizing stress, we reach unique glucose and sugar levels. This enables HydroGreen producers to maximize dry matter yield, and the application in the ruminant fermentation process. The glucose yield per square foot for wheat and barley increases until ~2.5 lbs/ft^2 and quickly decreases thereafter.

Recommended Grain Densities				
Variety	**Unit**	**Minimum**	**Maximum**	**Recommended**
Wheat Grain Density	lbs/ft^2	1.5	2.7	2.5
Barley Grain Density	lbs/ft^2	1.3	2.6	2.4
Wheat Grain Density	g/ft^2	680	1225	1150
Barley Grain Density	g/ft^2	630	1175	1100

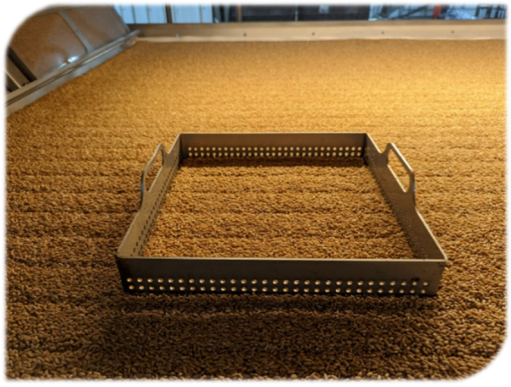
This grain density allows for successful hydration of the grain early on and minimizes heat accumulation and stress. What's unique is the correlation to dry matter yields. Most would think that putting more grain on the system will result in more of the HydroGreen Product. That's simply not the case, the highest dry matter yields are correlated to producing the most glucose per square foot. **Putting more dry matter (grain) on the table does not increase dry matter output.**

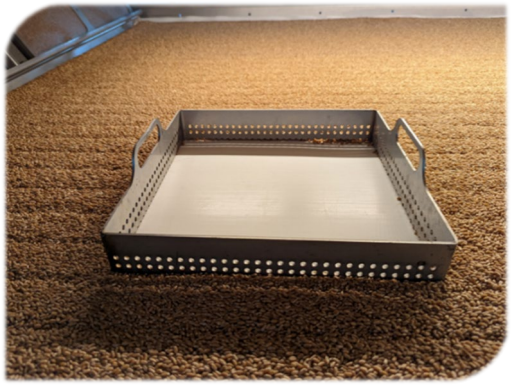
For example, at 3 lbs/ft^2, there will be dry matter loss of about 5-10%. At 2.5 lbs/ft^2 we'll see gains of 10-15%. That's just from a pure dry matter perspective. The value of those crops is also very correlated to these types of changes. It is critically important that we do not over or under apply grain on the system. This will help in our goal to maximize glucose production per square foot.

Measuring Grain Density

Check grain density often, especially with a new load of grain, a change in grain variety, or a significant change in outside temperature or humidity. These scenarios will change the grain density on your HydroGreen system.

To measure grain density, you need a square-foot tool. If you do not have one of these tools, please contact us and we can send you one. It is important to replicate these steps on the high and low side of the table.



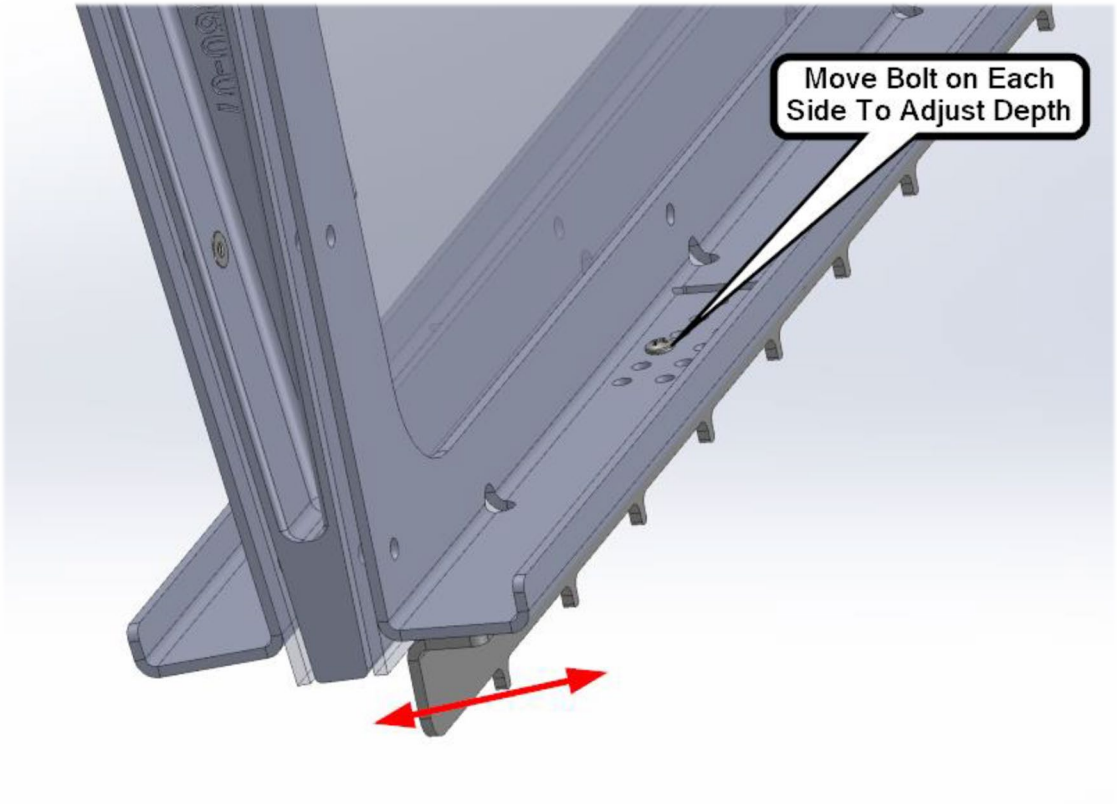


1. Seed out the table as normal and pause it after 3 feet or so.
2. Place the square-foot tool on the seeded-out portion of the table.
3. Vacuum out the entire contents of the square-foot tool.
4. Weigh the contents.
5. Do this on the high and low side of the table.
6. Adjust the seeder as needed. (See below)
7. Repeat steps 1-6 until you get the desired seed density evenly across the table

Adjusting Grain Density

The HydroGreen seeder is designed to give the operator complete control over grain density. This is done by adjusting the seeder to increase or decrease grain depth. Grain depth adjustments will either increase or decrease the amount of HydroGreen ultimately harvested. HydroGreen recommends setting the seeder to place seed on the belt at depths between ½-¾ inches as a starting point and then measuring the grain density as described above and adjusting as needed to achieve a grain density of 2.5 lbs/ft^2 or 1150 g/ft^2 for wheat or of 2.4 lbs/ft^2 or 1100 g/ft^2 for barley.

The seeder can be adjusted by moving the seed rake forward or back and securing the desired position with a bolt on each side through aligning holes. If you cannot achieve the desired adjustment, flipping the rake is a possible solution. See the illustration below.



Environmental Standards

The ideal HydroGreen Crop begins with the right grow room environment. It is essential for key variables, such as temperature, air movement, water schedule, and humidity, to meet the ideal growing conditions for small grains. Small changes in these key variables can have noticeable changes in physical appearance and nutrient composition during the grow cycle. If not managed properly, these key variables, general machine maintenance, and cleaning, can result in poor crop performance. These factors can be connected and could lead to independent concerns, but when trying to troubleshoot problems remember to review all environmental aspects that it may be related to.

Temperature

Temperature is an important factor to manage as it has a great effect on the products' growth and nutritional value.

Maintaining the environment at about 65°F at 140 hours of growth, allows the grain to optimize its nutritional value and genetic potential. If the temperature is too high, the nutritional value of the fodder will decrease. Along with providing a growing environment to support optimum development, care should be taken to avoid product heating at the end of the growth cycle.

Air movement

Managing air movement can help your growth as well. It is important for air movement to be as uniform as possible within the grow room and along the tables. Air movement helps regulate the temperature of the sprouted grains and helps create a uniform crop across the table. Sufficient airflow throughout the grow room is needed to ensure that the micro-environment surrounding the plant is approximately equal to the entire grow room environment. Use an anemometer to measure air flow.

Humidity

Humidity is needed to support proper uptake of water early during development but can be a hindrance to more developed sprouted grain. Maintaining humidity as specified below ensures proper development while avoiding product heating concerns.

Hydrogen Peroxide (H_2O_2)

It is important to use the correct concentration of hydrogen peroxide. Hydrogen peroxide helps prevent mold and bacteria buildup that will create issues with crop performance and water drainage. If the concentration is too high, it can stunt the crops' growth.

Cleanliness

Keeping your grow room and grow systems clean is an important key to success. Refer to the Grow Room Cleaning Checklist included in appendix of this booklet.

Key areas include:

a. Harvest Area
b. Belts and Conveyors
c. Gutters
d. Moving Parts
e. Floors

Ideal Growing Conditions

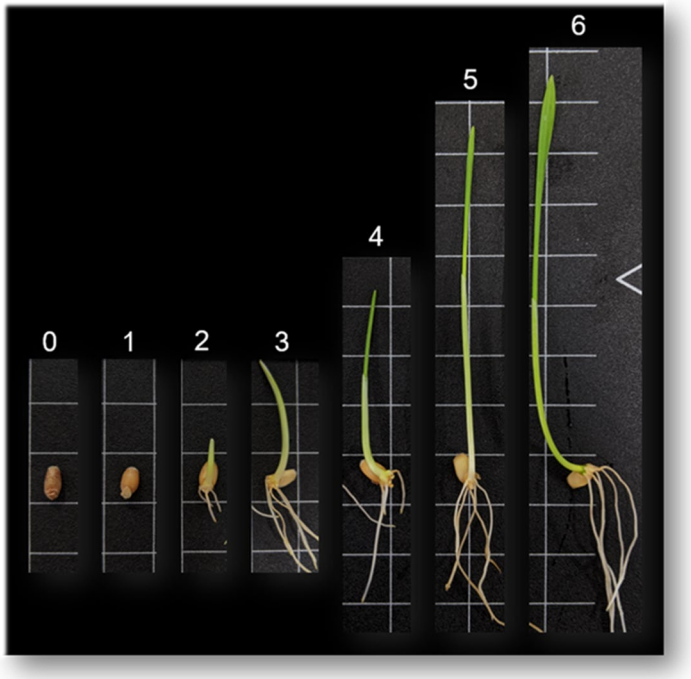
RANGES WILL VARY BASED ON YOUR SPECIFIC GRAIN VARIETY AND LOCATION

Variable	Unit	Min	Max	Recommended
Environment				
Air Temperature	°F	63	72	65
Crop Temperature	°F	68	74	71
Humidity	%	40	75	65
Air Movement	CFM	50	200	100
Carbon Dioxide	ppm	0	1000	800
Light Duration	hours/day	12	24	18
Water				
Water Temperature	°F	55	85	65
pH	pH	5.8	7.8	6.8
H_2O_2 – Maintenance	ppm	50	180	80
H_2O_2 – Disinfectant	ppm	1000	3000	2000
Salinity	ppt	0	1000	500
Nitrate	ppm	NA	NA	<200
TDS	ppm	0	1000	500
TSS	mg/L	NA	NA	<5
TOC	mg/L	NA	NA	<25
Grain				
Grain Density – WHEAT	lbs/ft^2	1.5	2.7	2.5
Grain Density – BARLEY	lbs/ft^2	1.3	2.6	2.4
Grain Density – WHEAT	g/ft^2	680	1225	1150
Grain Density – BARLEY	g/ft^2	630	1175	1100
Growth				
5-day Grow Duration	hours	110	120	116
6-day Grow Duration	hours	135	145	140

Stages of Growth

1. Hydration

- The grain absorbs water which causes it to swell.
- This process is affected by factors such as temperature, humidity, and the seed's physical and chemical properties.
- The absorption of water is a critical initial step to proper sprout development.



2. Metabolic Activation

- After proper hydration metabolism begins, and the seed comes out of dormancy.
- This triggers the production of enzymes that break down stored starch into smaller and easily digestible molecules that are needed for respiration in the cells.
- These molecules are then transported to the embryo for further use.

3. Germination

- The emergence of the radicle through the seed coat is the sign germination has begun.
- The coleoptile (protective covering of the stem) and lateral roots emerge next.
- This process also triggers the metabolism and breakdown of stored molecules to rapidly increase.

4. Seedling Development

- As the plant grows, it breaks down stored molecules which provide energy for the rapid growth of both stem and roots.
- Once the plant has true leaves, it will produce more pigments for photosynthesis, which helps it to make more food for itself.

5. Harvest

- The goal is to harvest the most nutritious sprouts possible, as soon as possible.
- This means that we want to encourage water absorption and metabolic activity.
- However, we want to harvest the sprouts prior to the start of photosynthesis.
- Photosynthesis will reduce the nutrient availability of the sprouts.

Water Schedule

Water management is critical to the success of a HydroGreen system. Manage this using the system's control panel. The schedule will differ based on the variety of grain used and is simplified into three different phases. The key is to adjust the watering schedule according to each of these phases and their individual objectives.

The three phases of the water schedule are:

Phase 1

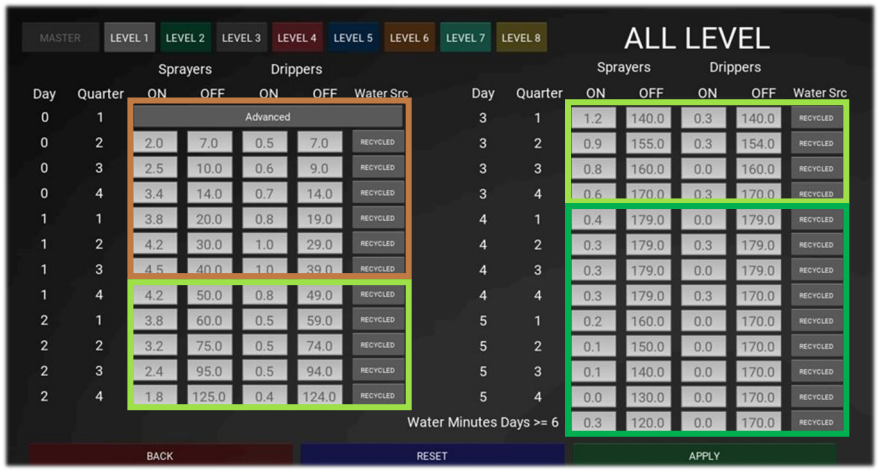
Hydrate the seed as rapidly and as uniformly as possible.

Phase 2

Avoid stress by providing the minimum amount of water and allowing for complete, efficient, and thorough drainage.

Phase 3

Avoid secondary fermentation and accumulation of heat on the belt.



Phase 1 (0-36 hours)

The objective in phase 1 is to hydrate the grain rapidly and uniformly. The grain should be checked at the 24-hour mark for uniform radical protrusion. Using a straight edge on the high side of the table pull back and evaluate the grain from top to bottom. If any grain is not hydrated, the watering duration should be increased. Do this in increments of 1/10 of a minute. For instance, if the sprayers are on for 2 minutes every 7 minutes, increase the duration to 2.1-2.3 minutes every 7 minutes. Conversely, if erosion is occurring, reduce the duration to 1.8-1.9 minutes every 7 minutes. Adjust and evaluate until the grain is thoroughly saturated without erosion.

Phase 2 (36-75 hours)

The objective in phase 2 is to avoid stress by providing the minimum amount of water needed and allowing for complete, efficient, and thorough drainage. Apply water just so it reaches approximately 60-70% relative moisture content in the middle of the grain bed. The product should feel slightly damp when touched. If your fingers feel very wet, reduce the water. If water is seen on the bottom of the belting, cut back water rapidly. If there is worry that not enough water is being applied, as long as brown discolorations on the roots are not seen, everything is fine. This promotes root development and most importantly, mitigates stress.

Phase 3 (75-140 hours)

The objective in phase 3 is to avoid secondary fermentation and accumulation of heat on the belt. Temperatures should not reach 80°F anywhere, at any stage of development. 68-74°F, should be the target. If temperatures do surpass 80°F, measures need to be taken to manipulate control factors to reduce heat accumulation as these conditions may lead to mold development. In terms of the water schedule, in this phase a very slight spritz is all that is needed, about 6-12 seconds every two to three hours. Then allow low humidity and air movement perform as an evaporative cooler and wick the heat away. If that does not work, try decreasing grow room temperature and humidity, and/or adjusting air movement.

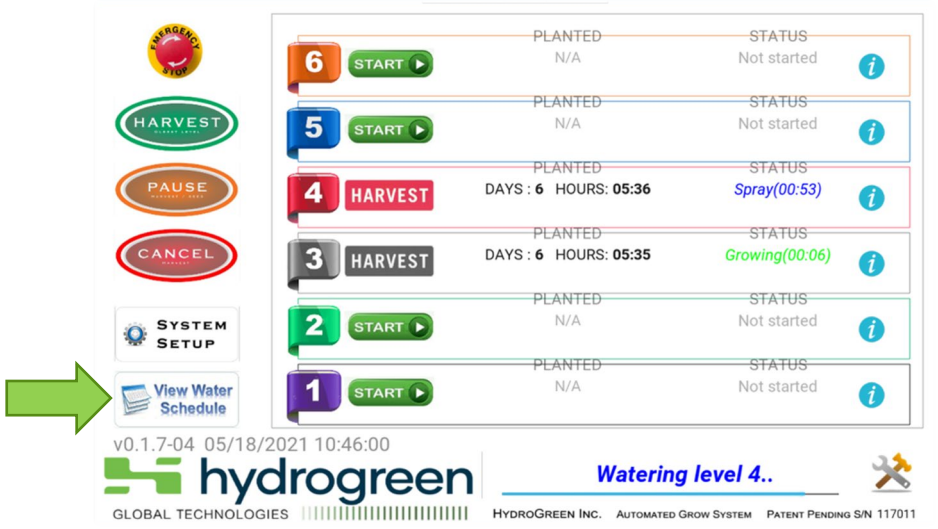
Water Quality

Hydrogen peroxide is essential to the system. It acts as a plant signaling compound and a disinfecting agent. If you're not applying hydrogen peroxide on the system, you're not capturing the full value of the system. Ensure you are always at about 80 ppm. If you're having a difficult time, and the sprouted grain is under stressful conditions, increase this to 100-180 ppm.

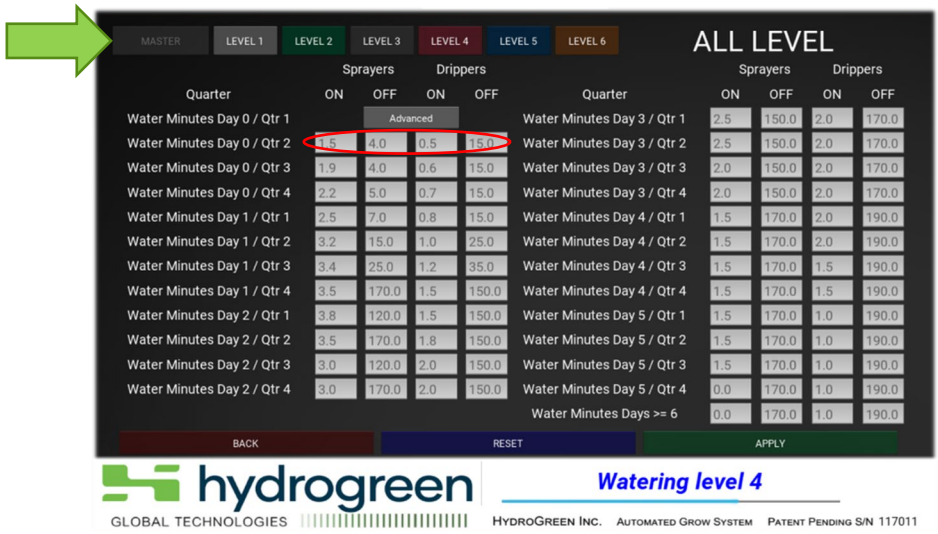
Adjusting the Water Schedule

HydroGreen Grow Systems come equipped with a default water schedule designed to serve as a starting point for a small grain crop produced using recommended settings. Alterations in seeding depth, crop, crop variety, and environmental conditions will likely necessitate changes from the default water schedule setting. To change and adjust the water schedule on a HydroGreen Grow System follow the instructions outlined below.

1. By selecting the “View Water Schedule” button, you can view and modify the current watering schedule of each level.

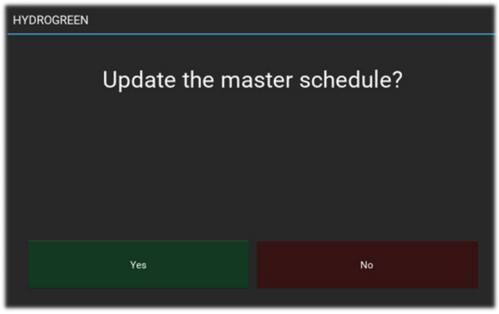


2. To modify the water schedule for all levels, select the “MASTER” tab. Alterations to this schedule can be applied to all levels simultaneously. In most situations, changes to the “MASTER” tab are recommended to improve consistency of the daily HydroGreen output. If changes to a specific level are desired, this can be accomplished in a similar manner by selecting the level of interest.

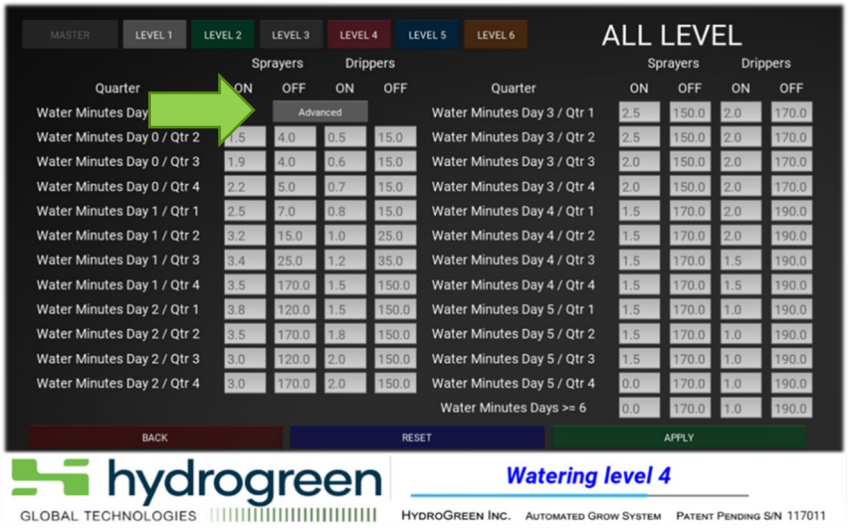


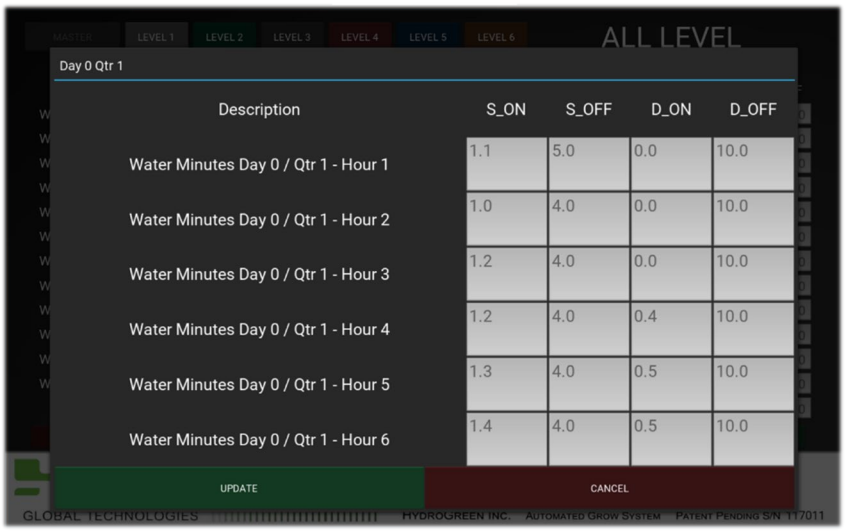
3. Change the water schedule to meet desired objectives. Guidelines for modifying the water schedule are included earlier in this document. The four columns within each quarter represent overhead spray on duration, overhead spray off cycle, dripper on duration, and dripper off cycle, respectively, in minutes. Values of 1.5, 4.0, 0.5 and 15.0 above translate into the overhead spray nozzles turning on every 4.0 minutes for 1.5 minutes of output along with the drippers initiating every 15.0 minutes for 0.5 minutes of output.

4. Save water schedule changes by selecting the “APPLY” button. A prompt will appear asking if you want to update the master schedule; select “Yes”.



5. Select the “Advanced” button on the MASTER sheet. This will allow the modification of the water schedule for the first six hours of growth in an hour-by-hour fashion. Once the desired advanced schedule has been set, select apply and update as previously completed.





Feed Troubleshooting

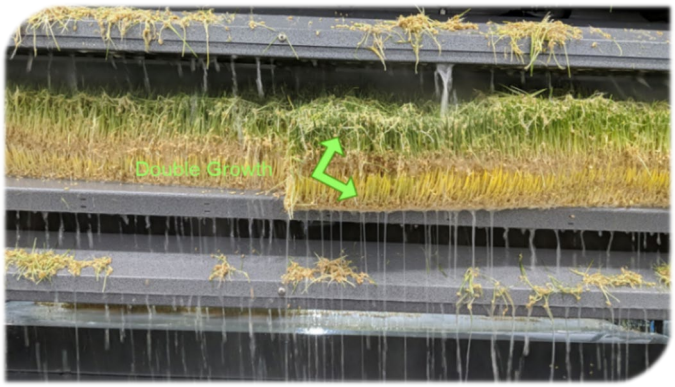
Crop growth troubleshooting should begin with inspecting your grow room environment to ensure temperature, humidity, and other key variables are meeting the ideal growing conditions for small grains (see table on page 8). Small changes in temperature and humidity can have noticeable changes in physical appearance and nutrient composition over a six day grow cycle.

HydroGreen crop performance is affected by each of these factors including as well as machine maintenance, and cleaning. Troubleshooting any suboptimal crop should involve reviewing all environmental aspects connected to the issue. HydroGreen support staff should be consulted for optimum system and crop production support, as each DGS or GLS system is unique and requires independent management.

The main crop performance issues are:

Double Growth

Double growth is two layers or separation of growth, one on top of the other. This can lead to difficulty harvesting and inconsistency in growth and nutritional value.



Causes:

Double Growth occurs when the grain fails to be uniformly hydrated due to inadequate water delivery during the first 36 hours of growth.

As seen in the photo the top growth was at a harvestable stage on day six while the double growth on the bottom started 1-2 days after initial seed out. Feed quality and consistency will suffer due to the delayed secondary growth.

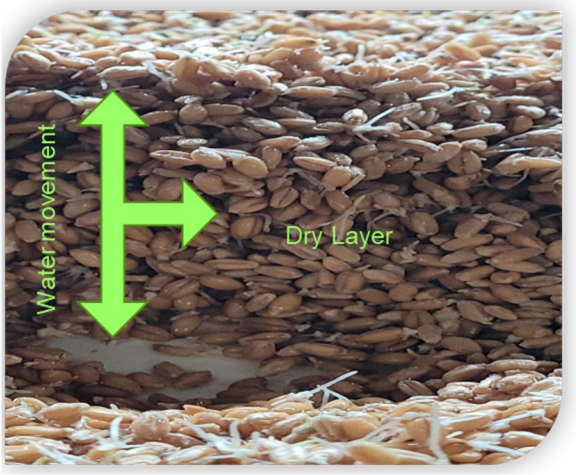
Prevention:

Properly adjusting the system's water schedule will help prevent this issue. Grain hydration should be reviewed after the first 24 hours. Beyond the first 36 hours improper or shallow watering could result in double growth and/or dry pockets of grain.

To inspect grain imbibition after 24 hours of growth:

- Separate the grain bed layer on the high side of the table and inspect for uniform grain hydration.
- If the bottom layer of grain is dry, adjust the water schedule accordingly.
- Remember, the water schedule can vary on different types of grain varieties.

For proper grain hydration, it is important to ensure that the grain is uniformly wet within the first 24 hours. If the top portion of the grain bed takes up water before the bottom, or if the middle portion remains dry, it indicates uneven water distribution. To achieve uniform hydration, adjust the water schedule to increase water throughout the grain bed.



As you will see in the photo, the middle layer of grain is still dry due to poor water schedule settings as well as excessive grain density. In this situation the grain density should be reduced, and the water schedule should be adjusted for both the sprayers and drippers. The water will eventually meet in the middle as it soaks down from the top and up from the bottom. Remember the water schedule will vary with different types of grain such as barley, hard red wheat, and soft wheat.

Heating

Heating is considered an issue when the temperature of the mat of sprouted grains is between 85-90°F. Excessive heat will lead to other issues including hot spots, mold, fermentation, and bacterial growth.

Causes:

- Water schedule may be too aggressive towards the end of the growth cycle.
- The environmental temperature is too high.
- Inadequate airflow is creating microclimates.

Prevention:

Monitor the temperature of the sprouted grains during the third quarter of growth.

- Check by pulling back a part of the leaves to expose the surface of the roots.
- Use an infrared temperature reader to check the temperature. (68-74°F is recommended)
- Check bottom of developed crop/root growth for "hot spots."
- If heating is found, adjust the water schedule in the last few quarters of the growth cycle as well as the temperature of the room. Check different areas of each table to verify uniformity.

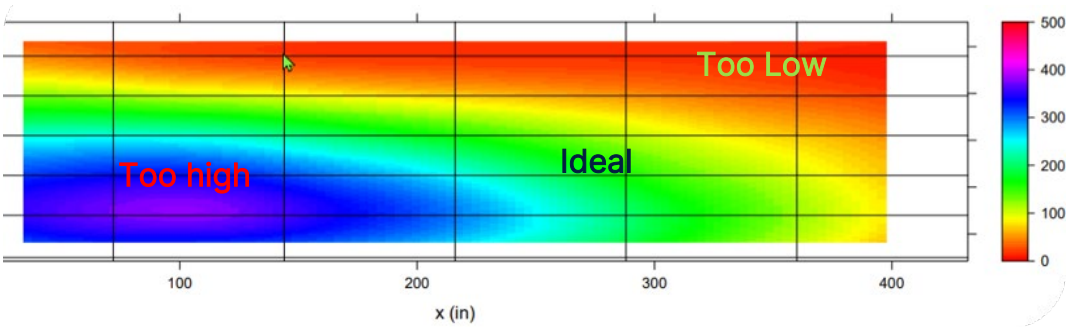
Monitor the airflow of the crop throughout the entire growing cycle.

- Use an anemometer to check different areas on each level to determine airflow and dead spots. (75-125 CFM is recommended)
- Adjust fan location to move airflow across all levels.
- Add fans if needed to improve overall airflow.

Crop Heating, mold, fermentation, bacterial growth, and hot spots can occur with a high room temperature, poor air flow, and an aggressive late watering schedule. When the crop is near harvest, any excessive water and other microclimate issues combined will increase the heating problem. Any irrigation in the last 36 hours should only be used to keep the crop cool until harvest. Drippers should be used minimally to avoid root heating.

Ensure that the system is free of stagnant air as this could cause heating due to crop growth and inadequate airflow. Microclimates will develop and increase the air and crop temperatures.

As seen in the chart below, too much airflow at the bottom of the system (blue), while keeping the crop cool, will have a negative impact. Areas in red show stagnate airflow and potential areas for development of hot microclimates. The ideal areas in green show proper airflow which will aid in the proper crop production. If necessary, adjust or add fans to improve airflow across all tables.



Erosion

Erosion is when the mat of grain shifts or flows towards the low side of the table. Erosion of grain on the system can lead to uneven poor crop growth, no growth, clogged drains, and flooding.

Causes:

- An aggressive water schedule in the beginning of the grow cycle.
- High water pressure.
- Grain density is too low.

Prevention:

- Check the grain depth, water schedule, and/or water pressure.
- Verify that everything is within tolerance for the specific grain being used and adjust accordingly.
- Observe the sprayers early in the growth cycle to determine if the pressure is excessive and adjust where needed.
- Check drains to ensure that openings are not clogged which can cause flooding further into the growth cycle.
- Remember, these factors can vary depending on the variety of small grain being used.
- As a temporary solution, move along the table using your hand to remove grain from blocking the drains.

Flooding

Flooding occurs when water is not able to leave the table due to plugged drains from grain, bacteria/fungus buildup, or improper belt position on the low side of the table. When this occurs, crop production is poor and may lead to harvest issues especially if the belt is riding up on the low side. Any bacterial/fungal growth in the drains can expand into crop production if not properly managed. It is important to monitor the tables to determine the cause of flooding.

Causes:

- **Erosion** – causing clogged drains.
- **Belt Blocking** – belt riding up on the low side of the belt blocking the drains.
- **Bacteria** – bacteria or fungus in the drains will clog them.

Prevention:

- **Erosion:** when erosion has occurred resulting in clogged drains, as a temporary solution, use your hand to move the grain away from the drain holes to allow water to properly flow out. After harvesting, adjust the water schedule and/or grain depth.
- **Belt Blocking:** If the belt is riding up the low side as the machine is being seeded out, reposition the belt to ride true. If you are usure of how to do this, please call HydroGreen Customer Support.
- **Bacteria:** If bacteria or fungus is plugging drain holes and gutters, use a scrub brush and chlorine solution along with water to remove all foreign material and disinfect the drains and gutters. Repeat this cleaning process on a regular schedule to prevent buildup of unwanted bacterial growth.

Fermentation

Crop Fermentation can occur during the late stages of growth, prior to harvest, due to excessive watering during the last hours. The roots of the crop will be extremely wet or saturated and will have an acidic or vinegar type order. Once the crop has reached this point it will be difficult to harvest and crop heating may occur. Crop quality is likely to be reduced due to these conditions.

Causes:

- Too much water is administered towards the end of the growth cycle.
- As the sprouted grains grow, they will hold onto the water which can lead to fermentation, heating, and underdeveloped grain.

Prevention:

- Adjust the water schedule during the last quarter of the growth cycle.
- Cut a few small squares in different areas and observe the root structure, its moisture content, and any unusual order. Roots should be damp and firm, not saturated and mushy. You should be able to see the root structure if it is ideal. Fermented roots will be a solid mat of mush.

Uneven Growth

Uneven Growth is random patches of underdeveloped grain or "hills" along the mat of sprouted grain. When this occurs crop production suffers, processing efficiency is reduced, and system economics are negatively impacted.

Causes:

- Underdeveloped Grain:
  - High Side: Waves in the belt or uneven water distribution of the drippers.
  - Middle: Poor water distribution of the sprayers.
  - Low Side: Drain blockage and flooding.
- "Hills" along the mat:
  - Possibly "Double Growth"
  - Rippled belt

Prevention:

- Underdeveloped Grain:
  - Evaluate sprayers and drippers regularly for uniform performance.
  - If flooding occurs, remove any grain from the drains. After harvest, adjust the water schedule and grain depth.
  - After every harvest, drains and gutters should be cleaned and free of any grains or bacterial growth.
- "Hills" along the mat:
  - To determine if the hill is caused by Double Growth, cut out a sample in that area. If found, adjust grain depth and water schedule accordingly.
  - In the ripples of a belt, the grain cannot be properly wetted, resulting in inconsistent germination or undeveloped grain. Once the belt develops ripples, it is nearly impossible to produce a consistent crop. The belt will need to be replaced to eliminate this issue.

When determining the reasons for uneven growth, collect as much data as possible relating to belt condition, sprayer or dripper performance, flooding, dry pockets, grain hydration, grain quality, grain density, and water schedule. Review all potential causes and consult with HydroGreen customer service support staff to troubleshoot.

Ungerminated Grain

Ungerminated Grain is grain that has not sprouted. Usually found underneath or within the mat of sprouted grain. In the top photo, the grain depth is excessive. Water will not uniformly move through the grain profile. This causes a dry midsection that results in double growth and/or dry pockets at harvest. The other photo shows ungerminated seed at the bottom of the root mat. Again, this is due to a lack of adequate watering at the beginning of the cycle.

Causes:

- Grain germination may be poor.
- Grain depth/density is too deep.
- Watering at the beginning of the grow cycle is inadequate.

Prevention:

Preventing ungerminated grain is easily managed.

- Adjust the water schedule and/or seeding depth.
- Be sure to adjust just enough to provide enough water to all layers but prevent erosion.
- Check grain depth as described below.
- Verify your grain density is within HydroGreen recommendations.
- Verify grain germination and nutritional performance by submitting a sample to the HydroGreen Research Team for testing.

Evaluate grain depth for proper hydration in the first 24 hours of the growth cycle. To do this take a knife or straight edge and push down into the grain to the table, then pull towards you, exposing the grain profile. If the grain is dry in the middle or bottom, adjust your sprayers and drippers to increase output.

When evaluating crop production during the mid and late growing cycles, take a knife and cut a small square to view the rotting structure. And note any double growth or ungerminated grain. If the crop has either of these, adjust your sprayers and drippers to increase output and thoroughly wet out the grain at the early end of the growing cycle.

Bacteria Buildup

Bacterial buildup can create issues not only with drainage and crop performance, but also with water that is recycled. Any water that sits for a period will allow the bacterial growth to begin. When this occurs, table drains begin backing up, causing flooding issues and poor crop performance. Cleaning and general housekeeping procedures should be used on a regular basis to prevent bacterial growth from occurring.

Causes:

- Little to no cleaning of the drains and belt.
- Little to no H_2O_2 or bleach is applied to the water for cleaning.

Prevention:

- Use a scrub brush and hose to clean the bacteria out of the drains and gutters.
- Spray a bleach/water solution to kill off any remaining bacteria.
- A clean system is a happy system!

Mold

Mold: Fungus that grows within and between the roots and shoots can be a white or dark color. Poor growing conditions favor fungus growth, water quality, system cleanliness, environmental conditions, and grain quality can all impact the potential growth of mold. Multiple areas need to be managed to prevent mold development on a growing crop.

Causes:

- Unclean/unfiltered water.
- Little to no H_2O_2 concentration. Hydrogen peroxide helps disinfect pipes, lines, tables and reduce any spores that may be attached to the seed.
- Grow system is unclean, this will almost always guarantee mold growth and poor production.
- Environmental temperature is too high.
- Poor airflow on table.
- Dirty diseased grain.
- Product fermentation.

Prevention:

- Check H_2O_2 levels every day to prevent bacterial growth. If bacteria are found, check H_2O_2 levels and increase accordingly.
- Make sure to clean the belts, drains, and gutters.
- Use cleaned high quality grain.
- Have green tested for germination.
- Always follow environmental guidelines provided by HydroGreen to reduce any potential issues tied to mold growth.
- Ensure air temp, humidity, and airflow are at recommended levels.
- Make sure to incorporate hydrogen peroxide and maintain levels every day to prevent bacterial growth. Regularly clean belts, drains and gutters. Use disinfectants such as bleach and gutters and drains to sanitize and prevent buildup. Use cleaned, high quality grain from a reliable source.

Summary

In summary, one production problem can be a result of a single issue or a multitude of issues. As a system operator, you must be willing to investigate every potential avenue to find the root cause of every problem. Simply addressing one potential cause may create other problems later. Thoroughly think through the whole process and ask questions. Take pictures, videos, notes, and anything that would assist in troubleshooting the issue or issues. As always, consult with HydroGreen customer support staff to troubleshoot problems that are occurring.

Appendix

See the following pages for cleaning, maintenance, & harvest checklists.

Sample Submission Form

hydrogreen
NUTRITION TECHNOLOGY

A DIVISION OF CUBICFARM SYSTEMS CORP.

Sample Submission Form

Customer/Farm Name _____

Email_____

Phone Number_____

Product Sample

Sample Collection Date _____

Growth Duration _____

Seeding Depth _____

Seed Variety _____

Comments:

Grain Sample

Sample Collection Date_____

Grain Type (i.e., Barley) _____

Grain Variety_____

Comments:

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HYDROGREENGLOBAL.COM

HydroGreen Grow Room Daily Cleaning Checklist

Daily Grow Room Cleaning Checklist

Initials	Item	Description
	Cutter Chamber	Squeegee before washing, avoid spraying on to belt and seeders. Spray to front under the seeder
	Front Drains	Drains below cutters, spray back corners and through opening on dripper side, clean all drains below original harvest level drain.
	Gutters	Spray and scrub gutters on level harvested.
	Front Cutter Siding	Side of cutter enclosure, remove stuck debris off hoses, wires, motors.
	Seeder & Seeder Clamps	Spray Seeder clamps to remove stuck debris, remove any stuck debris in or under seeder.
	Side Table Drains	Start on level 6 on front end. Scrub and wash until completely clean of all debris. Clean towards back of machine.
	Back Side Drain Gutter	Spray out vertical drain, run water through drain until the water runs clear.
	Pull Back Bars & Belts	Scrub pull-back bar and belt. Remove any leftover debris. Spray off belt and splash shield.
	Clutch/Motor Cover	Can be done as needed. Scrub any noticeable debris and wash.
	Horizontal Conveyor	Spray under belt and high side of conveyor. Spray off all splash shields, walkways, and spools.
	Vertical Conveyor	Remove conveyor catch-tote, clean under low end, spray low end shaft. Remove debris from white belt and high-end belt tray.
	Seed Cleaner	Clean as needed. Remove any debris from under or around cleaner, dump clear bin DAILY.
	Walls	Spray and scrub walls as needed.
	Under Machines	Squeegee all debris to one side of machine and remove all excess water.
	Floor & Floor Drains	Ensure that the whole floor is clean and dry. Must be done daily. Run water down floor drains at the end of the day.

HydroGreen Grow System Maintenance Checklists

Daily Checklist	
Date Checked	**Item**
	Check grow room temperature **(63-72°F)** and humidity **(40-70%).**
	Check CO2 level if you have a fresh air makeup system.
	Empty seed cleaner tub.
	Make sure seed cleaner is working properly.
	Make sure the H_2O_2 barrels are not empty, and pump is working.
	Clean harvest end of table and conveyor after harvest.
	After seeding, confirm no nozzles are plugged and spray area is correct on all levels.
	Inspect grow film cleanliness and clean as needed.
	Check seeder tub and augers for growth.

Weekly Checklist	
Date Checked	**Item**
	Lubricate jaw slides on all levels with light oil.
	Lightly grease the speed shaft on the cutter with white lithium grease.
	Clean gutter with brush if slime has accumulated.
	Wash down the back of the table (end opposite of the harvest end)
	Grease conveyor bearings.
	Wash conveyor from the top down, starting with the exit door and chute.
	Drain air from air compressor.

Monthly Checklist	
Date Checked	**Item**
	Ensure the dehumidifier or HRV is working properly.
	Check filters on dehumidifier or HRV, change if dirty, write date changed on filter.
	Check oil in the high-pressure pump, change as recommended by manufacturer.
	Check filters on HVAC system, change if dirty, write date changed on filter.
	Look at condenser on HVAC system, clean with garden hose if needed, be careful not to bend condenser fins.
	Check drain tube for furnace.
	Check seed depth (check monthly or anytime variety changes)

HydroGreen Grow System Harvest Checklists

Pre-Harvest Checklist

Check	Item
	Pull feed wagon under chute door
	Lower chute & open chute door
	Wet the chute
	Verify bulk bin seed level
	Verify clean seed bin level
	Verify H_2O_2 barrel level
	Verify the seeder is in the raised position
	Verify the belt is tight

Harvest Checklist

Check	Item
	Press the HARVEST button & choose option
	Visually inspect that the belt is moving in the right direction
	Visually inspect that the harvest jaw is engaged & seeding jaw is disengaged
	After cutter motor turns on, open the cutter water valve
	Turn on conveyor
	Verify the belt cleaning sprayers are on
	Verify the cutter nozzles are not plugged
	Verify the cutter is cutting correct size pieces
	Verify conveyor is not plugging
	Shut off cutter water
	Verify all product is off level
	HARVEST COMPLETE

Post-Harvest Checklist

Check	Item
	Clean conveyors
	Shut off conveyor once product is clear
	Spray down chute, clear any leftover debris
	Close chute door & raise chute
	Clean debris off trays beneath the belt
	Clean debris out of drains
	See Daily Grow Room Checklist for other cleaning items

Seeding Checklist

Check	Item
	Verify pull back bar returns far enough to miss the seeder lowering
	Verify seeder lowers
	Verify seeder motor engages
	Verify belt stops once seeder is empty
	Verify seed depth is adequate
	Verify belt stop once complete
	SEEDING COMPLETE
	Verify nozzles are pivoting & spraying correct patterns
	Verify drippers are watering equally