



POTATO STORAGE SOLUTIONS

CLEAN AND SANITIZE STORAGE | BIN PILER APPLICATION | STORAGE & REMEDIAL TREATMENT

A THREE STEP PROGRAM





PROTECTING POTATOES DURING STORAGE

Potatoes can incur significant losses from storage diseases. Storage pathogens find their way into the tuber at harvest from wounds or bruises and from contaminated storage facilities. Early curative treatment right after harvest/before storage and intermittent applications during storage can help in reducing the incidence and severity of storage losses. The primary diseases of concern during potato storage include but are not limited to:

Bacterial Soft Rot caused by bacterium *Erwinia carotovora*, Dry Rot caused by fungus *Fusarium* spp., Late Blight caused by oomycete *Phytophthora infestans*, Pink Rot caused by oomycete *Phytophthora erythroseptica*, Pythium Leak caused by oomycete *Pythium* spp., Ring Rot caused by bacterium *Clavibacter michiganensis* subsp. *sepedonicus*, and Silver Scurf caused by fungus *Helminthosporium solani*.

BIOSAFE SYSTEMS' PROVEN PRODUCTS FOR POTATO STORAGES

GreenClean[®]PRO

GreenCleanPRO fungicide controls & prevents microbial cross contamination of floor surfaces in potato storages.

StorOx[®] 2.0

StorOx 2.0 broad spectrum bactericide/fungicide is fully labeled for post harvest treatments including bin piler applications, injection into storage humidification, and fogging systems to treat potatoes in storage.

HOLDit[®]

HOLDit improves the performance of BioSafe Systems' activated peroxygen and product formulations by creating a residual for increased contact & kill time. HOLDit will allow for more even coverage of potatoes in storage when applying fungicides.

GreenClean[®] Alkaline Cleaner

GreenClean Alkaline Cleaner is a concentrated, high foaming liquid detergent containing a blend of alkaline builders, dispersants, and wetting agents that lift away organic deposits and emulsify grease and oils.

SaniDate[®] 5.0

SaniDate 5.0 is an EPA registered peroxyacetic acid sanitizer and disinfectant that is effective against plant and human health pathogens.

OxiPhos[®]

OxiPhos is a systemic bactericide/fungicide used to prevent pathogens in potato storages. This combination of phosphorous acid and activated peroxide is proven to be effective against storage pathogens.

BIOSAFE SYSTEMS' POTATO STORAGE SOLUTIONS

BioSafe Systems develops and manufactures sustainable chemistries that prevent and control plant pathogens in the field as well as in post harvest applications. We help potato growers by providing sustainable storage solutions through our Activated Peroxygen products that are effective on a broad range of plant and human pathogens such as Listeria, E. coli, and Salmonella. BioSafe Systems' products are designed for the modern day storage manager to help provide the highest degree of sanitation and control over stored potatoes. This results in increased storage quality and increased pack-out, which in return maximizes profits.

BIOSAFE SYSTEMS' 3 STEP POTATO STORAGE PROGRAM:

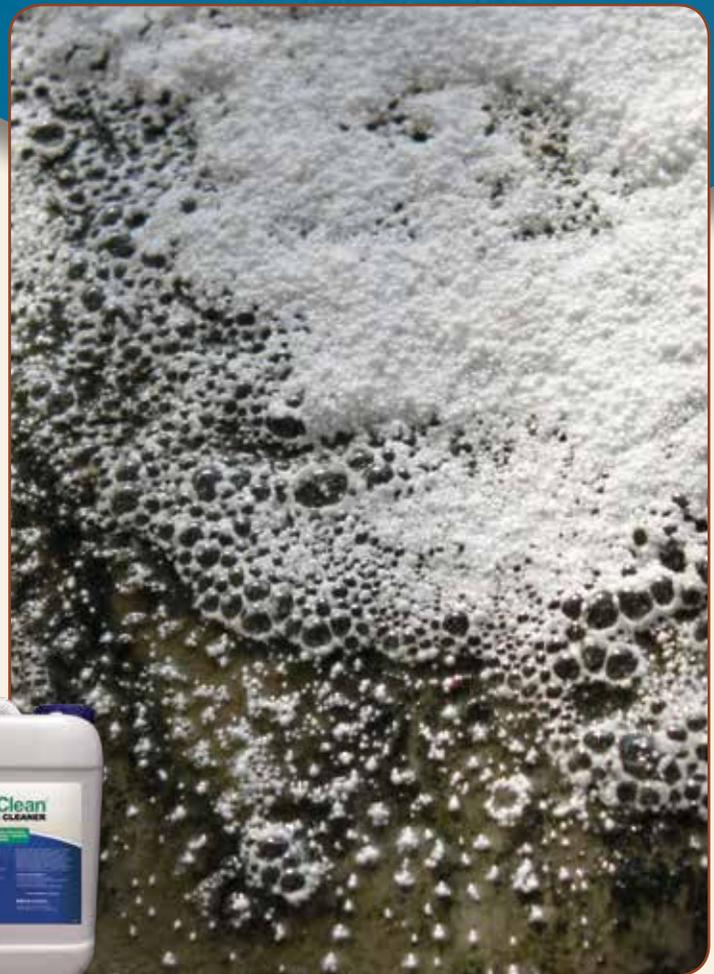
1. Clean & Sanitize Storage
2. Bin Piler Application
3. Storage & Remedial Treatment



STEP 1:

CLEAN AND SANITIZE STORAGE

Cleaning and disinfecting is an essential part of an annual preventative program to suppress and eliminate organisms that have survived from the previous season. BioSafe Systems provides specially formulated high strength acid cleaners as well as high strength alkaline cleaners. These products help to remove built up organic and inorganic deposits and contamination from storage facility walls, floors, and plenum pipes. Similarly, StorOx 2.0 and/or SaniDate 5.0 may be used to perform the disinfection function. StorOx 2.0 was shown to be effective as a surface disinfectant on such pathogens as Bacterial Ring Rot (Table 1) and Soft Rot (Table 2).



GENERAL CLEANING PROGRAM

A general cleaning and disinfection program of potato storage structures, trucks, equipment, and plenum pipes include the following steps:

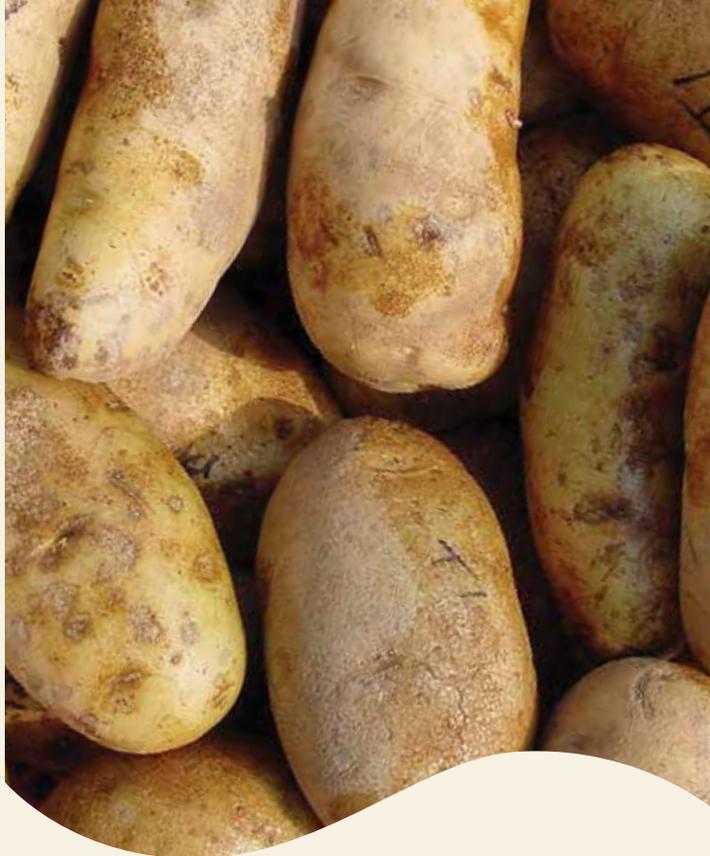
1. Remove/sweep out gross filth (potato debris , etc.). It's important to clean off all visible dirt and organic deposits.
2. Clean with hot water + GreenClean Alkaline Cleaner with a contact time up to 20 minutes.
3. Soak with StorOx 2.0 or SaniDate 5.0 solution for at least 10 minutes. A hydraulic sprayer may be used to apply StorOx 2.0 or SaniDate 5.0. Applying through our BioFoamer unit will infuse StorOx 2.0 and SaniDate 5.0 into a thick foam, providing a visual cue for coverage and extended contact time.

No rinse required.

STORAGE FLOOR TREATMENT

Potato storage floors can harbor bacterial and fungal pathogens such as silver scurf, bacterial ring rot, and nematodes. Floor cleaning and disinfection include the following steps:

1. Remove two to three inches of old soil and replace with new, clean soil.
2. Or use BioSafe Systems granular EPA registered fungicide GreenCleanPRO to treat the soil surface.
3. GreenCleanPRO prevents microbial cross contamination.
4. GreenCleanPRO will activate itself when it comes into contact with the soil and will leave behind a high pH residual that will help inhibit other organisms from becoming established.



RESEARCH

Table 1. StorOx 2.0 as a Surface Disinfectant on *C. michiganese subsp. Sepedonicus*, Causal Organism of Bacterial Ring Rot (BioSafe Systems Study)

Treatment	<i>C. michiganese subsp. Sepedonicus</i> Average CFU/Carrier
Control	8.5×10^5
StorOx 2.0 1:100 Contact Time: 10 Minutes	1° = 0 2° = 0

1° = Primary Subculture; 2° = Secondary Subculture

Table 2. StorOx 2.0 as a Surface Disinfectant on *Pectobacterium carotovora*, Causal Organism of Potato Soft Rot (Dr. Jacobsen 2012; Montana State)

Treatment	Initial Slime Population	After Spray	After 30 Mins.	After 60 Mins.
Water	High	High	Low	Trace
StorOx 2.0 1.2 fl. oz./gallon	High	0	0	0
Virex 0.5 fl. oz./gallon	High	Trace	Trace	Trace

The most critical step in treating storage potatoes is on the bin piler.

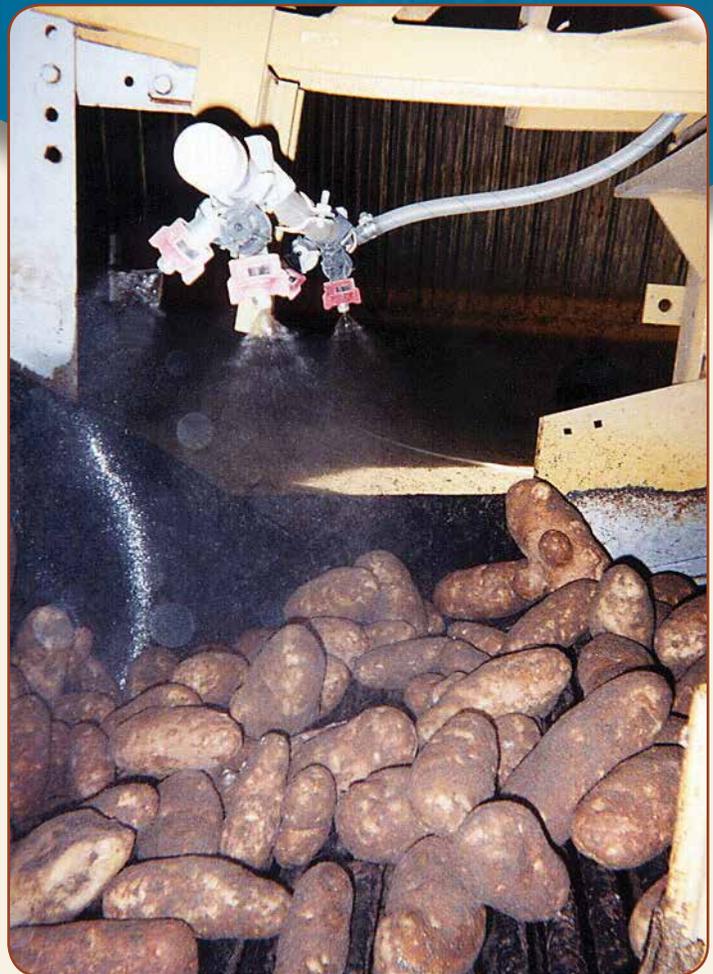


Mix HOLDit Drift Retardant and Deposition Aid with your BioSafe Systems fungicide for improved coverage and increased contact control in bin piler applications for potato storages. HOLDit works well when combined with OxiPhos or StorOx 2.0 to ensure that potatoes are covered evenly in storages.

STEP 2:

BIN PILER APPLICATION

Growers should treat harvested potatoes as they go into storage on the bin piler. BioSafe Systems' products StorOx 2.0 and OxiPhos can be considered for this application. Both products provide an initial knockdown of important diseases including Late Blight, Pink Rot, and Soft Rot (Figs.1-4). Spray application at this stage provides a superior protection option since the potatoes can be easily reached. BioSafe Systems can provide a simple to use cart mounted dosing system that is compatible with either StorOx 2.0 or OxiPhos. The Bin Piler Applicator is outfitted with an adjustable water powered dosing system that provides various and accurate dosing dilutions from 1:20-1:200 and there is no electrical requirement. It is easy to use and has proven to be an effective bin piler application system.



BIN PILER TREATMENT PROGRAM

A general cleaning and disinfection program of potato storage structures, trucks, equipment, and plenum pipes include the following steps:

1. Set up a spray bar over the bin piler's conveyer belt. Using BioSafe Systems' Bin Piler Applicator provides an easy and simple installation over existing conveyer belts.
2. Use low volume spray nozzles (0.5-1.0 gallon per ton of potatoes). BioSafe Systems recommends setting up two spray bars spaced 10-20 ft. apart to ensure adequate coverage.
3. Calibrate chemical injection system with BioSafe Systems' StorOx 2.0 or OxiPhos.
4. Add HOLDit to fungicide for improved coverage and contact time.

- OxiPhos: 6.4-12.8 fl. oz per 0.5 gallon of water per ton of potatoes
- StorOx 2.0: 1.28-2.56 fl. oz per 0.5 gallon of water per ton of potatoes
- HOLDit: Add 2.5 to 5% volume/volume

RESEARCH

Figure 1. StorOx 2.0 on Pink Rot and Late Blight (Dr. Gachango et al., 2010)

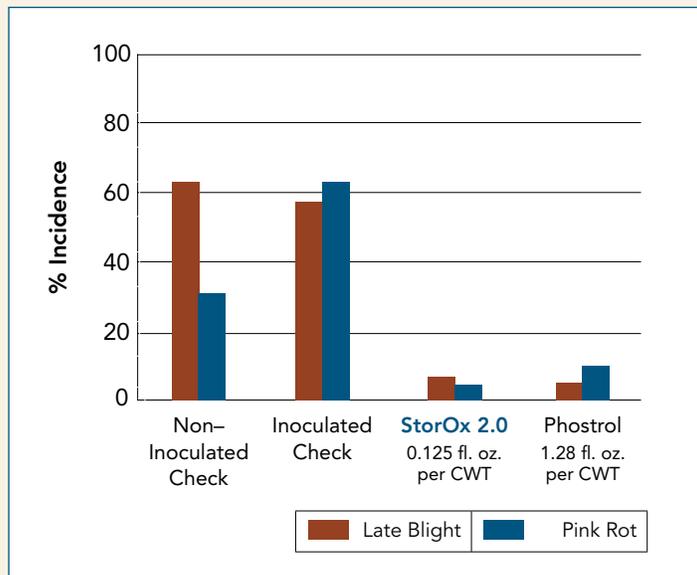


Figure 3. OxiPhos on Pink Rot (Dr. Olsen et al., 2013)

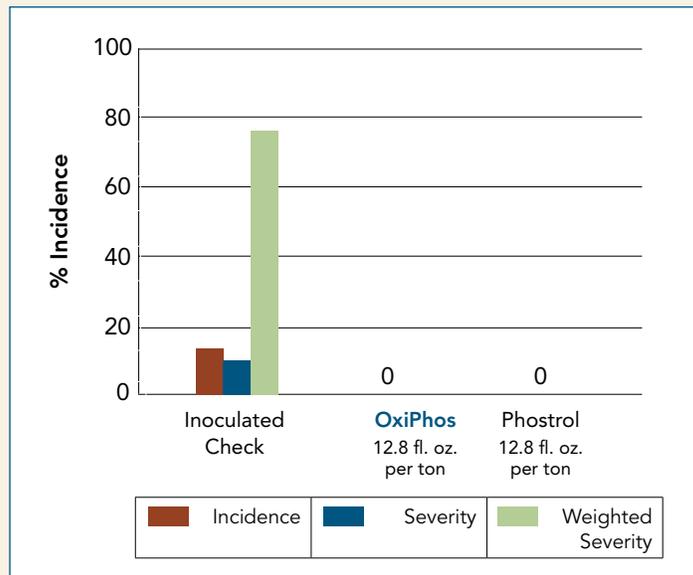


Figure 2. OxiPhos on Late Blight (Dr. Olsen et al., 2013)

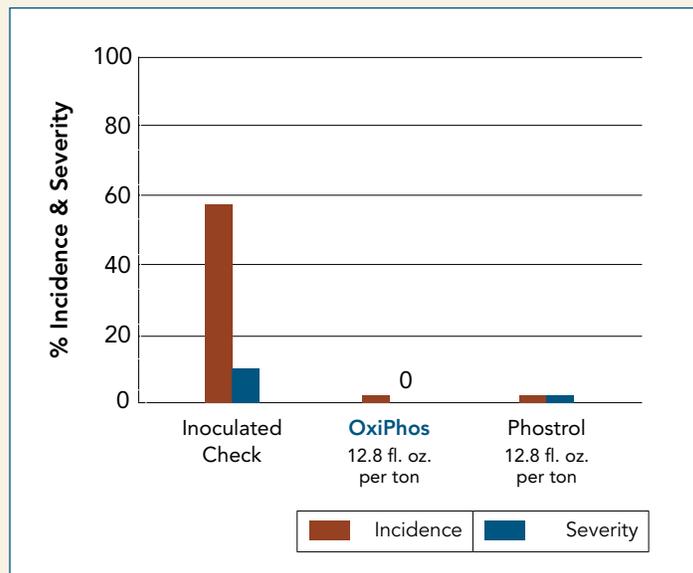
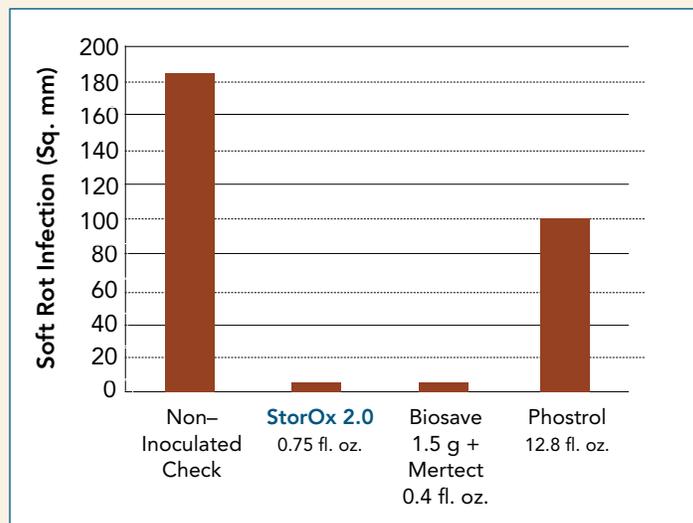


Figure 4. Effect of StorOx 2.0 on Potato Soft Rot (Dr. Jacobsen, 2012, Montana State University)

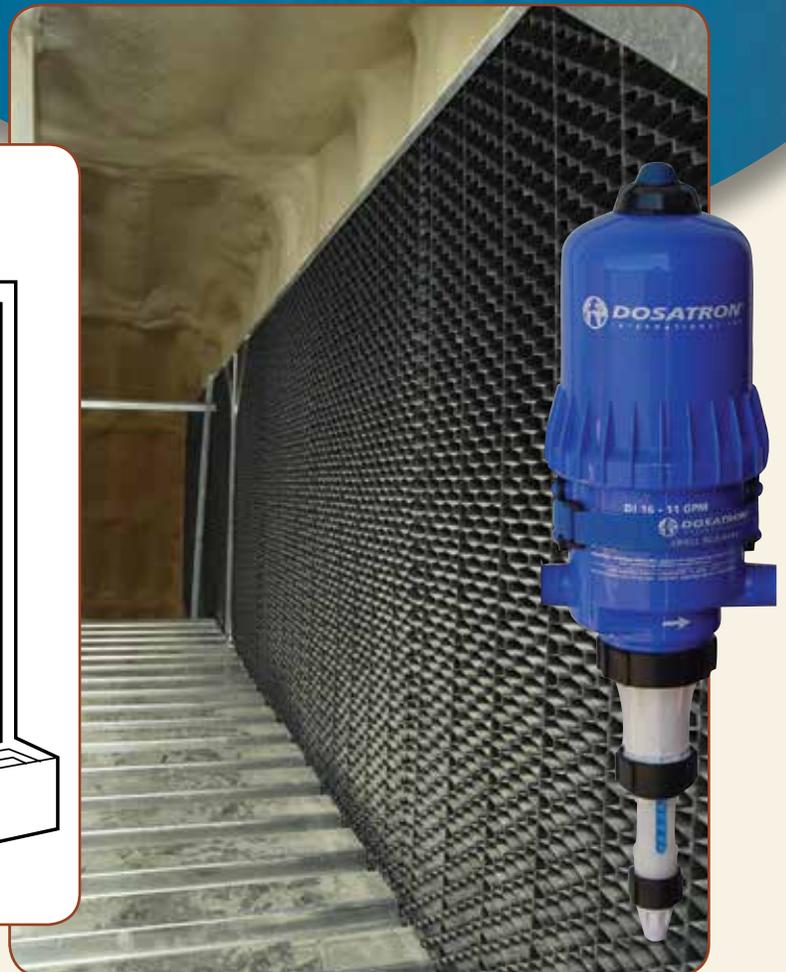
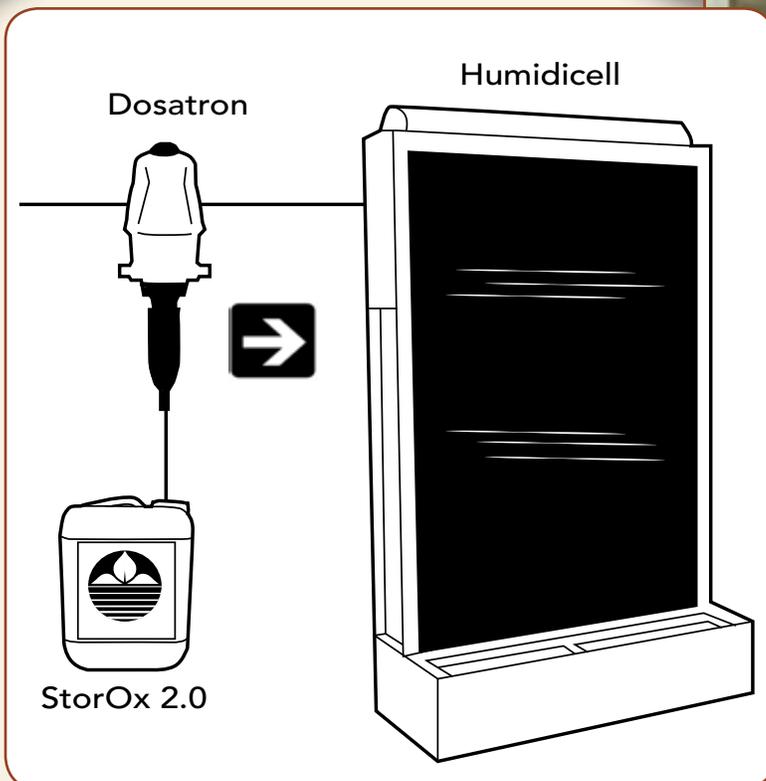


STEP 3:

DIRECT INJECTION OF CHEMICALS INTO HUMIDIFICATION

Biosafe Systems Chemical Injection and Humidification Programs offer control, reliability, and effectiveness. The most important part of the control program is to treat the potatoes as they are in storage as a long term preventative program. By injecting StorOx 2.0 and/or OxiPhos into the water of the humidification system, the chemical compounds become part of the water vapor and are carried up through the potato pile to react with bacterial and fungal organisms.

To ensure improved storage quality, BioSafe Systems recommends using a Humidicell, a fan that blows water into the air. Use StorOx 2.0 at a rate of 1:500 in the Humidicell base to keep air clean, cool, and moist. This rate will keep Humidicells in good working order throughout the storage season. Keeping cell decks clean will provide up to a 30% increase to a humidification system's efficiency, as well as help protect potatoes against Bacterial Soft Rot and other storage diseases. For best results, BioSafe Systems can provide a low cost, easy to use chemical injector to inject a measured amount of StorOx 2.0 to effectively treat Humidicells.



HUMIDIFICATION & CHEMICAL INJECTION TREATMENT PROGRAMS

1. To maintain 90-95% humidity in the ventilation air, the humidification rate typically ranges from 1-3 gallons of water per hour per 1,000 CFM (this range can be even higher if the difference between supply air temperature and return air temperature is high).
2. The average ventilation rate used in potato storage is about 20 CFM per ton with a range of 10-30 CFM. Based on 20 CFM per ton, it comes around to 0.02-0.06 gallons of water per hour per ton of potato or 0.48-1.44 gallons of water per ton per 24-hour day.
3. Apply StorOx 2.0 or OxiPhos during the first 16 weeks of potato storage to reduce losses from storage rots. This includes injecting product into the humidification system for eight hours per day for two weeks. After 2 weeks, fog StorOx 2.0 for 8 hours on a once a week basis for 14 weeks.
4. BioSafe Systems also offers an OxiMonitoring System that accurately measures the active ingredients of StorOx 2.0 and the hydrogen peroxide levels of OxiPhos in the air to help determine when proper treatment levels have been achieved. This system may also be incorporated into the storage's humidity control panel so that automated control of chemical injection may be achieved.

The following example provides an estimate of product usage (StorOx 2.0) for a 16 week program:

Ex: For a 20,000 CWT storage capacity (1,000 tons), at 0.48-1.44 gallons of water per ton per 24 hour day to maintain 95.0% relative humidity, this is equivalent to 480-1,440 gallons of water for 1,000 tons per day. **A 16 week 1:100 StorOx 2.0 humidification program for this storage facility would require:**

Table 1. 16 Week StorOx 2.0 Humidification Treatment, 1:100

Treatment	StorOx 2.0 Gallons Used
First 2 Weeks (Daily for 8 Hours)	22.4-67.2 Gallons
Remaining 14 Weeks (Once a Week for 7 Hours)	22.4-67.2 Gallons

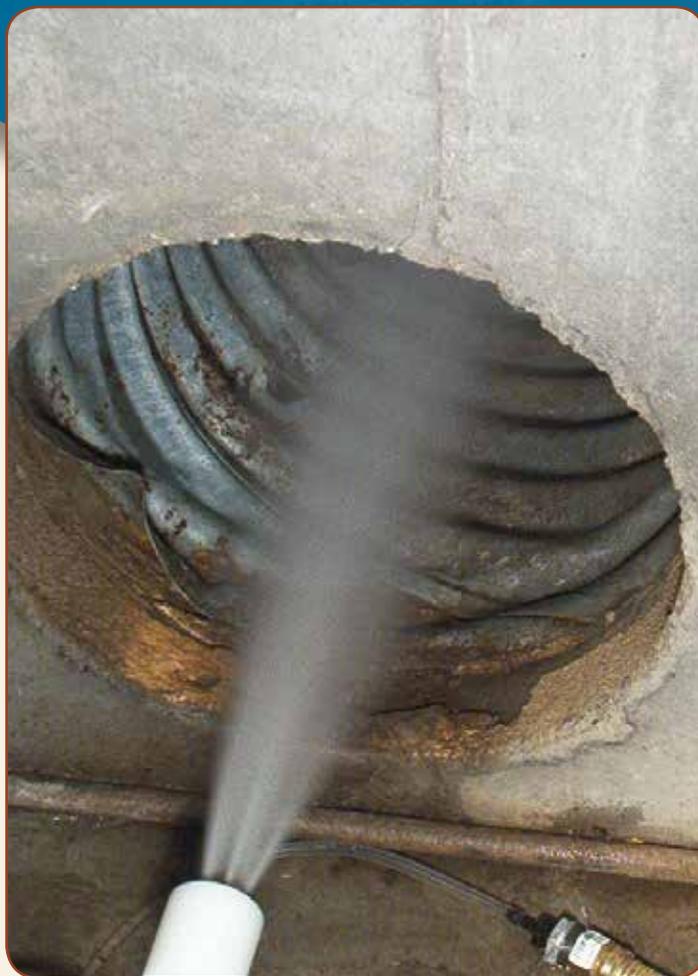
Total approximate StorOx 2.0 usage is 44.8-134.4 gallons during the storage season.



STEP 3 CONTINUED:

REMEDIAL TREATMENT

BioSafe Systems' team of potato specialists can help provide remedial treatment within the storage to help contain any infection outbreak within the pile. No matter how diligent a grower is in the sanitation of storages or the implementation of bin piler applications and treatments through humidification systems, a challenging year of disease in the field will make any preventative program difficult to maintain control. Our innovative foggers may be used to direct a treatment application of either StorOx 2.0, OxiPhos, or SaniDate 5.0 to help contain breakouts and keep them from contaminating the storage. Over the past twelve years of treating storages, our specialists have developed specialized methods and equipment to effectively contain disease and essentially "mummify" the disease in place.



BIOSAFE SYSTEMS' EQUIPMENT FOR POTATO STORAGES*

BioFogger II

The BioFogger II makes it easy to treat potato and onion storages. It is a 'Best in Class' humidifier and chemical applicator. It incorporates our Activated Peroxygen Technology into a concentrated fog to help control and prevent Bacterial Soft Rot, Late Blight, Pink Rot, and Silver Scurf. The BioFogger II can be used with StorOx 2.0 and OxiPhos.

Bin Piler Applicator

The Bin Piler Applicator is a high quality, simple to use, injection system that accurately doses BioSafe Systems' Activated Peroxygen Technology to bin piler spray bar systems. The Bin Piler Applicator provides a chemical injector that's water pressure driven, requiring no electrical hookups. It works with a standardized spray bar assembly that may be easily mounted to any bin piler. The Bin Piler Applicator is a versatile tool that accurately measures dilutions of 1:20-1:200.

*For best results, use equipment with BioSafe Systems' storage protection products StorOx 2.0, SaniDate 5.0, and OxiPhos.



Let BioSafe Systems provide powerful and effective preventative and control programs for your storage.

Visit www.biosafesystems.com/potatoprogram.asp or call 1.888.273.3088 (toll-free) and ask to speak with a potato specialist to learn more.

ABOUT BIOSAFE SYSTEMS

BioSafe Systems LLC, a family-owned manufacturer of sustainable disease control products, began selling its flagship product ZeroTol[®] to the horticulture industry in 1998. The company quickly expanded to the agricultural, industrial, and consumer markets with innovative pest control solutions, applications, and products. The mission of BioSafe Systems is to provide disease control solutions utilizing reduced-risk chemistries that do not negatively impact the health and safety of people and the environment. The company is headquartered in Connecticut, but provides products and services in North and South America.

Communication, training, and product support are essential components in all disease management programs. BioSafe Systems offers many support programs and resources to help keep QA Managers educated and their food safety programs in compliance through the constantly changing landscape of regulations, inspections, and restrictions.

BioSafe Systems takes pride in prompt and effective customer service. Call BioSafe Systems' toll-free number, 1.888.273.3088, and speak with a representative who will answer questions and offer expertise. There are also over a dozen technical service managers throughout the country who are available for in-person meetings.

