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Efficacy of OxiDate™ for Control of Early Blight (*Alternaria solani*) in Potato Storages

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Abstract: Potato storage trials were conducted in 2002 and 2003 in New Brunswick, Canada. Two potato cultivars, Russet Burbank and Dark Red Norland were used. Potato samples in mesh bags (9 kg each) untreated with sprout inhibitors were placed in wooden pallet boxes commonly used in potato storages. A wooden divider divided each box into two portions. Six samples of Russet Burbank were placed in one portion and 6 samples of Dark Red Norland were placed in the other portion. Two treatments (control and OxiDate 1:50) were replicated three times for each cultivar. Using a fogging system, treatments were applied daily for 2 weeks (8 h/day) and then once (8 h) per week for the duration of the experiment. Results indicated that OxiDate treatment helped reduce the level of early blight severity in storage by up to 10.4% over 16 weeks when compared to the untreated check.

Key words: *Alternaria solani*, hydrogen peroxide, *Solanum tuberosum*

INTRODUCTION

Potato (*Solanum tuberosum* L.) production in Canada is intensively managed and requires frequent application of costly pesticides to maintain high yield and quality[1]. However, despite this extensive use of pesticides, approximately 22% of potato yield is lost annually to diseases and pests[2]. Post harvest treatments may be necessary to protect potatoes from diseases that occur or progress during storage. Such diseases include silver scurf, soft rot, dry rot, pink rot, early blight, late blight, leak and powdery scab among others.

Alternaria solani, the cause of early blight of potato, is becoming a serious problem in the potato industry of many countries[3-6]. Early blight poses a significant risk to crop productivity in the field and to tuber quality in storage. In some areas, severe epidemics have reported storage losses of up to 30%[5]. Studies have shown that tuber infection occurs at harvest and decay develops in storage. The reasoning for this is that spores present on the soil surface and on foliage infect tubers through wounds created at harvest. Therefore, surface disinfestation of freshly harvested tubers could eliminate infection in storage[7].

Preventing potato spoilage during storage is of great economic concern to the industry[8]. Most of the registered treatments are disinfectants; they work as surface sterilants and are not curative. Purogene (chlorine dioxide), ozone and OxiDate (hydrogen peroxide) have been shown to effectively retard the progress of storage diseases[8-13]. In combination with good storage management practices, including temperature and humidity control, these products represent good means of preventing potato spoilage during storage.

The EPA first approved hydrogen peroxide (H_2O_2; OxiDate) for use on potatoes in 1999. OxiDate is an environmentally-friendly, broad-spectrum disinfectant that provides immediate control of pathogens. It works by oxidising fungi and bacteria and has been used successfully during vegetable storage[9,14,15]. OxiDate has several potential applications for potato storage. First, it may be used to sanitize the storage area and equipment that will come in contact with the potatoes, i.e., the walls, floors, bin pilers, etc. Second, it may be used as a piler application to treat potatoes as they are being loaded through the bin piler just prior to storage. Third, it may be injected into the storage humidification system, through the plenum pipes, for spot treatments[16].

MATERIALS AND METHODS

Potato cultivars: The experiment was conducted in 2002 and 2003. Two potato cultivars, Russet Norkotah and Dark Red Norland were used in this experiment. Tubers were not treated with chemicals or sprout inhibitors before use. Each 9 kg tuber sample was placed in a plastic mesh bag. For each cultivar, 36 bags of 9 kg each were used to conduct the experiment (total of 648 kg). The bags were placed on a layer (approximately 91 kg) of potatoes in each pallet box. Pallet boxes were 1.2 m long, 1.2 m wide and 1.07 m high.

Inoculation with *Alternaria solani*: For each bag of 9 kg of potatoes, 15 tubers were inoculated with

Fig. 1: Inoculation of tubers with early blight fungal spore suspension

Fig. 2: Fogging system and experiment setup

Alternaria solani. Four incisions of 1 cm^3 each were made in each tuber and 10 μL of early blight spore suspension (9.35×10^4 spore mL^{-1}) was injected in each incision (Fig. 1). Incisions were covered with parafilm for 48 h and then the parafilm was removed before transferring the potatoes into storage. Tubers were stored in the plastic mesh bags for 4 months.

Experiment setup: The pallet boxes were divided into 2 portions with a wooden divider. Six bags of 9 kg of potatoes each of Russet Norkotah were placed in one portion and 6 bags of Dark Red Norland were placed in the other portion of the box. Each pallet box represented one replicate. The 3 replicates were set one on top of the other to simulate a pile of potatoes in a big storage area. The bottom pallet box was placed on a pallet 30 cm above floor level and at the center of the plenum. A fogging system, consisted of a 53-l water tank, timer, fogging controller, air and water solenoids all mounted on a free standing wood support frame was used to emit the OxiDate or water solutions in the bins. This was then connected to a 5 hp air compressor. The air and water hoses were placed under a 30 cm high pallet next to the plenum (Fig. 2). The fogging system was calibrated to emit an amount of 15 l/8 h.

Two treatments, control and OxiDate 1:50 were included. OxiDate (27% H_2O_2), a clear, colourless liquid with a pungent odour (freezing point, -30°C; specific gravity, 1.09; pH, 1.33; solubility, complete) was supplied by BioSafe Systems, CT, USA. Each treatment was run in separate storage bin to prevent cross contamination. Bins were set at approximately 10°C and 90+% RH. The control treatment was tap water only. All treatments were applied using the fogging system. Airflow was turned on at the same time as the fogging system to allow the fog to spread through the tubers. Treatments were applied daily for 2 weeks (8h/day) and then once (8 h) per week for the duration of the experiment.

The three boxes, including the pallet on the floor, were covered with plastic sheets and secured using staples and tape. The top of the uppermost box was also covered with a sheet of plastic (Fig. 2). Samples (1 bag of 9 kg each) were taken before treatment and then at 2, 4, 8, 12 and 16 weeks after treatment.

Disease assessment: Ten inoculated tubers were taken from each bag and assessed for severity of early blight. For comparison purposes, 10 un-inoculated tubers were also cut open for assessment. Disease severity was assessed by measuring the length and width of each incision in millimeters using a digital caliper. Mean lesion area was calculated and used in the statistical analyses. Data were analyzed in a 3-way Randomized Complete Block Design using the statistical analysis program CoStat (CoHort Software, Monterey, CA, USA). Mean separation was performed using Student-Newman-Keuls Test at p=0.05.

RESULTS AND DISCUSSION

A significant difference was noted among OxiDate treatments (p=0.007) and cultivars (p=0.001) with regards to the level of infection with early blight averaged over a period of 16 weeks of storage (Table 1 and Fig. 3). Although early blight increased over time, the severity of the disease was reduced when OxiDate was applied

Table 1: Analysis of variance based on percentage of early blight developed in potatoes treated and untreated with OxiDate over a period of 16 weeks of storage

Source of variation	DF	MS	F	p[1]
Treatment (T)	1	7.30	0.007	**
Date (D)	5	366.30	0.001	***
Variety (V)	1	49.10	0.001	***
T x D	5	2.99	0.011	*
T x V	1	46.80	0.001	***
D x V	5	17.20	0.001	***
T x D x V	5	7.10	0.001	***
Model	23	90.05	0.001	***
Error	2856			
Total	2879			

[1] Significant at 5%

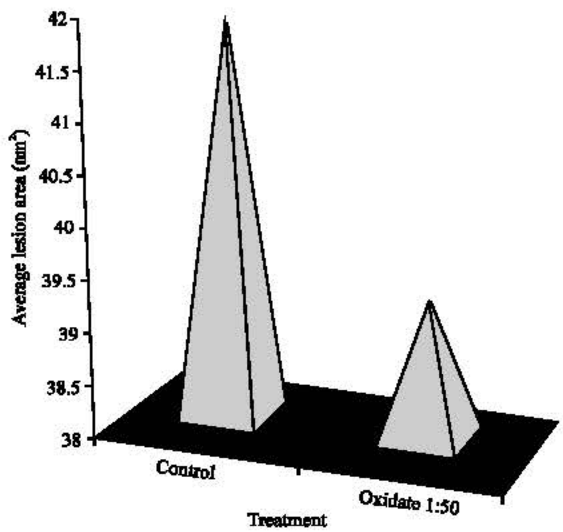

Fig. 3: Mean lesion area (mm^2) of early blight developed on tubers over 16 weeks for both Dark Red Norland and Russet Burbank potato cultivars

Fig. 4: Early blight lesion development on OxiDate treated potatoes (left) and untreated check (right)

(Fig. 4). In the case of the cultivar Russet Burbank, severity of early blight in the control treatment after 16 weeks of storage was 61.3%, compared with 62.6% in the 1:50 OxiDate treatment. For Dark Red Norland, severity of early blight in the control treatment after 16 weeks of storage was 58.5%, compared to 68.9% in the 1:50 OxiDate treatment (Fig. 5).

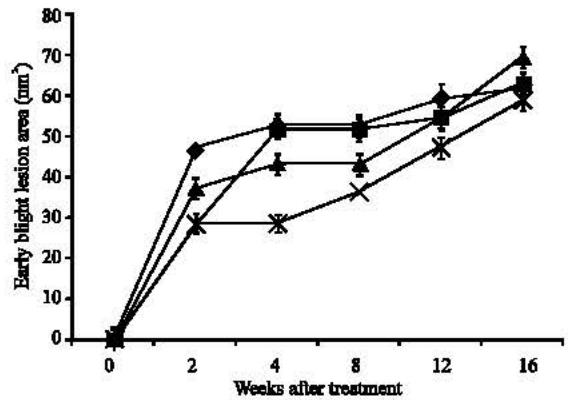

Fig. 5: Mean lesion area (mm^2) of early blight measured over 16 weeks of storage in treated and untreated bins. Control, Russet Burbank (--■--); OxiDate 1:50 Russet Burbank (--♦--); control Dark Red Norland (--▲--) and OxiDate 1:50 Dark Red Norland (--X--)

The cultivars Russet Burbank and Dark Red Norland were chosen because they are susceptible to common potato storage diseases including early blight. Present results suggest that OxiDate can retard the development early blight. The product did not adversely affect glucose or sucrose levels in potatoes stored over a 16-week period[17]. Similar results have been documented for treatments of chlorine dioxide[7] and ozone[18-22]. Reducing the risk of disease during the initial stages of storage is crucial to maintain product quality and prevent further pathogen development.

Kirk[11] compared the effectiveness of Purogene (chlorine dioxide) and OxiDate (hydrogen peroxide) treatments in controlling dry rot, soft rot and late blight pathogens and their associated secondary infections. Results showed that the application of these sanitary agents reduced the potential for tuber breakdown in storage in the absence of significant damage to the tubers. Present results agree with these conclusions.

Potato pathogens on the surface of tubers could potentially be controlled by adding disinfectants to humidification water. In this experiment, emitting OxiDate through a fogging system in storage proved to be effective. Although present results indicate that this method was successful, other proposed methods include piler application immediately after harvest and before storage. Norikane *et al.*[12] studied the efficacy of using water treated with chlorine dioxide and hydrogen peroxide in the storage facility's humidification system to control the growth of dry rot, soft rot and late blight pathogens.

Their preliminary results showed that the system was able to maintain satisfactory environmental conditions (9-10°C and 95-100% RH).

The concern that some scientists have on the ability of OxiDate to spread throughout a potato pile was not an issue in this experiment as we forced OxiDate to go through the pallet boxes. The fogging system operated by an air compressor produced a very fine mist that can easily be forced through a potato pile. The spread of early blight in potato storages can be reduced by up to 10.4% if OxiDate is applied at a rate of 1:50. The consumers have to decide whether such decrease in potato storage diseases would justify the cost of treatment.

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