EVALUATION OF CHLORINE AND DIATOMACEOUS EARTH FOR CONTROL OF INTERNAL DECAY IN ONION BULBS

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Introduction

In the past few years in the Pacific Northwest, there has been an increase in internal onion bulb decomposition of one or more scales. Unlike neck rot or plate rot, this internal decomposition is difficult to detect externally, resulting in onion bulb quality control issues in marketing. The internal decomposition is often associated with one or more scales that do not finish forming completely into the neck, resulting in small gaps close to the neck and associated with dry scales extending into the bulb from the neck. These incomplete scales could provide an opening for pathogenic organisms to infect the bulb interior in the field prior to harvest. Another potential source of pathogenic organisms could be bulb mites entering the bulb during bulb curing, prior to harvest. Dry bulb mites have been found to cause damage to and induce decay of stored garlic (Jepson and Putnam 2008). Dry bulb mites can infect cultivated members of the genus *Allium*, including onion, garlic, and leeks.

Chlorine has been found to be effective in controlling pathogenic microorganisms that infect horticultural produce after harvest (Praeger et al. 2016). Diatomaceous earth has been found to be effective in controlling stored grain mites (Wakil et al. 2010). This trial tested chlorine and diatomaceous earth for control of internal decay of onion.

Materials and Methods

Onions were grown in 2016 on an Owyhee silt loam previously planted to wheat. A soil analysis taken in the fall of 2015 showed that the top foot of soil had a pH of 7.6 and 3.1% organic matter. In the fall of 2015, the wheat stubble was shredded and the field was irrigated. The field was then disked, moldboard plowed, and groundhogged. Based on a soil analysis, 44 lb of phosphorus/acre, 50 lb of potassium (K)/acre, 180 lb of sulfur/acre, 9 lb of zinc/acre, 1 lb of manganese/acre, 1 lb copper/acre, and 2 lb of boron/acre were broadcast before plowing. After plowing, the field was fumigated with K-Pam® at 15 gal/acre and bedded at 22 inches.

Seed was planted in double rows spaced 3 inches apart at 150,000 seeds/acre. Each double row was planted on beds spaced 22 inches apart. Immediately after planting, the field received a narrow band of Lorsban 15G® at 3.7 oz/1,000 ft of row (0.82 lb ai/acre) over the seed rows and the soil surface was rolled. Onion emergence started on April 5. On May 9, alleys 4 ft wide were cut between plots, leaving plots 23 ft long.

The field had drip tape laid at 4-inch depth between pairs of beds during planting. The drip tape had emitters spaced 12 inches apart and an emitter flow rate of 0.22 gal/min/100 ft (Toro Aqua-Traxx, Toro Co., El Cajon, CA). The distance between the tape and the center of each double row of onions was 11 inches.

The onions were managed to minimize yield reductions from weeds, pests, diseases, water stress, and nutrient deficiencies. For weed control, the following herbicides were broadcast on May 2: GoalTender® at 0.09 lb ai/acre (4 oz/acre), Buctril® at 12 oz/acre, Poast® at 0.25 lb ai/acre (16 oz/acre), and Prowl® H_2O at 0.83 lb ai/acre (2 pt/acre).

For thrips control, the following insecticides were applied: Movento® at 5 oz/acre and Aza-Direct® at 12 oz/acre on May 26 and June 2 by ground application; Agri-Mek® SC at 3.5 oz/acre on June 10 and 17 by ground application; Radiant® at 10 oz/acre on June 25, July 2 and 23 by aerial application; Lannate® at 3 pt/acre on July 10, 17, and 30 by aerial application.

Urea ammonium nitrate solution (URAN) at 20 lb nitrogen (N)/acre was applied through the drip tape weekly starting May 10 and ending June 10, totaling 80 lb N/acre. Starting on June 14, root tissue and soil solution samples were taken every week from field borders (variety 'Vaquero') and analyzed for nutrients by Western Laboratories, Inc., Parma, Idaho. Nutrients were applied through the drip tape only if both the root tissue and soil solution analyses concurrently indicated a deficiency. Nitrogen was applied at the fixed amount previously mentioned, but was limited to 80 lb/acre, because the soil solution test indicated the soil was supplying the crop with ample amounts of N. Potassium was deficient in both the soil and the roots on several sampling dates. A total of 100 lb K/acre was applied in 20-lb increments during the season based on the soil and tissue analyses.

Onions were irrigated automatically to maintain the soil water tension (SWT) in the onion root zone below 20 cb (Shock et al. 2000). Irrigation durations were 8 hours, 19 min to apply 0.48 inch of water. The automated irrigation system was started on April 26 and irrigations ended on September 2.

Two strips of onion, variety Vaquero (Nunhems Seed Co., Parma, ID), were divided into plots that were 23 ft long by 4 double rows wide with 4-ft alleys between plots. The experimental design was a randomized complete block with four treatments (Table 1) replicated six times. A bleach solution was made by dissolving granular calcium hypochlorite ($Ca(ClO)_2$,49% Cl) in water to make a 100-ppm Cl concentration. The solution was broadcast at 44.5 gallons/acre. The diatomaceous earth was broadcast at 37 lb/acre in 148 gal water/acre. Both solutions were broadcast over the four onion double rows on August 26, September 2 and 13. For treatment 3, which received both solutions, the bleach was applied prior to the diatomaceous earth.

The onions were lifted to field cure on September 12, prior to the last diatomaceous earth and bleach applications. Onions from the middle two rows in each plot were topped by hand and bagged on September 20. The bags were put in storage on September 30. The storage shed was ventilated and the temperature was slowly decreased to maintain air temperature as close to 34°F as possible. Onions were evaluated out of storage on March 2, 2017.

Two hundred bulbs from each plot were cut longitudinally and evaluated for the presence of incomplete scales, dry scales, internal bacterial decay, and internal decay caused by *Fusarium proliferatum*. Incomplete or dry scales were defined as scales that had more than 0.25 inch from the center of the neck missing or dry or any part missing or dry lower down on the scale.

Table 1. Treatments applied to onions for reduction of internal decay.

Treatment	Bleach ($Ca(ClO)_2$)	Diatomaceous earth
1	no	no
2	yes	no
3	yes	yes
4	no	yes

Results and Discussion

The percentage of bulbs with incomplete scales without internal decay averaged 47% (Table 2). The percentage of bulbs with incomplete scales and dry scales without internal decay averaged 22%. Internal decay caused by either bacteria or the fungus *Fusarium proliferatum* averaged only 1.3% of bulbs, which made it nearly impossible to determine whether chlorine or diatomaceous could help prevent bulb decay.

Treatment of bulbs with chlorine resulted in a slight but statistically significant increase in the percentage of bulbs with incomplete scale and bacterial decay and in the total percentage of bulbs with bacterial decay (Table 2). Treatment of bulbs with diatomaceous earth resulted in a slight but statistically significant decrease in the percentage of bulbs with dry scales. Treatment of bulbs with both chlorine and diatomaceous earth resulted in a small but statistically significant reduction in the percentage of bulbs with dry scales.

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Table 2. Onion internal defects (incomplete scale, dry scale, internal rot) in response to chlorine (Cl) and diatomaceous earth (D.E.), Malheur Experiment Station, Oregon State University, Ontario, OR, 2016.

Treatment		No disease				Bacterial decay				*Fusarium proliferatum*				Total	
		No defect	Inc. scale	Dry scale	Inc. + dry scale	No defect	Inc. scale	Dry scale	Inc. + dry scale	No defect	Inc. scale	Dry scale	Inc. + dry scale	Inc. + dry scale	Int. rot
		%													
Check		31.2	45.3	0.0	23.1	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.1	68.4	0.4
Cl		27.1	46.1	0.0	24.9	0.2	0.4	0.0	0.9	0.0	0.2	0.0	0.2	71.0	1.8
D.E.		30.1	46.1	0.0	22.7	0.1	0.3	0.0	0.4	0.0	0.1	0.0	0.2	68.8	1.1
Cl, D.E.		31.5	49.3	0.0	17.5	0.1	0.9	0.0	0.3	0.0	0.3	0.0	0.1	66.8	1.7
Average		30.0	46.7	0.0	22.1	0.1	0.5	0.0	0.4	0.0	0.1	0.0	0.1	68.8	1.3
Cl	no	30.6	45.7	0.0	22.9	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.2	68.6	0.8
	yes	29.3	47.7	0.0	21.2	0.1	0.7	0.0	0.6	0.0	0.2	0.0	0.1	68.9	1.8
D.E.	no	29.2	45.7	0.0	24.0	0.1	0.3	0.0	0.5	0.0	0.1	0.0	0.1	69.7	1.1
	yes	30.8	47.7	0.0	20.1	0.1	0.6	0.0	0.4	0.0	0.2	0.0	0.2	67.8	1.4
LSD (0.05) $_{Cl}$		NS	NS	NS	NS	NS	0.4	NS	NS	NS	NS	NS	NS	NS	0.8
LSD (0.05) $_{D.E.}$		NS	NS	NS	2.9	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD (0.05) $_{Cl \times D.E.}$		NS	NS	NS	4.1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS