THE 64th ANNUAL MEETING of the IDAHO & MALHEUR COUNTY ONION GROWERS' ASSOCIATIONS

TUESDAY, FEBRUARY 6, 2024

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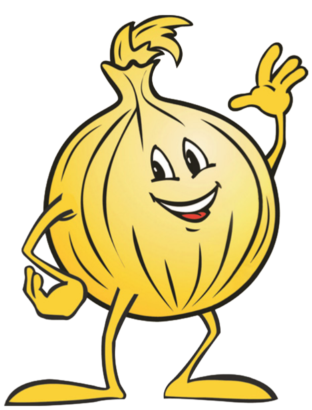
Welcome

TO THE

64th ANNUAL

IDAHO & MALHEUR COUNTY ONION GROWERS' MEETING



PLEASE SILENCE YOUR CELL PHONES WHILE IN THE AUDITORIUM.

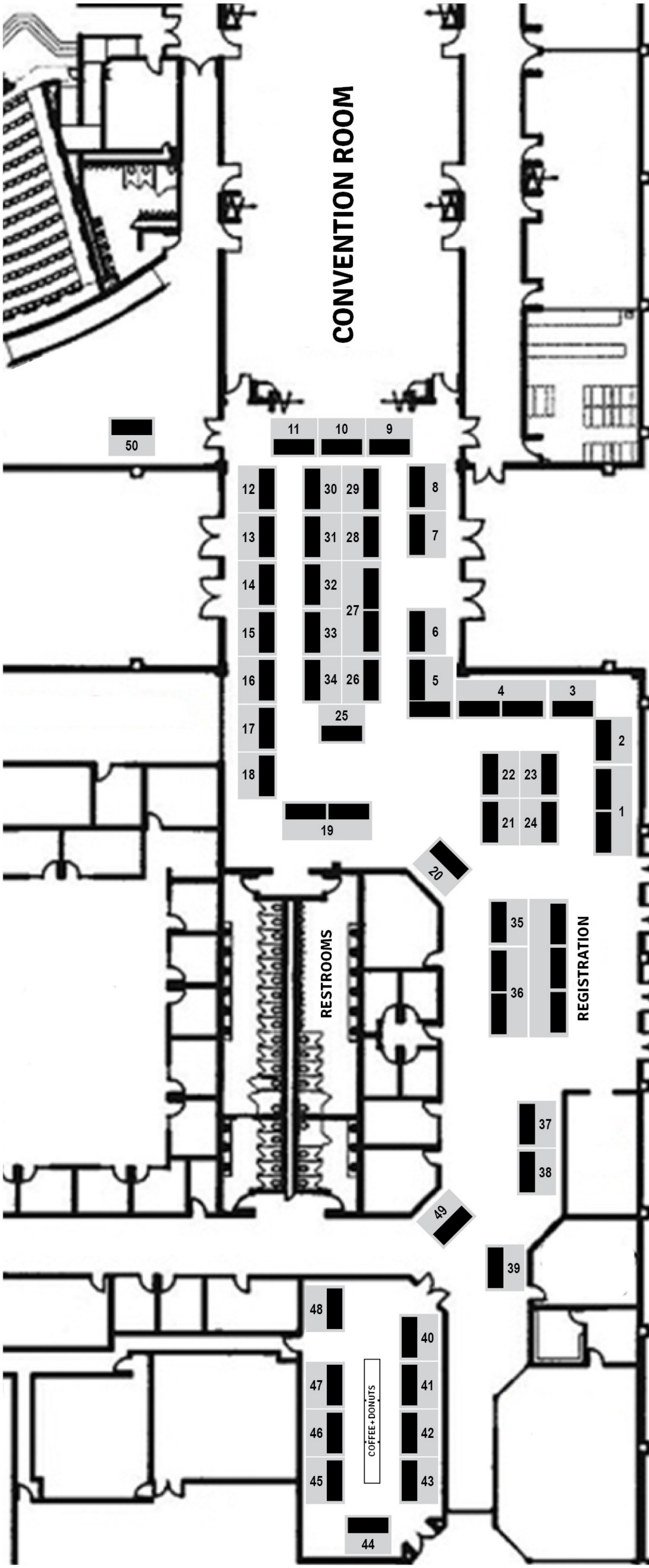
THANK YOU!

Idaho-Malheur County Onion Grower Associations
Annual Meeting
February 6, 2024

Four Rivers Cultural Center ● 676 SW 5th Avenue ● Ontario, OR 97914

CEU Credits: Oregon 4 (1 Core + 3 Other); Idaho 3; CCA 5.5

Start	End	Topic	Speaker
7:00	8:00	Registration/Coffee	
8:00	**8:05**	**Welcome and Seed Drawing**	Jarom Jemmett, IOGA
8:05	8:20	Updates on Stemphylium leaf blight	James Woodhall UI Parma
8:20	9:05	Thrips management and the impact of thrips on Stemphylium Leaf Blight and Bulb Rots	Stuart Reitz, OSU MES
9:05	9:35	Optimizing Irrigation Scheduling through Soil Moisture Sensors Network for Onions	Uday Sekaran, OSU MES
9:35	**10:30**	**Trade Show**	
10:30	11:00	Onion Economics-Costs and Returns for Treasure Valley Onion Production	Gina Greenway, Greenway Research
11:00	11:30	Economic Outlook for 2024	Doug Robison, Ag West Farm Credit
11:30	12:00	Ag Employer Obligations, Wage and Hour and H-2A Update	Jen Uranga, Mt. West Ag Consulting
12:00	**1:00**	**Lunch, Hall of Fame,** **Marketing Order Nominations & Elections**	
1:00	**1:30**	**Trade Show**	
1:30	1:35	Afternoon Welcome and Seed Drawing	Corey Maag, MCOGA
1:35	1:50	Tape Recycling	Marina Denny, Andrew Norwood, OSU Foundation
1:50	2:20	"Stop the Rot": Grower-relevant results from a national onion bacterial project	Lindsey du Toit, WSU, Mt. Vernon
2:20	2:50	Onion Disease Update	James Woodhall, UI Parma
2:50	3:00	Seed Report - Seminis	Richard Navarrete, Technical Sales, Vegetable Seeds; Jace Crossley – Technical Sales, Bayer Crop Protection
3:00	3:30	Get to Know Palmer amaranth and waterhemp: New Invasive Weeds in the Pacific Northwest Region	Joel Felix, OSU MES
3:30	4:00	What You Cannot See Is Harming Your Onions: Wireworms, Seedcorn Maggot and Bulb Mites	Stuart Reitz, OSU MES



IDAHO & MALHEUR COUNTY ONION GROWERS' ASSOCIATIONS 2024 ANNUAL MEETING

TUESDAY, FEBRUARY 6, 2024
FOUR RIVERS CULTURAL CENTER - ONTARIO, OR

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4. Nunhems / BASF
5. Nutrien Ag Solutions
6. Auto Ranch Group
7. AgWest Farm Credit
8. Romans Precision Irrigation
9. The Nichols Accounting Group
10. Simplot Grower Solutions
11. Toro
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13. Yakima Label
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15. Marathon Pipeline LLC
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22. BASF
23. TKI—Crop Vitality
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25. Water Treatment Resources
26. RegenAg Nation
27. Valley Wide Cooperative & Valley Agronomics
28. Gowan Seed Company
29. Clearwater Supply
30. Nichino
31. Nutrient Tech
32. Integrated Biological Systems
33. Idaho State Dept. of Agriculture
34. Corteva Agriscience
35. Agri-Lines Irrigation, Inc.
36. Bain Aviation, Inc.
37. Western Laboratories, Inc.
38. Flipping Iron Inc.
39. **VENDOR REGISTRATION & INFORMATION**
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42. BEAR UAV
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44. Gearmore
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46. Gowan USA, LLC
47. Ocean Agro
48. Vantage Northwest / Agri-Service
49. Ellips USA
50. Rain for Rent

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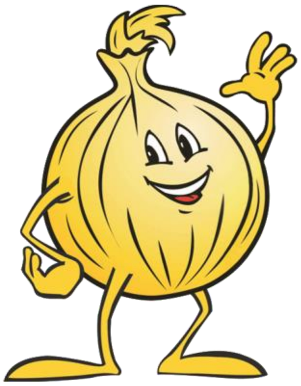

QUICK NOTES

<u>Nametags must be</u> worn at all events. They are your admission and proof of registration for the conference.

<u>Pesticide Credits</u>: You may register for credits at the end of the day in the auditorium. The following credits are available:

- Three (3) Idaho
- Four (4) Oregon (Core: 1 Other: 3)
- 5.5 Certified Crop Advisor (CCA)

<u>Charging Station</u>: Do your electronics need charged? There is a charging station available at the registration desk.

<u>Cell Phones</u>: Please respect other conference participants and our presenters by placing all cell phones in the off or vibrator mode while you are at the conference. Feel free to use your cell phones during breaks.

<u>Recycle</u>: Following the conference, we will have a container at the registration desk for your lanyard and nametag so we can use it again next year. This is one way we can reduce the cost to the organization.

<u>Conference Evaluations</u>: How do we make improvements? By what you tell us! Therefore, we are asking you to evaluate the overall conference. *<u>Please leave your conference evaluation at the registration desk by 4:00 PM and pick up a reward for your effort.</u>*

<u>WiFi Login Info:</u>
Username: FRCC Guest
Password: 0123456789

<u>Thanks to Our Door Prize Sponsors</u>:
A special thanks to many of our sponsors who provided door prizes for the Annual Meeting!

<u>AMG Staff at Registration</u>:
Let us know if we can assist you.

- Rick Waitley, Executive Director
- Patxi Larrocea-Phillips, Executive Assistant
- Benjamin Kelly, Executive Assistant
- Sarah Freeman, Administrative Associate
- Sydney Knight, Administrative Associate
- Patty Nottingham, Bookkeeper
- Kyra Gibson, Staff Assistant
- Tom Connelly, Staff Assistant
- Vicky Connelly, Staff Assistant
- Carla Thompson, Staff Assistant
- Linda Lee, Staff Assistant

Contact Information:

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55 SW 5th Ave., Suite 100
Meridian, ID 83642
Ph: 208-888-0988
Fax: 208-888-4586
rick@amgidaho.com
patxi@amgidaho.com
sarah@amgidaho.com

<u>2025 Annual Meeting</u>: Save the Date for the 65th Annual Meeting of the Idaho & Malheur County Onion Growers Associations! It is scheduled for:

Tuesday, February 4, 2025
Four Rivers Cultural Center
Ontario, OR

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LUTHER MARKWART | KEYNOTE SPEAKER

Luther Markwart was raised on a family dairy farm in eastern Michigan and grew sugarbeets for 9 years as a 4-H project. His grandparents and parents raised sugarbeets beginning in 1933. He earned a Bachelor's Degree in Business Administration from Michigan State University.

Luther has been a leader and advocate for the sugarbeet industry for over 40 years. Since 1982 he has served as Executive VP of the American Sugarbeet Growers Association in Washington, DC, representing sugarbeet growers in 11 states. He has served as advisor to the U.S. Congress, USDA, Office of the U.S. Trade Representative, and other federal agencies that have direct or indirect impact on the domestic sugar industry. He was directly involved in the formulation and passage of the sugar provisions of the last eight farm bills (1981-2018) and served eight terms as Chairman of the industry-wide American Sugar Alliance. Luther has been an advisor to USDA and USTR for international trade negotiations, beginning with the International Sugar Agreement in Geneva in 1982. Luther has served as Co-Chairman of the Sugar Industry Biotechnology Council since 2003 leading the first successful introduction of sugar produced from genetically engineered sugarbeets/ sugar cane in the world. He is the 2017 recipient of the prestigious Savitsky Award for his leadership in the introduction, adoption and defense of biotechnology in the beet sugar industry.

Luther lives in McLean, VA, with his spouse, Terri, and their three children, Christian, Lauren and Megan.

EXP. BIO ONLINE >>

2024 SCHEDULE *"Seeds of Change: Navigating the Future of Idaho Ag"*

MONDAY, FEBRUARY 19 (Boise Centre West)

5:30PM **All Idaho Strolling Supper** *with Idaho Legislators*

TUESDAY, FEBRUARY 20 (Boise Centre West)

7:30AM **Opening Session & Summit Challenge** by Dr. Larry Branen
Welcome by Samantha Parrott, *Co-Chairman*

8:15AM **Inside the Beltway & Will There Be a New Farm Bill?**
Luther Markwart, *Executive Vice President*
American Sugarbeet Growers Association (D.C.)

2024 Pat Takasugi Leadership Award:
Idaho Hay & Forage Industry

10:00AM **Break** - Enjoy some Idaho Commodity Products

10:30AM **Responsible Water Management: Key to Idaho's Future**
MODERATOR: Paul Arrington, *Exec. Dir., ID Water Users Assn.*
Mat Weaver, Director, *Idaho Dept. of Water Resources*
Brian Patton, *Idaho Water Resource Board*
Angie Hansen, *Idaho Dept. of Water Resources*

12:00PM **Seating for Governor's Awards Luncheon**

12:15PM **Governor's Awards Idaho Luncheon**
"Excellence in Agriculture"
Governor Brad Little

Reception for Award Winners & Guests to follow

Adjournment

REGISTER ONLINE AT **WWW.LEADERSHIPIDAHOAG.ORG/AGSUMMIT**

Idaho-Eastern Oregon Onion Hall of Fame Recipients

1986 *Henry G. Ankeny (I)
*Delance “Doc” Franklin (R)
*Roy Hornlund
*Robert Johnson (S)
*S.E. Johnson (S)
*Maylin Maxfield
*Lynn Parsons (I)
*Art Walz
*Jim Williams

2000 *Joe Y. Saito (O)
*Jim Watson (I)

2001 *Tom Iseri (O)
*Mas Kido (I)
*Joe Yoshio Komoto (O)
*Kay Teramura (O)
*Earl M. Winegar (I)

2002 *Lyle Andrew (I)
*Ralph Bowman (I)
Kris Inouye (I)
*Lynn Josephson (I)
*Sig Murakami (O)
Tom Uriu (O)

2003 Phil Batt (I)
*Herb Haun (I)
*Charles E. Johnson (S)
*Joel Mitchell
*Tom Moore (O)

2004 *Hiro Kido (I)
*Tony Miyasako (I)
*Paul Saito (O)
Chuck Stanger (R)
*Virgil Story (I)

2005 *Mel Beck
*Joe Berenter (S)
*Jerry Bowman (I)

2006 *Jim Burr (R)
*Roy Hirai (O)
*E.D. Michaelson (S)
Jerry Stone (S)

2007 *S. P. (Shay) Bybee (O)
*Samuel E. Hartley, Sr (O).
*Edward W. Muir (O)

2008 *George Tamura (I)
Larry Link (S)
Ray Obendorf (I)
*Harvey Wilmot (S)

2009 *Shigeru (Shig) Hironaka (O)
*Harold Lawrence Pace (I)

2010 *Bob Curl (S)
Noble Morinaka, Jr. (O)

2011 *Lynn Jensen (R)

2012 Clint Shock (R)
David Shuff (S)

2013 Dr. Ron Engle (R)
*Pat Takasugi (I)

2014 Brent Clement (S)
Bob Komoto (O)
C. Robert Woods (I)

2015 *Dan Symms (I)
Dr. Rick Watson (R)

2016 Ron Mio (I)
Reid Saito (O)

2017 *Ken Nelson (I)
Clinton Wissel (I)

2018 *Garry Bybee (O)
*Isao Kame Kameshige (O)

2019 Ken Teramura (O)
Ray Winegar (I)

2020 Dell Winegar (I)
Paul Skeen (O)

2021 *No Award – Virtual Conference*

2022 Jim Farmer (I)
John Watson (O)

2023 Herb Haun (I)
Jerry Baker (O)

Legend:
*Deceased
I – Idaho O – Oregon
S – Industry Support R – Researchers

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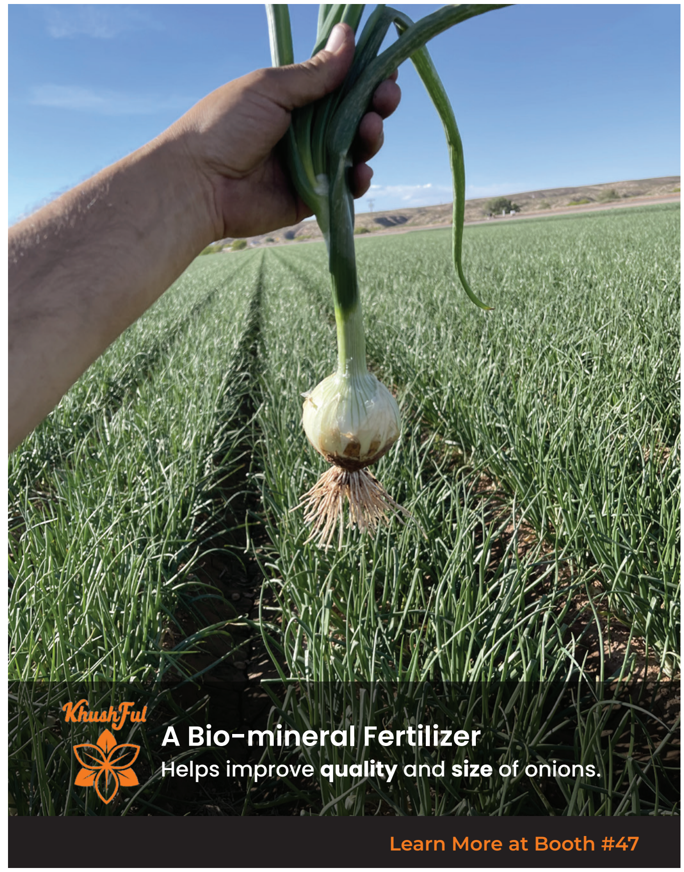
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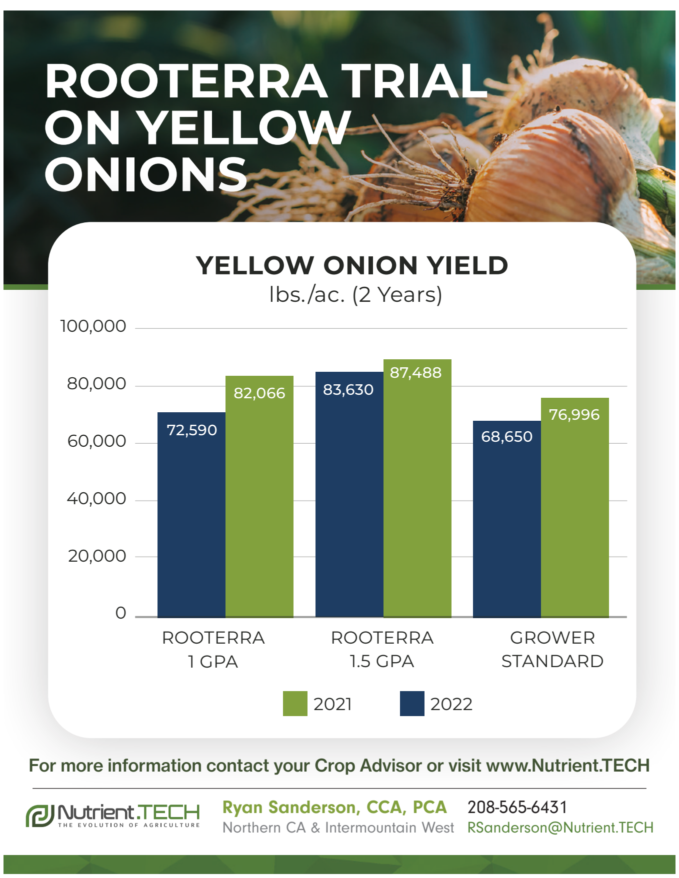
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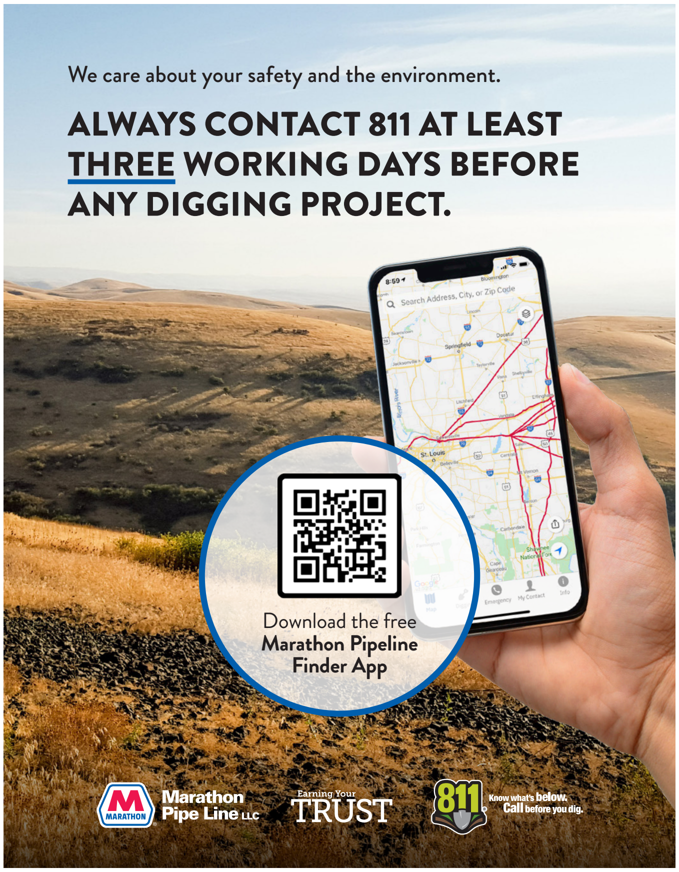
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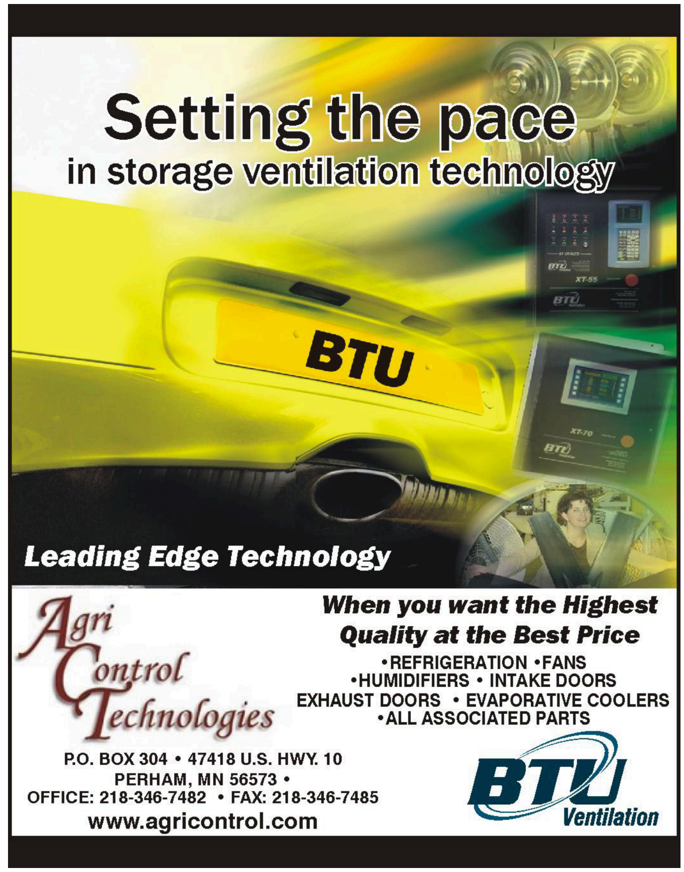
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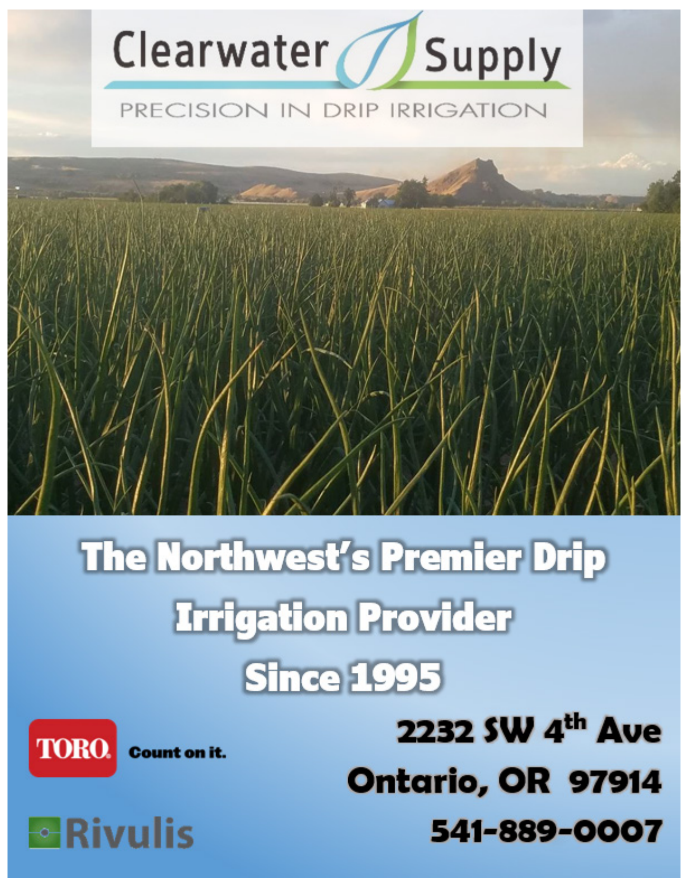
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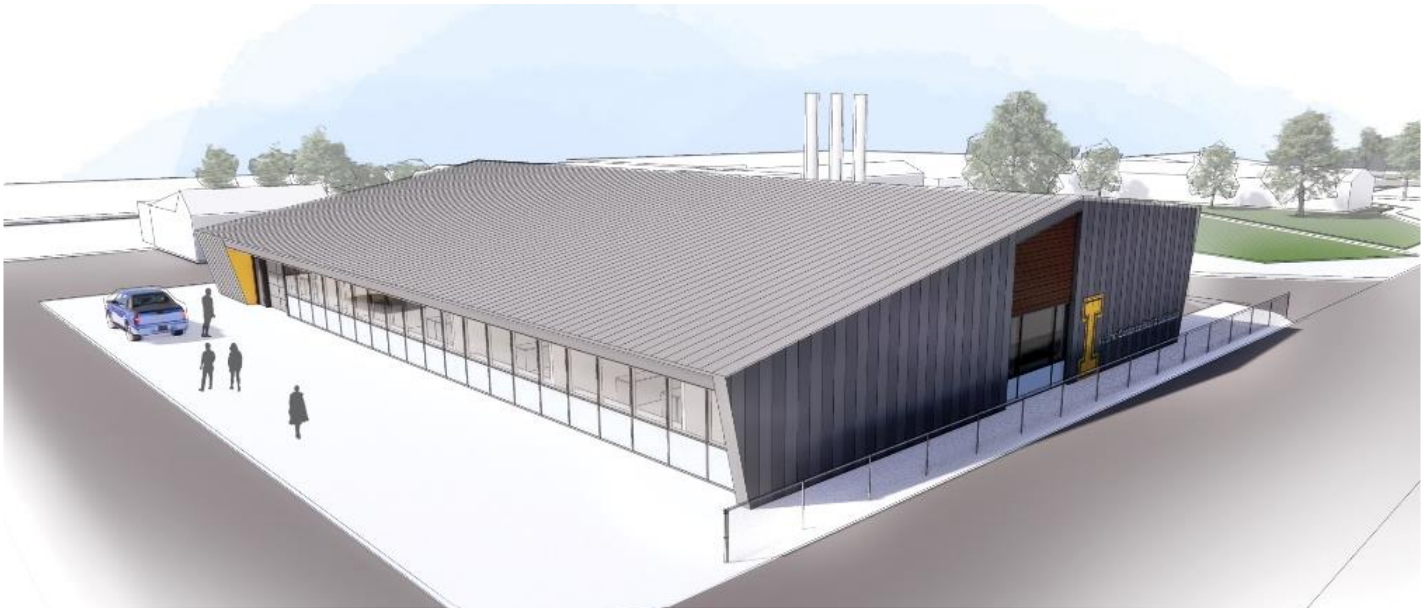


Please join us for a ribbon cutting ceremony to celebrate the grand opening of the new Idaho Center for Plant and Soil Health at the Parma Research and Extension Center.

Tuesday, February 20
3:30 – 5:30 p.m. MT

Parma Research and Extension Center
29603 U of I Ln, Parma ID 83660

Event will include light refreshments, tours of the facility and a program celebrating the generous partners who made this effort possible.

Kindly RSVP by Friday, February 8, 2024 to:
Carly Schoepflin
craska@uidaho.edu or 208.885.4037

Table of Contents: Research Reports

IDAHO-MALHEUR COUNTY
ONION GROWERS' PRODUCER BOOKLET

PINK DIVIDER:

TITLE: **Long Term Storage of Onion Cultivars (2022/2023 Report)**
Mike Thornton, Ransey Portenier, Oksana Morgan and Kyler Beck

TITLE: **Stunting and stand loss in drip-irrigated onions - 2023**
Mike Thornton, Ransey Portenier, Oksana Morgan

TITLE: "**Cheat the Heat": Influencing Soil Temperature to Maximize Onion Yield and Quality**
Kyler Beck, Luca Distefano
Mike Thornton, Ransey Portenier, Oksana Morgan

TITLE: **Influencing Soil Temperature to Maximize Onion Yield and Quality - 2023**
Jeff Michaels, Kyler Beck, Luca Distefano
Mike Thornton, Ransey Portenier, Oksana Morgan

GOLDENROD DIVIDER:

TITLE: **Determination of the Impact of Temperature and other Curing Parameters on Onion Bulb Rot Caused by co-infection of *Botrytis* spp. and *Pantoea* spp. in Storage.**
Brenda Schroeder, James Woodhall

BLUE DIVIDER:

TITLE: **Cost of Onion Production in Idaho and Eastern Oregon**
Gina Greenway

TITLE: **5 Year Summary Onion Production Costs Idaho and Malheur County Oregon**
Gina Greenway

YELLOW DIVIDER:

TITLE: **Evaluating the Effects of Straw Residue at Various Rates on Direct-Seeded Onions in 2023**
James Woodhall

MONITORING ONION PESTS ACROSS THE TREASURE VALLEY – 2023

Stuart Reitz, Malheur Experiment Station, Oregon State University, Ontario, OR

Objective

Provide growers, crop advisors and allied industry members with regional assessments of seasonal pest abundance in commercial fields.

Introduction

Growers continue to be challenged in how to manage thrips and iris yellow spot virus, which is transmitted by thrips. The Idaho-Eastern Oregon region has a range of different growing areas, and thrips and virus pressures vary across those areas. Growers have asked for assistance in monitoring pest pressure within their areas so that they can make better informed management decisions.

Methods

In 2023, seventy-seven commercial onion fields (7 - 10 fields in each of eight growing areas) were monitored weekly for thrips, IYSV, and other pest problems on a weekly basis from the week of May 15 through the week of August 5. Those growing areas were 1) Oregon Slope; 2) Weiser, 3) Vale, 4) Ontario, 5) Nyssa, 6) Adrian, 7) Fruitland/New Plymouth, and 8) Parma/Notus/Marsing. Fifty-nine of the fields were yellow onions (76% of the fields), 12 were red onions (16%), 4 were white onions (5%), and 2 were shallots (3%).

A minimum of 10 plants per field were sampled for adult and immature thrips; counts of the number of green leaves were taken on those plants as a measure of crop development. Up to 50 plants per field were inspected for thrips early in the season when infestations, which is when populations tend to be sporadic. A minimum of 200 plants per field were inspected for symptoms of iris yellow spot virus.

Averages of adult and immature thrips, and IYSV incidence for each district were reported to growers, crop advisors and others each week until tops began to go down in most fields. Reports also tried to include other relevant information affecting crop status and health. Growers received individual weekly reports on their particular fields.

Results and Conclusions

Overall, thrips pressure in 2023 was moderate compared with previous years. Figures 1 and 2 show thrips populations in onions not treated with insecticides. Numbers in these untreated plots were lower in 2023 than in 2022, but higher than they were in 2021. Populations were low at the beginning of the growing season with the cool early spring conditions and then peaked in July, which is when populations naturally peak. The increase in thrips abundance in late June and July corresponds with the transition from the cool spring temperatures to the summer heat (Figure 3). Summer temperatures were relatively mild, allowing plants to continue good growth, which helps to compensate for the increase in thrips abundance. In years with extreme heat, plant growth slows leading to more concentrated thrips feeding damage on leaves.

Thrips had begun colonizing commercial fields by the week of May 20. The fields that had thrips at this point were at the 2- or 3-leaf stage, which is the typical growth stage when thrips begin to colonize onions. Fields with younger plants (flag leaf, first leaf) had not yet been colonized by thrips. Thrips numbers were low (<0.1 per plant) and sporadic within the colonized fields. Less than 3% of plants had thrips at this time (Figure 4). Immature thrips were not detected until the following week with a few individuals found in fields in Fruitland, Ontario, and Parma.

Thrips populations built rapidly through the first two weeks of June and peaked in abundance in July. Over 95% of plants had thrips present at the end of June and remained at those high infestation levels until late July when some fields with early varieties began to mature and thrips numbers in those fields naturally declined (Figure 4). The regions with lowest populations of thrips tended to be the Oregon Slope and Weiser. Regions to the south (Adrian and Parma) tended to have higher populations in 2023.

The first plants infected with iris yellow spot virus (IYSV) were detected the week ending July 1 in a field in Adrian and a field in Parma (Figure 8). By the week ending July 14, virus infected plants were found in one third of the monitored fields. Infected plants were found in all growing regions except Vale that week. Virus incidence continued to escalate through the end of July and August. The highest levels of infection were in Adrian (31% of plants infected) and Parma/Notus/Marsing (14% of plants infected). Those infection rates were much higher than in the other growing areas. By August 4, virus infected plants were found in 84% of monitored fields. Virus symptoms become more apparent over time and are often noticed even when thrips populations are going down at the end of the season. Keep in mind, virus infections occur 1 – 2 weeks before the lesions become evident.

Please note that Figures 4 through 8 show averages for each growing area and that patterns among individual fields vary. Individual fields often showed peaks in thrips abundance, which largely depended on when and what insecticides were applied. Figure 9 shows the patterns for three representative fields with varying degrees of thrips pressure.

Acknowledgments

I appreciate the assistance of the cooperating growers and crop advisors. This project was funded by the Idaho-Eastern Oregon Onion Committee.

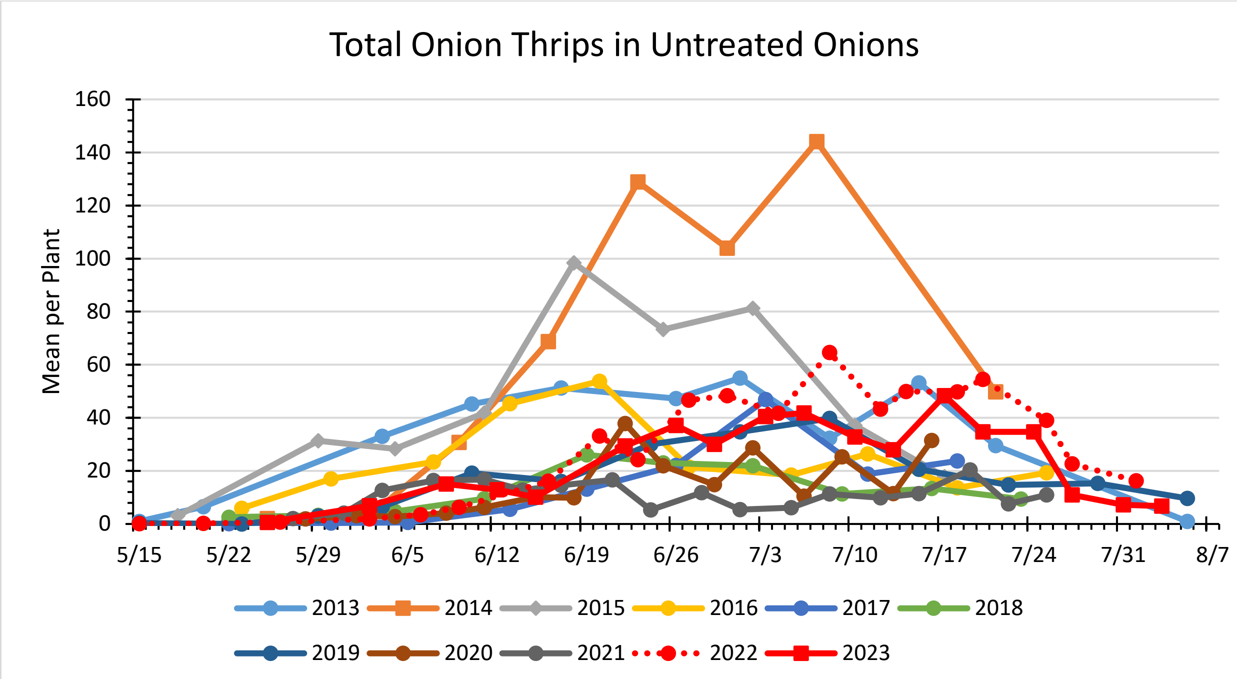


Figure 1. Mean total thrips per plant for each sample date in untreated onion plots at the Malheur Experiment Station from 2013 to 2023. The 2023 data are shown by the red squares and solid red line. The red dashed line with squares shows the 2022 results for comparison. Populations were relatively low during the cool, wet conditions early in the spring. Populations built through June and July as temperatures rose but still remained relatively moderate.

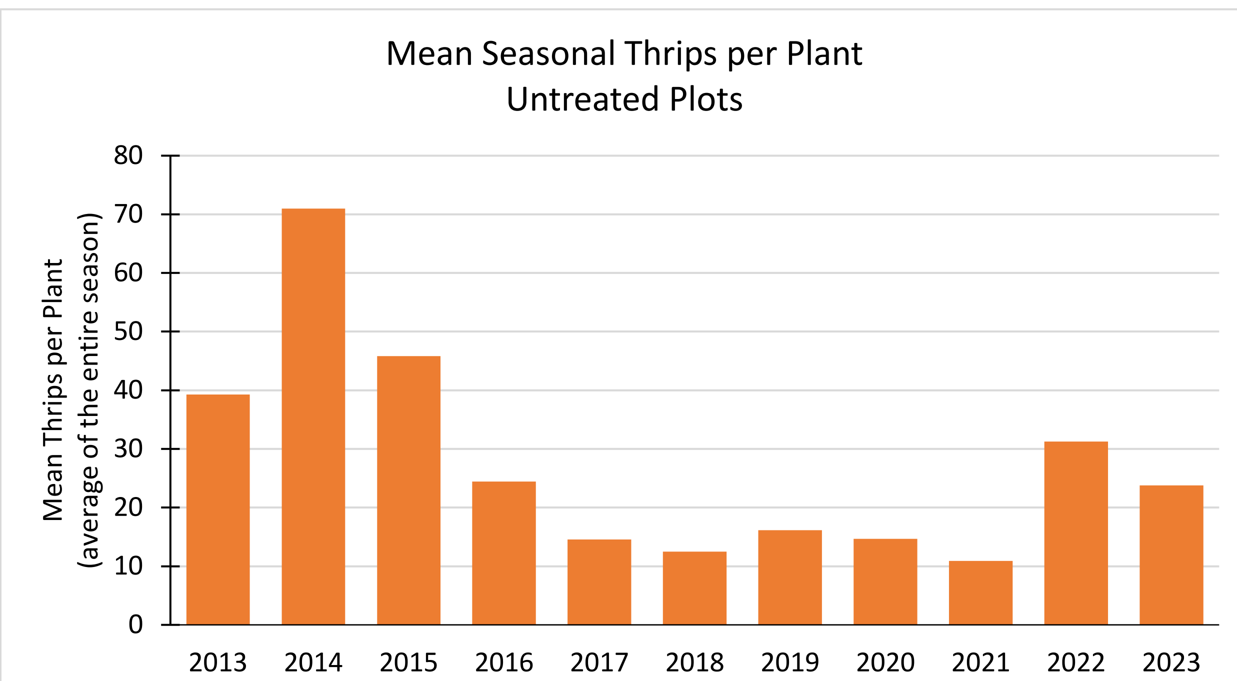


Figure 2. Mean total thrips per plant, averaged over the season (May – August), in untreated onion plots at the Malheur Experiment Station from 2013 to 2023.

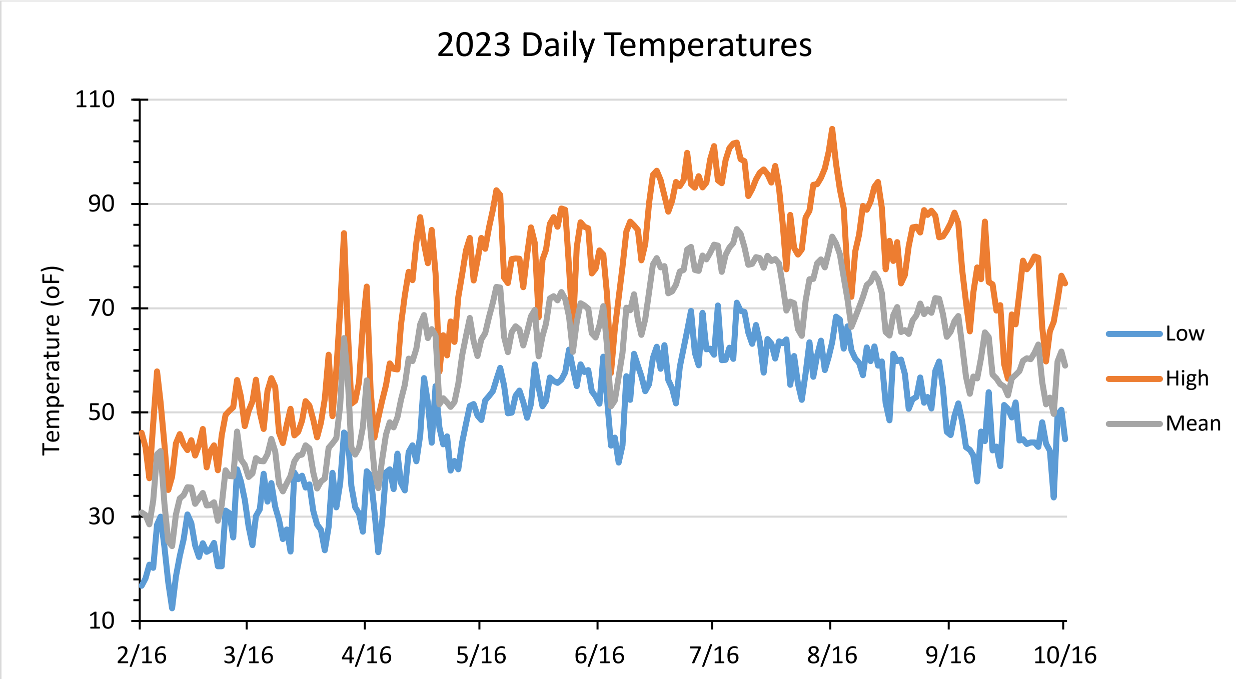


Figure 3. Daily high, low and mean temperatures for the 2023 growing season (February – October) at Ontario, OR.

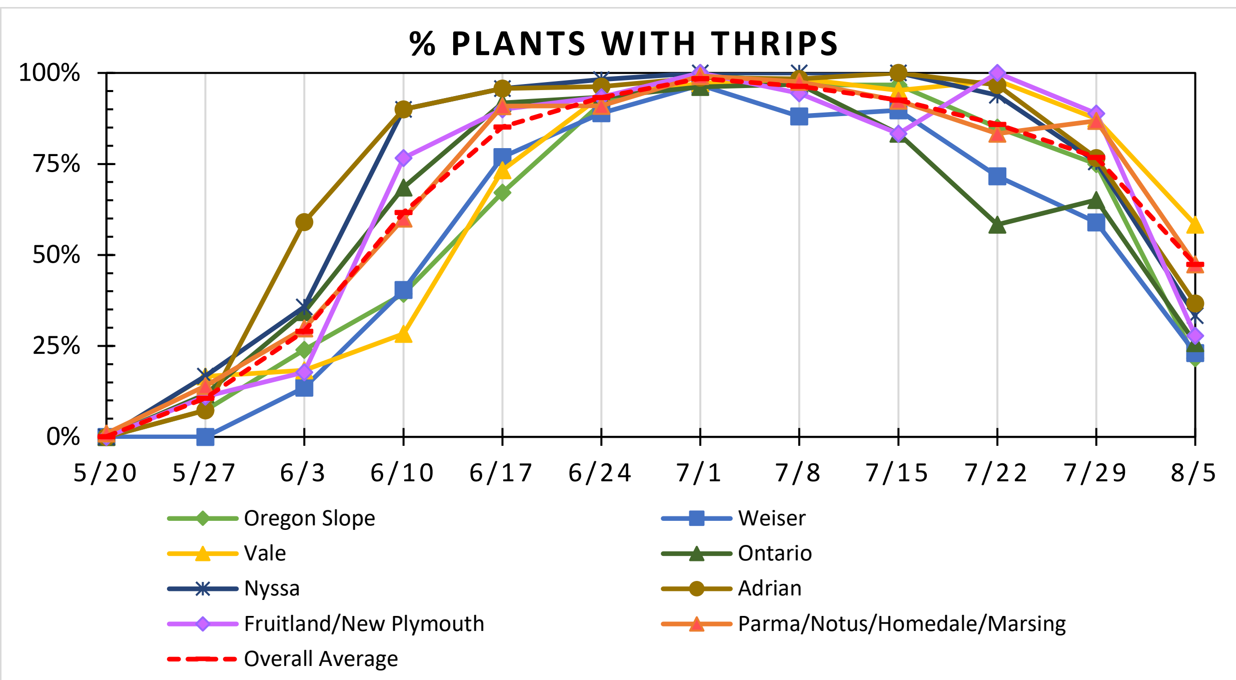


Figure 4. Average percentage of onion plants with thrips present during the 2023 season from different growing areas of the Treasure Valley. From late June to late July, thrips can be found on almost all plants. Populations naturally decline as onion plants mature (i.e., as the necks soften before tops begin to go down).

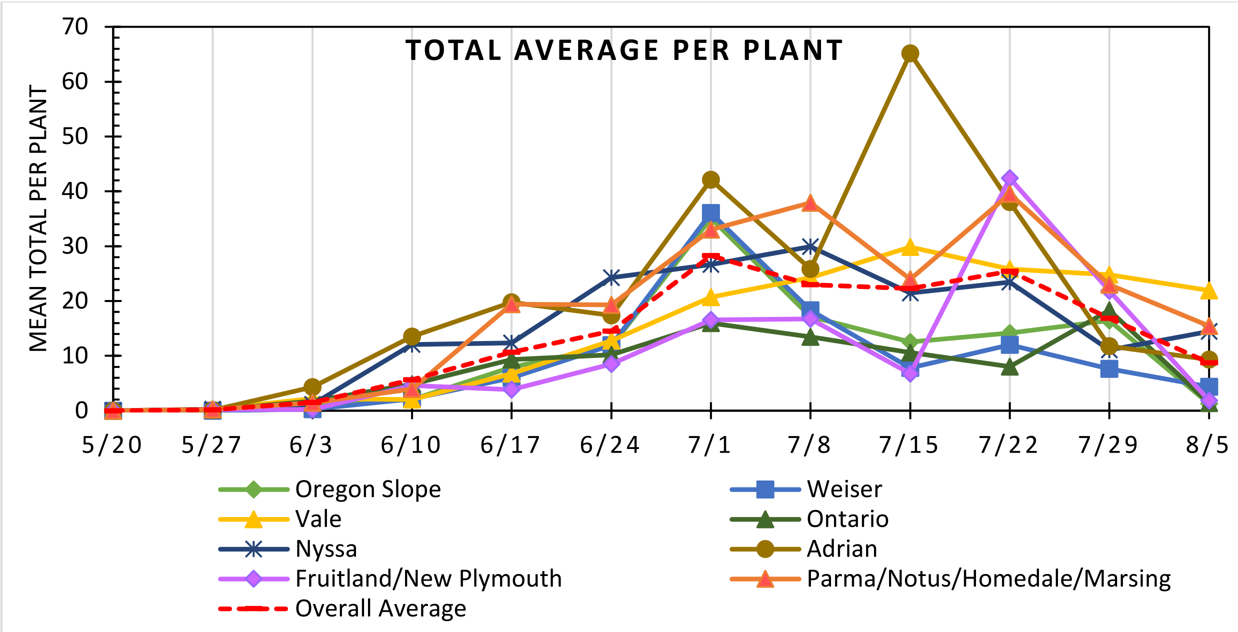


Figure 5. Seasonal trends of total thrips in onion growing areas of the Treasure Valley during 2023.

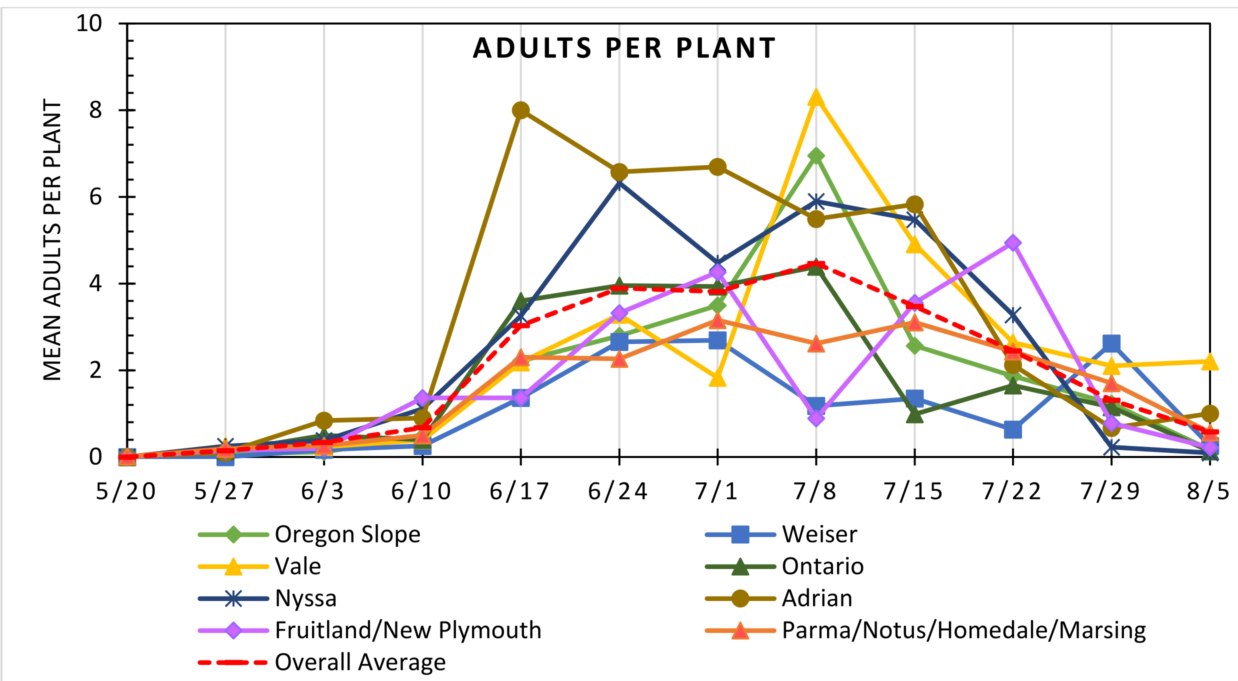


Figure 6. Seasonal trends of adult thrips in onion growing areas of the Treasure Valley during 2023.

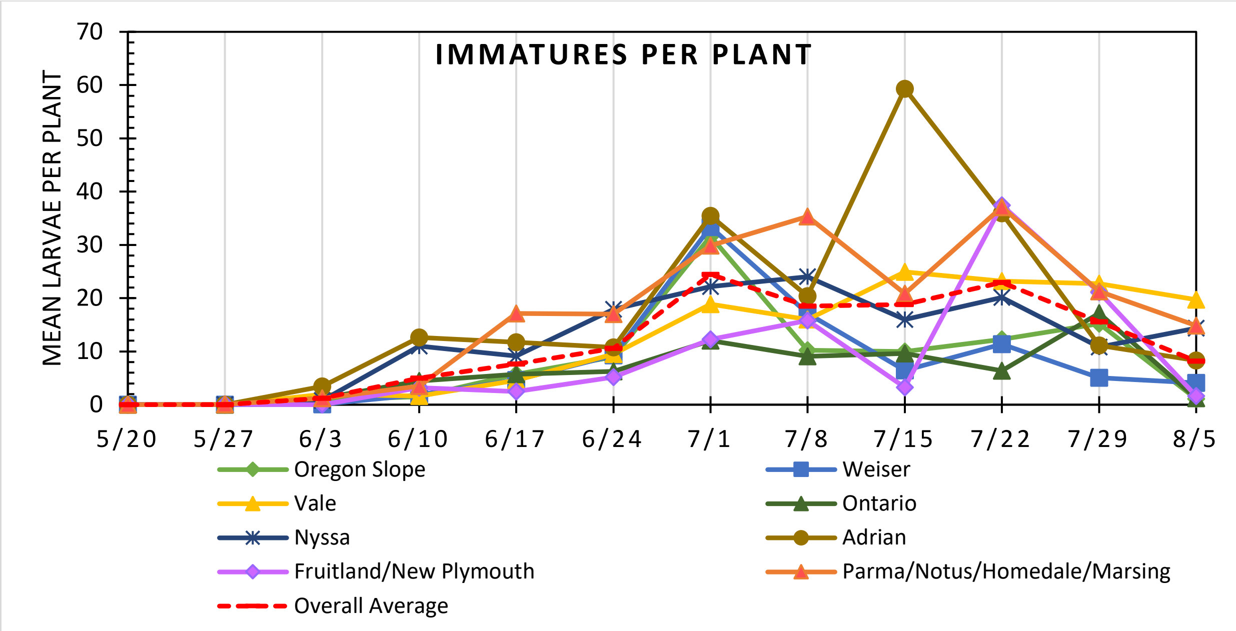


Figure 7. Seasonal trends of immature thrips in onion growing areas of the Treasure Valley during 2023. After initial colonization, the majority of thrips in a field are immatures,

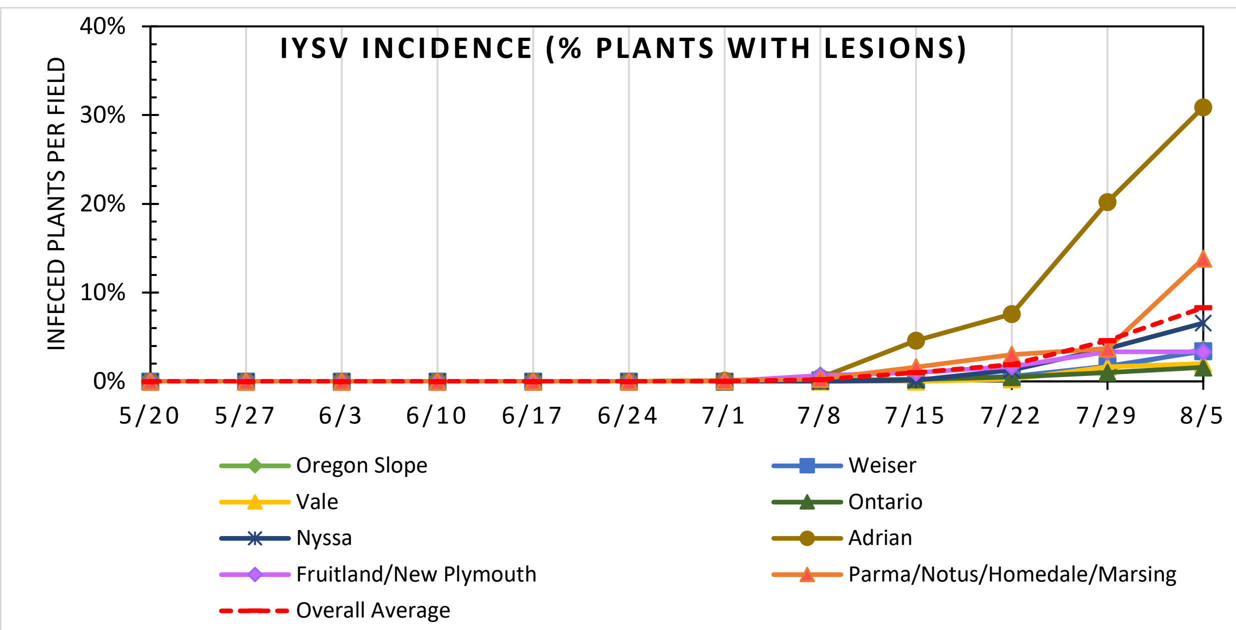
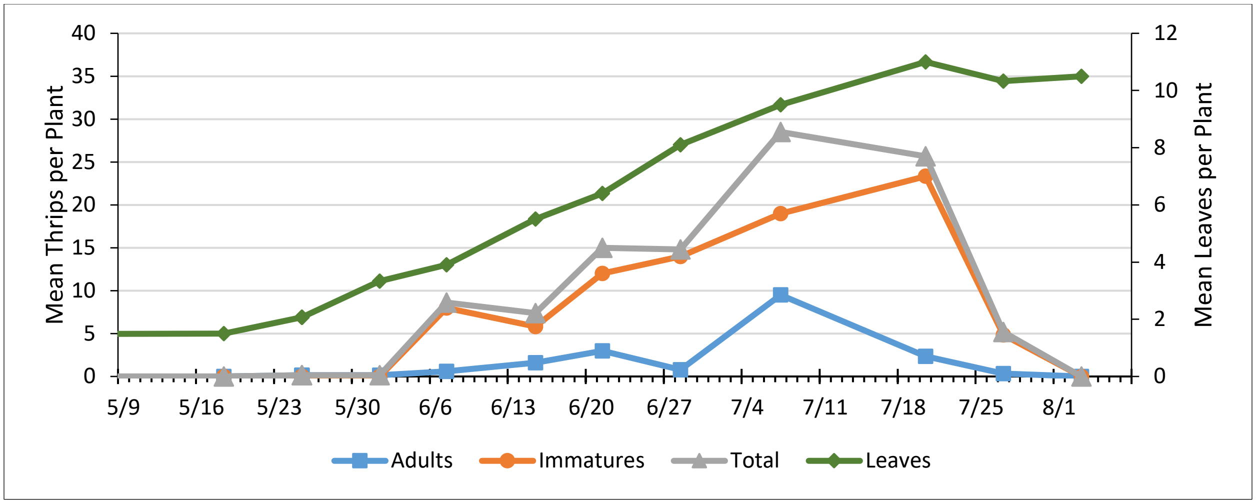
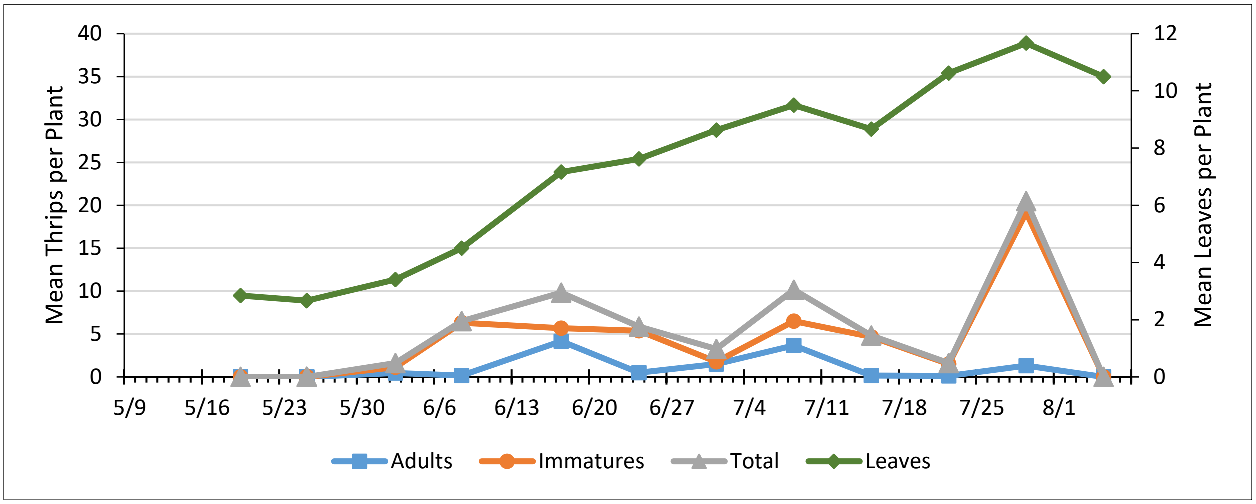


Figure 8. Seasonal incidence of Iris yellow spot virus in commercial onion fields from different growing areas of the Treasure Valley during 2023. Values are the mean percentage of infected plants per field for each area.





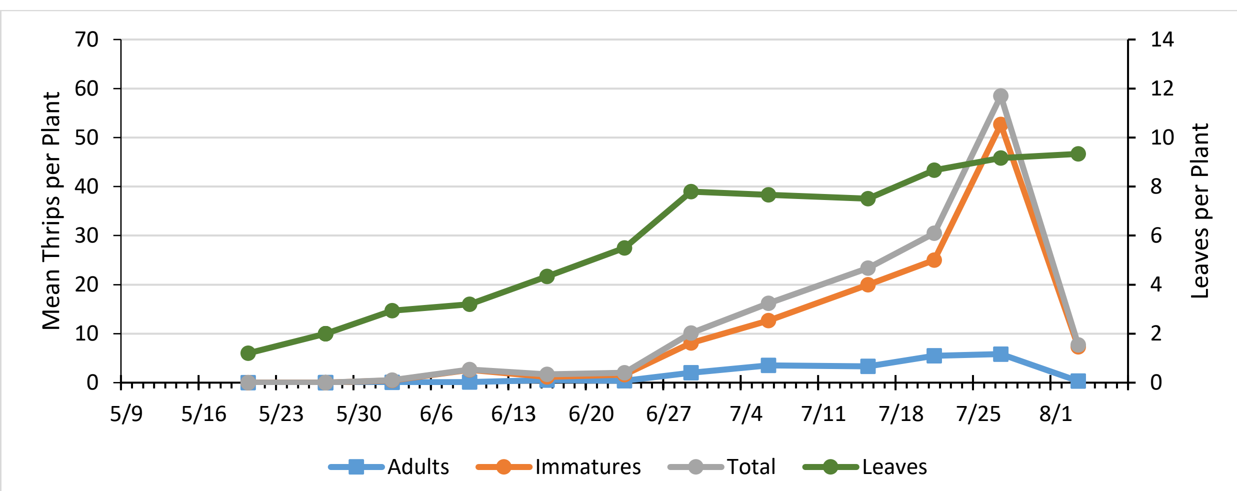


Figure 9. Representative trends for individual fields during the 2023 growing season. Note the different scales for thrips numbers among the graphs.

THRIPS MANAGEMENT AND THE IMPACT OF THRIPS ON STEMPHYLIUM LEAF BLIGHT AND BULB ROTS

Stuart Reitz, Bill Buhrig, Ian Trenkel, Hannah Rose, Alicia Rivera, Kyle D. Wieland, and Erik B. G. Feibert, Malheur Experiment Station, Oregon State University, Ontario, OR

Introduction

In recent years, Stemphylium leaf blight (SLB), caused by the fungus *Stemphylium vesicarium,* has become a more important foliar fungal disease for onions grown in the Treasure Valley. In the initial stages of SLB, pale brown to tan oval-shaped lesions form on the outer leaves. Lesions turn a dark brown to olive color as fungal conidia are produced. As foliage dies back, photosynthetic capacity is lost and reduced bulb size. Dead leaf tissue increases the risk of storage problems, including increased incidence of bulb rots.

Stemphylium can invade leaf tissue damaged by other causes, including scarred tissue from thrips feeding and lesions from thrips-transmitted iris yellow spot virus. Thrips management is therefore critical to minimizing the incidence and severity of SLB.

The objectives of this research trial were to determine how:

1) thrips management affects the incidence and severity of SLB, and yield and quality of onions.
2) fungicides affect the incidence and severity of SLB, and yield and quality of onions.

Figure 1. Stemphylium leaf blight on onion (left). Developing iris yellow spot lesion on onion (center). Stemphylium leaf blight developing in iris yellow spot lesion on onion (right).

Materials and Methods

The trial was grown on an Owyhee silt loam previously planted to wheat. 10 t/acre of composted cattle feedlot manure was applied after plowing in the fall. The field was fumigated with K-Pam at 15 gal/acre and marked out at 22 inches.

The trial was planted on April 13, 2023, using the variety 'Vaquero' (BASF Nunhem's Vegetable Seeds). Seed was planted in double rows spaced three inches apart at 3.8 inches between seeds within a single row for a seeding rate of 150,000 seeds per acre. Two double rows were planted on 44-inch beds, with the middle of the double rows 20 inches apart. Planting was done with an Agricola Italiana vacuum planter. Plots were 23 feet long and 4 double rows (7.33 ft) wide.

The experimental design was a randomized complete block with a factorial treatment arrangement. The first treatment factor was insecticide treatment, with plots either being treated with insecticides or left untreated. The second factor was fungicide treatment, with plots receiving one of four fungicide treatments. There were four replicates of each treatment combination. See Table 1 for the insect and fungicide treatment programs. Each individual plot received one of the two insecticide treatment programs and one of the four fungicide treatment programs.

Insecticides were applied weekly for eight weeks beginning June 6 and continued until July 25 (Table 1). The insecticide program in this trial is one that has been effective in managing thrips and producing high yields in previous research trials. Fungicides were applied every two weeks beginning after bulb initiation. Four applications were made from July 7 until August 18, which was just prior to tops beginning to go down.

Pesticides were applied with a CO_2 powered backpack sprayer using a 4-nozzle boom with 11004 nozzles and operating at 30 PSI and 35 gallons per acre.

Besides the experimental insecticide and fungicide treatments, standard commercial practices for the Treasure Valley were used. The field was drip irrigated.

Onion emergence started on 1 May.

Because of the late planting, thrips did not colonize the trial until June 2. Counts were made by counting thrips on ten consecutive plants in one of the middle two rows of each plot. Counts were taken twice per week, at approximately 3 and 6 days after treatment. Adult and larval thrips were recorded separately. In addition to individual sample date counts, total accumulated thrips numbers were determined by calculating the area under the curve for cumulative thrips-days numbers from one sample point to the next.

On August 25, ten onion plants per plot were evaluated for the severity of iris yellow spot and SLB. Both diseases were rated on a scale of 0 – 4 (0 = no disease, 1 = mild, 2 = moderate, 3 = major, 4 = severe) (Table 2).

Onions from the middle two rows in each plot were topped, bagged, and placed in storage on 21 September. The ambient-air storage shed was ventilated, and the temperature was decreased slowly to maintain an air temperature as close to 34°F as possible.

Onions were graded out of storage on 18 December. During grading, bulbs were separated according to external quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Marketable yield consisted of No.1 bulbs larger than 2¼ inches.

During grading, 100 No. 1 bulbs from each plot were cut longitudinally and evaluated for the presence of incomplete scales, dry scales, internal bacterial rot, and internal rot caused by *Fusarium proliferatum* or other fungi. Incomplete scales were defined as scales that had more than 0.25 inch from the center of the neck missing or any part missing lower down on the scale. Dry scales were defined as scales that had more than 0.25 inch from the center of the neck dry or any part dry deeper in the scale.

Results

The trial was planted approximately 3 weeks later than normal because of wet spring conditions. Wet conditions persisted early in the growing season with 29 days of measurable precipitation from planting through bulb initiation. There were 10 more days of rain during the rest of the season, including 1.35 inches recorded 3 days after the final fungicide application.

Pesticide Application Restrictions

The insecticide applications for this trial are all within the label limits for each product and meet recommended resistance management practices of limiting the number of applications to no more than two for each individual product and then rotating to different mode of action classes.

For the fungicides, the applications for Bravo Weather Stik and Pristine are within the label limits for those products. However, best resistance management recommendations would limit the number of applications to two before rotating to different mode of action classes. For Luna Tranquility, the label limit is 54.7 fl oz/acre. Therefore, the experimental protocol of four applications at 27 fl oz/acre exceeds the label. Further, for resistance management, no more than two applications are recommended.

Pesticide Effects on Pest and Disease Pressure

The insecticide applications significantly reduced the thrips pressure across all fungicide treatments. The insecticide treatment reduced the cumulative number of thrips by 24% over the season compared with the untreated check treatment (Figure 2). In concert with the reduction in thrips pressure, insecticide applications reduced the severity of iris yellow spot virus (Figure 2). Severity ratings were 1/3 to more than 1/2 lower with insecticide applications. Stemphylium leaf blight was also significantly lower with insecticide applications (Figure 2).

There were no statistical differences in SLB severity among the fungicide treatments when they were applied to plots without insecticides (Figure 2). However, when applied to plots that were also treated with insecticides, the fungicides significantly reduced the severity of SLB compared with the check that did not receive a fungicide treatment.

There were some interesting interactions between fungicide and insecticide treatments. The numerically highest SLB severity rating was for Bravo Weather Stik without insecticide treatments, but the lowest damage rating was for Bravo in combination with the insecticides. Luna Tranquility and Pristine had numerically lower SLB ratings when combined with insecticide treatments. Numerically, their SLB damage ratings when combined with insecticides were less than 1/2 of the levels when the fungicides were applied without insecticides.

Pesticide Effects on Yield and Bulb Rots

Because of the greater thrips control, yields were significantly higher with insecticide applications than without (Table 3; Figure 3). Overall marketable yields were 22% higher with insecticide applications than without insecticide applications. Yields of colossal and supercolossal bulbs were twice as high with insecticide applications than without insecticides.

The proportion of diseased bulbs was significantly higher when insecticides were not applied than when insecticides were applied (Figure 4). Diseased bulbs included those infected with *Botrytis* neck rot, *Fusarium proliferatum,* black mold or bacterial pathogens. Neck rot was the most common bulb rot across all treatments. Neck rot comprised 72 – 87% of the bulb rots.

Insecticide use alone without a fungicide reduced diseased bulbs by 11% compared with the no insecticide – no fungicide treatment. However, when combined with one of the three fungicides, the insecticide effect was more pronounced. Diseased bulbs were reduced by 45 – 69% when the fungicides were complemented with insecticides compared with fungicides without insecticides (Figure 4).

All three of the tested fungicides reduced the proportion of diseased bulbs compared with the no fungicide control (Figure 4). There were no differences among the three tested fungicides. However, the fungicide effect was only apparent with the insecticide treatment. There was no difference in the proportion of diseased bulbs between the fungicides and the no fungicide control when no insecticides were used.

Conclusions

This trial demonstrated the importance of thrips management in reducing damage to onions. Maintaining good thrips management reduces the severity of thrips-transmitted iris yellow spot virus. The lower damage from thrips feeding and iris yellow spot results in less severe Stemphylium leaf blight.

When combined with insecticide applications, fungicides can reduce the severity of Stemphylium leaf blight.

The combination of insecticide and fungicide applications significantly reduces the incidence of bulb rots. They also increase overall yield and the size profile of onions.

Repeated use of chlorothalonil, the active ingredient in Bravo Weather Stik, can have phytotoxic effects on onions, which may have contributed to the relatively low yields when Bravo was applied four times in this trial.

Acknowledgements

We appreciate the excellent technical assistance of Jimena Anguiano, Maddox Atagi, Bennett Johnson, Amber Lovett, and Helen Vega. This project was funded by the Idaho-Eastern Oregon Onion Committee, cooperating chemical companies, Oregon State University, and the Malheur County Education Service District.

Table 1. Insecticide and fungicide treatments, and application dates for the Stemphylium leaf blight trial, Malheur Experiment Station, 2023.

Insecticide Treatment Program	Insecticides & Adjuvants	IRAC Mode of Action	Product Type	Rate	Application Timing
1	Untreated Check - insecticide		--	--	--
2	AZA-DIRECT	UN	Insecticide	16 FL OZ/A	AB
	M-PEDE	UN	Insecticide/Penetrating Adjuvant	2 % V/V	AC
	MOVENTO HL	23	Insecticide	2.5 FL OZ/A	BC
	NIS		Adjuvant (Spreader, Penetrant)	0.125 % V/V	B
	AGRI-MEK SC	6	Insecticide	3.5 FL OZ/A	D
	NIS		Adjuvant (Spreader, Penetrant)	0.125 % V/V	D
	RADIANT	5	Insecticide	10 FL OZ/A	EG
	M-PEDE	UN	Insecticide/Penetrating Adjuvant	2 % V/V	EG
	EXIREL	28	Insecticide	13.5 FL OZ/A	HJ
	DYNE-AMIC		Adjuvant (Spreader, Penetrant)	0.25 % V/V	HJ
Fungicide Treatment Program	**Fungicides & Adjuvants**	**FRAC Mode of Action**	**Product Type**	**Rate**	**Application Timing**
1	UNTREATED - Fungicide		--	--	--
2	PRISTINE	7, 11	Fungicide	18 OZ/A	FIKL
	INTERLOCK		Adjuvant (Spreader/Sticker)	6.4 FL OZ/A	FIKL
3	BRAVO WEATHERSTICK	M5	Fungicide	48 FL OZ/A	FIKL
4	LUNA TRANQUILITY	7, 9	Fungicide	27 FL OZ/A	FIKL
	INTERLOCK		Adjuvant (Spreader/Sticker)	6.4 FL OZ/A	FIKL

Application Timing	A	B	C	D	E	F
Date	June 6	June 13	June 20	June 27	July 4	July 7
Pesticide Treatment	Insecticide	Insecticide	Insecticide	Insecticide	Insecticide	Fungicide

Application Timing	G	H	I	J	K	L
Date	July 11	July 18	July 21	July 25	August 4	August 18
Pesticide Treatment	Insecticide	Insecticide	Fungicide	Insecticide	Fungicide	Fungicide

Table 2. Ratings scales for SLB and IYSV used in the for the Stemphylium leaf blight trial, Malheur Experiment Station, 2023.

Score	Stemphylium Leaf Blight (SLB)	Iris yellow spot virus (IYSV)
0	No lesions	No lesions
1	Few small lesions / "dirty" leaf tips	few small lesions on <3 leaves
2	Multiple lesions on multiple leaves	Several lesions on > 3 leaves
3	Lesions covering 25-50% leaf surface	Multiple large lesions on majority of leaves
4	Lesions covering >50% leaf surface	Defoliation

Table 3. Marketable yield for the Stemphylium leaf blight trial for fungicide and insecticide treatments and their interactions. Means followed by the same lowercase letter are not statistically different. If no letters follow a set of means, there are no statistical differences. Yield data are cwt/acre.

Fungicide		**Medium cwt/ac**		**Jumbo cwt/ac**		**Colossal cwt/ac**		**Super cwt/ac**		**Marketable cwt/ac**	
Control		23.8		290.9		288.6	a	182.1	a	785.3	a
Bravo		22.8		309.9		208.9	b	71.7	b	613.3	b
Luna		17.5		277.7		245.2	ab	158.1	a	698.5	ab
Pristine		23.4		316.2		264.3	a	132.8	a	736.7	a
	LSD	**ns**		**ns**		**48.0**		**50.1**		**ns**	
Insecticide											
None		27.0	a	350.4	a	200.2	b	61.5	b	639.1	b
Yes		16.7	b	247.0	b	303.3	a	210.9	a	777.9	a
	LSD	**8.8**		**71.3**		**45.5**		**35.4**		**100.7**	
Fungicide	**Insecticide**										
Control	None	30.2		383.5		263.8		87.0	b	764.4	
Control	Yes	17.4		198.3		313.5		277.3	a	806.3	
Bravo	None	25.0		348.1		140.5		42.6	b	556.1	
Bravo	Yes	20.7		271.8		277.3		100.7	b	670.5	
Luna	None	21.4		311.5		186.8		63.7	b	583.4	
Luna	Yes	13.5		244.0		303.6		252.5	a	813.6	
Pristine	None	31.6		358.7		209.6		52.5	b	652.4	
Pristine	Yes	15.2		273.7		319.1		213.1	a	821.0	
LSD		**ns**		**ns**		**ns**		**70.8**		**ns**	
P Values											
Fungicide		**0.7041**		**0.8527**		**0.0203**		**0.0005**		**0.0342**	
Insecticide		**0.0239**		**0.0063**		**0.0001**		**0.0001**		**0.0019**	
Fungicide X Insecticide		**0.7613**		**0.6009**		**0.5472**		**0.0244**		**0.3898**	

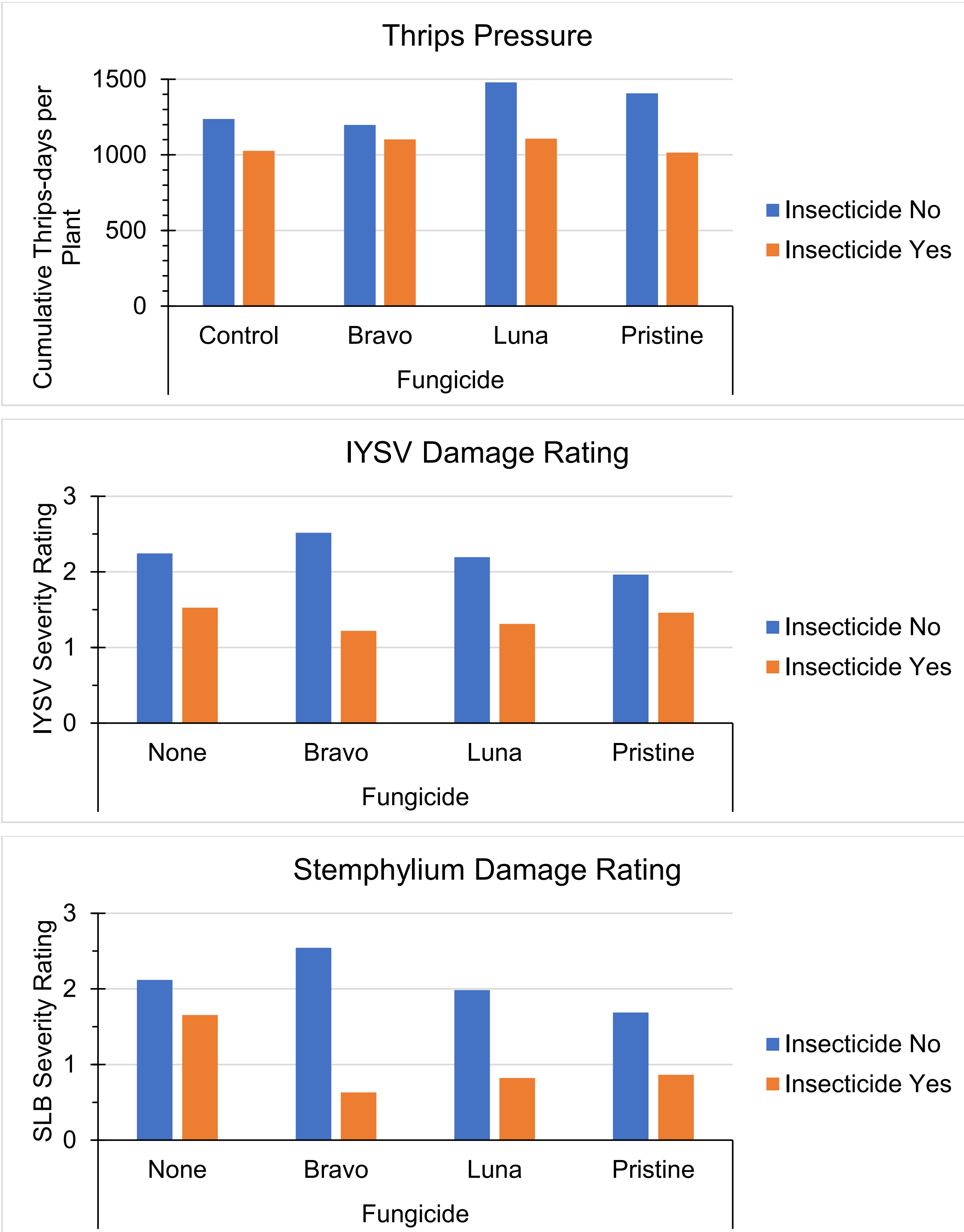


Figure 2. Effects of insecticide and fungicide treatments on thrips pressure (top), iris yellow spot severity and Stemphylium leaf blight (SLB) severity in onion, Malheur Experiment Station 2023. Higher damage ratings indicate greater disease severity.

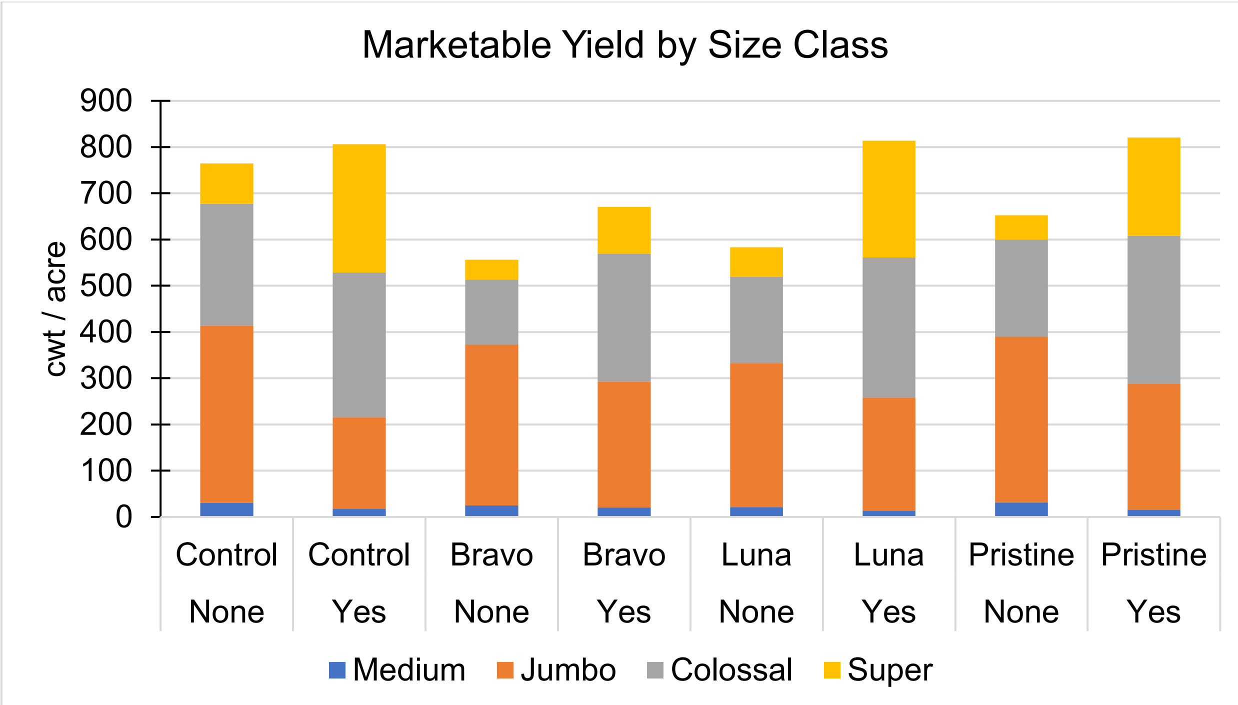


Figure 3. Size profiles of onions in the Stemphylium leaf blight trial for fungicide and insecticide treatments, Malheur Experiment Station 2023.

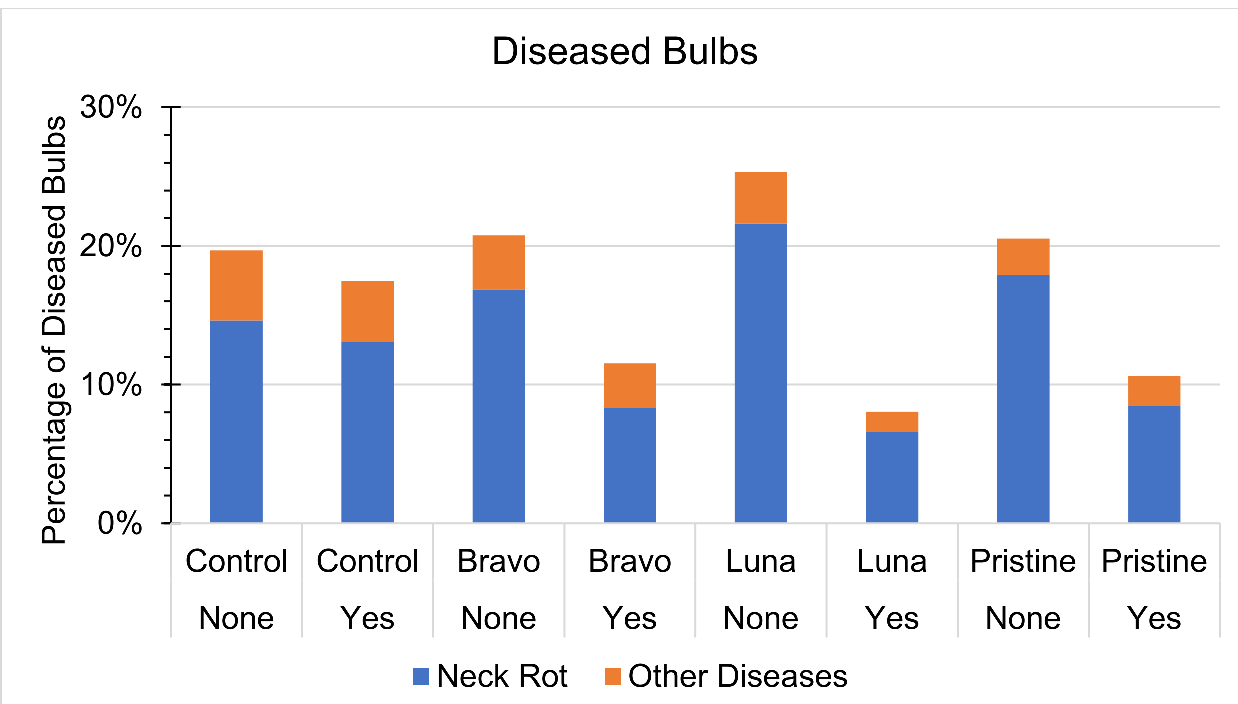


Figure 4. Percentage of diseased bulbs when evaluated after three months of storage. Blue portion of bars represent the percentage of bulbs with Botrytis neck rot. Orange bars represent the percentage of bulbs infected with other fungal or bacterial diseases. The x-axis shows the fungicide treatment and insecticide treatment below that.

INSECTICIDES AND INSECTICIDE USE PATTERNS FOR MANAGEMENT OF THRIPS AND IRIS YELLOW SPOT VIRUS

Stuart Reitz, Erik Feibert, Kyle Wieland, Ian Trenkel, Alicia Ramires, Hannah Rose

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Objectives

We conducted several trials to examine the efficacy of different insecticides and to help optimize application methods and timings.

1) **Seasonal Insecticide Rotation Programs.** Compare season-long insecticide rotations for their efficacy in thrips and virus management, and their effects on yield.
2) **Compare the efficacy of insecticide tank mixes versus single insecticide applications.** We compared two-way and three-way combinations of three insecticides (Agrimek, Lannate, Radiant) to applications of those insecticides individually.
3) **Insecticide Application Interval Trial.** This trial examined the effect of the interval between spray applications on thrips management. The intervals evaluated were 7, 10, and 14 days between applications.
4) **Insecticide Application Timing for Thrips Management in Red and Yellow Onions**. We compared the effectiveness of early-season, late-season, and full-season insecticide applications for thrips management in red and yellow onions.

Introduction

Onion thrips and the thrips-transmitted iris yellow spot virus continue to be the major pests for onion production in the Treasure Valley. Insecticides remain the primary tool for thrips and virus management. However, there is a limited set of registered insecticides with efficacy against thrips, and thrips are able to rapidly develop resistance to insecticides. Therefore, it is important to assess the effectiveness of currently registered insecticides and to determine when during the season different insecticides may be used most effectively. It is also important to determine the effectiveness of new products and how they may be integrated into an overall thrips management program.

Materials and Methods

Onions, seeded at 150,000 plants per acre, were grown at the Malheur County Experiment Station. All trials used the cultivar ‘Vaquero’ (Nunhem’s). In the Red-Yellow trial, the red cultivar was ‘SV4643NT’ (Seminis), and ‘Vaquero’ was the yellow cultivar. For all experiments, treatments were replicated four times. Each treatment plot was four double rows wide by 23 feet long.

The trial was planted on April 13, 2023, and was planted in double rows spaced 3 inches apart on beds spaced 22 inches apart. The trial was drip irrigated. The field had drip tape laid at 4-inch depth between pairs of beds during planting. The drip tape had emitters spaced 8 inches apart and an emitter flow rate of 0.09 gallons per hour (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 10 inches. Standard management practices were followed to maintain the crop during the season.

Insecticide Applications

Insecticide treatment sequences were designed to evaluate the performance of various products at various times during the season.

Tank mixes were designed to determine if there are additive, synergistic, or antagonistic interactions among specific products.

Insecticide applications were made with a CO_2 backpack sprayer using a 4-nozzle boom with 11004 nozzles at 30 PSI and 35 gallons per acre. A threshold of one thrips per leaf was used to determine when insecticide applications started. The first application for all trials was June 3.

Data Collection

Thrips counts began May 25. Counts were made by counting thrips on ten consecutive plants in one of the middle two rows of each plot. Counts were taken twice per week, at approximately 3 and 6 days after treatment. Adult and larval thrips were recorded separately. In addition to individual sample date counts, total accumulated thrips numbers were determined by calculating the area under the curve for cumulative thrips-days numbers from one sample point to the next.

To determine yield, onions from the middle two double rows in each plot were topped by hand, bagged, and moved into storage and graded in October. During grading, bulbs were separated according to external quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼-3 inches), jumbo (3-4 inches), colossal (4-4¼ inches), and super colossal (>4¼ inches). Bulb counts for all categories of bulbs were recorded during grading. Marketable yield consisted of No.1 bulbs larger than 2¼ inches.

1 – Seasonal Insecticide Rotation Programs

The objective of this trial was to compare season-long insecticide rotations for their efficacy in thrips and virus management, and their effects on yield. Seven programs with registered products were evaluated (Table 1). Twenty-four different programs were evaluated. Ten of those programs included experimental or unregistered products and are not reported here.

Treatment 1 was an untreated control.

Treatment 2 was the standard reference program that has been used as the standard for our trials in recent years and consisted of two applications of Movento HL, two applications of AGRI-MEK SC, two applications of Radiant, and two applications of Lannate.

Treatment 4 was the same as Treatment 2 but substituted Minecto Pro for Agrimek. Treatment 14 was the same as the reference program (Treatment 2) except that Minecto Pro was substituted for Agri-Mek SC. Minecto Pro has two active ingredients, abamectin (also the active ingredient in Agri-Mek SC and Reaper) plus cyantraniliprole (also the active ingredient in Exirel and Verimark).

Treatment 12 substituted Senstar for Movento HL and Exirel for Lannate. Senstar has the same active ingredient as Movento HL plus an insect growth regulator (pyriproxyfen). Therefore, it is intended to target immature thrips (larvae).

Treatments 13 and 14 used two applications of Senstar at later intervals in spray program.

Treatment 15 was similar to the reference program but substituted Exirel for Lannate.

Treatment 16 substituted Agrix Shield for Azadirachtin. Agrix Shield contain neem plus plant essential oils.

Treatment 18 has been a high preforming program. It uses Azadirect and M-Pede initially allowing Movento to be used later in the season. Azadirect and M-Pede are also used with Movento HL to knockdown thrips numbers while Movento becomes active in the plant.

Treatment 20 also includes Azadirect and moves Movento HL to the second and third applications. This program also included Exirel at the end of the program.

Treatment 21 substituted Senstar for Movento HL and applied it later in the season.

Treatment 23 started with two applications of Torac followed by Movento HL applied with Azadirect.

Treatment 24 used Torac applied with Movento HL.

Applications were made weekly for eight weeks, beginning June 9 when thrips populations reached a one thrips per threshold. The last application date was July 28.

Table 1. Insecticide programs used in the seasonal insecticide trial. Application dates: June 9, B: June 16; C: June 23; D: June 30; E: July 7; F: July 14; G: July 21; H: July 28.

Treatment	Products	Rate		Application Timing
1	Control			-
2	MOVENTO HL	2.5	FL OZ/A	AB
2	DYNE-AMIC	0.7	PT/A	AB
2	AGRI-MEK SC	3.5	FL OZ/A	CD
2	DYNE-AMIC	0.25	% V/V	CD
2	RADIANT	8	FL OZ/A	EF
2	DYNE-AMIC	0.25	% V/V	EF
2	LANNATE LV	3	PT/A	GH
2	DYNE-AMIC	0.25	% V/V	GH
4	MOVENTO HL	2.5	FL OZ/A	AB
4	DYNE-AMIC	0.7	PT/A	AB
4	MINECTO PRO	10	FL OZ/A	CD
4	DYNE-AMIC	0.25	% V/V	CD
4	RADIANT	8	FL OZ/A	EF
4	DYNE-AMIC	0.25	% V/V	EF
4	LANNATE LV	3	PT/A	GH
4	DYNE-AMIC	0.25	% V/V	GH
8	AZA-DIRECT	16	FL OZ/A	AB
8	M-PEDE	2	% V/V	AB
8	MOVENTO HL	2.5	FL OZ/A	CD
8	MINECTO PRO	10	FL OZ/A	EF
8	RADIANT	10	FL OZ/A	GH
8	DYNE-AMIC	0.25	% V/V	CDEFGH
12	SENSTAR	10	FL OZ/A	AB
12	DYNE-AMIC	0.25	% V/V	ABCDEF
12	AGRI-MEK SC	3.5	FL OZ/A	CD
12	RADIANT	8	FL OZ/A	EF
12	EXIREL	20.5	FL OZ/A	GH
12	NIS	0.25	% V/V	GH

Treatment	Products	Rate		Application Timing
13	EXIREL	20.5	FL OZ/A	AB
13	NIS	0.25	% V/V	AB
13	SENSTAR	10	FL OZ/A	CD
13	RADIANT	8	FL OZ/A	EF
13	AGRI-MEK SC	3.5	FL OZ/A	GH
13	DYNE-AMIC	0.25	% V/V	CDEFGH
14	EXIREL	20.5	FL OZ/A	AB
14	NIS	0.25	% V/V	AB
14	AGRI-MEK SC	3.5	FL OZ/A	CD
14	SENSTAR	10	FL OZ/A	EF
14	RADIANT	8	FL OZ/A	GH
14	DYNE-AMIC	0.25	% V/V	CDEFGH
15	MOVENTO HL	2.5	FL OZ/A	AB
15	DYNE-AMIC	0.7	PT/A	AB
15	AGRI-MEK SC	3.5	FL OZ/A	CD
15	DYNE-AMIC	0.25	% V/V	CD
15	RADIANT	8	FL OZ/A	EF
15	DYNE-AMIC	0.25	% V/V	EF
15	EXIREL	20.5	FL OZ/A	GH
15	NIS	0.25	% V/V	GH
16	AGRIX	27	FL OZ/A	ABC
16	M-PEDE	2	% V/V	ABD
16	MOVENTO HL	2.5	FL OZ/A	CD
16	AGRI-MEK SC	3.5	FL OZ/A	EF
16	RADIANT	8	FL OZ/A	GH
16	DYNE-AMIC	0.25	% V/V	CEFGH
18	AZA-DIRECT	16	FL OZ/A	ABC
18	M-PEDE	2	% V/V	ABD
18	MOVENTO HL	2.5	FL OZ/A	CD
18	AGRI-MEK SC	3.5	FL OZ/A	EF
18	RADIANT	8	FL OZ/A	GH
18	DYNE-AMIC	0.25	% V/V	CEFGH

Treatment	Products	Rate		Application Timing
20	AZA-DIRECT	16	FL OZ/A	AB
20	M-PEDE	2	% V/V	AB
20	MOVENTO HL	2.5	FL OZ/A	BD
20	AGRI-MEK SC	3.5	FL OZ/A	CD
20	RADIANT	8	FL OZ/A	EF
20	DYNE-AMIC	0.25	% V/V	CDEF
20	EXIREL	13.5	FL OZ/A	GH
20	NIS	0.25	% V/V	GH
21	AZA-DIRECT	16	FL OZ/A	AB
21	M-PEDE	2	% V/V	AB
21	SENSTAR	10	FL OZ/A	BD
21	AGRI-MEK SC	3.5	FL OZ/A	CD
21	RADIANT	8	FL OZ/A	EF
21	DYNE-AMIC	0.25	% V/V	CDEF
21	EXIREL	13.5	FL OZ/A	GH
21	NIS	0.25	% V/V	GH
23	TORAC	24	FL OZ/A	AB
23	NIS	0.25	% V/V	AB
23	MOVENTO HL	2.5	FL OZ/A	CD
23	AZA-DIRECT	16	FL OZ/A	CD
23	DYNE-AMIC	0.25	% V/V	CD
23	AGRI-MEK SC	3.5	FL OZ/A	EF
23	DYNE-AMIC	0.25	% V/V	EF
23	RADIANT	8	FL OZ/A	GH
23	DYNE-AMIC	0.25	% V/V	GH
24	AZA-DIRECT	16	FL OZ/A	AB
24	M-PEDE	2	% V/V	AB
24	MOVENTO HL	2.5	FL OZ/A	CD
24	TORAC	24	FL OZ/A	CD
24	NIS	0.25	% V/V	CD
24	AGRI-MEK SC	3.5	FL OZ/A	EF
24	DYNE-AMIC	0.25	% V/V	EF
24	RADIANT	8	FL OZ/A	GH
24	DYNE-AMIC	0.25	% V/V	GH

Results and Conclusions

All insecticide treatment programs reduced thrips populations compared with the untreated control. As typical of small plot trials at the experiment station, differences in adult populations are minimal. Reductions in larval populations ranged from 21% to 54% in the insecticide treatment programs compared with the untreated control. Figure 1 shows the average number of adults + larvae per plant averaged over the season.

The proportion of immatures in the untreated control population tends to increase over the season, and generally reaches 80 – 90% of the thrips on plants not receiving insecticides. The proportion of immatures can be used to help assess the efficacy and residual effect of an insecticide application. Low populations that are largely made up of adults indicate a field that is being recolonized by adults following a successful application.

Late in the season, populations in the untreated control (Treatment 1) tend to decline, which, in part, reflects the plants becoming less suitable for thrips because of the extensive feeding previous feeding damage on these plants. It is common to see late season spikes in thrips populations in lush, well-managed fields with later maturing varieties as thrips disperse in from earlier maturing varieties or poorly managed fields with extensively damaged plants that no longer support thrips.

The reference program (Treatment 2) performed well despite a late season increase in thrips following the first Lannate application on July 21 (Figures 1 and 2). However, other programs also outperformed the reference program.

Treatment 21 was the overall best performing program. It substituted Senstar for Movento HL. These two products share an active ingredient, spirotetramat, but Senstar contains an additional active ingredient, pyriproxyfen, that acts as an insect growth regulator. Pyriproxyfen takes time to kill thrips larvae, but it begins to work immediately whereas spirotetramat takes time to become active in the plant. Treatment 21 used Senstar in the third and fourth applications so that the spirotetramat was available when thrips larval populations reach their peak during July. Other programs that moved Movento HL or Senstar later into the season performed well (Figures 1 and 2).

Treatment 21 and other well-performing programs (Treatments 15, 20) included Exirel at the end of the season instead of Lannate, which kept thrips populations under better control than Lannate.

Exirel is also effective as an early season option. For example, it provided good control early in Treatment 13. Overall, Treatment 13 may not have been as effective as possible because Senstar was applied after Exirel but without a knockdown adulticide.

Programs that included Torac (23 and 24) performed well. The use of Torac as an adulticide with Movento HL was effective (Treatment 24). Torac is a contact insecticide and performs better before the canopy gets too dense.

All of the insecticide programs had higher marketable yields than the untreated control (Figure 3). Marketable yields ranged from 22 – 29% greater than the untreated control. Treatments 2, 20 and 21 had the numerically highest yields at ~1150 cwt/acre, which was 29% greater than the untreated control.

The untreated control had 39% of marketable yield in the colossal and supercolossal size classes. The insecticide treatments had significantly larger size profiles, with 55 – 68% of the marketable yield in the largest size classes.

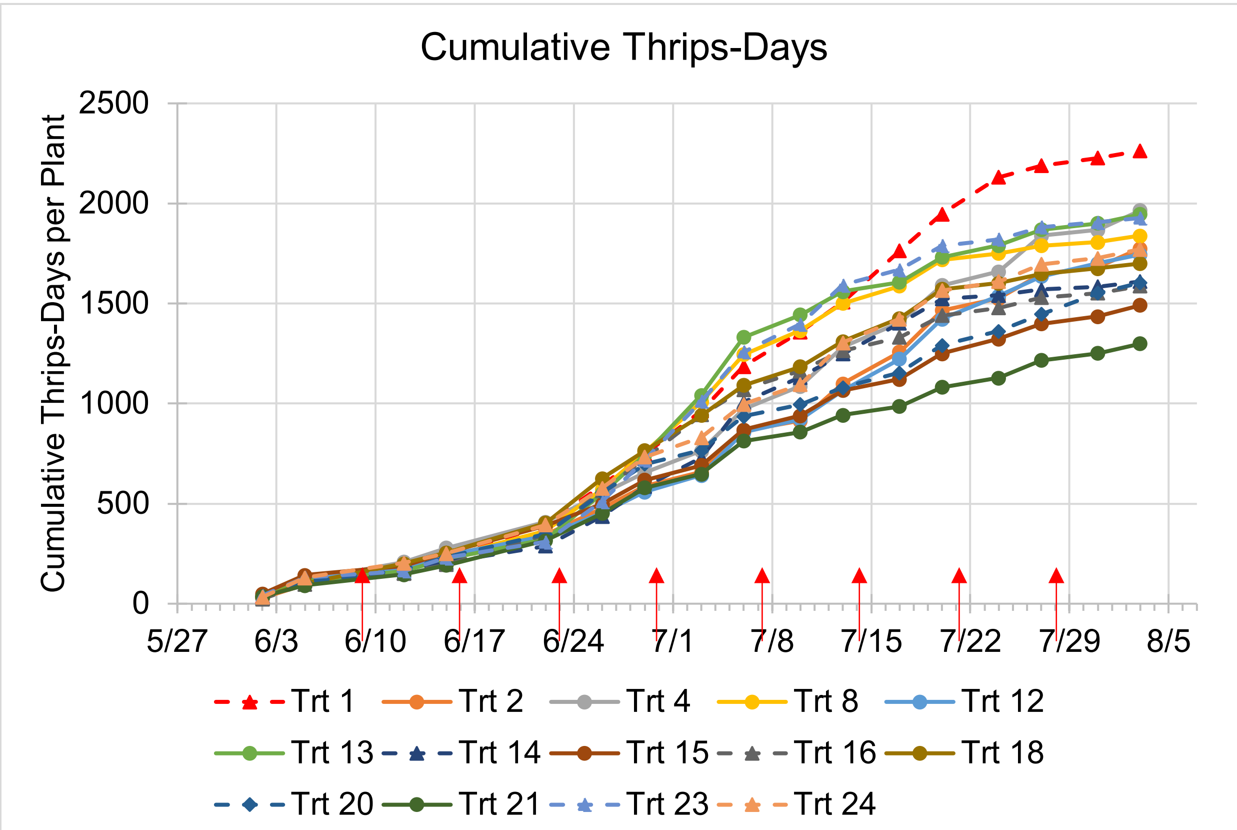

Figure 1. Cumulative thrips-days per plant over the season different seasonal insecticide programs. The angle of the line between sample dates indicates number of thrips recorded over that time period. The steeper the line, the more thrips were present. The untreated control (Trt 1) had the most thrips pressure over the season. Treatment 21 performed the best over the season. Application dates are shown by the red arrows.

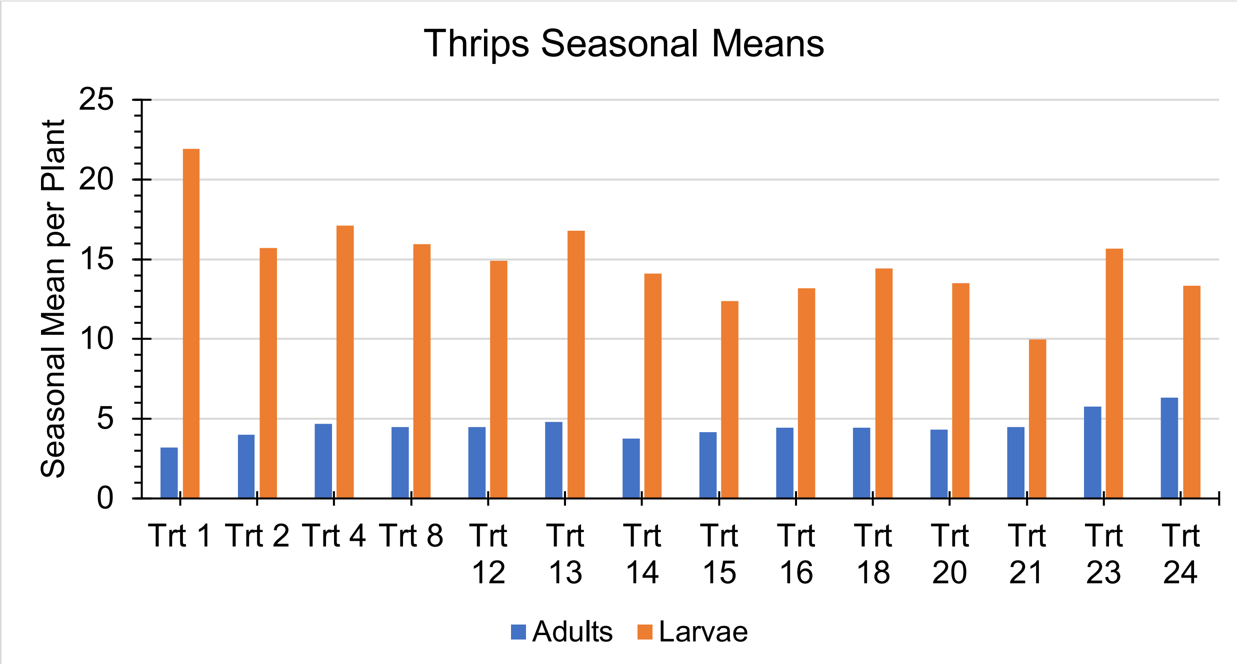

Figure 2. Mean number of thrips per plant averaged over the season. See Table 1 for treatment details.

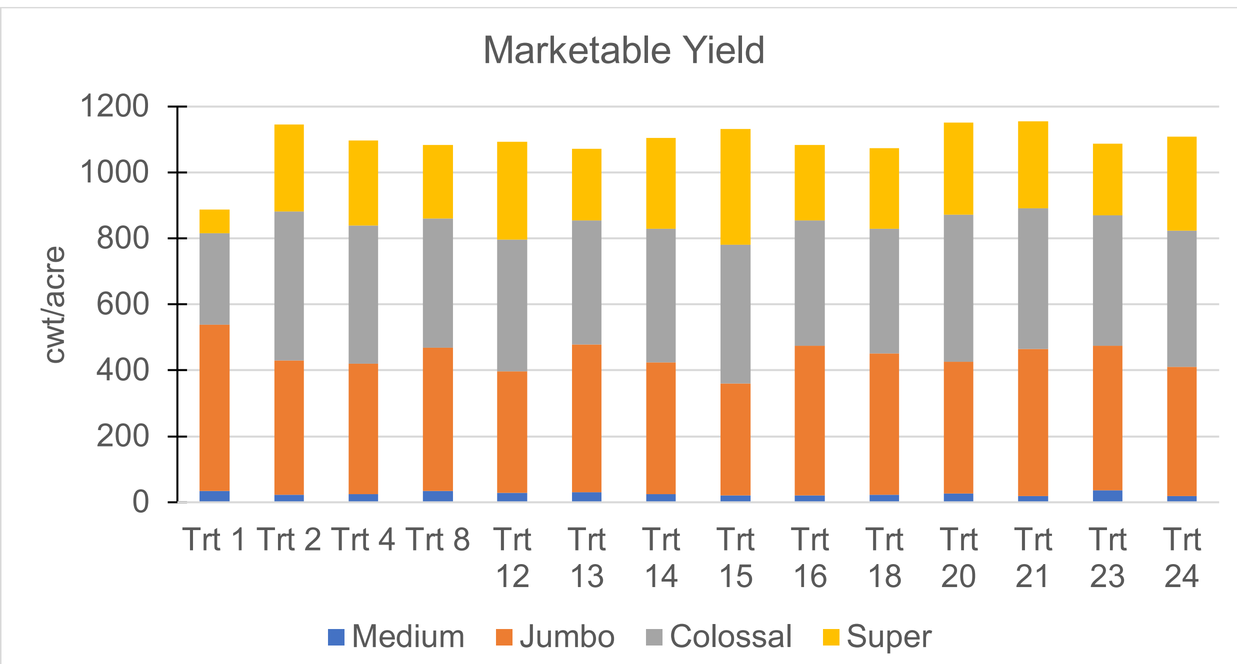

Figure 3. Marketable yield from the seasonal insecticide program trial. The reference program (Trt 2: Movento-Agrimek-Radiant-Lannate and the similar program (Treatment 14 that substituted Minecto Pro for Agrimek) had the highest yields. The programs that start with Azadirect + M-Pede to delay the use of Movento (especially Treatment 5 and 6) had high proportions of large size classes of onions. See Table 1 for insecticides used in each program and their application dates.

2 – Insecticide Application Interval Timing Trial

This trial examined the effect of the interval between spray applications on thrips management. The intervals evaluated were 7, 10, and 14 days between applications and addressed the following questions:

1. How does the interval between insecticide applications affect thrips management and yield?
2. Are longer application intervals detrimental to thrips control and yield?

Applications began at the same time for the six insecticide programs. However, the number of applications varied among the timing intervals. Nine (9) applications were made in the 7-day programs. Six applications were made in the 10-day programs, and five applications were made in the 14-day programs (Tables 2 and 3).

The insecticide treatment programs were based on our standard reference program (Noted as Standard treatments in Table 3) and one of the more effective seasonal programs (noted as Alternate treatments in Table 3). These programs are based on weekly applications, so the 10- and 14-day programs do not include all of the applications or products. Because the 7-day program included 9 applications, the 7-Day Standard treatment included a final application with Exirel at 13.5 fl oz/acre, and the 7-Day Alternate treatment included a final application with Azadirect at 16 fl oz/acre + M-Pede at 2% v/v.

Table 2. Treatment application dates for the interval spray trial.

Timing Code in Table 4	7 Day Interval	10 Day Interval	14 Day Interval
A	6/6/2022	6/6/2022	6/6/2022
B	6/13/2022		
C		6/16/2022	
D	6/20/2022		6/20/2022
E	6/27/2022	6/27/2022	
F	7/4/2022		7/4/2022
G		7/7/2022	
H	7/11/2022		
I	7/18/2022	7/18/2022	7/18/2022
J	7/25/2022		
K		7/28/2023	
L	8/1/2022		8/1/2023

Table 3. Treatments used in the timing interval trial. See Table 3 for dates of applications that correspond to the application codes below.

Treatment	Program	Products	Rate		Applications
1		Control			
2	7 Day Standard	MOVENTO HL	2.5	FL OZ/A	AB
		DYNE-AMIC	0.7	PT/A	AB
		AGRI-MEK SC	3.5	FL OZ/A	DE
		DYNE-AMIC	0.25	% V/V	DE
		RADIANT	8	FL OZ/A	FH
		DYNE-AMIC	0.25	% V/V	FH
		LANNATE LV	3	PT/A	IJ
		DYNE-AMIC	0.25	% V/V	IJ
		EXIREL	13.5	FL OZ/A	L
		DYNE-AMIC	0.25	% V/V	L
3	7 Day Alternate	AZA-DIRECT	16	FL OZ/A	ABDL
		M-PEDE	2	% V/V	ABEL
		MOVENTO HL	2.5	FL OZ/A	DE
		M-PEDE	2	% V/V	ABEL
		AGRI-MEK SC	3.5	FL OZ/A	FH
		DYNE-AMIC	0.25	% V/V	DFHIJ
		RADIANT	10	FL OZ/A	IJ
		DYNE-AMIC	0.25	% V/V	DFHIJ
4	10 Day Standard	MOVENTO HL	2.5	FL OZ/A	AC
		DYNE-AMIC	0.7	PT/A	AC
		AGRI-MEK SC	3.5	FL OZ/A	EG
		DYNE-AMIC	0.25	% V/V	EG
		RADIANT	8	FL OZ/A	IK
		DYNE-AMIC	0.25	% V/V	IK
5	10 Day Alternate	AZA-DIRECT	16	FL OZ/A	ACE
		M-PEDE	2	% V/V	ACI
		MOVENTO HL	2.5	FL OZ/A	EG
		AGRI-MEK SC	3.5	FL OZ/A	IK
		DYNE-AMIC	0.25	% V/V	CEGIK
6	14 Day Standard	MOVENTO HL	2.5	FL OZ/A	AD
		DYNE-AMIC	0.7	PT/A	AD
		AGRI-MEK SC	3.5	FL OZ/A	FI
		RADIANT	8	FL OZ/A	L
		DYNE-AMIC	0.25	% V/V	FIL
7	14 Day Alternate	AZA-DIRECT	16	FL OZ/A	AD
		M-PEDE	2	% V/V	ADL
		MOVENTO HL	2.5	FL OZ/A	FI
		AGRI-MEK SC	3.5	FL OZ/A	FI
		RADIANT	8	FL OZ/A	L
		DYNE-AMIC	0.25	% V/V	FIL

Results and Conclusions

All of the insecticide programs significantly, except the 14-day alternate program reduced thrips pressure compared to the untreated control (Figures 4 and 5). The 7-day alternate program gave the best overall thrips control. The 7-day programs gave significantly better thrips control than the 10-day programs and the 14-day programs. The 10-day programs gave significantly better control than the 14-day programs.

All of the insecticide programs increased marketable yields compared with the untreated control. The untreated control had disproportionately more yield in the smaller size classes (medium and jumbo) than in the larger (colossal and supercolossal) size classes (Figures 6 and 7). The 7-day programs had greater yields in the colossal and supercolossal classes than the 10-day and 14-day programs. There was no statistical difference in the size profile of the 10 and 14-day programs, although numerically, the 10-day programs had a greater size profile.

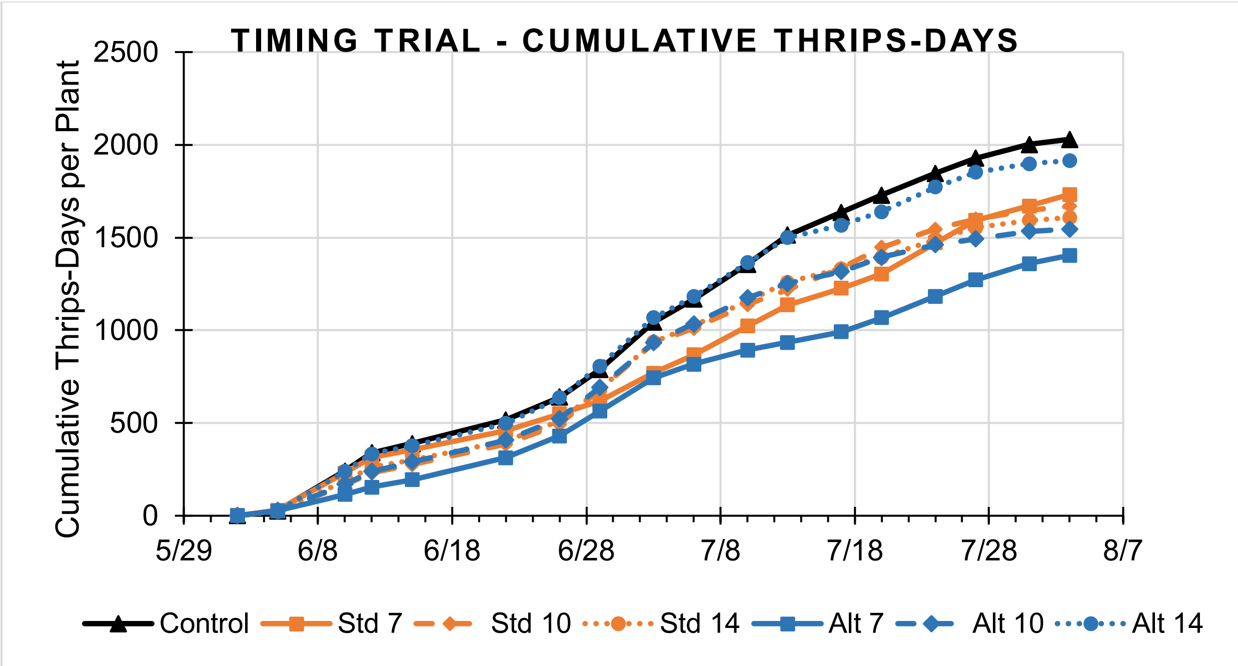

Figure 4. Cumulative thrips-day on a per plant basis for the application interval timing trial. See Tables 2 and 3 for application dates and products used.

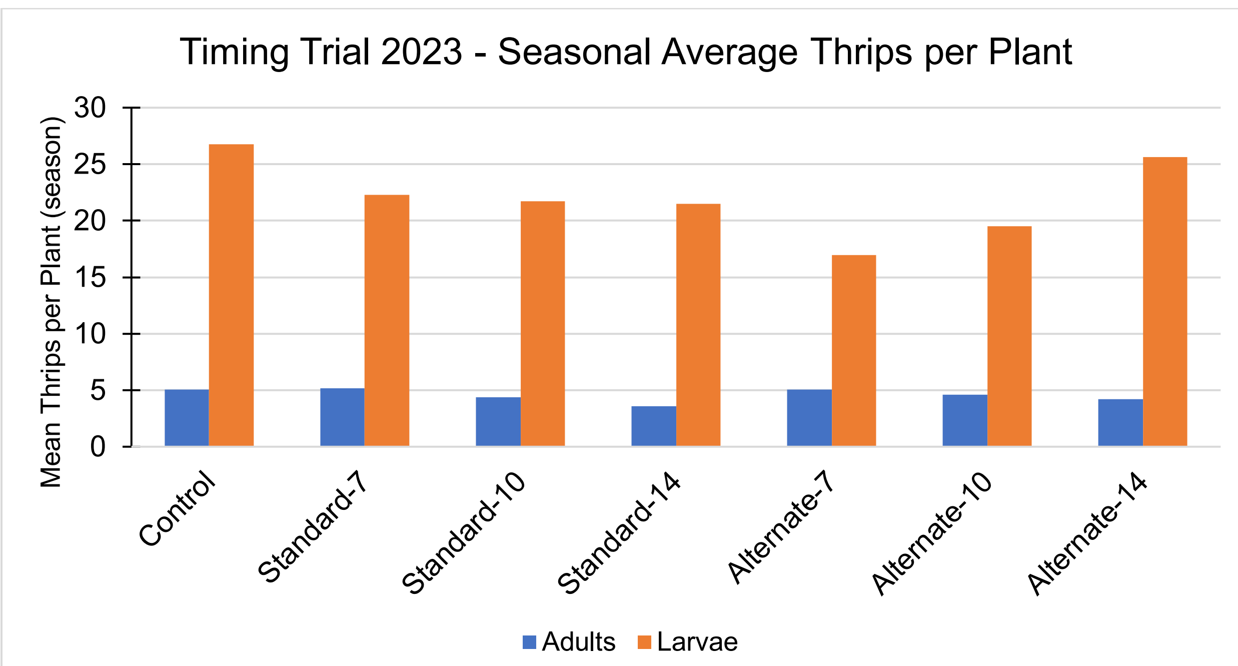

Figure 5. Mean thrips averaged over the season for the timing interval treatments. Standard treatments are noted as 'Std,' and Alternate treated are noted as 'Alt.' Thrips numbers were reduced with all of the insecticide treatments. There was no significant difference between in thrips management for the different timings; however, the alternate treatments outperformed the standard treatments.

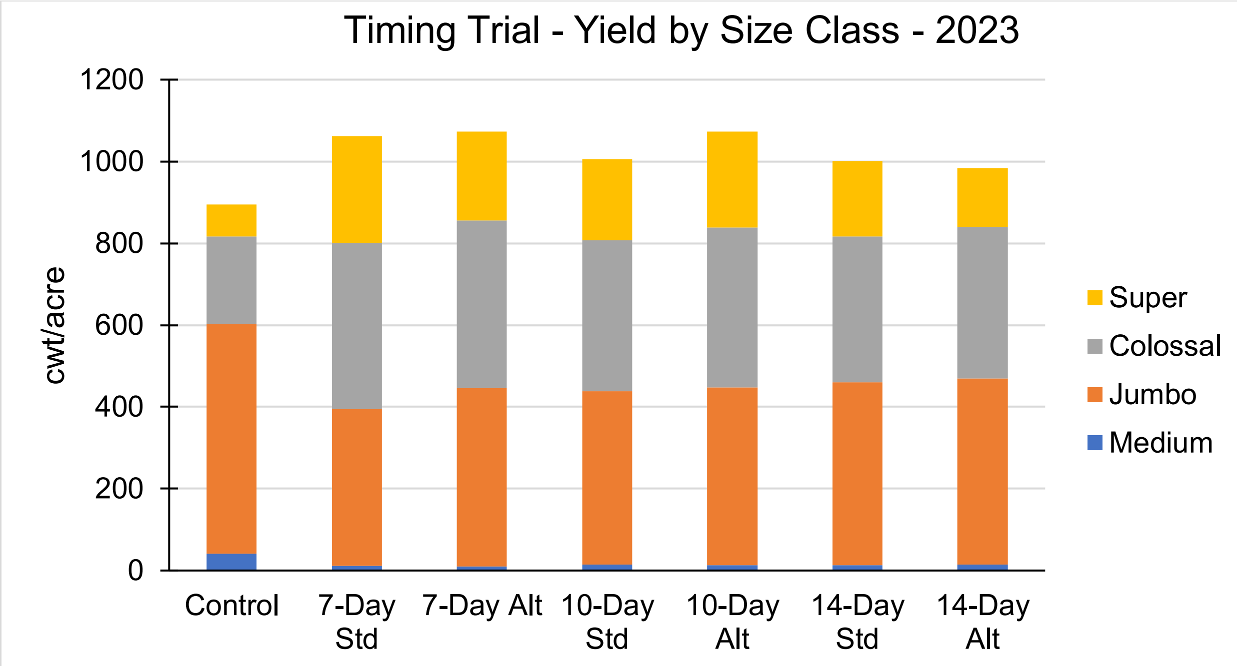

Figure 6. Marketable yield (cwt/acre) for the Red-Yellow trial. See Table 5 for treatment applications and dates. The season-long treatment programs had larger size profiles than the other timing programs. The late programs had higher yields and size profiles than the early programs.

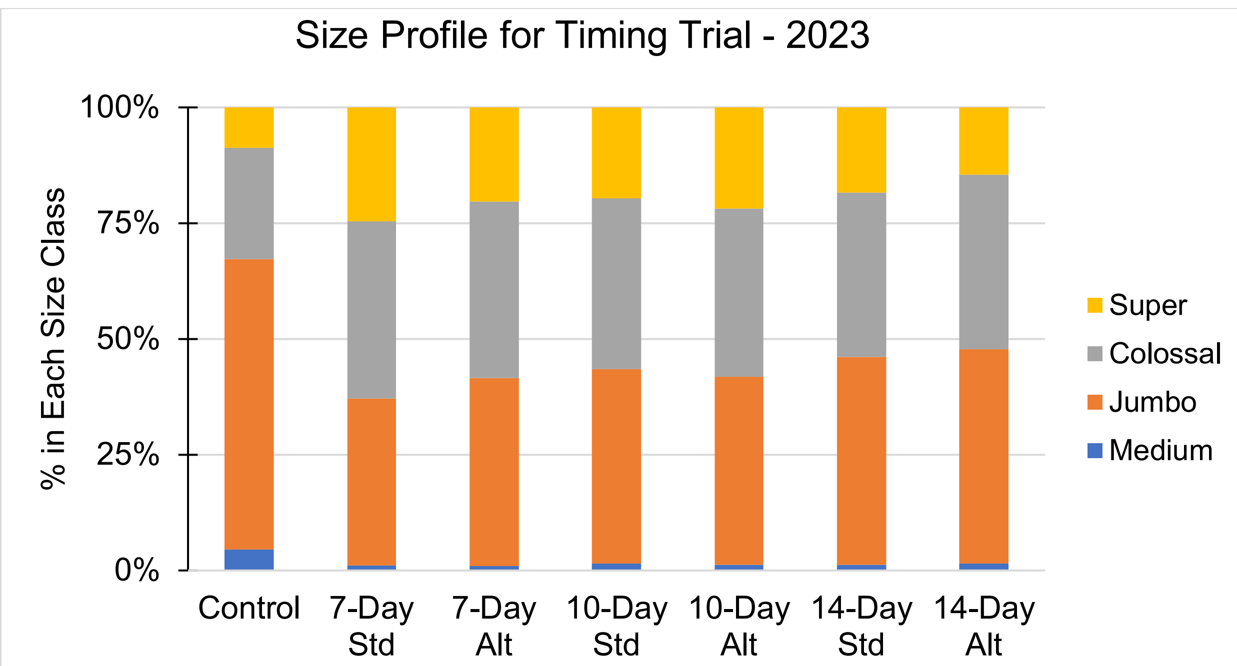

Figure 7. Percentage of marketable yield for the application timing trial. Values in bars are the percentages for each size class for the respective treatments.

4 – Insecticide Application Timing for Thrips Management in Red and Yellow Onions

This trial compares the effectiveness of early-season, late-season, and full-season insecticide applications for thrips management in red and yellow onions.

The full season timing consisted of eight weekly applications of insecticides made from June 6 to July 25 (Table 4).

The early season timing consisted of four weekly insecticide applications made from June 3 to June 27 (Table 4).

The late season timing consisted of four weekly insecticide applications made from July 4 to July 25 (Table 4).

Table 4. Sequence of insecticides used in the early season, late season, and full season treatment programs. No insecticides were applied to the untreated control. Insecticide product names and rates per acre are given. Insecticides were applied with Dyne-amic

	Insecticide Application Program			
Date	Early Season	Late Season	Full Season	Untreated Control
1. June 06	Movento HL 2.5 fl oz Azadirect 16 fl oz	None	Movento HL 2.5 fl oz Azadirect 16 fl oz	None
2. June 13	Movento HL 2.5 fl oz Azadirect 16 fl oz	None	Movento HL 2.5 fl oz Azadirect 16 fl oz	None
3. June 20	Agrimek SC 3.5 fl oz	None	Agrimek SC 3.5 fl oz	None
4. June 27	Agrimek SC 3.5 fl oz	None	Agrimek SC 3.5 fl oz	None
5. July 04	None	Movento HL 2.5 fl oz Azadirachtin 16 fl oz	Exirel 13.5 fl oz	None
6. July 11	None	Movento HL 2.5 fl oz Azadirachtin 16 fl oz	Exirel 13.5 fl oz	None
7. July 18	None	Radiant SC 8 fl oz	Radiant SC 8 fl oz	None
8. July 25	None	Radiant SC 8 fl oz	Radiant SC 8 fl oz	None

Results and Conclusions

Thrips pressure was much lower than in a similar trial conducted in 2022. However, red onions still tended to have greater populations of thrips than yellow onions. Across all treatments in the 2023 trial, thrips pressure was 26% greater for red onions than for yellows. The difference varied among the insecticide spray programs. In the season long program, there was virtually no difference in populations between the red and yellow onions. Thrips pressure was 40% greater in untreated red onions than untreated yellows. Thrips pressure was about 30% greater in the early-sprayed reds than the early-sprayed yellows, and 34% greater for the late sprayed reds compared with the late-sprayed yellows.

Only the season-long spray programs led to a significant reduction in thrips compared to the untreated controls. Thrips numbers increased substantially in the early season program late in the season after the insecticide applications ceased (Fig. 8 and 9).

Marketable yields differed among the insecticide treatment programs (Table 5; Figures 10 and 11). For yellow onions, yields were variable because of stand issues. In particular, the early season program significant stand loss, which distorted yields. For the other three treatment programs, there were no differences in marketable yields. However, size profiles were greater in the season long program than in the other programs. The season long program had the greatest proportion of bulbs in the largest size classes. The size profile was the smallest for the unsprayed control program. For red onions, marketable yields were significantly higher in the season long program than in the control and early season programs. Size profile was larger for the season long and late season program than for the control and early season programs.

Based on these results, maintaining season-long management of thrips is critical for optimizing yields and size profiles. These results, in concert with similar trials conducted in 2021 and 2022 indicate that late season thrips damage has the most significant effect on yield and size. Maintaining good thrips management in the later stages of the season (i.e., through July) when thrips pressure is most intense is important for preserving yields and size profiles.

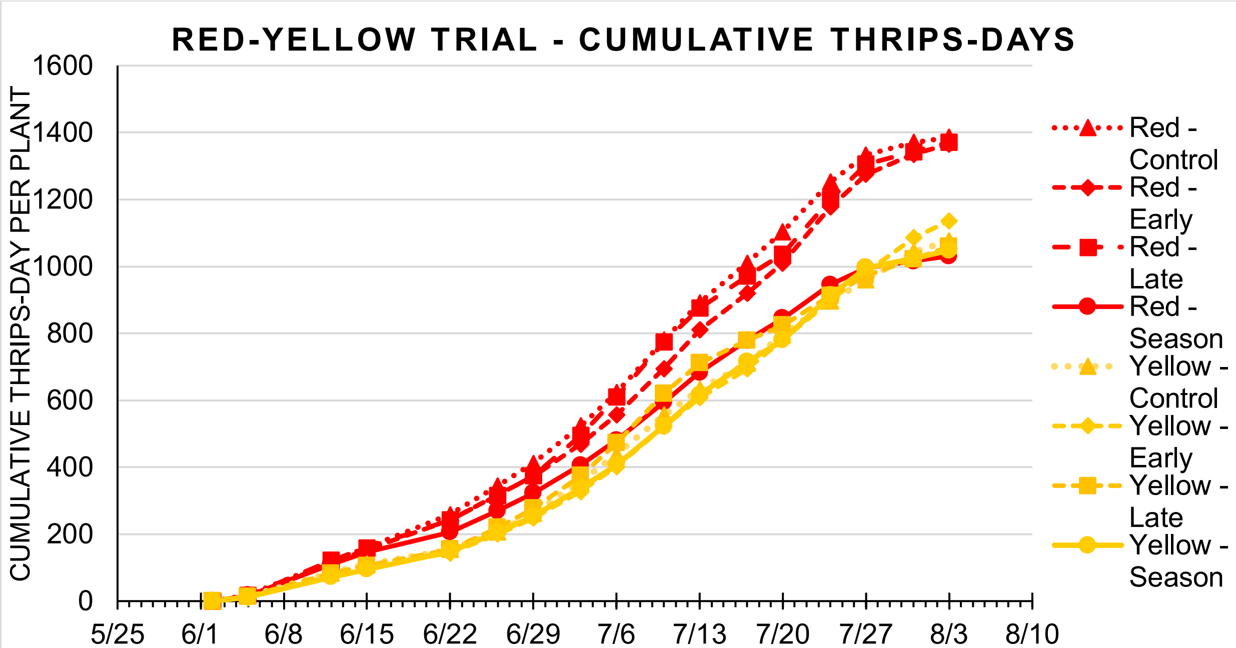

Figure 8. Cumulative thrips-days on a per plant basis over the season for the different seasonal insecticide programs. The angle of the line between any sample dates indicates the number of thrips recorded over that time period. The steeper the line, the more thrips were present over that sampling interval. See Table 5 for applications.

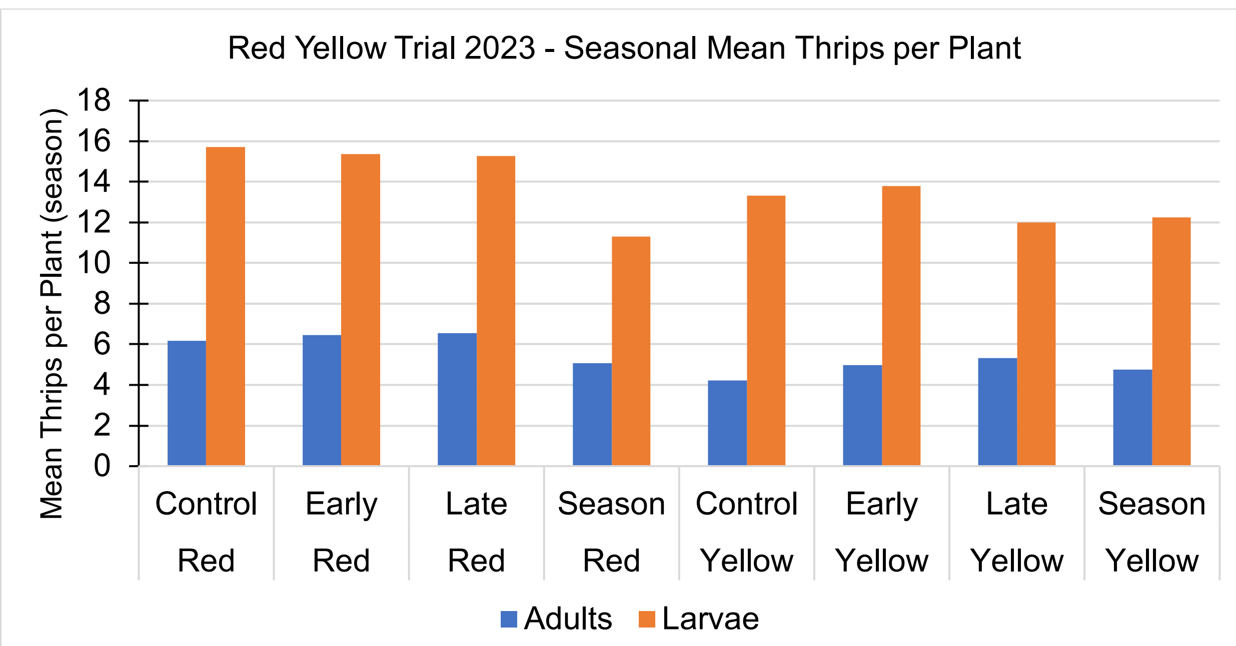

Figure 9. Mean thrips per plant averaged over the season for the Red-Yellow trial treatments. The early programs received four insecticide applications from June 6 – June 27. The late programs received insecticide applications from July 4 – July 25. The season programs received eight insecticide applications from June 6 – July 25. See Table 5 for applications and application dates.

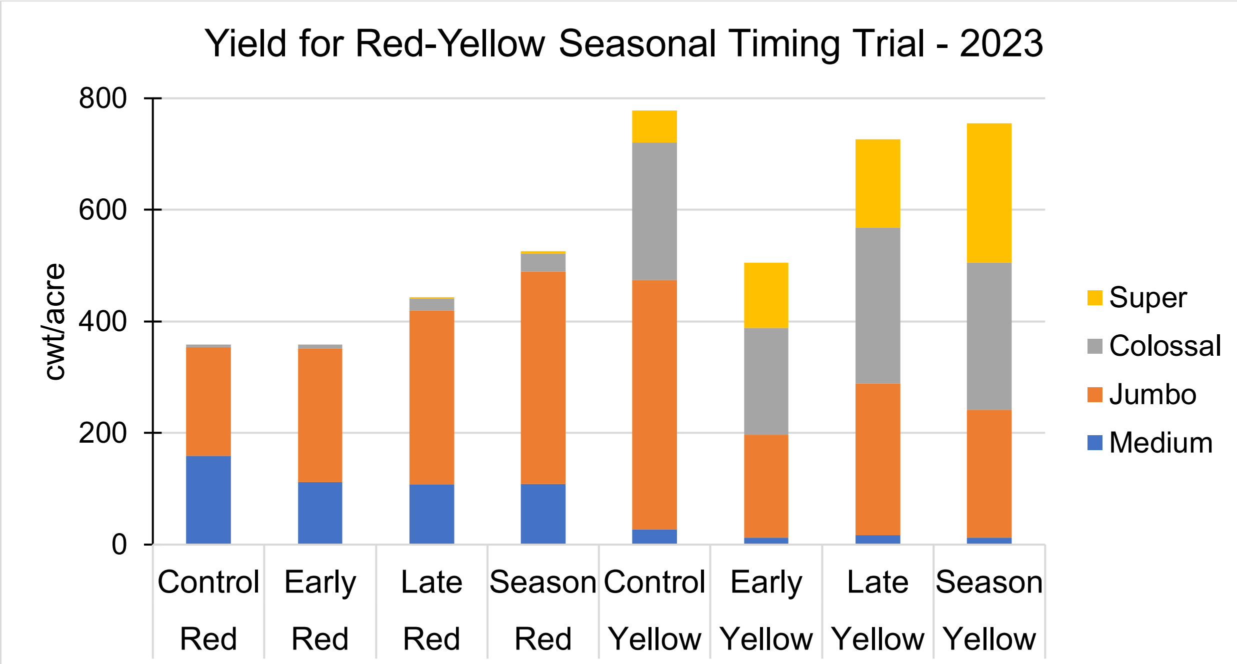

Figure 10. Marketable yield (cwt/acre) for the Red-Yellow trial. See Table 5 for treatment applications and dates. The season-long treatment programs had larger size profiles than the other timing programs. The late programs had higher yields and size profiles than the early programs.

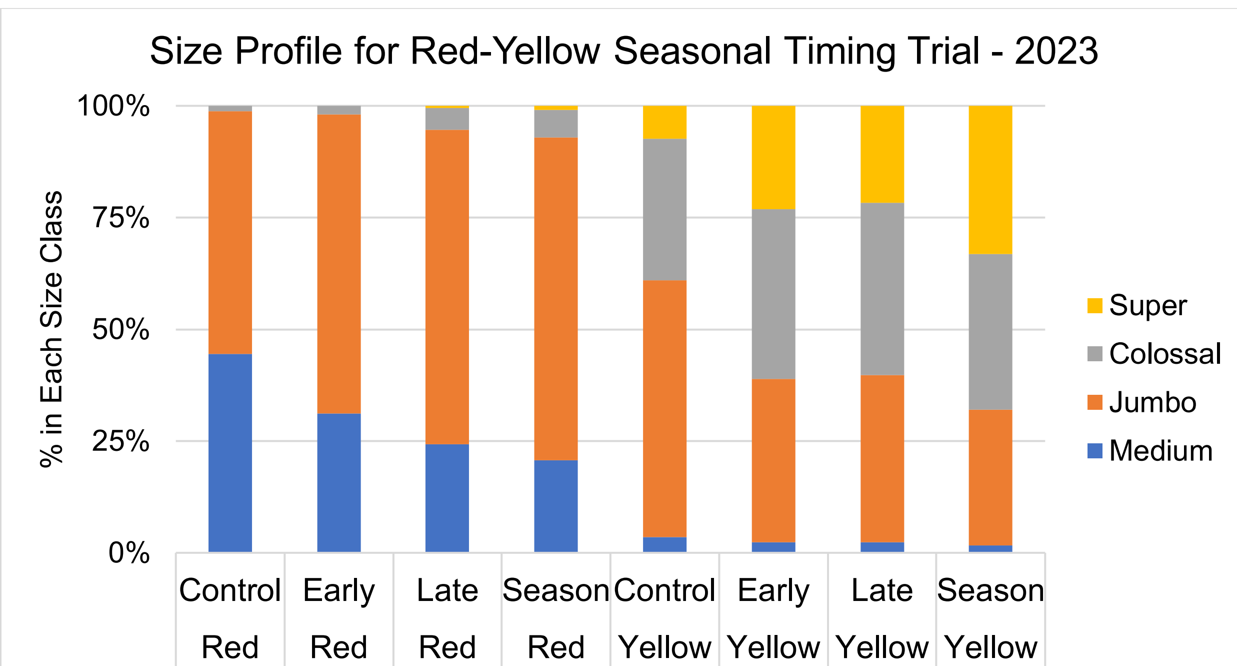

Figure 11. Percentage of marketable yield for the red-yellow insecticide timing trial. Values in bars are the percentages for each size class for the respective treatment.

Table 5. Yield results for the 2023 red-yellow seasonal timing trial. Please see table xx for the spray programs.

Spray Treatment	Medium cwt/ac		Jumbo cwt/ac		Colossal cwt/ac		Super cwt/ac		Marketable cwt/ac		% Medium		% Jumbo		% Colossal		% Supers	
Control	93.5	a	320.6		125.3		28.7	b	593.9		21.7	a	51.4		16.9		3.6	c
Early	69.2	ab	212.2		99.3		58.5	b	448.6		18.6	a	50.5		16.5		10.0	bc
Late	62.5	b	291.1		151.1		79.8	ab	597.9		13.5	b	51.0		21.4		11.2	bc
Season	60.5	b	304.8		148.1		127.6	a	653.2		11.1	b	49.9		20.2		16.5	a
LSD	**26.0**		**ns**		**ns**		**52.4**		**ns**		**5.1**		**ns**		**ns**		**4.5**	
Color																		
Red	121.9	a	281.5		245.5	a	1.7	b	450.3	b	28.9	a	60.4	a	3.2	b	0.3	b
Yellow	17.8	b	282.8		16.4	b	145.6	a	713.1	a	2.5	b	40.4	b	35.5	a	21.0	a
LSD	**18.4**		**ns**		**34.6**		**37.0**		**132.7**		**3.6**		**6.1**		**2.9**		**3.2**	
Color - Treatment																		
Red Control	159.3		194.8	c	4.2		0.0	d	404.0		39.9	a	47.2	cd	1.0		0.0	d
Red Early	112.0		239.9	bc	6.9		0.0	d	383.0		30.8	b	60.5	ab	1.7		0.0	d
Red Late	107.5		311.4	abc	21.9		2.0	d	466.9		24.6	bc	65.1	ab	4.5		0.3	d
Red Season	108.9		380.1	ab	32.6		4.9	d	547.5		20.4	c	68.8	a	5.8		0.8	cd
Yellow Control	27.8		446.4	a	246.5		57.3	cd	783.8		3.6	d	55.6	bc	32.8		7.1	c
Yellow Early	12.3		184.5	c	191.8		116.9	bc	536.2		2.4	d	37.3	de	36.3		23.2	b
Yellow Late	17.5		270.9	bc	280.2		157.6	b	729.0		2.4	d	36.9	de	38.3		22.1	b
Yellow Season	12.1		229.6	bc	263.7		250.4	a	759.0		1.8	d	31.0	e	34.7		32.2	a
LSD	**ns**		**175.3**		**ns**		**74.1**		**ns**		**7.2**		**12.3**		**ns**		**6.4**	
P Values																		
Color	**0.0001**		**0.9760**		**0.0001**		**0.0001**		**0.0007**		**0.0001**		**0.0001**		**0.0001**		**0.0001**	
Spray Treatment	**0.0388**		**0.3015**		**0.1326**		**0.0056**		**0.2331**		**0.0015**		**0.9347**		**0.1451**		**0.0001**	
Color*Treatment	**0.3661**		**0.0162**		**0.4621**		**0.0090**		**0.6519**		**0.0074**		**0.0001**		**0.4884**		**0.0001**	

2023 ONION VARIETY TRIALS

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Introduction

Onion variety development for eastern Oregon and western Idaho is a continual process. Annually, seed companies enter their emerging varieties into an annual onion variety trial held at the Malheur Experiment Station. Direct-seeded yellow, white, and red long-day onion varieties were evaluated in 2023 for yield, grade, bulb decomposition, disease, thrips damage, maturity, bolting, and bulb single centers. Growers and seed industry representatives had the opportunity to examine the varieties at the annual Onion Variety Day on 30 August and during a bulb evaluation out of storage on 9 January 2024. Onion varieties were evaluated objectively for bolting, yield, grade, single centers, and storability. Varieties were evaluated subjectively for maturity, thrips leaf damage, iris yellow spot virus (IYSV), bulb shape, bulb shape uniformity, flesh brightness, and skin color and retention.

Materials and Methods

The trial was grown on an Owyhee silt loam previously planted to wheat. A soil analysis taken in the fall of 2022 showed a pH of 8.3, 3.79% organic matter, 5 ppm nitrogen (N) as nitrate, 2 ppm N as ammonium, 72 ppm phosphorus (P), 755 ppm potassium (K), 37 ppm sulfur as sulfate (S), 3741 ppm calcium, 850 ppm magnesium, 309 ppm sodium, 2.2 ppm zinc (Zn), 8 ppm manganese (Mn), 2.1 ppm copper (Cu), 14 ppm iron, and 0.8 ppm boron (B). Based on the soil analysis, 50 lbs N/ac, 70 lbs P/acre, 15 lbs sulfate/acre, 250 lbs elemental sulfur/ac, 1 lb Mn/acre, 8 lbs Zn/acre, and 1 lb B/acre were broadcast after plowing. 10 t/acre of composted cattle feedlot manure was applied after plowing. The field was fumigated with K-Pam at 15 gal/acre, then marked out at 22 inches.

The varieties were planted in four adjacent trials based on bulb color and harvest date (yellow, white, red, early). The experimental design of each full-season trial and the early-maturing trial were randomized complete blocks with five replicates. A sixth, non-randomized replicate was planted for demonstrating onion variety performance to growers and seed company representatives at the Onion Variety Day (30 August, 2023). All trials were planted 12 April in plots 4 double-rows wide and 27 ft long. The early-maturing trial had 10 yellow varieties from four seed companies; the full-season yellow trial had 28 varieties from six seed companies; the full-season white trial had six varieties from three seed companies, and the full-season red trial had six varieties from four seed companies.

Seed was planted in double rows spaced three inches apart at nine seeds/ft of single row. Two double rows were planted on 44-inch beds, with the middle of the double rows 20 inches apart. Planting was done with customized John Deere Flex Planter units equipped with disc openers.

The field was drip irrigated. The automated irrigation system was started on 5 June, and irrigation ended on August 20.

Onion emergence started on 1 May. Postemergence, 4’ alleys were cut between plots, leaving them 23 ft long. The seedlings were hand-thinned on May 27 and 29 to a target spacing of 4.25 inches between individual onion plants in each single row, or 134,174 plants/acre.

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: Roundup PowerMax (glyphosate) at 22 oz/acre, and Prowl H2O (pendimethalin) at 1.5 pints/acre on 28 April; GoalTender (oxyfluorfen) at 4 oz/acre, Brox 2EC (bromoxynil) at 16 oz/acre and Prowl H2O (pendimethalin) at 2 pints/acre on 10 June: Avatar (clethodim) at 16 oz/acre on 11 June.

For thrips control, the following insecticides were applied by ground: Aza-Direct (azadirachtin) at 12 oz/acre and M-Pede (potassium salts of fatty acids) at 5.6 pts/acre on 6 June; Movento HL (spirotetramat) at 2.5 oz/acre and Agri-Mek (abamectin) at 3.5 oz/acre on 13 June and again 20 June; Exirel (cyantraniliprole) at 20 oz/acre on 27 June and 4 July; Radiant (spinetoram) at 8 oz/acre on 11 July and July 18; Lanveer (methomyl) at 8 oz/ac on 25 July; and Radiant at 8 oz/acre on 1 August.

Starting on June 13, weekly root tissue and soil samples were taken from the check (Vaquero) and analyzed for nutrients by Western Laboratories, Inc., Parma, Idaho. Root tissue was analyzed for nutrient concentration, and soil samples were analyzed for concentrations of nutrients in the soil solution. Nutrients were applied only if both the root tissue and soil solution concentrations were simultaneously below the critical levels (Table 1).

Table 1. Nitrogen applied through the drip tape in 2023. Malheur Experiment Station, Oregon State University, Ontario, OR.

Date	N, lb/acre
30-May	25
15-Jun	25
28-Jun	25
10-Jul	25
total	100

Onions in the early-maturing trial were evaluated for maturity and bolting on 31 July. Onions in the red, yellow, and white variety trials were evaluated for maturity and bolting on 31 July, 15 August, and 31 August. Onions in each plot were evaluated subjectively for maturity by visually rating the percentage of onions with the tops down and percent dry leaves. Onions in the red, yellow and white variety trials were evaluated for IYSV severity on 7 August. For the IYSV evaluations, ten consecutive onions in one of the middle two rows in each plot were given a subjective rating on a scale of 0 to 5 for severity of IYSV symptoms. The rating was 0 if there were no symptoms, 1 if 1 to 25% of foliage was diseased, 2 if 26 to 50% of foliage was diseased, 3 if 51 to 75% of foliage was diseased, 4 if 76 to 99% of foliage was diseased, and 5 if 100% of foliage was diseased.

Onions from the middle two double rows in each plot of the early maturing varieties were topped by hand, bagged, and stored on 15 August. The early maturing onions were graded on 24 August.

For the full season harvest, onions from the middle two rows in each plot were topped, bagged and placed in storage on 20 September. The ambient-air storage shed was ventilated, and the temperature was slowly decreased to maintain air temperature as close to 34°F as possible.

At harvest, 25 consecutive bulbs from one of the border rows ranging in diameter from 3½ to 4¼ inches were rated for single centers. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing if they were single centered (bullet) or had a small, multiple center.

Red and white onions were graded out of storage on 6 & 8 December respectively. Yellow onions were graded out of storage 11-14 December. During grading, bulbs were separated according to external quality: bulbs without blemishes (No. 1s), split bulbs (No. 2s), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Marketable yield consisted of No.1 bulbs larger than 2¼ inches.

During grading, fifty No. 1 bulbs from each plot were cut longitudinally and evaluated for the presence of incomplete scales, dry scales, internal bacterial rot, and internal rot caused by *Fusarium proliferatum* or other fungi. Incomplete scales were defined as scales that had more than 0.25 inch from the center of the neck missing or any part missing lower down on the scale. Dry scales were defined as scales that had more than 0.25 inch from the center of the neck dry or any part dry deeper in the scale.

On January 9, 2024, a sample of each variety was evaluated for bulb shape, uniformity, firmness, skin color, skin retention, and flesh brightness (Tables 5 and 6, Figure 1). The quality characteristics were evaluated by a group of people who did not know the variety identities. Evaluators included OSU personnel, seed company representatives, and other stakeholders.

The varieties from each of the early-maturity and full-season trials were compared for yield, grade, internal quality, and disease expression. Varietal differences were determined using analysis of variance. Means separation was determined using a protected Fisher's least significant difference test at the 5% probability level, LSD (0.05). The least significant difference values in each table should be considered when comparisons are made between varieties for significant differences in their performance characteristics. Differences between varieties equal to or greater than the LSD value for a characteristic should exist before any variety is considered different from any other variety in that characteristic. Because variety performance varies by year, growers are encouraged to review variety performance data over a number of years before choosing a variety to plant.

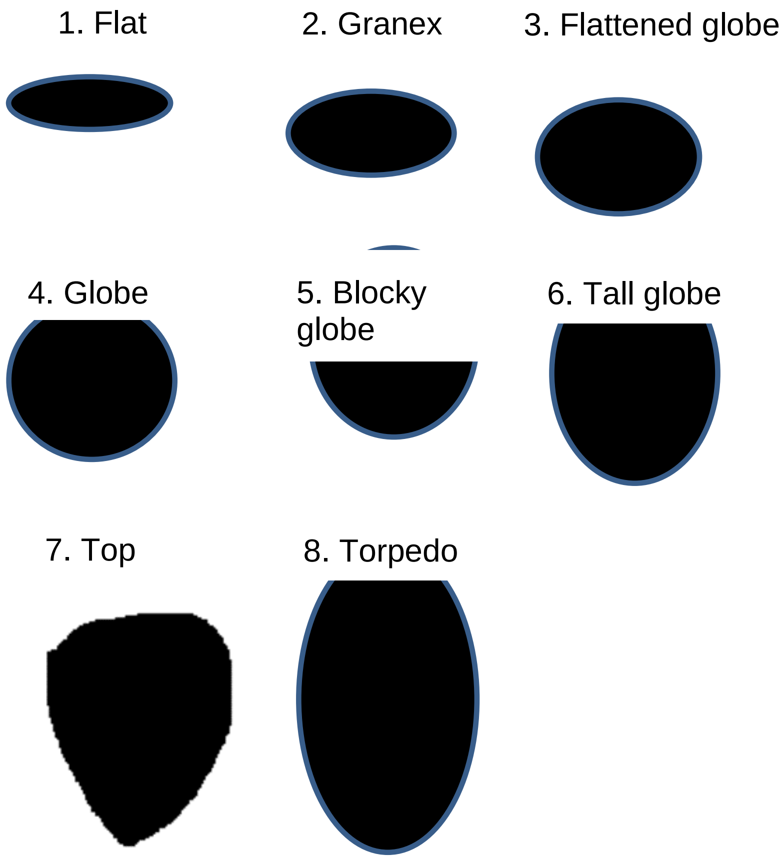

Figure 1. Onion bulb shape rating system. Malheur Experiment Station, Oregon State University, Ontario, OR.

Table 2. Onion variety subjective quality evaluation rating system.

Characteristic	Scale	Description
Bulb shape	1-8	see Fig. 1
Skin color	1-5	1 = light, 5 = dark, white varieties: 1=dark, 5=white
Bulb shape uniformity	1-5	1 = nonuniform shape, 5 = uniform shape
Firmness	1-5	1 = soft, 5 = hard
Skin retention	1-5	1 = bald, 5 = no cracks
Flesh brightness	1-5	yellow varieties: 1 = yellow, 5 = white (5 = more desirable)
	1-5	red varieties: 1 = pale red, 5 = dark red (5 = more desirable)
	1-5	white varieties: 1 = less white, 5 = very white (5 = more desirable)

Results

In 2023, the trial planting date (12 April) was the latest since 1997 when these records were started due to cool, wet conditions. This was 20 days later than the average planting date (March 23) over the previous 26 years. The month of June was mostly average to cooler while July and August were amenable with good growing conditions (Table 3). Onion evapotranspiration curves at the Malheur Experiment Station showed reduced overall crop water use in 2023 when compared to the previous two years. (Figure 2). Growing degree unit accumulation in 2023 (3412) was similar to the 80-year avg (3257) (Figure 3).

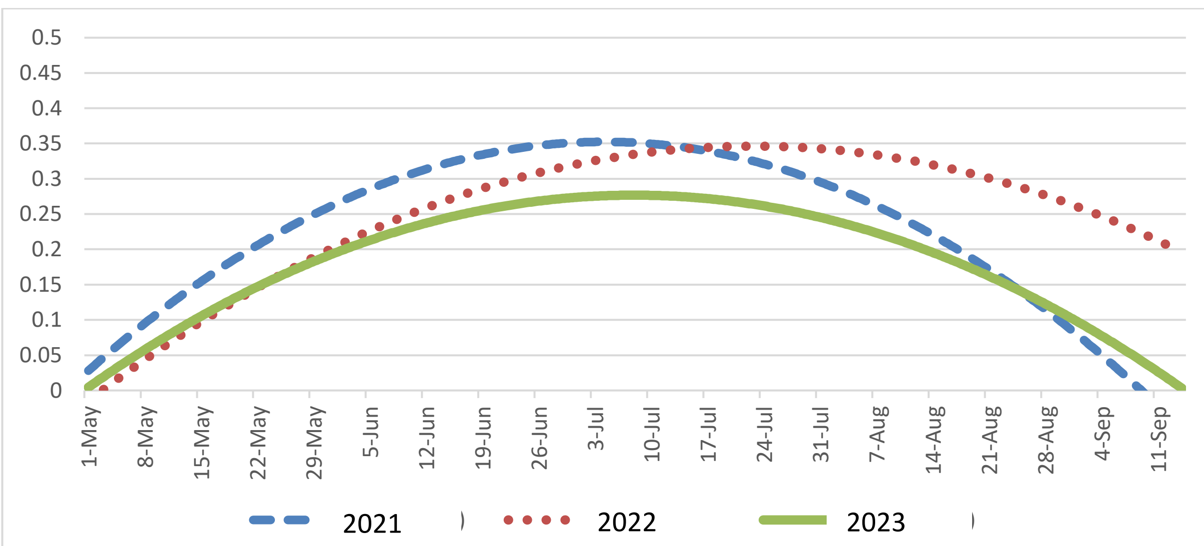

Figure 2. Onion evapotranspiration curves for 2021-2023 at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

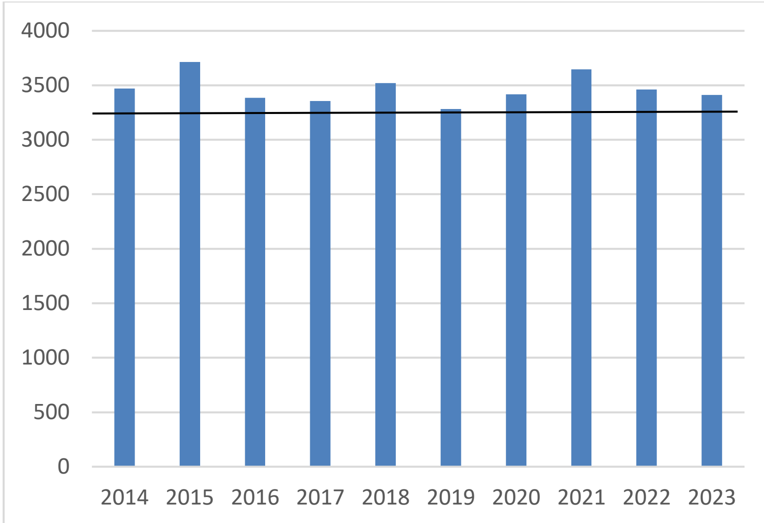

Figure 3. Growing degree units accumulated 2014-2023 with a bar denoting the 80-year average. Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

Table 3. Monthly average maximum and minimum air temperature (°F) in 2023 and the 80-year averages. Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

		Apr	May	Jun	Jul	Aug
Maximum	2023	61.0	77.7	81.1	95.7	88.5
	Average	64.3	73.6	82.0	92.0	90.1
Minimum	2023	35.3	50.3	54.8	62.7	60.3
	Average	37.2	45.4	52.2	58.4	55.8

Early-maturing Trial

On 31 July, varieties Highlander, and Outlander had 70% or more tops down (Table 4). The average tops down including them was 26%. Frontier, Avalon, Scout, Ovation, Spanish Medallion and Yosemite were all less than 10% tops down.

The percentage of onions that were functionally single centered averaged 54.5% and ranged from 21.6% for Highlander to 92% for Avalon (Table 5). Total yield averaged 643 cwt/acre, ranging from 330 cwt/acre for Outlander to 975 cwt/acre for Scout (Table 6). The highest percent of Jumbo onions (>50%) 125 days after planting were for Switchback, Scout, Elsye, and Ovation (Table 6).

Full-season Trials

Yellow varieties. On 31 August, the percentage of tops down averaged 73% and ranged from 30% for Caliber to 100% for Traverse (Table 7).

The severity of thrips leaf damage, on a scale from 0 to 10 (0-none), averaged 2.0 and ranged from 1.0 for several varieties to 4.0 for Traverse (Table 7). Bolting was very low in 2023, with most varieties having no bolting (data not shown). The incidence of Iris Yellow Spot Virus (IYSV) averaged 15% of plants infected and ranged from 6% for Almanzoro, Campero, and

Hamilton to 36% for Glorioso. IYSV severity was low in this trial, with an average rating of 0.1 (0–10% of foliage diseased).

The percentage of functionally single-centered bulbs averaged 87% and ranged from 64% for Sedona and 37-126 to 99% for Oloroso (Table 8).

Total yield out of storage in December 2023 averaged 887 cwt/acre and ranged from 622 cwt/acre for Traverse to 1088 cwt/acre for Sedona (Table 9). Marketable yield out of storage averaged 871 cwt/acre and ranged from 604 cwt/acre for Thunderstone to 1075 cwt/acre for Sedona.

In December 2023, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 25% and ranged from 5% for TTA 782 to 48% for Montero (Table 10). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 8% and ranged from 0.4% for Yakama to 22% for Montero. In 2023, internal decomposition was mainly caused by Botrytis (4.0%) and *Fusarium proliferatum* (3.4%) (Table 11).

Results of the subjective evaluation can be found in table 12.

White varieties. The percentage of tops down averaged 19% on 15 August (Table 13).

The severity of thrips leaf damage, on a scale from 0 to 10, was low, averaging 1.0 (Table 13). IYSV severity was low in this trial, with all varieties showing low intensity of symptoms, with a rating of 1 (0–25% of foliage diseased) or less. Bolting was very low in 2023, not exceeding 0.1% of bulbs, with most varieties having no bolting. The percentage of functionally single-centered bulbs averaged 90% and ranged from 62% for White Cloud to 97% for Rhea (Table 14).

Total yield in December 2023 averaged 928 cwt/acre and ranged from 829 cwt/acre for White Cap to 1000 cwt/acre for 37-127 (Table 15). Marketable yield averaged 912 cwt/acre and ranged from 812 cwt/acre for White Cap to 983 cwt/acre for Rhea. Storage decomposition averaged 0.1% and ranged from 0% for Rhea, Brundage, White Cap, and Cometa to 0.5% for White Cloud.

In December 2023, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 29% and ranged from 13% for White Cap to 45% for 37-127 (Table 16). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 16% and ranged from 7% for White Cloud to 22% for Cometa. In 2023, the internal decomposition was mainly caused by *Fusarium proliferatum* (Table 17).

Results of the subjective evaluation can be found in table 18.

Red varieties. The percentage of tops down averaged 3% on 31 July, 26% on 15 August, and 87% on 31 August (Table 19).

The percentage of functionally single-centered bulbs averaged 76% and ranged from 38% for Barolo to 94% for Purple Haze (Table 20).

Total yield in December 2023 averaged 586 cwt/acre and ranged from 400 cwt/acre for 37-128 to 822 cwt/acre for Tannat (Table 21). Marketable yield averaged 528 cwt/acre and ranged from

255 cwt/acre for 37-128 to 805 cwt/acre for Tannat. Storage decomposition averaged 3.3% and ranged from 0% for Redwing and Red Beret to 17% for 37-128.

In December 2023, the percentage of bulbs with incomplete scales, regardless of dry scale or disease, averaged 29% and ranged from 14% for Barolo to 44% for Tannat (Table 22). The percentage of bulbs with internal decomposition, regardless of incomplete or dry scales, averaged 7% and ranged from 0.4% for Barolo to 13% for Red Beret. In 2023, the internal decomposition was mainly caused by *Fusarium proliferatum* (Table 23).

Results of the subjective evaluation can be found in Table 24.

Acknowledgements

This project was funded by the Idaho-Eastern Oregon Onion Committee, cooperating onion seed companies, Oregon State University, and the Malheur County Education Service District and supported by Formula Grant nos. 2022-31100-06041 and 2022-31200-06041 from the USDA National Institute of Food and Agriculture.

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Table 4. Maturity ratings for early maturing onion varieties harvested in August 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	31-July	
		Tops down	Leaf dryness
		----------- %	-----------
A. Takii	Frontier	3	13
	Highlander	72	16
	Outlander	90	23
	Switchback	48	15
Crookham	Avalon	0	0
	Scout	6	0
Enza Zaden	Elsye	31	5
Sakata	Ovation	2	0
	Spanish Medallion	4	1
	Yosemite	7	0
Average		26	7
LSD (0.05)		10	4

Table 5. Single and multiple-center bulb ratings for early maturing onion varieties harvested in August 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Multiple center			Single center	
		large	medium	small	functional[a]	bullet
		------------ % -------------				
A. Takii	Frontier	9.0	39.0	42.0	52.0	10.0
	Highlander	42.4	36.0	16.8	21.6	4.8
	Outlander	28.0	44.0	22.4	28.0	5.6
	Switchback	14.4	49.6	27.2	36.0	8.8
Crookham	Avalon	0.8	7.2	39.2	92.0	52.8
	Scout	8.8	16.0	20.8	75.2	54.4
Enza Zaden	Elsye	16.8	25.6	36.0	57.6	21.6
Sakata	Ovation	7.2	24.0	33.6	68.8	35.2
	Yosemite	31.2	32.0	24.8	36.8	12.0
	Spanish Medallion	6.0	17.0	29.0	77.0	48.0
	Average	16.5	29.0	29.2	54.5	25.3
	LSD (0.05)	12.3	16.7	11.4	11.3	11.1

[a]Functional single-centered bulbs are the small multiple-centered bulbs plus the bullet-centered onions.

Table 6. Yield and grade performance of early-maturing onion varieties harvested in August 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

			Marketable yield by grade							Size distribution			
Company	Variety	Total yield	Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	No. 2s	>4¼ in	4-4¼ in	3-4 in	2¼-3 in
		cwt/acre								%			
A. Takii	Frontier	405.5	351.2	0.0	0.0	65.5	285.7	54.1	0.2	0.0	0.0	16.0	70.0
	Highlander	380.1	312.6	0.0	3.8	121.8	187.0	59.9	7.6	0.0	1.0	32.0	49.0
	Outlander	330.4	234.2	0.0	0.0	22.7	211.5	95.3	0.8	0.0	0.0	6.6	63.9
	Switchback	370.1	297.8	0.0	0.0	70.8	227.0	72.2	0.0	7.1	25.3	59.8	6.0
Crookham	Avalon	863.5	848.2	61.4	220.5	514.8	51.5	14.2	1.1	8.9	36.2	49.3	4.1
	Scout	974.7	961.5	87.9	350.0	484.1	39.5	9.3	3.9	2.6	15.3	62.1	15.0
Enza Zaden	Elsye	742.1	705.9	20.4	116.2	459.3	110.0	25.6	10.6	9.1	27.4	53.1	7.1
Sakata	Ovation	749.5	724.7	66.4	204.0	400.9	53.4	8.7	16.1	3.5	17.5	61.4	11.3
	Yosemite	769.8	722.2	27.6	134.3	474.3	86.0	19.1	28.5	16.8	32.4	42.3	4.4
	Spanish Medallion	845.8	811.2	138.9	278.3	358.5	35.5	13.1	21.5	0.0	0.0	19.0	61.2
	Average	643.1	597.0	40.3	130.7	297.3	128.7	37.1	9.0	4.8	15.5	40.2	29.2
	LSD (0.05)	81.6	86.3	36.4	64.6	87.9	41.7	18.5	13.2	5.2	7.7	10.5	6.2

Table 7. Maturity, IYSV ratings, thrips leaf damage on 31 August, and number of leaves per plant of full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

							Number of leaves	
Company	Variety	Tops down	Leaf dryness	IYSV severity[a]	IYSV incidence[b]	Thrips damage[c]	23-Jun	3-Aug
		-------- %	---------	0 - 5	%	0-10		
A. Takii	Traverse	100	53	0.3	26	4	7.7	10.0
	TTA-782	88	18	0.1	14	2	0.4	11.9
Bejo	Colt	79	14	0.2	18	1	6.8	11.5
	Hamilton	54	18	0.1	6	2	6.7	11.5
	Yakama	92	25	0.1	12	1	7.1	10.5
	Sedona	71	15	0.2	16	2	6.6	11.9
	EXP 375	99	34	0.2	16	3	7.1	10.8
Crookham	Trident	80	26	0.2	16	3	6.7	10.9
	Caldwell	84	21	0.1	14	2	7.0	11.4
	Caliber	30	14	0.2	18	1	6.5	12.4
	Epic	88	23	0.1	8	2	6.3	10.0
	Defender	64	19	0.1	8	2	6.6	10.8
Hazera	Thunderstone	77	27	0.1	14	3	7.1	11.3
	37-126	68	21	0.1	10	2	7.0	11.4
Nunhems	Anillo	74	22	0.2	20	2	7.0	11.1
	Arcero	62	27	0.2	18	2	6.9	10.9
	Campero	76	18	0.1	6	1	6.4	11.0
	Glorioso	88	25	0.4	36	2	6.5	10.8
	Granero	90	19	0.2	18	2	7.1	11.3
	Joaquin	58	12	0.1	12	1	7.1	12.1
	Montero	95	34	0.2	16	3	7.0	11.0
	Oloroso	42	26	0.1	8	2	6.7	11.1
	Pandero	44	18	0.1	8	1	6.6	12.2
	Vaquero	47	21	0.2	18	2	7.0	12.0
Seminis	Crusher	90	17	0.1	12	2	6.8	11.5
	Tucannon	80	17	0.1	6	2	6.8	11.5
	Almanzoro	79	16	0.2	18	1	6.5	11.6
	Hatchet	44	20	0.1	14	2	7.0	12.0
	Average	73	22	0.1	15	2	6.6	11.3
	LSD (0.05)	12	5	NS	NS	1	0.5	0.75

[a] IYSV severity: 0 = no disease, 5 = 100% of foliage diseased

[b] IYSV Incidence: percentage of the 10 plants evaluated having at least one lesion

[c] Thrips leaf damage: 0 = no damage, 10 = most damage.

Table 8. Single- and multiple-center ratings for full-season yellow onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

		Multiple center			Single center	
Company	Variety	large	medium	small	functional[a]	bullet
		%				
A. Takii	Traverse	0.0	16.8	45.6	83.2	37.6
	TTA-782	7.2	17.6	48.0	75.2	27.2
Bejo	Colt	0.8	6.4	32.8	92.8	60.0
	Hamilton	6.4	16.0	33.6	77.6	44.0
	Legend	0.0	3.2	32.0	96.8	64.8
	Sedona	14.4	21.6	40.0	64.0	24.0
	EXP 375	7.2	17.6	42.4	75.2	32.8
Crookham	Trident	0.0	2.4	14.4	97.6	83.2
	Caldwell	0.0	1.6	12.0	98.4	86.4
	Caliber	0.8	3.2	11.2	96.0	84.8
	Epic	0.0	8.8	20.8	91.2	70.4
	Defender	1.6	4.8	16.0	93.6	77.6
Hazera	Thunderstone	3.2	23.2	30.4	73.6	43.2
	37-126	7.2	28.8	31.2	64.0	32.8
Nunhems	Anillo	0.0	1.6	8.8	98.4	89.6
	Arcero	0.8	4.0	17.6	95.2	77.6
	Campero	5.6	35.2	37.6	59.2	21.6
	Glorioso	0.8	4.8	30.4	94.4	64.0
	Granero	2.4	6.4	27.2	91.2	64.0
	Joaquin	2.4	4.0	19.2	93.6	74.4
	Montero	0.8	2.4	32.8	96.8	64.0
	Oloroso	0.0	0.8	11.2	99.2	88.0
	Pandero	0.8	8.0	33.6	91.2	57.6
	Vaquero	6.4	9.6	35.2	84.0	48.8
Seminis	Crusher	1.6	2.4	19.2	96.0	76.8
	Tucannon	0.0	5.6	16.8	94.4	77.6
	Almanzoro	3.2	14.4	39.2	82.4	43.2
	Hatchet	4.0	5.6	31.2	90.4	59.2
	Average	2.8	9.9	27.5	87.3	59.8
	LSD (0.05)	4.1	7.7	12.9	9.3	12.8

[a] Functional single-centered bulbs are the small multiple-centered bulbs plus the bullet-centered onions.

Table 9. Yield and grade of full-season experimental and commercial yellow onion varieties graded out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Total yield	Marketable yield by grade Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	No. 2s	Total rot	Neck rot	Plate rot	Black mold
		cwt/acre								% of total yield			
A. Takii	Traverse	622	610	2	9	470	129	12	0	0.1	0.0	0.1	0.0
	TTA782	942	923	74	343	476	30	8	7	0.2	0.0	0.2	0.0
Bejo	Colt	1030	1016	58	308	602	48	9	5	0.1	0.0	0.1	0.0
	Hamilton	908	881	6	126	684	65	11	15	0.0	0.0	0.0	0.0
	Yakama	1088	1075	74	339	628	33	10	1	0.2	0.0	0.0	0.0
	Sedona	994	947	17	227	645	58	9	38	0.0	0.0	0.0	0.0
	EXP 375	802	774	4	88	591	90	15	13	0.1	0.0	0.1	0.0
Crookham	Trident	763	747	11	71	557	107	16	0	0.1	0.0	0.1	0.0
	Caldwell	925	914	61	246	562	45	10	0	0.1	0.0	0.1	0.0
	Caliber	933	920	169	345	376	30	11	0	0.1	0.0	0.1	0.0
	Epic	852	839	20	154	580	85	13	0	0.0	0.0	0.0	0.0
	Defender	843	832	48	174	543	67	10	0	0.1	0.0	0.1	0.0
Hazera	Thunderstone	631	604	13	124	399	68	17	9	0.1	0.0	0.1	0.0
	37-126	863	854	50	241	532	31	7	2	0.1	0.0	0.1	0.0
Nunhems	Anillo	923	913	47	233	581	51	9	1	0.0	0.0	0.0	0.0
	Arcero	904	893	47	256	543	47	11	0	0.0	0.0	0.0	0.0
	Campero	893	880	53	198	582	47	7	5	0.1	0.0	0.1	0.0
	Glorioso	757	734	0	49	581	105	23	0	0.0	0.0	0.0	0.0
	Granero	980	972	69	337	530	37	6	1	0.0	0.0	0.0	0.0
	Joaquin	1003	995	182	378	398	36	9	0	0.0	0.0	0.0	0.0
	Montero	900	887	31	215	579	62	9	3	0.0	0.0	0.0	0.0
	Oloroso	729	720	13	157	509	41	7	1	0.1	0.0	0.1	0.0
	Pandero	870	857	140	281	414	22	7	5	0.0	0.0	0.0	0.0
	Vaquero	854	841	31	216	552	42	7	4	0.2	0.0	0.2	0.0
Seminis	Crusher	1049	1027	125	349	516	37	9	1	1.2	0.0	1.2	0.0
	Tucannon	912	901	82	254	512	54	9	1	0.1	0.0	0.0	0.0
	Almanzoro	870	847	45	241	507	54	12	8	0.2	0.0	0.2	0.0
	Hatchet	1007	987	128	383	445	31	8	7	0.2	0.0	0.2	0.0
	Average	887	871	57	226	532	55	10	5	0.10		0.10	
	LSD (0.05)	95	98	44	73	102	24	6	10	NS		NS	

Table 10. Internal defects of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

		All bulbs						Diseased bulbs						
		Complete scales			Incomplete scales			Complete scales			Incomplete scales			Total
Company	Variety	no dry scale	dry scale	total	no dry scale	dry scale	total	no dry scale	dry scale	total	no dry scale	dry scale	total	
							------------------------------- %	-------------------------------						
A. Takii	Traverse	64.9	0.4	65.3	20.9	13.8	34.7	0.0	0.4	0.4	0.4	3.0	3.4	3.8
	TTA782	94.8	0.4	95.2	3.2	1.6	4.8	0.4	0.0	0.4	0.0	1.2	1.2	1.6
Bejo	Colt	80.8	0.0	80.8	10.0	9.2	19.2	0.0	0.0	0.0	0.0	0.8	0.8	0.8
	Hamilton	77.6	0.4	78.0	10.0	12.0	22.0	2.0	0.0	2.0	0.8	3.6	4.4	6.4
	Yakama	86.4	0.4	86.8	5.2	8.0	13.2	0.0	0.0	0.0	0.0	0.4	0.4	0.4
	Sedona	79.6	0.0	79.6	7.2	13.2	20.4	0.4	0.0	0.4	1.2	4.4	5.6	6.0
	EXP 375	74.8	0.0	74.8	19.6	5.6	25.2	0.4	0.0	0.4	1.6	1.6	3.2	3.6
Crookham	Trident	70.0	0.0	70.0	13.6	16.4	30.0	2.0	0.0	2.0	1.6	6.0	7.6	9.6
	Caldwell	86.8	0.0	86.8	9.6	3.6	13.2	1.2	0.0	1.2	0.0	0.0	0.0	1.2
	Caliber	78.4	0.8	79.2	12.8	8.0	20.8	3.6	0.0	3.6	1.2	4.4	5.6	9.2
	Epic	70.4	0.0	70.4	10.8	18.8	29.6	1.2	0.0	1.2	0.8	4.4	5.2	6.4
	Defender	80.0	0.4	80.4	13.2	6.4	19.6	1.2	0.0	1.2	0.8	1.6	2.4	3.6
Hazera	Thunderstone	58.0	0.4	58.4	15.2	26.4	41.6	1.6	0.0	1.6	1.2	5.2	6.4	8.0
	37-126	73.8	0.4	74.2	10.9	15.0	25.9	1.2	0.0	1.2	1.2	5.7	6.9	8.1
Nunhems	Anillo	68.8	0.8	69.6	5.6	24.8	30.4	6.4	0.8	7.2	0.0	11.6	11.6	18.8
	Arcero	70.4	0.4	70.8	12.0	17.2	29.2	0.4	0.0	0.4	2.0	6.0	8.0	8.4
	Campero	84.8	0.8	85.6	4.0	10.4	14.4	2.4	0.4	2.8	0.4	3.6	4.4	6.8
	Glorioso	80.8	0.8	81.6	6.0	12.4	18.4	5.6	0.0	5.6	0.8	5.6	6.4	12.0
	Granero	74.8	0.0	74.8	7.6	17.6	25.2	2.0	0.0	2.0	1.6	4.8	6.4	8.4
	Joaquin	78.4	0.4	78.8	9.6	11.6	21.2	2.4	0.0	2.4	1.2	4.8	6.0	8.4
	Montero	52.0	0.0	52.0	11.6	36.4	48.0	1.2	0.0	1.2	2.4	18.4	20.8	22.0
	Oloroso	58.4	1.6	60.0	9.8	30.3	40.0	2.0	0.4	2.4	3.6	13.6	17.2	19.5
	Pandero	75.6	0.4	76.0	10.4	13.6	24.0	1.6	0.4	2.0	0.8	4.0	4.8	6.8
	Vaquero	68.7	1.2	69.8	12.3	17.9	30.2	4.0	0.0	4.0	1.6	10.7	12.3	16.3
Seminis	Crusher	82.8	2.4	85.2	4.0	10.8	14.8	4.4	0.0	4.4	0.0	3.2	3.2	7.6
	Tucannon	76.4	1.6	78.0	5.6	16.4	22.0	2.4	0.8	3.2	1.2	3.2	4.4	7.6
	Almanzoro	89.2	2.8	92.0	2.0	6.0	8.0	1.6	0.0	1.6	0.8	1.6	2.4	4.0
	Hatchet	52.4	1.2	53.6	16.0	30.4	46.4	0.4	0.4	0.8	0.8	4.4	5.2	6.0
	Average	74.6	0.6	75.3	10.0	14.8	24.7	1.9	0.1	2.0	1.0	4.9	5.9	7.9
	LSD (0.05)	9.7	NS	10.1	7.1	8.5	10.1	2.8	NS	2.8	NS	4.8	4.5	4.9

Table 11. Internal decomposition by disease type of full-season experimental and commercial yellow onion varieties evaluated out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Bacterial Rot	*Fusarium proliferatum*	Neck Rot	Black Mold
			--------------- % ---------------		
A. Takii	Traverse	0.0	0.3	0.4	3.1
	TTA782	0.0	1.6	0.0	0.0
Bejo	Colt	0.0	0.8	0.0	0.0
	Hamilton	0.4	5.2	0.8	0.0
	Yakama	0.0	0.4	0.0	0.0
	Sedona	0.0	4.4	1.2	0.4
	EXP 375	0.0	0.4	1.2	2.0
Crookham	Trident	0.0	2.8	6.8	0.0
	Caldwell	0.0	0.4	0.8	0.0
	Caliber	0.0	2.4	6.8	0.0
	Epic	0.0	1.6	4.0	0.8
	Defender	0.4	0.8	2.4	0.0
Hazera	Thunderstone	0.0	3.2	4.4	0.4
	37-126	0.0	4.0	3.7	0.4
Nunhems	Anillo	2.4	6.0	10.4	0.0
	Arcero	0.4	4.4	3.6	0.0
	Campero	0.4	2.4	3.6	0.4
	Glorioso	0.4	4.8	6.8	0.0
	Granero	0.0	4.0	4.4	0.0
	Joaquin	1.2	4.8	2.4	0.0
	Montero	0.8	10.8	10.0	0.4
	Oloroso	0.0	10.9	8.6	0.0
	Pandero	0.0	3.6	3.2	0.0
	Vaquero	0.4	7.9	7.9	0.0
Seminis	Crusher	0.0	1.2	6.4	0.0
	Tucannon	0.4	2.4	4.8	0.0
	Almanzoro	0.0	0.0	4.0	0.0
	Hatchet	0.0	2.4	3.6	0.0
	Average	0.3	3.4	4.0	0.3
	LSD (0.05)	0.97	3.49	3.76	0.68

Table 12. Subjective evaluation of bulb characteristics for yellow onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

Company	Variety	Bulb shape[a]	Bulb shape uniformity[b]	Firmness[b]	Scale retention[b]	Skin color[b]	Flesh brightness[b]
			---------- 1 - 5 ----------				
A. Takii	Traverse	4.0	4.0	3.5	2.5	3.5	4.5
	TTA782	4.0	4.0	4.0	5.0	4.5	3.0
Bejo	Colt	3.5	3.0	4.0	5.0	4.0	3.5
	Hamilton	4.0	4.0	4.5	5.0	4.5	3.0
	Yakama	3.0	2.5	3.5	3.0	3.0	4.0
	Sedona	4.0	3.5	4.0	4.0	3.5	3.5
	EXP 375	3.0	2.0	4.0	3.0	3.5	3.5
Crookham	Trident	4.0	2.0	3.0	3.0	3.0	3.0
	Caldwell	4.0	4.0	3.5	3.5	3.0	5.0
	Caliber	3.0	3.0	3.5	3.5	3.5	4.0
	Epic	5.0	3.0	3.5	3.5	3.5	4.0
	Defender	4.0	3.0	4.0	3.5	4.0	4.0
Hazera	Thunderstone	4.0	4.0	3.5	3.0	3.5	4.0
	37-126	5.0	4.0	4.0	4.5	4.0	3.5
Nunhems	Anillo	4.0	4.5	3.5	5.0	4.0	4.5
	Arcero	4.0	4.0	4.0	4.5	4.5	5.0
	Campero	4.0	3.5	3.5	4.0	4.5	3.0
	Glorioso	5.0	4.5	4.5	5.0	5.0	4.0
	Granero	3.0	3.5	3.5	4.0	4.0	3.0
	Joaquin	4.0	3.5	4.0	4.0	4.0	4.5
	Montero	3.0	2.0	3.0	3.5	3.0	3.5
	Oloroso	4.0	4.0	4.5	4.0	4.0	4.0
	Pandero	5.0	4.0	3.5	4.5	4.0	3.0
	Vaquero	4.0	3.0	4.5	4.5	4.0	3.5
Seminis	Crusher	6.0	4.5	3.5	4.5	4.0	4.0
	Tucannon	4.0	4.5	4.0	5.0	4.0	3.5
	Almanzoro	6.0	3.0	3.5	4.0	3.5	4.0
	Hatchet	4.0	4.0	3.5	3.5	4.0	4.0
	Average	4.1	3.5	3.8	4.0	3.8	3.8

[a] Bulb shape: see Fig. 1.
[b] Subjective ratings are described in Table 4: 1 = worst, 5 = best.

Table 13. Maturity, thrips leaf damage, and IYSV ratings of full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

		August 15					Number of leaves	
Company	Variety	Tops down	Leaf dryness	Thrips leaf damage[a]	IYSV severity[b]	IYSV Incidence[c]	23-Jun	3-Aug
		-------- % --------		0 - 10	0 - 5	%		
Crookham	Brundage	21	7	1.2	0.3	24	6.9	11.3
	White Cap	17	7	1.6	0.2	22	6.5	11.9
	White Cloud	19	8	1.0	0.1	12	6.3	11.1
Hazera	37-127	5	5	1.0	0.2	22	7.4	12.2
Nunhems	Cometa	28	5	1.6	0.1	10	6.8	11.7
	Rhea	21	4	1.0	0.2	16	6.7	11.7
	Average	19	6	1	0.2	18	6.8	11.7
	LSD (0.05)	9	3	0.5	NS	NS	0.4	NS

[a] Thrips leaf damage: 0 = no damage, 10 = most damage.

[b] IYSV severity: 0 = no disease, 5 = 100% of foliage diseased

[c] IYSV Incidence: percentage of the 10 plants evaluated having at least one lesion

Table 14. Single- and multiple-center ratings for full-season white onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

		Multiple center			Single center	
Company	Variety	large	medium	small	functional[a]	bullet
			-------------------------- % --------------------------			
Crookham	Brundage	0.8	4.0	13.6	95.2	81.6
	White Cap	0.0	5.6	13.6	94.4	80.8
	White Cloud	11.2	27.2	26.4	61.6	35.2
Hazera	37-127	2.4	4.8	20.0	92.8	72.8
Nunhems	Cometa	0.8	2.4	12.8	96.8	84.0
	Rhea	0.0	3.0	10.1	97.0	87.0
	Average	2.5	7.8	16.1	89.6	73.6
	LSD (0.05)	4.1	6.8	9.1	8.7	11.8

[a] Functional single-centered bulbs are the small multiple-centered bulbs plus the bullet-centered onions.

Table 15. Yield and grade of full-season experimental and commercial white onion varieties graded out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

			Marketable yield by grade									
Company	Variety	Total yield	Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in	Small	No. 2s	Total rot	Neck rot	Plate rot
			cwt/acre							% of total yield		
Crookham	Brundage	874	858	63	252	488	55	11	1	0.0	0.00	0.00
	White Cap	829	812	62	242	450	58	13	3	0.0	0.04	0.00
	White Cloud	942	912	71	283	498	60	12	10	0.5	0.04	0.07
Hazera	37-127	1000	983	142	422	401	19	6	6	0.1	0.02	0.06
Nunhems	Cometa	962	953	103	333	483	34	9	0	0.0	0.00	0.00
	Rhea	960	951	59	309	542	41	9	0	0.0	0.00	0.00
	Average	928	912	83	307	477	45	10	3	0.1	0.02	0.02
	LSD (0.05)	66	65	40	76	NS	21	NS	NS	NS	NS	NS

Table 16. Internal defects of full-season experimental and commercial white onion varieties evaluated out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

		All bulbs						Diseased bulbs						
		Complete scales			Incomplete scales			Complete scales			Incomplete scales			Total
Company	Variety	no dry scale	dry scale	total	no dry scale	dry scale	total	no dry scale	dry scale	total	no dry scale	dry scale	total	
		%												
Crookham	Brundage	71.2	0.0	71.2	7.2	21.6	28.8	0.8	0.0	0.8	1.6	16.8	18.4	19.2
	White Cap	85.6	1.2	86.8	2.0	11.2	13.2	1.6	0.4	2.0	0.0	5.6	5.6	7.6
	White Cloud	82.8	0.4	83.2	4.4	12.4	16.8	1.2	0.0	1.2	0.4	5.6	6.0	7.2
Hazera	37-127	55.0	0.0	55.0	20.5	24.5	45.0	0.4	0.0	0.4	4.4	15.7	20.1	20.5
Nunhems	Cometa	72.4	0.4	72.8	2.4	24.8	27.2	2.8	0.0	2.8	0.0	19.2	19.2	22.0
	Rhea	57.2	0.8	58.0	17.2	24.8	42.0	0.4	0.0	0.4	2.0	16.0	18.0	18.4
	Average	70.7	0.5	71.2	8.9	19.9	28.8	1.2	0.1	1.3	1.4	13.1	14.5	15.8
	LSD (0.05)	12.2	NS	12.2	11.2	NS	12.2	NS	NS	NS	NS	NS	NS	NS

Table 17. Internal decomposition by disease type of full-season experimental and commercial white onion varieties evaluated out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Bacterial Rot	*Fusarium proliferatum*	Neck Rot	Black Mold
			--------------- % ---------------		
Crookham	Brundage	0.4	14.8	4.0	0.0
	White Cap	0.0	6.0	1.6	0.0
	White Cloud	0.0	4.8	2.4	0.0
Hazera	37-127	0.4	17.6	2.4	0.0
Nunhems	Cometa	2.0	4.8	6.8	0.0
	Rhea	1.6	14.0	2.8	0.0
	Average	0.7	10.3	3.3	
	LSD (0.05)	NS	NS	NS	

Table 18. Subjective evaluation of bulb characteristics for white onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

Company	Variety	Bulb shape[a]	Bulb shape uniformity[b]	Firmness[b]	Scale retention[b]	Skin color[b]	Flesh brightness[b]
			--------------------------------- 1 - 5 ---------------------------------				
Crookham	Brundage	4.0	3.5	4.0	4.0	3.0	3.0
	White Cap	6.0	3.5	3.0	4.0	4.0	4.0
	White Cloud	4.0	3.0	3.5	3.5	2.5	3.0
Hazera	37-127	3.5	4.0	4.0	4.0	3.5	3.5
Nunhems	Cometa	5.0	4.0	4.0	4.0	3.5	3.5
	Rhea	4.0	3.0	4.0	4.0	3.0	3.5
	Average	4.4	3.5	3.6	3.9	3.3	3.4

[a] Bulb shape: see Fig. 1.
[b] Subjective ratings are described in Table 4: 1 = worst, 5 = best.

Table 19. Maturity ratings and number of leaves per plant of full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

		July 31		August 15		August 31		Number of leaves	
Company	Variety	Tops down	Leaf dryness	Tops down	Leaf dryness	Tops down	Leaf dryness	23-Jun	3-Aug
		%							
Bejo	Redwing	0	5	6	17	77	44	6.8	9.7
Crookham	Purple Haze	2	1	15	15	77	50	6.5	10.1
	Red Beret	4	4	32	18	82	50	6.3	10.6
Enza Zaden	Barolo	8	3	66	16	100	43	6.7	8.5
	Tannat	1	0	23	5	93	20	6.9	11.7
Hazera	37-128	3	7	11	25	92	80	6.2	10.7
	Average	3	3	26	16	87	48	6.6	10.2
	LSD (0.05)	3	4	15	6	12	17	0.38	0.83

Table 20. Single- and multiple-center ratings for full-season red onion varieties, Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

		Multiple center			Single center	
Company	Variety	large	medium	small	functional[a]	bullet
		%				
Bejo	Redwing	0.0	8.0	22.4	92.0	69.6
Crookham	Purple Haze	0.8	5.6	14.4	93.6	79.2
	Red Beret	3.2	4.8	16.8	92.0	75.2
Enza Zaden	Barolo	21.6	40.0	29.6	38.4	8.8
	Tannat	3.2	19.9	34.9	76.9	42.0
Hazera	37-128	11.5	25.6	39.6	62.9	23.3
	Average	6.7	17.3	26.3	76.0	49.7
	LSD (0.05)	10.9	9.7	15.5	15.3	11.7

[a] Functional single-centered bulbs are the small multiple-centered bulbs plus bullet-centered onions.

Table 21. Yield and grade of full-season experimental and commercial red onion varieties graded out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	Total yield	Marketable yield by grade					Small	No. 2s	Total rot	Neck rot	Plate rot	Black mold
			Total	>4¼ in	4-4¼ in	3-4 in	2¼-3 in						
		---------- cwt/acre ----------								----- % of total yield -----			
Bejo	Redwing	590	535	0.0	18.0	376.7	140.4	55.0	0.0	0.0	0.0	0.0	0.0
Crookham	Purple Haze	562	513	0.0	9.8	306.0	197.4	46.2	1.2	1.4	0.0	1.4	0.0
	Red Beret	536	494	0.0	16.4	304.1	173.5	40.1	1.9	0.0	0.0	0.0	0.0
Enza Zaden	Barolo	608	565	0.0	8.4	360.1	196.9	34.4	7.2	0.7	0.0	0.7	0.0
	Tannat	822	805	3.0	76.0	635.4	90.6	14.4	2.3	0.5	0.0	0.5	0.0
Hazera	37-128	400	255	0.0	0.7	64.0	190.1	84.8	43.7	17.0	0.0	17.0	0.0
	Average	586	528	0.5	21.5	341	164.8	45.8	9.4	3.3		3.3	
	LSD (0.05)	79	78	2.2	16.2	64.2	35.1	12.3	13.9	NS		NS	

Table 22. Internal defects of full-season experimental and commercial red onion varieties evaluated out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Company	Variety	All bulbs						Diseased bulbs						
		Complete scales			Incomplete scales			Complete scales			Incomplete scales			Total
		no dry scale	dry scale	total	no dry scale	dry scale	total	no dry scale	dry scale	total	no dry scale	dry scale	total	
		---------- % ----------												
Bejo	Redwing	72.5	5.0	77.5	13.2	9.3	22.5	0.0	0.0	0.0	0.4	3.6	4.0	4.0
Crookham	Purple Haze	66.3	0.4	66.7	13.7	19.7	33.3	1.2	0.0	1.2	0.4	4.0	4.4	5.6
	Red Beret	66.8	0.4	67.2	16.8	16.0	32.8	5.2	0.0	5.2	1.6	6.0	7.6	12.8
Enza Zaden	Barolo	86.4	0.0	86.4	11.2	2.4	13.6	0.0	0.0	0.0	0.4	0.0	0.4	0.4
	Tannat	55.2	0.4	55.6	20.9	23.5	44.4	1.2	0.0	1.2	0.8	7.7	8.5	9.7
Hazera	37-128	72.9	0.0	72.9	12.8	14.3	27.1	2.8	0.0	2.8	0.0	5.7	5.7	8.5
	Average	70.0	1.0	71.0	14.2	14.2	29.0	1.7		1.7	0.6	4.5	5.1	6.8
	LSD (0.05)	NS	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS	6.9

Table 23. Internal decomposition by disease type of full-season experimental and commercial red onion varieties evaluated out of storage in December 2023, Malheur Experiment Station, Oregon State University, Ontario, OR.

Seed company	Variety	Bacterial Rot	*Fusarium proliferatum*	Neck Rot	Black Mold
			--------------- % ---------------		
Bejo	Redwing	0.4	3.6	0.0	0.0
Crookham	Purple Haze	1.6	4.0	0.0	0.0
	Red Beret	6.8	6.0	0.0	0.0
Enza Zaden	Barolo	0.0	0.4	0.0	0.0
	Tannat	1.2	8.5	0.0	0.0
Hazera	37-128	4.9	3.6	0.0	0.0
	Average	2.5	4.3		
	LSD (0.05)	4.3	NS		

Table 24. Subjective evaluation of bulb characteristics for red onion varieties. Malheur Experiment Station, Oregon State University, Ontario, OR, 2023.

Company	Variety	Bulb shape[a]	Bulb shape uniformity[b]	Firmness[b]	Scale retention[b]	Skin color[b]	Flesh brightness[b]
				--------------------------------- 1 - 5	--------------------------------		
Bejo	Redwing	4.0	3.5	4.0	3.5	3.0	3.0
Crookham	Purple Haze	3.0	3.0	3.0	3.0	3.0	3.0
	Red Beret	3.0	2.0	2.5	2.0	3.0	3.0
Enza Zaden	Barolo	4.0	3.0	3.0	1.0	4.5	4.0
	Tannat	3.0	3.0	3.5	4.0	4.5	4.5
Hazera	37-128	4.0	2.5	4.0	4.0	4.0	4.0
	Average	3.5	2.8	3.3	2.9	3.7	3.6

[a] Bulb shape: see Fig. 1.

[b] Subjective ratings are described in Table 4: 1 = worst, 5 = best.

Onion Response to Seeding and Irrigation Depths and Wheat Straw Mulching

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Jim Klauzer, Clearwater, Ontario, OR.
Kyler Beck, Former Agronomist, McCain Foods USA.

Objectives

1. Evaluate the impact of seeding, drip irrigation depths, and straw mulching on soil temperature.
2. Evaluate the impact of seeding and drip irrigation depths and straw mulching on the marketable yield of onion bulbs and soil health.

Introduction

Heat stress in the absence of adequate soil moisture conditions can be an important limiting factor to crop growth and development. The stress intensity, duration, and rate of temperature rise are all factors that dictate the impact on crop growth and yield. While some crops are resistant to heat stress during critical growth stages, there is evidence that onions are susceptible to extreme heat (and water) stress during bulb initiation and development stages immediately following. Onions have a relatively slow leaf growth rate and less ground cover compared to other crops. In general, shallow-rooted crops like onion are less drought tolerant than deep-rooted species such as alfalfa or corn. These crop characteristics coupled with high temperatures during June and July could allow more solar radiation to be absorbed between the rows and in the furrows of drip-irrigated fields. A rise in temperature has been directly linked to a decrease in photosynthetic efficiency and, ultimately, crop yield. The cardinal temperature for optimal seedling growth before bulb initiation and bulb development is 20-25 °C (68-77°F). Researchers have found that onions grown at 25 °C (77 °F) resulted in the largest average bulb diameter, bulb index, and pyruvic acid content; and that bulb weight was reduced at 30 °C (86 °F) due to heat stress. The excessive early season heat in 2015 and 2021 could help explain some of the yield and quality issues that manifested in the Pacific Northwest onion crop during those years.

Using straw mulch can help to keep exposed, dry soil cool, which is essential for crops like onions. Mulching also helps retain soil moisture, improve nutrient, and water retention, and encourage favorable soil microbial activity. Straw mulch has been proven to increase the yield of furrow and drip irrigated onions and increasing planting depth has anecdotally been linked with mitigating the impact of heat stress. This work aims to identify the most effective combination of seeding depth, drip irrigation depth, and mulching techniques to reduce the impact of heat stress on onions, especially during June and July and thereby increase marketable yield. Further, fine-tuning irrigation and seeding depth could be useful in managing limited water supplies, reducing crop stress, and increasing crop profitability.

Methods

A field study was conducted in Spring 2023 at the Malheur Experiment Station to evaluate the response of onions to drip tape and seeding depths and wheat straw mulching.

Treatments Details and Experimental Design:
Main plot: 2 Drip irrigation depths – 3 and 5 inches
Split plots - 3 Mulching placement techniques – No mulching, Tape row mulching and Non-tape row mulching.
Split-split plots: 2 Seeding depths – 0.5 and 1.0 inches.

Drip depth (Inch)	Mulch	Seeding depth (Inch)
3	None	0.5
		1
	Tape row	0.5
		1
	Non-tape row	0.5
		1
5	None	0.5
		1
	Tape row	0.5
		1
	Non tape row	0.5
		1

Experimental Design: Randomized complete block design with a split-split plot with four replications.

Drip Irrigation depth treatments: Drip tape was laid at 3- and 5-inch depths between pairs of double rows during planting. The drip tape had an emitter spacing of 8 inches apart and a flow rate of 0.22 gallons/minute/100 ft of tape. The distance between the tape and the center of each double row of onions was 10 inches. Onions were irrigated automatically to maintain the soil water potential in the onion root zone below 20 cb in each mulch split plot separately. Soil water potential in each mulch split plot was measured with two soil moisture sensors (Watermark Soil Moisture Sensors Model 200SS; Irrometer Co., Inc., Riverside, CA) installed in split plot at 6- and 12-inch depth in the center of the double-row.

Mulching treatments: Wheat straw was applied in June 2023 between all onion rows for the tape row treatment and between every other row for the non-tape row treatment. The straw mulch for the non-tape row treatment was applied to the wheel rows and to the center row (non-drip tape row).

Onion seeding depth treatments: Onion seeds (Vaquero) were planted at 0.5- and 1.0-inch depth in double rows on 22-inch ft beds.

Cultural practices: The onions were managed to minimize yield reductions from weeds, pests, foliar diseases, and nutrient deficiencies. Recommended cultural and nutrient management practices were practiced throughout the crop growth. Nutrients were applied based on the extension guidelines each week through drip tape.

Soil Temperature Measurement: Soil temperatures were measured twice a week in the midafternoon in each plot using two Vegetronix THERM200 soil temperature sensors at 2-inch depth in the middle of the double row.

Plant Sampling and Harvest: Plant samples were collected randomly from each treatment and rated for pink root. At the end of the season, bulbs were lifted and topped according to standard practice, and individual treatments were harvested separately and graded for yield and bulb size distribution.

Results

In June, the soil temperature in the plot where drip tape was installed at a 5-inch depth was significantly higher than that in the plot where it was installed at a 3-inch depth. During July and August, we did not observe any significant impact of drip tape depth on soil temperature. We also did not observe any significant changes in soil temperature under mulching treatments in June and July. However, in August, non-tape row mulching treatment recorded significantly higher soil temperature compared to the no mulching treatment. We found an interaction between drip tape depth and mulching treatments in June. Drip tape installed at 3-inch depth with tape row mulching had significantly low soil temperature compared to drip tape installed at 5-inch depth with no mulching.

Onion yield reflected the stand count. The marketable yield across medium, jumbo, colossal, and super colossal grades remained unaffected by drip depth treatments (Table 1). Tape row mulch treatment showed a significant positive impact on the super colossal grade. However, total yield did not exhibit any notable changes with different mulching treatments. Seeding depth emerged as a significant factor influencing marketable yield. A seeding depth of 0.5 inches resulted in significant increases for medium, jumbo, and colossal grades. Specifically, compared to the 1-inch seeding depth treatment: medium grade increased by 1.58 times, jumbo grade increased by 2.22 times and colossal grade increased by 1.98 times.

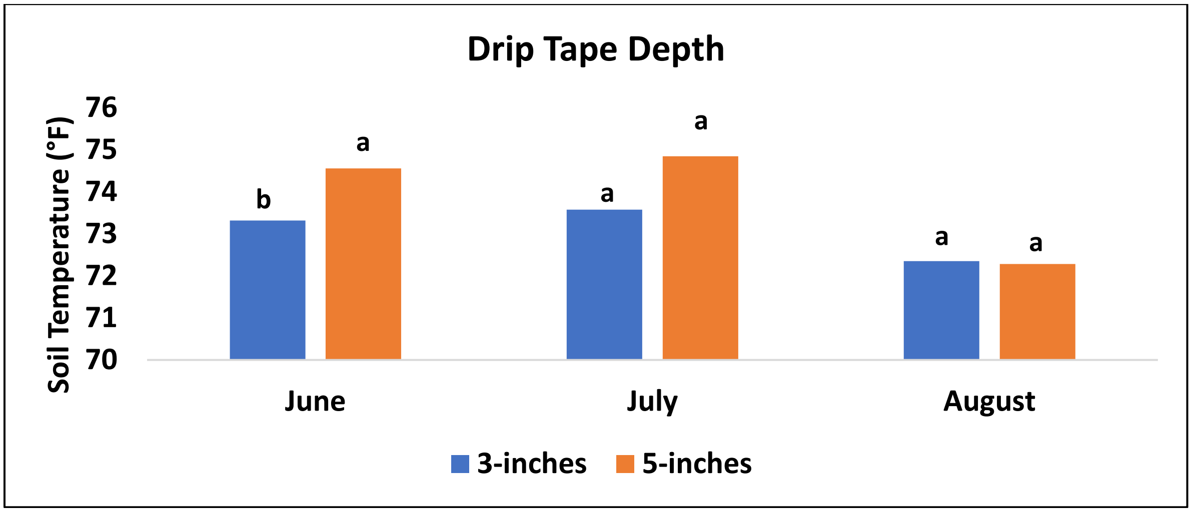
At harvest, soil samples collected at a surface depth of 0-15 cm revealed notable impacts of management practices on soil health (Table 2). Drip tape installation at 3 inches exhibited a 42.7% increase in soil respiration and a 35.0% rise in microbial active carbon compared to the 5-inch depth installation. Non-tape row mulching significantly enhanced soil parameters, including organic matter, soil available phosphorus, potassium, sulfate-S content, water-soluble organic N, and soil respiration, surpassing the effects of no mulching. Moreover, the overall soil health score was markedly higher with non-tape row mulching than tape row mulching. Seeding depth also positively influenced soil respiration and microbial active carbon.

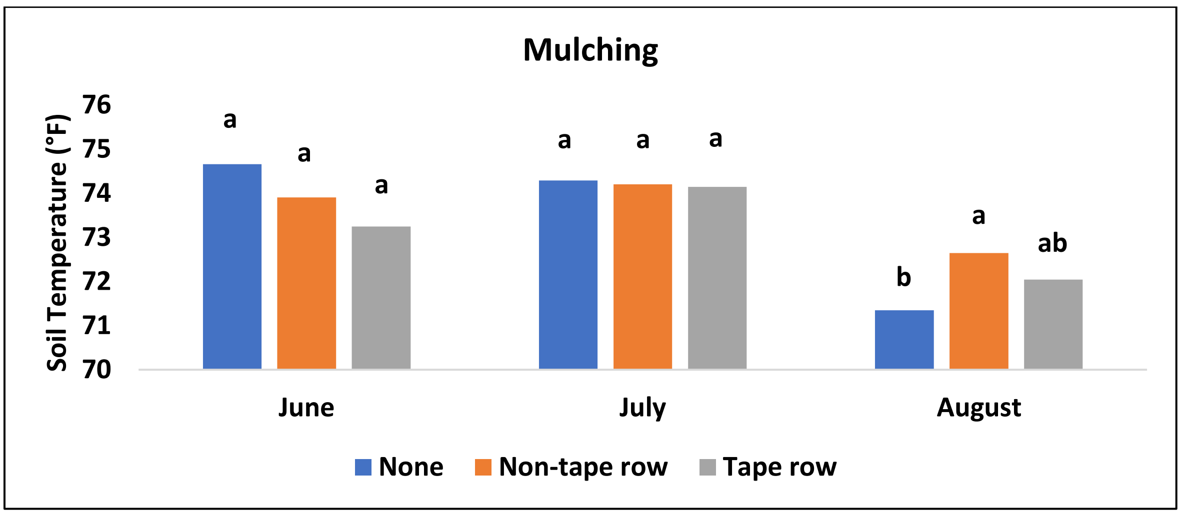
We also performed several plan health assessments such as plant height, leaves count, plant nutritional status, and pink root assessment and found no differences between the treatments (Table 3).

Conclusions

The results revealed that in June month, 3-inch drip tape depth reduced the soil temperature compared to 5-inch drip tape depth, but this difference faded on the subsequent months of July and August. Mulching treatments showed no significant impact on soil temperature in June and July; however, in August, the non-tape row mulching treatment led to increase in soil temperature compared to the no mulching. An interesting interaction effect was observed in June, where the combination of a 3-inch drip tape depth with tape row mulching resulted in significantly lower soil temperature compared to the 5-inch depth with no mulching. The study also showed that drip depth doesn't significantly affect the onion yield, but tape row mulch increased super colossal grade. Seeding depth at 0.5 inches is key for achieving significantly higher yield of medium, jumbo, and colossal grades. Regarding soil health, a 3-inch drip depth increases soil respiration and microbial activity. Non-tape row mulch is beneficial, enhancing soil nutrients, and the overall soil health score. Strategic seeding depth also positively impacts soil respiration and microbial activity. In conclusion, planting onions at a shallow depth of 0.5-inch, using drip tape at 3-inches, and applying straw mulch work together to regulate soil temperature, ensure proper irrigation, and promote soil health, ultimately enhancing onion yield.

Figure 1. Vegetronix soil temperature measurement observed under various treatments.





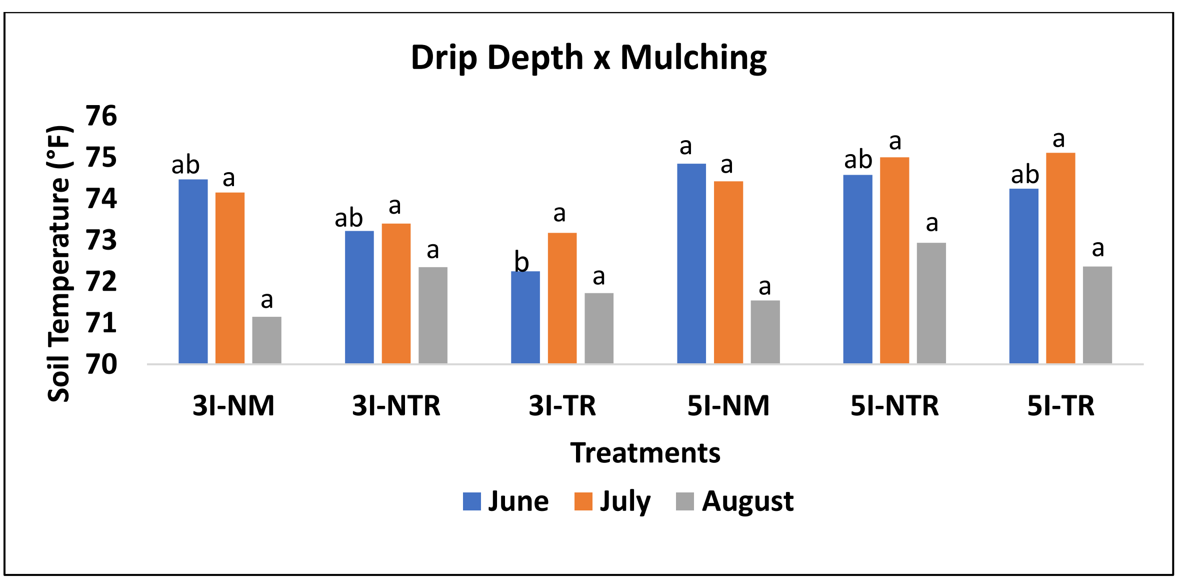


Table 1. Effect of drip tape depth, mulching, and seeding depth on onion yield.

Treatments	Small	Medium	Jumbo	Colossal	Super Colossal	Total	Yield (Cwt/ac)
	lb/plot						
Drip Depth							
3-inches	0.44	2.21	22.08	44.86	122.28	191.91	568.69
5-inches	0.37	1.82	19.47	40.76	135.30	197.67	585.77
Mulch							
None	**0.59a**	2.31	22.23	42.32	**119.08b**	200.11	592.97
Non-tape row	**0.34b**	1.87	22.13	46.35	**121.85b**	190.52	564.55
Tape row	**0.29b**	1.87	17.96	39.76	**145.43a**	193.76	574.15
Seeding Depth							
0.5-inch	**0.55a**	**2.47a**	**28.64a**	**56.90a**	123.78	197.63	585.62
1-inch	**0.26b**	**1.56b**	**12.91b**	**28.71b**	133.80	191.96	568.83
	Analysis of variance p>F						
Drip Depth	0.498	0.319	0.515	0.345	0.130	0.605	0.605
Mulch	0.042	0.449	0.249	0.349	0.003	0.730	0.730
Seedling depth	0.006	0.009	<.0001	<.0001	0.121	0.575	0.575

Table 2. Effect of drip tape depth, mulching, and seeding depth on soil health.

Treatments	Organic Matter LOI (%)	Olsen P	Potassium	Sulfate-S	Organic N H_2O	CO_2 Soil Respiration (lb/ac/day)	Microbially Active Carbon (%)	Soil Health Score
		ppm						
Drip Depth								
3-inches	2.66	27.55	596.67	84.13	16.59	**16.12a**	**10.68a**	6.62
5-inches	2.70	25.63	574.17	86.81	20.13	**11.30b**	**7.91b**	6.31
Mulch								
None	**2.65b**	**23.28b**	**544.57b**	**79.26b**	**17.32b**	**13.59b**	**8.91ab**	**6.51ab**
Non tape row	**2.73a**	**30.62a**	**647.38a**	**104.97a**	**23.33a**	**15.20a**	**10.21a**	**7.13a**
Tape row	**2.68ab**	**25.88b**	**564.32b**	**72.18b**	**14.43b**	**12.33ab**	**8.76b**	**5.75b**
Seeding Depth								
0.5-inch	2.69	25.48	578.08	90.09	18.56	**15.32a**	**10.30a**	6.74
1-inch	2.68	27.70	592.75	80.85	18.15	**12.09b**	**8.29b**	6.20

Table 3. Effect of drip tape depth, mulching, and seeding depth on plant nutrient concentration and pink root.

Treatments	Nitrogen	Phosphorus	Potassium	Pink root
		%		
Drip Depth				
3-inches	1.09	0.30	0.72	5.58
5-inches	1.17	0.32	0.73	7.98
Mulch				
None	1.18	0.30	0.71	6.03
Non tape row	1.15	0.31	0.72	8.00
Tape row	1.07	0.32	0.75	6.31
Seeding Depth				
0.5-inch	1.18	0.31	0.75	6.38
1-inch	1.09	0.31	0.70	7.19

Acknowledgment

We appreciate the funding support from the Idaho-Eastern Oregon Onion Committee.

ONION RESPONSE TO OPTOGEN® (BICYCLOPYRONE) HERBICIDE RATE STARTING AT 1-LEAF STAGE

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Introduction

Optogen (bicyclopyrone) herbicide was recently registered for weed control in onion, garlic, and green onions. It is a group 27 herbicide marketed by Syngenta® under the trade name Optogen®. The current label for Optogen allows pre-emergence or directed-post-emergence applications only in row middles. Broadcast applications are not allowed because of the reported high injury to onions. The objective of this study was to evaluate the response of onion variety 'Granero' to Optogen herbicide applied starting when onions were at the 1-leaf post-directed (row middles) or post-emergence broadcast at various rates to onion plants at the 2-leaf stage.

Materials and Methods

A field experiment was conducted in 2023 at the Malheur Experiment Station to evaluate the response of direct-seeded onion variety 'Granero' to Optogen herbicide and weed control when applied at 0, 0.87, 1.75, 3.5, or 7 floz/a starting when onions were at the 1-leaf stage. The predominant soil was an Owyhee silt loam with a pH of 7.8 and 2.78% soil organic matter. The field was prepared the previous fall by flailing wheat stubble and irrigated. After drying, the field was disked, ripped, plowed, and groundhogged. Based on soil analysis, fertilizer was broadcast applied during fall 2022 at 50 lb N/acre, 100 lb P/acre, 40 lb S/acre, 100 lb elemental S/acre, 10 lb Zn/acre, and 10 lb Mn/acre. The field was fumigated using K-Pam at 12 gal/acre and beds were formed at 22-inch spacing.

The study area was sprayed with Roundup® at 1 qt/acre (1.13 lb ae/acre) on April 10, 2023 to control volunteer wheat. Beds were harrowed on April 11 and onion variety 'Granero' (Nunhems, Parma, ID) was seeded at about 125,000 seeds/acre (3.8 inches between seeds) on April 13, 2023. Onion seeds were planted in double rows spaced 3 inches apart on each 22-inch bed. The study area was sprayed with a tankmix of ProwlH2O at 32 fl oz/a plus Roundup® at 1 qt/acre (1.13 lb ae/acre) on April 28, 2023 to manage weeds prior to onion emergence (commonly known as 'delayed-preemergence'). Drip tape (with emitters spaced 8 inches apart and an emitter flow rate of 0.09 gallons per hour (0.22 gal/min/100 ft, Toro Aqua-Traxx, Toro Co., El Cajon, CA) was laid at 2-inch depth between each pair of beds on April 14. The distance between the tape and the center of each double row of onions was 11 inches.

The study had a randomized complete-block design with four replicates. Individual plots were 7.33 ft wide (4 beds) by 27 ft long. Herbicide treatments were applied using a CO_2-pressurized backpack sprayer fitted with a boom calibrated to deliver 20 gal/acre for delayed pre-emergence treatments and 30 gal/acre for post emergence treatments when onions were at 1- and 2-leaf stage. The study included an untreated control and a grower standard that received a delayed pre-emergence application of a tankmix of ProwlH20 32 floz/acre (pendimethalin 0.95 lb ai/acre) and glyphosate at 22 fl oz/acre (glyphosate 0.77 lb ae/acre).

Optogen (bicyclopyrone) treatments were applied on 5/16 (1-leaf timing) or 5/25 for the 2-leaf timing. In either timing, Optogen herbicide was applied at 0, 0.87, 1.75, 3.5 or 7 floz/a (bicyclopyrone 0.0114, 0.0228, 0.0455, 0.091 lb ai/acre), respectively, with the carrier volume at 30 gal/acre. Other treatments included tank-mixtures of Optogen 1.75, 3.5 or 7 floz/a plus Brox 2 EC at 8 floz/a. A grower standard comprised of Roundup 22 fl oz/acre + Prowl® H2O at 2 pt/acre (pendimethalin 0.95 lb ai/acre) and an untreated control were included. The complete list of treatments including application rates and timing are presented in tables 1-4 in this report. On May 18, the herbicide Poast® at 1.5 pt/acre (sethoxydim 0.287 lb ai/acre) plus COC at 1pt/a (0.41 % v/v) was sprayed to control grassy weeds. A tank-mixture of Brox® 2EC at 12 fl oz/acre (bromoxynil 0.188 lb ai/acre) plus GoalTender® at 4 fl oz/acre (oxyfluorfen 0.125 lb/ai acre) was applied when onion plants were at the 4-leaf stages (6/5/2023).

The number of plants in the two center beds were counted on May 22, 2023. In-season fertilizer was applied according to soil and tissue test results. Fertilizer was applied through drip irrigation on June 5, June 21, and July 13, 2023 to supply 50 lb N/acre on each incident.

Onion plants were sprayed with a suite of insecticide combinations on various dates as needed to control onion thrips. All other operations followed recommended local production practices for drip-irrigated onion.

Visible plant injury and weed control were assessed based on a scale of 0% (no onion injury or weed control) to 100% (complete onion plant killed or total weed control). Onion response to herbicide application timing and rate was assessed on 6/2 and 6/26/2023 (Table 1). Weeds within the two center beds of each plot were counted and hand-weeded (except for untreated plots) on 7/19.

The field was drip irrigated as needed from 5/11 to 8/14/2023. Plant tops were flailed on 8/31, and onion bulbs were lifted on 9/11/2023. Bulbs were hand harvested from 15 ft lengths of the two center beds in each plot on 9/18/2023, placed in burlap bags, and kept in the storage barn until graded. Bulbs were graded for yield and quality on 9/28 and 9/29, 2023 based on USDA standards as follows: bulbs without blemishes (U.S. No. 1), split bulbs (No. 2), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The U.S. No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Marketable yield consisted of U.S. No.1 bulbs greater than 2¼ inches in diameter.

After harvest, bulbs from a section of two center rows in each plot were rated for single centers on 10/10/2023. Twenty-five onion bulbs ranging in diameter from 3½ to 4¼ inches were rated. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing purposes if they were single centered (bullet) or had a small multiple center.

Data were subjected to analysis of variance and the treatment means were compared using protected LSD at the 0.05% level of confidence.

Results and Conclusions

In 2023, spring weather in the lower Treasure Valley was characterized by cool and wet conditions, which resulted in delayed onion seeding. Plant count on May 22 indicated plant population density ranging from 91,630 to 103,950 plants/acre across herbicide Optogen rates and timing treatments compared to 100,210 and 100,430 plants/acre for the untreated and grower standard, respectively (Figure 1). The average onion plant height on May 22 ranged from 6.9 to 7.4 inches/plant across Optogen treatments compared to 7.7 and 7.7 for the untreated control and grower standard, respectively (Figure 2).

Evaluations on 6/2 (17 days after Optogen application at 1-leaf stage) indicated visible injury at ≤8% across herbicide treatments (Table 1). Control for common lambsquarters was 84 to 96% for Optogen standalone treatments applied when onions were at the 1-leaf stage. Control in plots sprayed with tankmixes of Optogen plus Brox 2EC at 2-leaf stage was ≥ 90%. Similarly, control for hairy nightshade ranged from 93 to 100% control across herbicide treatments. On 6/26, visible plant injury was ≤ 5% for plants treated with Optogen 0.87 to 3.5 fl oz/a standalone or tankmixed with Brox 2EC at 4 fl oz/a at 1-leaf stage (Table 1). Plants treated with Optogen standalone at 7 fl oz/a at 1-leaf stage exhibited 39% injury. Similarly, a tankmixture of Optogen 3.5 fl oz/a plus Brox 2EC resulted in 29% injury. A tankmixture of Optogen 7 fl oz/a plus Brox 2EC at 8 floz/a at 2-leaf stage resulted in the greatest injury at 60%. These results suggested onion tolerance to Optogen applied at 1-leaf stage as long as the rate does not exceed 3.5 fl oz/a.

Weed counts and fresh plant biomass on 7/19 indicated almost complete control for common lambsquarters (≤2 weed/99 ft^2 with flesh weight of ≤1.08lb/99 ft^2), pigweed species (≤ 1 plant/99ft^2 and fresh plant biomass 0.29 lbs/99ft^2), and hairy nightshade ≤ 1 weed/99 ft^2 with flesh weight of ≤ 0.86 lb/99 ft^2), regardless of Optogen application rate timing (Table 2). These results suggest that Optogen applied at ≤ 3.5 fl oz/a to onion plants at 1-leaf stage followed by Brox 2EC and GoalTender at 4-leaf stage, could provide weed control similar to the grower standard of ProwlH2O delayed-PRE followed by Brox 2EC and GoalTender.

Onion yield for various bulb categories was similar across herbicide treatments, except for the jumbo size (Table 3). Overall marketable yield ranged from 636.6 to 1,007.5 cwt/a across Optogen treatments, with Optogen 7 fl oz/a plus Brox 2EC at 2-leaf stage resulting the lowest yield.

Bulb single centeredness is important to onion processors. The percentage of functionally single-centered bulbs (bullet plus small multiple center bulbs) ranged from 64 to 80% and was not affected by herbicide treatments (Table 4). Functional single centered bulbs was similar to the grower standard at 64%.

These results suggested improved weed control when Optogen was applied starting at the 1-leaf stage. Onion response to Optogen application on light textured soil is not known, but would likely result in higher injury than observed in the field where soil was predominantly silt loam. A follow up study to confirm these results will be conducted in 2024.

Acknowledgements

This project was funded by the Idaho-Eastern Oregon Onion Committee, cooperating chemical companies, Oregon State University, and the Malheur County Education Service District and supported by Formula Grant nos. 2023-31100-06041 and 2023-31200-06041 from the USDA National Institute of Food and Agriculture.

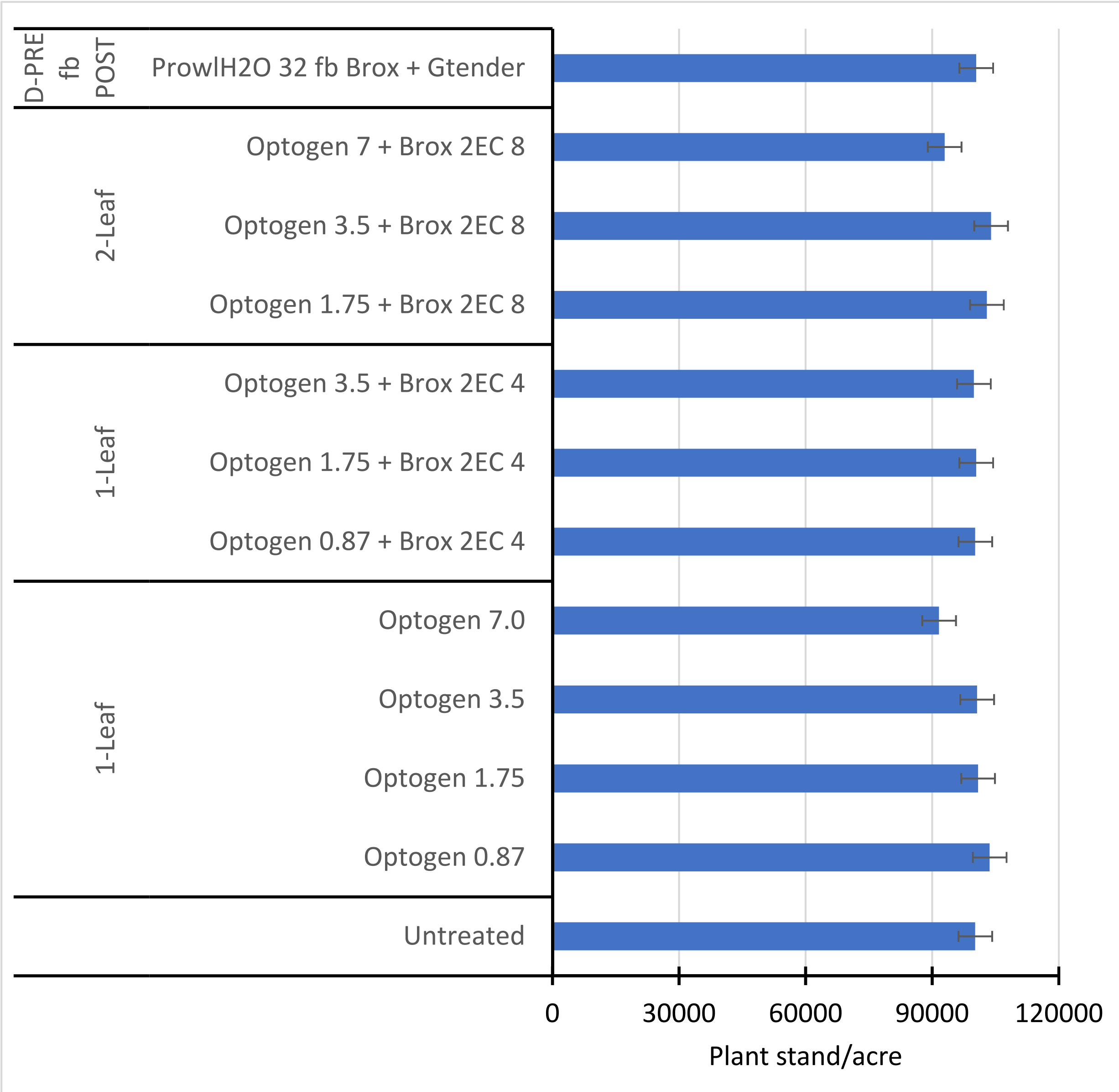

Figure 1. Onion plant stand/acre on 5/22/2023 in response to application of Optogen herbicide at various rates and timing to manage weeds at the Malheur Experiment Station, Ontario, OR 2023.

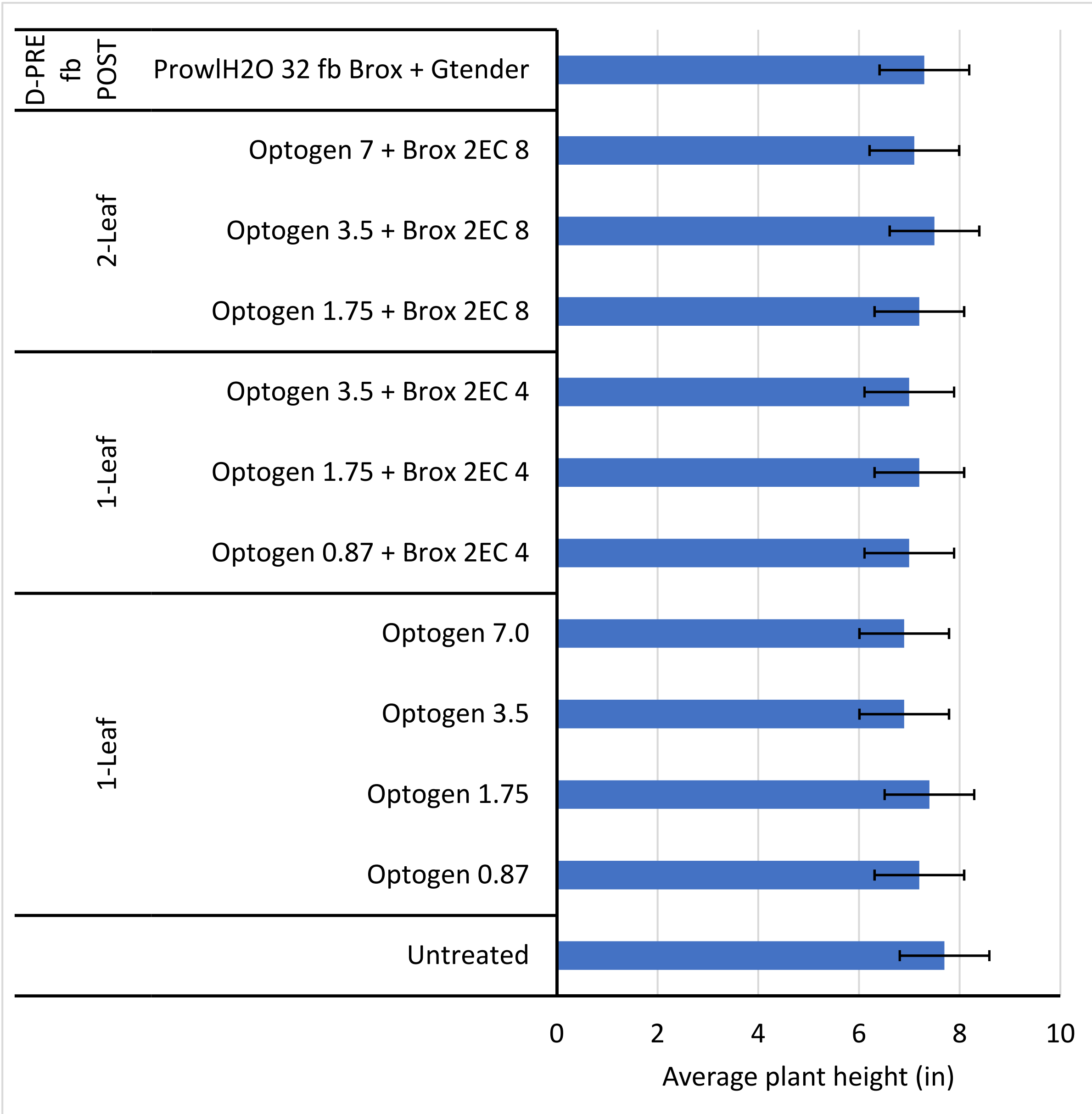

Figure 2. Average onion plant height (inches) on 6/20/2023 in response to application of Optogen herbicide at various rates and timing to manage weeds at the Malheur Experiment Station, Ontario, OR 2023.

Table 1. Onion injury on 6/2 and 6/26/2023 and weed control in response to broadcast application of Optogen (bicyclopyrone) herbicide to onion variety 'Granero' starting at 1-leaf stage at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1*]	Rate	Growth	Application	Onion Injury (6/2)	Weed control[2] Common lambsquarters	Pigweeds	Hairy nighjtshade	Onion Injury (6/26)
	fl oz/a	Stage	Description	%				
Untreated								
Optogen (bicyclopyrone)	0.87	1-Leaf	POST-BROADCAST 30 GPA	0 a	84 d	90 a	93 a	0 d
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	1.75	1-Leaf	POST-BROADCAST 30 GPA	0 a	93 bc	98 a	95 a	0 d
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	3.5	1-Leaf	POST-BROADCAST 30 GPA	3 a	90 cd	95 a	95 a	5 d
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	7	1-Leaf	POST-BROADCAST 30 GPA	4 a	96 abc	98 a	98 a	39 ab
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	0.87	1-Leaf	POST-BROADCAST 30 GPA	6 a	100 a	100 a	100 a	0 d
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	1.75	1-Leaf	POST-BROADCAST 30 GPA	5 a	100 a	100 a	100 a	5 d
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	3.5	1-Leaf	POST-BROADCAST 30 GPA	8 a	100 a	100 a	100 a	29 bc
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O	32	DPRE	DELAYED-PRE 20 GPA	0 a	100 a	100 a	100 a	0 d
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Optogen (bicyclopyrone)	1.75	2-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O	32	DPRE	DELAYED-PRE 20 GPA	0 a	99 ab	100 a	100 a	16 cd
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Optogen (bicyclopyrone)	3.5	2-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O	32	DPRE	DELAYED-PRE 20 GPA	0 a	100 a	100 a	100 a	60 a
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Optogen (bicyclopyrone)	7	2-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O (Grower std)	32	DPRE	DELAYED-PRE 20 GPA	0 a	100 a	100 a	100 a	0 d
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Brox 2EC	12	2&4-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2&4-Leaf	POST-BROADCAST 30 GPA					
LSD (P=0.05)				NS	7.4	NS	NS	21.4

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre). ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, *Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre) was applied at 4-leaf stage, GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.

[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 2. Weed count and fresh weight on 7/19/2023 in response to application of Optogen (bicyclopyrone) herbicide broadcast at various rates starting at 1-leaf stage to manage weeds in onion variety 'Granero' at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Rate	Growth	Application	C lambsquarters		pigweeds		Hairy nightshade		Smartweed		Total	
				Number	weight	Number	weight	Number	weight	Number	weight	weeds	weight
	fl oz/a	Stage	Description	99/ft^2									
Untreated control				74 a	28.46 a	272a	133.90a	941a	828.88a	149a	154.44a	1,436a	1,145.7a
Optogen (bicyclopyrone)	0.87	1-Leaf	POST- 30 GPA	2 b	1.08 a	1b	0.05b	1b	0.83b	0b	0.00b	3b	2.0b
Brox 2EC	8	2-Leaf	POST- 30 GPA										
GoalTender	4	2-Leaf	POST- 30 GPA										
Optogen (bicyclopyrone)	1.75	1-Leaf	POST- 30 GPA	2 b	0.67 a	1b	0.11b	1b	0.44b	0b	0.00b	4b	1.2b
Brox 2EC	8	2-Leaf	POST- 30 GPA										
GoalTender	4	2-Leaf	POST- 30 GPA										
Optogen (bicyclopyrone)	3.5	1-Leaf	POST- 30 GPA	1 b	0.13 a	1b	0.01b	0b	0.00b	0b	0.00b	1b	0.1b
Brox 2EC	8	2-Leaf	POST- 30 GPA										
GoalTender	4	2-Leaf	POST- 30 GPA										
Optogen (bicyclopyrone)	7	1-Leaf	POST- 30 GPA	1 b	0.26 a	0b	0.00b	1b	0.26b	0b	0.00b	2b	0.5b
Brox 2EC	8	2-Leaf	POST- 30 GPA										
GoalTender	4	2-Leaf	POST- 30 GPA										
Optogen (bicyclopyrone)	0.87	1-Leaf	POST- 30 GPA	0 b	0.09 a	0b	0.00b	0b	0.00b	0b	0.00b	0b	0.1b
Brox 2EC	4	1-Leaf	POST- 30 GPA										
Brox 2EC	8	2-Leaf	POST- 30 GPA										
GoalTender	4	2-Leaf	POST- 30 GPA										
Optogen (bicyclopyrone)	1.75	1-Leaf	POST- 30 GPA	0 b	0.00 a	0b	0.00b	0b	0.00b	0b	0.00b	0b	0.0b
Brox 2EC	4	1-Leaf	POST- 30 GPA										
Brox 2EC	8	2-Leaf	POST- 30 GPA										
GoalTender	4	2-Leaf	POST- 30 GPA										
Optogen (bicyclopyrone)	3.5	1-Leaf	POST- 30 GPA	0 b	0.00 a	0b	0.00b	0b	0.00b	0b	0.00b	0b	0.0b
Brox 2EC	4	1-Leaf	POST- 30 GPA										
Brox 2EC	8	2-Leaf	POST- 30 GPA										
GoalTender	4	2-Leaf	POST- 30 GPA										
Prowl H2O	32	DPRE	D-PRE 20 GPA	0 b	0.00 a	1b	0.04b	0b	0.00b	0b	0.00b	1b	0.0b
Optogen (bicyclopyrone)	1.75	2-Leaf	POST- 30 GPA										
Brox 2EC	8	2-Leaf	POST- 30 GPA										
ProwlH2O	32	DPRE	D-PRE 20 GPA	0 b	0.00 a	1b	0.24b	0b	0.00b	0b	0.00b	1b	0.2b
Roundup PowerMax	32	DPRE	D-PRE 20 GPA										
Ammonium Sulfate	96	DPRE	D-PRE 20 GPA										
Optogen (bicyclopyrone)	3.5	2-Leaf	POST- 30 GPA										
Brox 2EC	8	2-Leaf	POST- 30 GPA										
ProwlH2O	32	DPRE	D-PRE 20 GPA	0 b	0.05 a	2b	0.29b	0b	0.00b	0b	0.00b	2b	0.3b
Optogen (bicyclopyrone)	7	2-Leaf	POST- 30 GPA										
Brox 2EC	8	2-Leaf	POST- 30 GPA										
ProwlH2O (Grower std)	32	DPRE	D-PRE 20 GPA	0 b	0.00 a	0b	0.00b	0b	0.00b	0b	0.00b	0b	0.0b
Brox 2EC	12	2&4-Leaf	POST- 30 GPA										
GoalTender	4	2&4-Leaf	POST- 30 GPA										
LSD (P=0.05)				39.4	19.86	91.7	38.82	462.4	181.9	53.3	63.4	595.4	157.7

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), and 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre). ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, *Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre) was applied at 4-leaf stage, GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.
[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 3. Onion yield (cwt/acre) in response to application of Optogen (bicyclopyrone) herbicide directed- or broadcast applied at various rates to manage weeds in onion variety 'Granero' at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Rate	Growth	Application	US NO.2	Small	Marketable Medium	Jumbo	Colossal	S Colossal	Total	percent Marketable
	fl oz/a	Stage	Description	CWT/A[2]							%
Optogen (bicyclopyrone)	0.87	1-Leaf	POST-BROADCAST 30 GPA	0.0b	12.0a	40.1a	628.0a	306.6a	32.8a	1,007.5a	98.8a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA								
Optogen (bicyclopyrone)	1.75	1-Leaf	POST-BROADCAST 30 GPA	0.0b	5.7a	33.2a	514.6abc	373.2a	49.2a	970.0a	99.4a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA								
Optogen (bicyclopyrone)	3.5	1-Leaf	POST-BROADCAST 30 GPA	4.0a	5.3a	33.2a	456.1bcd	380.7a	100.8a	970.8a	99.0a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA								
Optogen (bicyclopyrone)	7	1-Leaf	POST-BROADCAST 30 GPA	0.0b	14.1a	51.9a	407.0cd	320.6a	99.6a	879.1a	98.4a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA								
Optogen (bicyclopyrone)	0.87	1-Leaf	POST-BROADCAST 30 GPA	1.9ab	7.8a	27.4a	498.9abc	346.2a	64.0a	936.4a	99.0a
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA								
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA								
Optogen (bicyclopyrone)	1.75	1-Leaf	POST-BROADCAST 30 GPA	0.0b	5.9a	45.2a	551.1abc	309.0a	44.1a	949.4a	99.4a
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA								
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA								
Optogen (bicyclopyrone)	3.5	1-Leaf	POST-BROADCAST 30 GPA	0.0b	9.4a	38.2a	408.6cd	303.6a	92.6a	843.1a	98.8a
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA								
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA								
Prowl H2O	32	DPRE	DELAYED-PRE 20 GPA	0.0b	6.9a	43.8a	481.6bc	278.4a	123.2a	927.0a	99.3a
Optogen (bicyclopyrone)	1.75	2-Leaf	POST-BROADCAST 30 GPA								
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
ProwlH2O	32	DPRE	DELAYED-PRE 20 GPA	3.1a	5.8a	48.1a	500.5abc	352.8a	59.1a	960.5a	99.1a
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA								
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA								
Optogen (bicyclopyrone)	3.5	2-Leaf	POST-BROADCAST 30 GPA								
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
ProwlH2O	32	DPRE	DELAYED-PRE 20 GPA	0.0b	11.2a	74.4a	315.7d	183.9a	62.5a	636.6b	97.9a
Optogen (bicyclopyrone)	7	2-Leaf	POST-BROADCAST 30 GPA								
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA								
ProwlH2O (Grower std)	32	DPRE	DELAYED-PRE 20 GPA	0.0b	8.5a	52.6a	583.1ab	315.4a	35.7a	986.9a	99.2a
Brox 2EC	12	2&4-Leaf	POST-BROADCAST 30 GPA								
GoalTender	4	2&4-Leaf	POST-BROADCAST 30 GPA								
LSD (P=0.05)				2.9	9.2	30.3	144.1	108.4	64.7	176.3	1.2

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), and 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre). ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, *Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre) was applied at 4-leaf stage, GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.
[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 4. Single and multiple center bulb rating (10/10/2023) in response to application of Optogen (bicyclopyrone) herbicide to onion variety 'Granero' starting at 1-leaf stage at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1*]	Rate	Growth	Application	Multiple centers[2,3] Large	Medium	Small	Single center[4] Bullet	Functional
	fl oz/a	Stage	Description	%				
Untreated								
Optogen (bicyclopyrone)	0.87	1-Leaf	POST-BROADCAST 30 GPA	7a	15a	28a	50a	78a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	1.75	1-Leaf	POST-BROADCAST 30 GPA	10a	25a	25a	40a	65a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	3.5	1-Leaf	POST-BROADCAST 30 GPA	9a	21a	25a	45a	70a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	7	1-Leaf	POST-BROADCAST 30 GPA	15a	16a	23a	46a	69a
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	0.87	1-Leaf	POST-BROADCAST 30 GPA	12a	28a	27a	33a	60a
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	1.75	1-Leaf	POST-BROADCAST 30 GPA	9a	21a	20a	50a	70a
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Optogen (bicyclopyrone)	3.5	1-Leaf	POST-BROADCAST 30 GPA	10a	26a	26a	38a	64a
Brox 2EC	4	1-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O	32	DPRE	DELAYED-PRE 20 GPA	6a	26a	20a	48a	68a
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Optogen (bicyclopyrone)	1.75	2-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O	32	DPRE	DELAYED-PRE 20 GPA	1a	22a	29a	48a	77a
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Optogen (bicyclopyrone)	3.5	2-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O	32	DPRE	DELAYED-PRE 20 GPA	8a	12a	19a	61a	80a
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Optogen (bicyclopyrone)	7	2-Leaf	POST-BROADCAST 30 GPA					
Brox 2EC	8	2-Leaf	POST-BROADCAST 30 GPA					
Prowl H2O (Grower std)	32	DPRE	DELAYED-PRE 20 GPA	13a	23a	25a	39a	64a
Roundup PowerMax	32	DPRE	DELAYED-PRE 20 GPA					
Ammonium Sulfate	96	DPRE	DELAYED-PRE 20 GPA					
Brox 2EC	12	2&4-Leaf	POST-BROADCAST 30 GPA					
GoalTender	4	2&4-Leaf	POST-BROADCAST 30 GPA					
LSD (P=0.05)				NS	NS	NS	NS	NS

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), and 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre). ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, *Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre) was applied at 4-leaf stage, GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.

[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

[3]Multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters <1½ inches, medium had diameters 1½ to 2¼ inches, and large had diameters >2¼ inches.

[4]"Functionally single centered" is composed of bullet and small multiple center.

ONION RESPONSE TO OPTOGEN® (BICYCLOPYRONE) HERBICIDE APPLIED POST-DIRECTED or POST-BROADCAST

Joel Felix and Joey Ishida, Malheur Experiment Station, Oregon State University, Ontario, OR

Introduction

Recently, Optogen (bicyclopyrone) herbicide received registration for weed control in onion, garlic, and green onions. It is a group 27 herbicide marketed by Syngenta® under the trade name Optogen®. The current label for Optogen allows pre-emergence or directed-post-emergence applications only in row middles. Broadcast applications are not allowed because of the reported high injury to onions. The objective of this study was to evaluate the response of onion variety 'Granero' to Optogen herbicide applied post-directed (row middles) or post-emergence broadcast at various rates to onion plants at the 2-leaf stage.

Materials and Methods

A field study was established during spring 2023 at the Malheur Experiment Station to evaluate the response of direct-seeded onion variety 'Granero' to bicyclopyrone herbicide and the level of weed control when applied PRE or Delayed-PRE at various application rates. The predominant soil was an Owyhee silt loam with a pH of 7.8 and 2.78% soil organic matter. The field was prepared the previous fall by flailing wheat stubble and irrigated. After drying, the field was disked, ripped, plowed, and groundhogged. Based on soil analysis, fertilizer was broadcast applied during fall 2022 at 50 lb N/acre, 100 lb P/acre, 40 lb S/acre, 100 lb elemental S/acre, 10 lb Zn/acre, and 10 lb Mn/acre. The field was fumigated using K-Pam at 12 gal/acre and beds were formed at 22-inch spacing.

The study area was sprayed with Roundup® at 1 qt/acre (1.13 lb ae/acre) on April 10, 2023 to control volunteer wheat. Beds were harrowed on April 11 and onion variety 'Granero' (Nunhems, Parma, ID) was seeded at about 125,000 seeds/acre (3.8 inches between seeds) on April 13, 2023. Onion seeds were planted in double rows spaced 3 inches apart on each 22-inch bed. All treatments (except the untreated control) were sprayed with a tankmix of ProwlH2O at 32 fl oz/a plus Roundup® at 1 qt/acre (1.13 lb ae/acre) on April 28, 2023 to manage weeds prior to onion emergence (commonly known as 'delayed-preemergence'). Drip tape (with emitters spaced 8 inches apart and an emitter flow rate of 0.09 gallons per hour (0.22 gal/min/100 ft, Toro Aqua-Traxx, Toro Co., El Cajon, CA) was laid at 2-inch depth between each pair of beds on April 14. The distance between the tape and the center of each double row of onions was 11 inches.

The study had a randomized complete-block design with four replicates. Individual plots were 7.33 ft wide (4 beds) by 27 ft long. Herbicide treatments were applied using a CO_2-pressurized backpack sprayer fitted with a boom calibrated to deliver 20 gal/acre for delayed pre-emergence treatments, while all post-emergence treatments were applied at 30 gal/acre. The study included an untreated control and a grower standard that received a delayed pre-emergence application of a tankmix of ProwlH20 32 floz/acre (pendimethalin 0.95 lb ai/acre) and glyphosate at 22 fl oz/acre (glyphosate 0.77 lb ae/acre).

Post emergence Optogen (bicyclopyrone) treatments were applied when onion plants were at the 2-leaf stage 5/25/2023. Optogen herbicide was applied at 0, 0.87, 1.75, 3.5 or 7 fl oz/a (bicyclopyrone 0.0114, 0.0228, 0.0455, 0.091 lb ai/acre), respectively. Other treatments included tank-mixtures of Optogen 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/a) plus Brox 2 EC at 8 fl oz/a (bromoxynil 0.125 lb ai/acre) or Optogen 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/a) plus bromoxynil 0.125 lb ai/acre). The complete list of treatments including application rates and timing are presented in tables 1-4 in this report. A grower standard comprised of Roundup 22 fl oz/acre + Prowl® H2O at 2 pt/acre (pendimethalin 0.95 lb ai/a) and an untreated control were included. The complete list of treatments including application rates and timing are presented in tables 1-3 in this report. On May 18, the herbicide Poast® at 1.5 pt/acre (sethoxydim 0.287 lb ai/acre) plus COC at 1pt/a (0.41 % v/v) was sprayed to control grassy weeds. A tank-mixture of Brox® 2EC at 12 fl oz/a (bromoxynil 0.188 lb ai/acre) plus GoalTender® at 4 fl oz/acre (oxyfluorfen 0.125 lb/ai a) was applied when onion plants were at the 4-leaf stage (6/5/ 2023).

The number of plants in the two center beds were counted on June 9, 2023. In-season fertilizer was applied according to soil and tissue test results. Fertilizer was applied through drip irrigation on June 5, June 21, and July 13, 2023 to supply 50 lb N/acre on each incident.

Onion plants were sprayed with a suite of insecticide combinations on various dates as needed to control onion thrips. All other operations followed recommended local production practices for drip-irrigated onion.

Visible plant injury and weed control were assessed based on a scale of 0% (no onion injury or weed control) to 100% (complete onion plant killed or total weed control). Onion response to herbicide application timing and rate was assessed on 6/2 and 6/26/2023 (Table 1). Weeds within the two center beds of each plot were counted and hand-weeded (except for untreated plots) on 7/19.

The field was drip irrigated as needed from 5/11 to 8/14/2023. Plant tops were flailed on 8/31, and onion bulbs were lifted on 9/11/2023. Bulbs were hand harvested from 15 ft lengths of the two center beds in each plot on 9/18/2023, placed in burlap bags, and kept in the storage barn until graded. Bulbs were graded for yield and quality on 9/28 and 9/29, 2023 based on USDA standards as follows: bulbs without blemishes (U.S. No. 1), split bulbs (No. 2), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The U.S. No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Marketable yield consisted of U.S. No.1 bulbs greater than 2¼ inches in diameter.

After harvest, bulbs from a section of two center rows in each plot were rated for single centers on 10/12/2023. Twenty-five onion bulbs ranging in diameter from 3½ to 4¼ inches were rated for single centeredness. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing purposes if they were single centered (bullet) or had a small multiple center.

Data were subjected to analysis of variance and the treatment means were compared using protected LSD at the 0.05% level of confidence.

Results and Conclusions

Weather conditions in the lower Treasure Valley during spring 2023 was characterized by cool and wet, which resulted in delayed onion seeding. Evaluations on June 2 (7 days after Optogen application), indicated variability in plant stand across herbicide treatments (Figure 1). Plant density ranged from 97,218 to 120,582 plants/acre across Optogen rates, compared to 114,444 plants/acre for the grower standard.

Evaluation on 6/2/2023 (8 days after 2-leaf application) indicated no visible onion injury (data not shown). Weed control on 6/2 was similar for Optogen directed- and broadcast applied treatments (Table 1). Control for common lambsquarters ranged from 96 to 100% across herbicide treatments. Pigweed species and hairy nightshade were controlled ≥ 85%, and common purslane at ≥ 71% across herbicide treatments. Evaluations on 6/26/2023 indicated ≤ 3% injury across Optogen directed sprayed treatments at ≤3.5 fl oz/acre, compared to 10% when applied for Optogen at 7 fl oz/acre, which is 2x the recommended rate. Onion injury was relatively greater when Optogen was broadcast applied at the rates indicated above (Table 1). The injury was characterized by bleached newer leaves, chlorosis and stunting particularly at the 7 fl oz/acre application rate. These results suggested that onions could tolerate application of Optogen as directed or broadcast at rates ≤ 3.5 floz/acre. Rainy conditions after herbicide application may have contributed to lack of onion injury.

Weed counts on 7/19 indicated complete control for common lambsquarters (data not shown). The number of pigweed species ranged from 0 to 6 plant/99ft^2 across Optogen rates and application type (Table 2). These results suggest that Optogen directed- or broadcat applied at the label recommended rate of 3.5 fl oz/a (depending on soil texture) followed by Brox 2EC and GoalTender at 4-leaf stage, could provide weed control similar to the grower standard of ProwlH2O delayed-PRE followed by Brox 2EC and GoalTender.

Onion yield was statistically similar across herbicide treatments (Table 3). Marketable yield ranged from 958.7 to 1,093.1 for Optogen 0.87 to 7 fl oz/a directed sprayed, compared to 857.1 to 1,056.2 cwt/a with broadcast applied treatments and 1,030 cwt/a for the grower standard. The yield was 1,019.7 cwt/a for a tank-mixture of Optogen 1.75 fl oz/a plus Brox 2EC at 8 fl oz/a. Marketable yield only varied across treatments for the medium grade bulbs.

Bulbs were evaluated for single centeredness, which is an important character to onion processors. The percentage of functionally single-centered bulbs (bullet plus small multiple center bulbs) was similar and ranged from 60 to 90% across herbicide treatments (Table 4).

These results suggested improved weed control when Optogen was direct- or broadcast applied up to 3.5 fl oz/a. The results suggested that any attempt to apply Optogen at rates greater than recommended on the label, would result in crop injury early in the season that would eventually culminate in reduced yield. Onion response to Optogen application on light textured soil is not known, but would likely result in higher injury than observed in the field where soil was predominantly silt loam. A follow up study to confirm these results will be conducted in 2024.

Acknowledgements

This project was funded by the Idaho-Eastern Oregon Onion Committee, cooperating chemical companies, Oregon State University, and the Malheur County Education Service District and supported by Formula Grant nos. 2023-31100-06041 and 2023-31200-06041 from the USDA National Institute of Food and Agriculture.

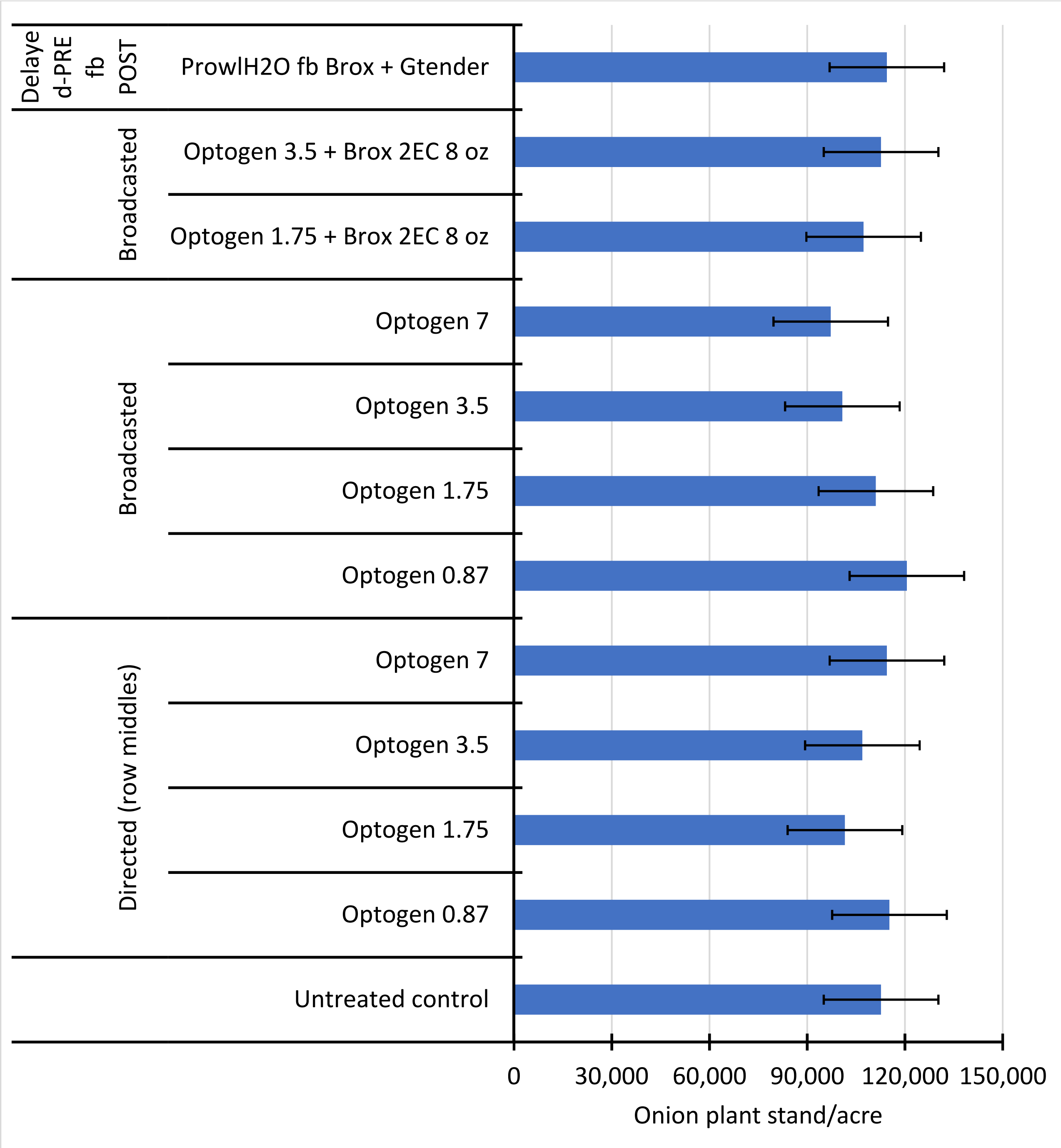

Figure 1. Plant stand on June 9 in a study to evaluate onion response and weed control with Optogen herbicide applied at various rates at the Malheur Experiment Station, Ontario, OR 2023.

Table 1. Weed control on June 2, 2023 in with the application of Optogen (bicyclopyrone) herbicide at various rates as POST-directed or broadcast sprayed to onion variety ‘Vaquero’ at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Form Conc lb ai/gal	Rate floz/a	Growth stage	POST Spray type	Common lambsquarters	Pigweeds	Hairy nightshade	Common purslane	Injury 6/26/203
					------------	------------ %[2]	------------	------------	------------
Untreated	--	--	--	---	---- ---	---- ---	---- ----	--- ---	--- ---
Prowl H2O	3.8	32	DPRE		96 a	94 a	93 a	90 a	0 d
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	0.87	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		98 a	96 a	88 a	95 a	3 d
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	1.75	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		96 a	96 a	89 a	90 a	1 d
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	3.5	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		93 a	91 a	88 a	85 a	10 bcd
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	7	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		96 a	85 a	85 a	81 a	0 d
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	0.87	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		99 a	98 a	88 a	71 a	5 cd
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	1.75	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		100 a	100 a	96 a	95 a	15 bc
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	3.5	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		100 a	100 a	95 a	96 a	75 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	7	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		100 a	100 a	100 a	98 a	3 d
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	1.75	2-Leaf	Broadcast					
Brox 2EC	2	8	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		100 a	100 a	100 a	100 a	19 b
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	3.5	2-Leaf	Broadcast					
Brox 2EC	2	8	2-Leaf	Broadcast					
Prowl H2O (Grower standard)	3.8	32	DPRE		100 a	100 a	100 a	99 a	0 d
Roundup PowerMax	4.5*	32	DPRE						
Ammonium Sulfate	100%	96	DPRE						
Brox 2EC	2	12	2&4-Leaf	Broadcast					
GoalTender	4	4	2&4-Leaf	Broadcast					
LSD (P=0.05)					NS	NS	NS	NS	12

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre), ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), *Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, COC=Crop Oil Concentrate, Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre), GoalTender 4 floz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.
[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 2. Weed count on 7/19/2023 (53 days after Optogen and 24 after the last herbicide application) at various rates rates as POST-directed or broadcast sprayed to manage weeds in onion variety 'Vaquero' at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Form Conc lb ai/gal	Rate floz/a	Growth stage	POST Spray type	Pigweeds No./99ft[2]	Pigweeds weight lbs/99ft[2]	Total weeds No./99ft[2]	Total weight lbs/99ft[2]
Untreated	--	--	--	---	---- ---	---- ---	---- ----	--- ---
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen	3.8 4.5 100 1.67	32 32 96 0.87	DPRE DPRE DPRE 2-Leaf	Directed	1 a	0.10 a	2 a	0.1 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen	3.8 4.5 100 1.67	32 32 96 1.75	DPRE DPRE DPRE 2-Leaf	Directed	1 a	0.05 a	1 a	0.1 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen	3.8 4.5 100 1.67	32 32 96 3.5	DPRE DPRE DPRE 2-Leaf	Directed	1 a	0.03 a	1 a	0.0 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen	3.8 4.5 100 1.67	32 32 96 7	DPRE DPRE DPRE 2-Leaf	Directed	3 a	0.73 a	3 a	0.7 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen	3.8 4.5 100 1.67	32 32 96 0.87	DPRE DPRE DPRE 2-Leaf	Broadcast	6 a	0.55 a	6 a	0.6 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen	3.8 4.5 100 1.67	32 32 96 1.75	DPRE DPRE DPRE 2-Leaf	Broadcast	3 a	0.42 a	4 a	0.4 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen	3.8 4.5 100 1.67	32 32 96 3.5	DPRE DPRE DPRE 2-Leaf	Broadcast	1 a	0.04 a	1 a	0.0 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen Prowl H2O	3.8 4.5 100 1.67 3.8	32 32 96 7 32	DPRE DPRE DPRE 2-Leaf DPRE	Broadcast	2 a	0.04 a	2 a	0.0 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen Brox 2EC	3.8 4.5 100 1.67 2	32 32 96 1.75 8	DPRE DPRE DPRE 2-Leaf 2-Leaf	Broadcast Broadcast	0 a	0.01 a	0 a	0.0 a
Prowl H2O Roundup PowerMax Ammonium Sulfate Optogen Brox 2EC	3.8 4.5 100 1.67 2	32 32 96 3.5 8	DPRE DPRE DPRE 2-Leaf 2-Leaf	Broadcast Broadcast	0 a	0.00 a	0 a	0.0 a
Prowl H2O (Grower standard) Roundup PowerMax Ammonium Sulfate Brox 2EC GoalTender	3.8 4.5* 100% 2 4	32 32 96 12 4	DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	Broadcast Broadcast	1 a	0.07 a	1 a	0.1 a
LSD (P=0.05)					NS	NS	NS	NS

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre), ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), *Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, COC=Crop Oil Concentrate, Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre), GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.
[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 3. Onion yield (cwt/acre) in response to application of Optogen (bicyclopyrone) herbicide directed- or broadcast applied at various rates to manage weeds in onion variety ‘Granero’ at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Form.[2] Conc.	Rate	Growth stage	POST Type[3]	US No. 2	Small	Marketable yield by grade[3] 2¼-3 in	3-4 in	4-4¼ in	>4¼ in	Total	Percent Marketable Yield
	lb ai/Gal	fl oz/a			cwt/A							
Untreated				--	0-	0-	0-	0-	0-	0-	0-	0-
Prowl H2O	3.8	32	DPRE		0.0 a	0.0 c	0.0 b	0.0 b	0.0 b	0.0 a	0.0 b	0.0 b
Roundup PowerMax	4.5	32	DPRE		0.0 a	2.7 bc	42.7 ab	610.3 a	313.6 a	126.5 a	1,093.1 a	99.0 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	0.87	2-Leaf	Directed								
Prowl H2O	3.8	32	DPRE									
Roundup PowerMax	4.5	32	DPRE		4.4 a	8.6 abc	37.9 ab	512.2 a	327.3 a	81.8 a	959.1 a	96.4 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	1.75	2-Leaf	Directed								
Prowl H2O	3.8	32	DPRE									
Roundup PowerMax	4.5	32	DPRE		7.8 a	10.1 abc	29.7 ab	480.1 a	351.4 a	145.7 a	1,006.9 a	95.8 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	3.5	2-Leaf	Directed								
Prowl H2O	3.8	32	DPRE									
Roundup PowerMax	4.5	32	DPRE		2.9 a	14.8 abc	42.7 ab	601.6 a	259.5 a	54.9 a	958.7 a	94.5 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	7	2-Leaf	Directed								
Prowl H2O	3.8	32	DPRE									
Roundup PowerMax	4.5	32	DPRE		1.3 a	9.9 abc	62.7 a	643.1 a	283.8 a	66.6 a	1,056.2 a	96.7 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	0.87	2-Leaf	Broadcast								
Prowl H2O	3.8	32	DPRE									
Roundup PowerMax	4.5	32	DPRE		0.0 a	10.5 abc	51.8 a	588.0 a	247.5 a	47.6 a	935.0 a	96.1 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	1.75	2-Leaf	Broadcast								
Prowl H2O	3.8	32	DPRE									
Roundup PowerMax	4.5	32	DPRE		3.3 a	10.7 abc	28.9 ab	423.4 a	361.7 a	116.0 a	930.0 a	94.2 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	3.5	2-Leaf	Broadcast								
Prowl H2O	3.8	32	DPRE									
Roundup PowerMax	4.5	32	DPRE		2.2 a	22.9 a	65.0 a	416.4 a	273.2 a	102.4 a	857.1 a	90.4 a
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	7	2-Leaf									
Prowl H2O	3.8	32	DPRE	Broadcast								
Prowl H2O	3.8	32	DPRE		2.9 a	7.4 bc	46.2 a	504.7 a	334.0 a	134.8 a	1,019.7 a	97.0 a
Roundup PowerMax	4.5	32	DPRE									
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	1.75	2-Leaf	Broadcast								
Brox 2EC	2	8	2-Leaf	Broadcast								
Prowl H2O	3.8	32	DPRE		5.2 a	16.3 ab	53.3 a	565.3 a	254.3 a	92.0 a	964.9 a	93.0 a
Roundup PowerMax	4.5	32	DPRE									
Ammonium Sulfate	100	96	DPRE									
Optogen	1.67	3.5	2-Leaf	Broadcast								
Brox 2EC	2	8	2-Leaf	Broadcast								
Prowl H2O (Grower standard)	3.8	32	DPRE		1.9 a	9.7 abc	47.4 a	595.2 a	321.2 a	66.2 a	1,030.0 a	96.9 a
Roundup PowerMax	4.5*	32	DPRE									
Ammonium Sulfate	100%	96	DPRE									
Brox 2EC	2	12	2&4-Leaf	Broadcast								
GoalTender	4	4	2&4-Leaf	Broadcast								
LSD (P=0.05)					11.8	15.14	45.63	237.38	147.9	153.67	277.85	5.88

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre), ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), *Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, COC=Crop Oil Concentrate, Brox 2EC 12 floz/a (bromoxynil 0.187 lb ai/acre), GoalTender 4 floz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.

[2]Form. Conc. = formulation concentration

[3]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 4. Single and multiple center bulb rating in response to application of Optogen (bicyclopyrone) herbicide rates and directed- or broadcast sprayed to onion variety ‘Vaquero’ at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Form Conc lb ai/gal	Rate floz/a	Growth stage	Spray type	Multiple centers[2,3] Large	Multiple centers[2,3] Medium	Multiple centers[2,3] Small	Single center[2,3,4] Bullet	Single center[2,3,4] Functional
					----------	----------	%	----------	----------
Untreated									
Prowl H2O	3.8	32	DPRE		6 a	12 a	32 ab	50 a	75 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	0.87	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		9 a	21 a	21 b	49 a	74 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	1.75	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		13 a	10 a	32 ab	45 a	70 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	3.5	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		8 a	17 a	22 b	53 a	77 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	7	2-Leaf	Directed					
Prowl H2O	3.8	32	DPRE		8 a	13 a	44 a	35 a	60 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	0.87	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		7 a	22 a	20 b	51 a	76 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	1.75	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		5 a	13 a	30 ab	52 a	77 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	3.5	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		8 a	12 a	15 b	65 a	90 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	7	2-Leaf						
Prowl H2O	3.8	32	DPRE	Broadcast					
Prowl H2O	3.8	32	DPRE		9 a	20 a	31 ab	40 a	65 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	1.75	2-Leaf	Broadcast					
Brox 2EC	2	8	2-Leaf	Broadcast					
Prowl H2O	3.8	32	DPRE		7 a	20 a	26 ab	47 a	72 a
Roundup PowerMax	4.5	32	DPRE						
Ammonium Sulfate	100	96	DPRE						
Optogen	1.67	3.5	2-Leaf	Broadcast					
Brox 2EC	2	8	2-Leaf	Broadcast					
Prowl H2O (Grower standard)	3.8	32	DPRE		9 a	26 a	22 b	43 a	68 a
Roundup PowerMax	4.5*	32	DPRE						
Ammonium Sulfate	100%	96	DPRE						
Brox 2EC	2	12	2&4-Leaf	Broadcast					
GoalTender	4	4	2&4-Leaf	Broadcast					
LSD (P=0.05)					NS	NS	20.8	NS	NS

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 floz/a (bicyclopyrone 0.091 lb ai/acre), ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), *Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, COC=Crop Oil Concentrate, Brox 2EC 12 floz/a (bromoxynil 0.187 lb ai/acre), GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.
[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).
[3]Multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters <1½ inches, medium had diameters 1½ to 2¼ inches, and large had diameters >2¼ inches.
[4]“Functionally single centered" is composed of bullet and small multiple center.

ONION RESPONSE TO OPTOGEN® (BICYCLOPYRONE) HERBICIDE APPLIED PRE- or DELAYED PREEMERGENCE

Joel Felix and Joey Ishida, Malheur Experiment Station, Oregon State University, Ontario, OR

Introduction

There are very few herbicides that could safely be applied to onion to manage weeds before onions reach the 2-leaf stage. Recently, Optogen (bicyclopyrone) herbicide was registered for weed control in onion, garlic, and green onions. It is marketed by Syngenta® under the trade name Optogen®. The current label for Optogen allows pre-emergence or directed-post-emergence applications only in row middles. Broadcast applications are not allowed because of high injury to onions. The objective of this study was to evaluate the response of onion variety 'Granero' to Optogen herbicide broadcast applied pre-emergence (PRE) or delayed-preemergence (DPRE).

Materials and Methods

A field study was established during spring 2023 at the Malheur Experiment Station to evaluate the response of direct-seeded onion variety 'Granero' to Optogen herbicide and the level of weed control when applied PRE or Delayed-PRE at various application rates. The predominant soil was an Owyhee silt loam with a pH of 7.8 and 2.78% soil organic matter. The field was prepared the previous fall by flailing wheat stubble and irrigated. After drying, the field was disked, ripped, plowed, and groundhogged. Based on soil analysis, fertilizer was broadcast applied during fall 2022 at 50 lb N/acre, 100 lb P/acre, 40 lb S/acre, 100 lb elemental S/acre, 10 lb Zn/acre, and 10 lb Mn/acre. The field was fumigated using K-Pam at 12 gal/acre and beds were formed at 22-inch spacing.

The study area was sprayed with Roundup® at 1 qt/acre (1.13 lb ae/acre) on April 10, 2023 to control all emerged weed prior to establishing the study. Beds were harrowed on April 11 and onion variety 'Granero' (Nunhems, Parma, ID) was seeded at about 125,000 seeds/acre (3.8 inches between seeds) on April 13, 2023. Onion seeds were planted in double rows spaced 3 inches apart on each 22-inch bed. Drip tape (with emitters spaced 8 inches apart and an emitter flow rate of 0.09 gallons per hour (0.22 gal/min/100 ft, Toro Aqua-Traxx, Toro Co., El Cajon, CA) was laid at 2-inch depth between each pair of beds on April 14. The distance between the tape and the center of each double row of onions was 11 inches.

The study had a randomized complete-block design with four replicates. Individual plots were 7.33 ft wide (4 beds) by 27 ft long. Herbicide treatments were applied using a CO_2-pressurized backpack sprayer fitted with a boom calibrated to deliver 20 gal/acre for PRE- and delayed pre-emergence treatments and 30 gal/acre for post emergence timing. The study included an untreated control and a grower standard that received a delayed pre-emergence application of a tankmix of ProwlH20 32 floz/acre (pendimethalin 0.95 lb ai/acre) and glyphosate at 22 fl oz/acre (glyphosate 0.77 lb ae/acre).

Optogen (bicyclopyrone) treatments were broadcast applied PRE on April 17 or delayed pre-emergence (DPRE) on April 28, 2023. In either timing, Optogen herbicide was applied at 0, 0.87, 1.75, 3.5 or 7 fl oz/a (bicyclopyrone 0.0114, 0.0228, 0.0455, 0.091 lb ai/acre), respectively. Other treatments included tank-mixtures of Optogen 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/a) plus ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre) or Optogen 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/a) plus ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre). A grower standard comprised of Roundup 22 fl oz/acre + Prowl® H2O at 2 pt/acre (pendimethalin 0.95 lb ai/acre) and an untreated control were included. The complete list of treatments including application rates and timing are presented in tables 1-4 in this report. On May 18, the herbicide Poast® at 1.5 pt/acre (sethoxydim 0.287 lb ai/acre) plus COC at 1pt/a (0.41 % v/v) was sprayed to control grassy weeds. A tank-mixture of Brox® 2EC at 12 fl oz/acre (bromoxynil 0.188 lb ai/acre) plus GoalTender® at 4 fl oz/acre (oxyfluorfen 0.125 lb/ai acre) was applied when onion plants were at the 2- and 4-leaf stages (May 23 and June 5, 2023).

The number of plants in the two center beds were counted on June 9, 2023. In-season fertilizer was applied according to soil and tissue test results. Fertilizer was applied through drip irrigation on June 5, June 21, and July 13, 2023 to supply 50 lb N/acre on each incident.

Onion plants were sprayed with a suite of insecticide combinations on various dates as needed to control onion thrips. All other operations followed recommended local production practices for drip-irrigated onion.

Visible plant injury and weed control were assessed based on a scale of 0% (no onion injury or weed control) to 100% (complete onion plant killed or total weed control). Onion response to herbicide application timing and rate was assessed on May 23 and June 6, 2023 (Table 1). Plots were hand-weeded (except for untreated plots) on July 22, 2022.

The field was drip irrigated from May 11 to August 14, 2023. Plant tops were flailed on August 31, and onion bulbs were lifted on September 11, 2023. Bulbs were hand harvested from 15 ft lengths of the two center beds in each plot on September 18, 2023, placed in burlap bags, and kept in the storage barn until graded. Bulbs were graded for yield and quality on September 28 based on USDA standards as follows: bulbs without blemishes (U.S. No. 1), split bulbs (No. 2), bulbs infected with the fungus *Botrytis allii* in the neck or side, bulbs infected with the fungus *Fusarium oxysporum* (plate rot), bulbs infected with the fungus *Aspergillus niger* (black mold), and bulbs infected with unidentified bacteria in the external scales. The U.S. No. 1 bulbs were graded according to diameter: small (<2¼ inches), medium (2¼–3 inches), jumbo (3–4 inches), colossal (4–4¼ inches), and super colossal (>4¼ inches). Marketable yield consisted of U.S. No.1 bulbs greater than 2¼ inches in diameter.

After harvest, bulbs from a section of two center rows in each plot were rated for single centers on October 10, 2023. Twenty-five onion bulbs ranging in diameter from 3½ to 4¼ inches were rated. The onions were cut equatorially through the bulb middle and separated into single-centered (bullet) and multiple-centered bulbs. The multiple-centered bulbs had the long axis of the inside diameter of the first single ring measured. These multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters less than 1½ inches, medium had diameters from 1½ to 2¼ inches, and large had diameters greater than 2¼ inches. Onions were considered "functionally single centered" for processing purposes if they were single centered (bullet) or had a small multiple center.

Data were subjected to analysis of variance and the treatment means were compared using protected LSD at the 0.05% level of confidence.

Results and Conclusions

In 2023, spring weather conditions in the lower Treasure Valley were characterized by cool and wet, which resulted in delayed onion seeding. Plant count on May 22 indicated differences in plant population density among treatments and ranged from 53,020 to 115,500 plants/acre across Optogen treatments, compared to 108,130 and 120,340 plants/acre for the grower standard and untreated control, respectively (Figure 1). Pre-emergence applied Optogn at at 1.75 to 7 fl oz/acre resulted in reduced plants stand, but not when it was applied delayed pre-emergence at the same rates. Plant height ranged from 6.6 inches/plant to 7.3 inches/plant, with plants sprayed with Optogen at 7 fl oz/acre being the shortest (Figure 2).

Evaluation on June 20 (15 days after the last herbicide application) indicated visible injury of ≤ 9% for plants treated with Optogen ≤ 3.5 fl oz/a and 70% for 7 fl oz/acre, which is 2x the recommended use rate (data not shown). The injury was characterized by bleached growing point, with some plants lacking the flag part of the leaf. Plant injury was ≤ 3% for post emergence treatments (data not shown).

Weed counts on July 6 indicated almost complete control for common lambsquarters (≤1 weed/99 ft^2 with flesh weight of ≤0.48 lb/99 ft^2), regardless of Optogen application timing (Table 1). However, PRE application of Optogen at 0.87 fl oz/a resulted in 50 weed/99 ft^2. The number of pigweed species ranged from 0 to 1 plant/99ft^2 across Optogen rates applied PRE, compared to 0 to 12 plants/99ft^2 when Optogen was applied delayed-preemergence. The low rate of Optogen, 0.87 fl oz/a, resulted in reduced hairy nightshade control at 28- and 29 plants/99ft^2 when applied PRE and Delayed-PRE respectively. Optogen at 1.75 to 7 fl oz/a provided ≤8 plants/99ft^2, which was similar to the grower standard (Table 1). Control for smartweed was ≤ 4 plants/99ft^2 regardless of application timing or rate. These results suggest that Optogen applied PRE or delayed-PRE at the label recommended rate of 3.5 fl oz/a (depending on soil texture) followed by Brox 2EC and GoalTender at 2- and 4-leaf stage, could provide weed control similar to the grower standard of ProwlH2O delayed-PRE followed by Brox 2EC and GoalTender.

Onion yield varied across herbicide treatments (Table 2). Marketable yield ranged from 846.3 to 925.7 cwt/a for Optogen 0.87 to 3.5 fl oz/a applied PRE, compared to 969.1 to 1,000.1 cwt/a with delayed-PRE and 1,051.6 cwt/a for the grower standard. Pre-emergence or Delayed-PRE, application at 7 fl oz/acre resulted in the lowest yield at 529.9 cwt/a and 787.1 cwt/a, respectively. Onion yield reflected the plant stand and the level of early weed control.

Bulb single centeredness is important to onion processors. The percentage of functionally single-centered bulbs (bullet plus small multiple center bulbs) varied slightly across herbicide treatments (Table 3). Functional single centered bulbs comprised 69 to 77% when Optogen was applied PRE, 70.7 to 76% across delayed-PRE treatments, compared to 84% for the grower standard.

These results suggested improved weed control when Optogen was broadcast applied PRE or delayed-PRE up to 3.5 fl oz/a. Any attempt to apply Optogen at rates greater than recommended, would result in crop injury early in the season that would eventually culminate in reduced yield. Onion response to Optogen application on light textured soil is not known, but would likely result in higher injury than observed in the field where soil was predominantly silt loam. A follow up study to confirm these results will be conducted in 2024.

Acknowledgements

This project was funded by the Idaho-Eastern Oregon Onion Committee, cooperating chemical companies, Oregon State University, and the Malheur County Education Service District and supported by Formula Grant nos. 2023-31100-06041 and 2023-31200-06041 from the USDA National Institute of Food and Agriculture.

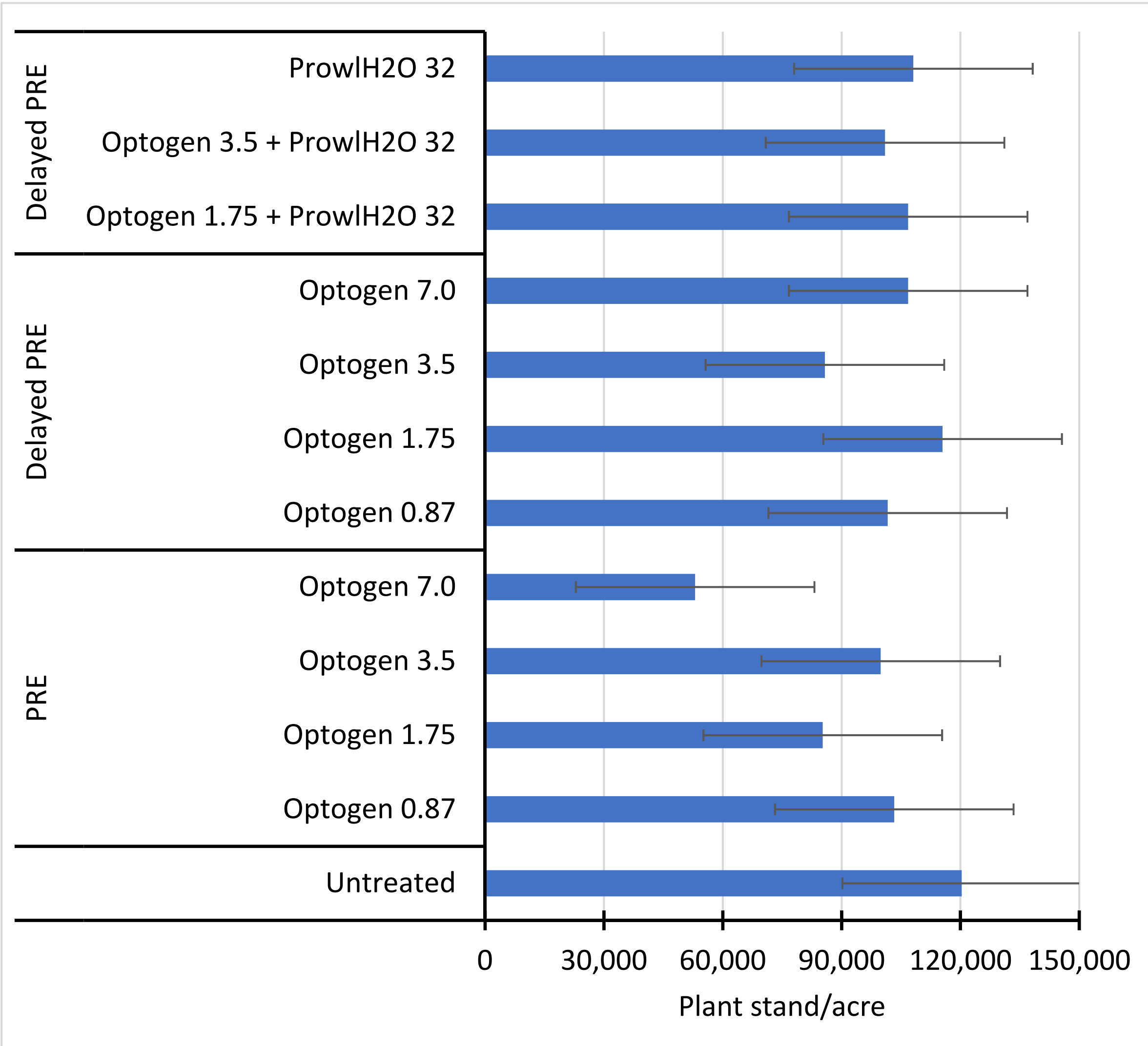

Figure 1. Onion plant stand/acre on 5/22/2023 in response to application of Optogen herbicide at various rates and timing to manage weeds at the Malheur Experiment Station, Ontario, OR 2023.

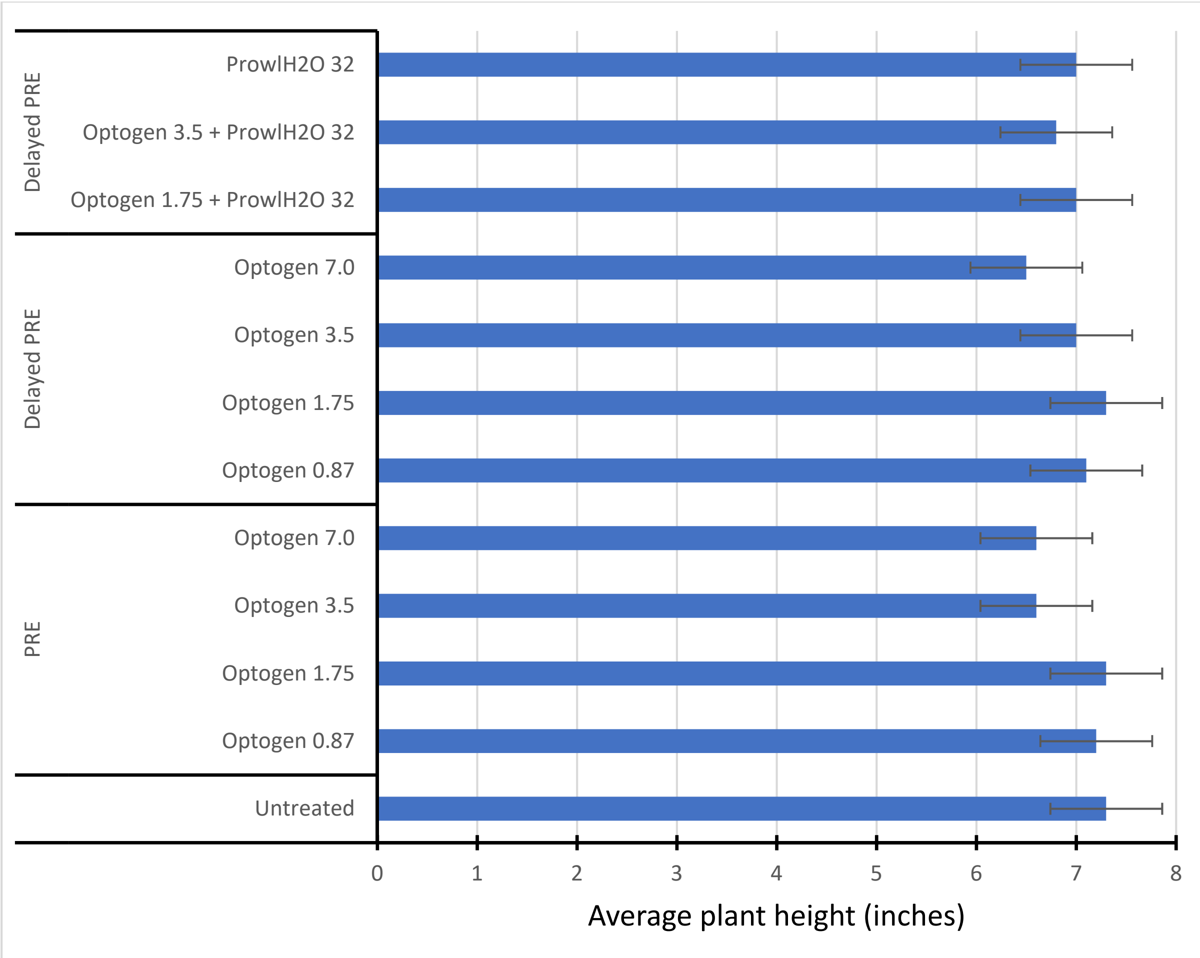

Figure 2. Average onion plant height (inches) on 5/22/2023 in response to application of Optogen herbicide at various rates and timing to manage weeds at the Malheur Experiment Station, Ontario, OR 2023.

Table 1. Number and fresh weight of weeds/99ft^2 on July 6 in response to application of bicyclopyrone pre- or delayed pre-emergence followed by post-emergence application of Brox 2EC and GoalTender in direct-seeded onion variety 'Granero' at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Form.[2] Conc.	Rate	Growth stage	Application	Common lambsquarters Number	Common lambsquarters Weight (lbs)	Pigweeds Number	Pigweeds Weight (lbs)	Hairy nightshade Number	Hairy nightshade Weight (lbs)	Smartweed Number	Smartweed Weight (lbs)	Total weeds Number	Total weeds Weight (lbs)
	lb ai/Gal	fl oz/a		date	Number or fresh weight/99ft^2									
Untreated				--	75 -	261.00 -	373 -	452.18 -	991 -	231.41 -	25 -	3.71 -	1,464	948.3
Optogen (bicyclopyrone)	1.67	0.87	PREPRE	4/17	50 b	0.21 b	1 b	0.99 b	28 a	18.19 a	4 a	1.17 a	34 a	20.6 a
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	1.75	PREPRE	3/28	0 a	0.00 b	1 b	2.66 b	2 ab	3.13 b	0 b	0.14 b	53 a	5.9 b
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	3.5	PREPRE	4/17	1 b	0.48 ab	1 b	2.52 b	0 b	0.00 b	2 ab	0.26 ab	3 a	3.3 b
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	7	PREPRE	4/17	0 b	0.10 b	0 b	0.00 b	0 b	0.00 b	1 ab	0.22 b	1 a	0.3 b
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	0.87	DPRE	4/28	1 b	0.58 ab	12 a	7.35 a	29 a	8.9 a	3 ab	0.89 ab	34 a	12.3 ab
COC	100%	38.4	DPRE	4/28										
Class Act NG (AMS)	50.5%	82	DPRE	4/28										
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	1.75	DPRE	4/28	1 b	0.87 a	4 b	7.38 a	8 ab	2.92 b	1 ab	0.12 b	13 a	11.3 ab
COC	100%	38.4	DPRE	4/28										
Class Act NG (AMS)	50.5%	82	DPRE	4/28										
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	3.5	DPRE	4/28	1 b	0.26 b	3 b	3.08 b	3 ab	1.13 ab	1 ab	0.10 b	5 a	9.9 ab
COC	100%	38.4	DPRE	4/28										
Class Act NG (AMS)	50.5%	82	DPRE	4/28										
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	7	DPRE	4/28	0 b	0.00 b	0 b	0.18 b	3 ab	1.32 b	1 ab	0.06 b	4 a	1.6 b
COC	100%	38.4	DPRE											
Class Act NG (AMS)	50.5%	82	DPRE											
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	1.75	DPRE	4/28	0 b	0.03 b	1 b	0.02 b	0 b	0.00 b	0 b	0.00 b	1 a	0.0 b
Prowl H2O	3.8	32	DPRE	4/28										
COC	100%	38.4	DPRE	4/28										
Class Act NG (AMS)	50.5%	82	DPRE	4/28										
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Optogen (bicyclopyrone)	1.67	3.5	DPRE	4/28	0 b	0.01 b	0 b	0.03 b	0 b	0.00 b	0 b	0.00 b	1 a	0.0 b
Prowl H2O	3.8	32	DPRE	4/28										
COC	100%	38.4	DPRE	4/28										
Class Act NG (AMS)	50.5%	82	DPRE	4/28										
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-Leaf	5/23 & 6/5										
Prowl H2O (Grower standard)	3.8	32	DPRE	4/28	0 b	0.02 b	1 b	0.09 b	0 b	0.00 b	0 b	0.00 b	2 a	0.1 b
Roundup PowerMax	4.5*	32	DPRE	4/28										
Brox 2EC	2	12	2&4-6Leaf	5/23 & 6/5										
GoalTender	4	4	2&4-6Leaf	5/23 & 6/5										
LSD (P=0.05)					43.2	0.59	6.1	4.17	27.2	12.45	3.3	0.95	52.6	13.0

[1]Optogen 0.87 floz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 floz/a (bicyclopyrone 0.091 lb ai/acre), ProwlH2O 32 floz/a (pendimethalin 0.98 lb ai/acre), *Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, COC=Crop Oil Concentrate, Brox 2EC 12 floz/a (bromoxynil 0.187 lb ai/acre), GoalTender 4 floz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.

[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 2. Onion yield (cwt/acre) in response to application of bicyclopyrone herbicide at pre- or delayed-preemergence at various rates to manage weeds in onion variety 'Granero' at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Form.[2] Conc.	Rate	Growth stage	Application	US No. 2	Small	Marketable yield by grade[3] 2¼-3 in	3-4 in	4-4¼ in	>4¼ in	Total	Percent Marketable Yield
	lb ai/Gal	fl oz/a			cwt/A							
Untreated				--	0-	0-	0-	0-	0-	0-	0-	0-
Optogen (bicyclopyrone)	1.67	0.87	PREPRE	4/17	4.1ab	12.8abc	104.4a	524.0abc	195.2b	22.7b	846.3ab	98.0ab
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	1.75	PREPRE	3/28	8.1a	13.0abc	54.8bcd	505.8abc	286.9ab	78.2ab	925.7ab	97.7ab
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	3.5	PREPRE	4/17	1.4ab	15.0ab	57.6bcd	469.2bc	257.1ab	82.7ab	866.6ab	98.1ab
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	7	PREPRE	4/17	3.5ab	6.9c	24.3d	168.2d	191.3b	146.1a	529.9c	97.9ab
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	0.87	DPRE	4/28	0.0b	13.1abc	94.0ab	605.6ab	255.5ab	34.3b	989.3ab	98.7ab
COC	100%	38.4	DPRE	4/28								
Class Act NG (AMS)	50.5%	82	DPRE	4/28								
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	1.75	DPRE	4/28	0.0b	10.8abc	67.1abc	598.3abc	272.3ab	62.4ab	1,000.1ab	98.9a
COC	100%	38.4	DPRE	4/28								
Class Act NG (AMS)	50.5%	82	DPRE	4/28								
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	3.5	DPRE	4/28	0.0b	17.5a	44.3cd	438.0c	336.6a	150.3a	969.1ab	98.3ab
COC	100%	38.4	DPRE	4/28								
Class Act NG (AMS)	50.5%	82	DPRE	4/28								
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	7	DPRE	4/28	1.7ab	14.4abc	57.0bcd	452.9bc	185.8b	91.4ab	787.1b	97.8b
COC	100%	38.4	DPRE									
Class Act NG (AMS)	50.5%	82	DPRE									
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	1.75	DPRE	4/28	1.6ab	14.2abc	63.9a-d	633.6a	209.2ab	22.5b	929.2ab	98.3ab
Prowl H2O	3.8	32	DPRE	4/28								
COC	100%	38.4	DPRE	4/28								
Class Act NG (AMS)	50.5%	82	DPRE	4/28								
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Optogen (bicyclopyrone)	1.67	3.5	DPRE	4/28	1.8ab	12.4abc	59.3bcd	574.9abc	292.8ab	94.7ab	1,021.7a	98.6ab
Prowl H2O	3.8	32	DPRE	4/28								
COC	100%	38.4	DPRE	4/28								
Class Act NG (AMS)	50.5%	82	DPRE	4/28								
Brox 2EC	2	12	2&4-Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-Leaf	5/23 & 6/5								
Prowl H2O (Grower standard)	3.8	32	DPRE	4/28	3.4ab	8.4bc	44.1cd	640.5a	282.3ab	84.7ab	1,051.6a	98.9a
Roundup PowerMax	4.5*	32	DPRE	4/28								
Brox 2EC	2	12	2&4-6Leaf	5/23 & 6/5								
GoalTender	4	4	2&4-6Leaf	5/23 & 6/5								
LSD (P=0.05)					6.8	8.1	40.9	161.0	130.5	106.0	224.6	1.4

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 fl oz/a (bicyclopyrone 0.091 lb ai/acre), ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), *Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, COC=Crop Oil Concentrate, Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre), GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis.

[2]Form. Conc. = formulation concentration

[3]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).

Table 3. Single and multiple center bulb rating in response to application of bicyclopyrone herbicide rates prior to onion variety 'Vaquero' emergence at the Malheur Experiment Station, Oregon State University, Ontario, OR 2023.

Treatment[1]	Form Conc lb ai/gal	Rate fl oz/a	Growth stage	Multiple centers[2,3,4] Large	Multiple centers[2,3,4] Medium	Multiple centers[2,3,4] Small	Single center[2,3,4] Bullet	Single center[2,3,4] Functional
				%				
Untreated								
Optogen (bicyclopyrone) Brox 2EC GoalTender	1.67 2 4	0.87 12 4	PRE 2&4-Leaf 2&4-Leaf	7.0 abc	16.3 a	20.2 ab	56.5 a	76.7 ab
Optogen (bicyclopyrone) Brox 2EC GoalTender	1.67 2 4	1.75 12 4	PRE 2&4-Leaf 2&4-Leaf	12.0 ab	16.0 a	24.0 ab	48.0 a	72.0 ab
Optogen (bicyclopyrone) Brox 2EC GoalTender	1.67 2 4	3.5 12 4	PRE 2&4-Leaf 2&4-Leaf	13.0 ab	18.0 a	25.0 ab	44.0 a	69.0 b
Optogen (bicyclopyrone) Brox 2EC GoalTender	1.67 2 4	7 12 4	PREPRE 2&4-Leaf 2&4-Leaf	14.0 ab	9.0 a	24.0 ab	53.0 a	77.0 ab
Optogen (bicyclopyrone) COC Class Act NG (AMS) Brox 2EC GoalTender	1.67 100% 50.5% 2 4	0.87 38.4 82 12 4	DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	16.0 a	13.3 a	26.1 ab	44.6 a	70.7 ab
Optogen (bicyclopyrone) COC Class Act NG (AMS) Brox 2EC GoalTender	1.67 100% 50.5% 2 4	1.75 38.4 82 12 4	DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	14.0 ab	13.0 a	26.0 ab	47.0 a	73.0 ab
Optogen (bicyclopyrone) COC Class Act NG (AMS) Brox 2EC GoalTender	1.67 100% 50.5% 2 4	3.5 38.4 82 12 4	DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	10.0 abc	14.0 a	18.0 b	58.0 a	76.0 ab
Optogen (bicyclopyrone) COC Class Act NG (AMS) Brox 2EC GoalTender	1.67 100% 50.5% 2 4	7 38.4 82 12 4	DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	7.0 abc	20.0 a	25.0 ab	48.0 a	73.0 ab
Optogen (bicyclopyrone) Prowl H2O COC Class Act NG (AMS) Brox 2EC GoalTender	1.67 3.8 100% 50.5% 2 4	1.75 32 38.4 82 12 4	DPRE DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	2.0 c	14.0 a	31.0 a	53.0 a	84.0 a
Optogen (bicyclopyrone) Prowl H2O COC Class Act NG (AMS) Brox 2EC GoalTender	1.67 3.8 100% 50.5% 2 4	3.5 32 38.4 82 12 4	DPRE DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	12.0 ab	11.0 a	23.0 ab	54.0 a	77.0 ab
Prowl H2O (Grower standard) Roundup PowerMax Ammonium Sulfate Brox 2EC GoalTender	3.8 4.5* 100% 2 4	32 32 96 12 4	DPRE DPRE DPRE 2&4-Leaf 2&4-Leaf	5.0 bc	11.0 a	26.0 ab	58.0 a	84.0 a
LSD (P=0.05)				9.6	NS	11.9	NS	14.1

[1]Optogen 0.87 fl oz/a (bicyclopyrone 0.0114 lb ai/acre), 1.75 fl oz/a (bicyclopyrone 0.0228 lb ai/acre), 3.5 fl oz/a (bicyclopyrone 0.0455 lb ai/acre), 7.0 fl oz/a (bicyclopyro ne 0.091 lb ai/acre), ProwlH2O 32 fl oz/a (pendimethalin 0.98 lb ai/acre), *Roundup PowerMax 32 fl oz/acre = glyphosate 1.13 lb ae/acre, COC=Crop Oil Concentrate, Brox 2EC 12 fl oz/a (bromoxynil 0.187 lb ai/acre), GoalTender 4 fl oz/a (oxyfluorfen 0.125 lb ai/acre. The untreated control was not included in statistical analysis. PRE=Pre emergence; DPRE=delayed pre emergence.
[2]Means within a column followed by the same letter are not significantly different (P = 0.05, LSD).
[3]Multiple-centered onions were ranked according to the inside diameter of the first entire single ring: small had diameters <1½ inches, medium had diameters 1½ to 2¼ inches, and large had diameters >2¼ inches.
[4]"Functionally single centered" is composed of bullet and small multiple center.

Long Term Storage of Onion Cultivars
2022/2023 Report

Mike Thornton, Ransey Portenier and Oksana Morgan
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Background

The Treasure Valley region of Western Idaho and Eastern Oregon supplies approximately 40% of the winter storage onions in the U.S. Processing accounts for a significant portion of crop usage. Extending the current storage season beyond May would increase the acreage of local onions that could be grown for processing. However, there is currently no information available on onion cultivars that have resistance to common onion decay pathogens, and thus potential for extended storage life. This study was designed to evaluate new onion cultivars under cold storage conditions to see if they could be kept until late spring. Both Vaquero and Crockett have been included as industry standards in every year of the trial since 2007.

Methods

Onion bulbs of 13 yellow onion cultivars consisting of commercial and pre-commercial lines, were collected from research trials at the Parma Research Center in the fall of 2022. The 13 entries were grown from direct seeding on March 22. Prior to harvest, the plants were treated with an application of Royal MH-30 at labeled rate. At harvest, 250 lbs. of Jumbo-sized onions were collected, and the samples were split into five 50-lb replicates.

Bulbs were lifted on 02 September, mechanically topped, and harvested on 13 September. After an initial period of ambient curing, the samples were placed in a controlled temperature room and held at 36^{o}F after mid-October. Hobo recorders placed in the room indicated that temperatures fluctuated by no more than 2 degrees, while relative humidity fluctuated between 70 and 90%.

On 23 June 2023 all 13 cultivars samples were removed from storage and evaluated for external decay, translucent scale, internal decay, and sprouting. If a bulb had both sprouting and decay, it was scored for decay. Bulbs that were sprouted, but not decayed were considered usable. External decay was scored as "marketable" if it only impacted the outer rings that would normally be removed during processing. Bulbs scored as unmarketable and had external decay that was too extensive to be removed during processing. All bulbs were sliced through the center to determine the level of internal decay and translucent scale.

Data were analyzed by ANOVA using the SAS statistical program. When the F-test was significant, means were separated using LSD at the 5% level.

Results

Both checks Vaquero and Crockett had over 80% marketable bulbs, while 10 of 11 pre-commercial lines showed above 85% (Table 1) Almonzoro performed the best in the percentage marketable bulbs category (96%). Oloroso exhibited the lowest percentage of marketable bulbs (72%) due to high incidence of translucent scale (20%). Hatchet and OLYS-1550 showed the highest over 10% internal decay. All lines, except Trident, did not exhibit more than 1% sprouting.

Summary

Vaquero, the industry standard, had over 80% marketable bulbs, which is below the long-term average for this cultivar. Meanwhile Crockett showed over 90%.

The proportion of marketable bulbs in 2022 was moderately influenced by both internal decay and translucent scale.

Most of hard x Spanish crosses continue to perform well after 9 months of cold storage.

Table 1. Incidence of external decay, internal decay, translucent scale and sprouting of 13 direct-seeded yellow onion cultivars on June 23, 2023, after long term cold storage at 36ºF. Values are means of five replications.

Cultivar	Good bulbs		External unusable		External usable		Internal decay		Sprouted		Translucent		Non-decayed	
Vaquero	83.8	d	0.0		0.0		7.6	bc	0.3	b	8.3	b	92.4	de
Epic	90.4	bc	0.2		0.0		2.4	fg	0.0	b	6.9	b	97.4	ab
Crusher	94.0	ab	0.0		0.0		3.2	efg	0.4	b	2.4	c	96.8	abc
Trident	89.2	bc	0.1		0.3		6.2	cde	2.2	a	2.3	c	93.4	bcd
Almonzoro	95.8	a	0.0		0.0		2.3	fg	0.8	b	1.3	c	97.7	a
Crockett	94.2	ab	0.4		0.4		4.3	c-g	0.0	b	0.7	c	94.9	a-d
Oloroso	72.4	e	0.0		0.3		7.2	cd	0.3	b	19.9	a	92.5	de
Campero	85.6	cd	0.2		0.2		3.8	dpg	0.6	b	9.5	b	95.8	a-d
Glorioso	93.0	ab	0.0		0.2		6.8	cde	0.0	b	0.2	c	93.0	cd
SVNV1672	91.0	ab	0.0		0.6		5.8	c-f	0.2	b	2.4	c	93.6	bcd
Hatchet	80.8	d	0.2		0.0		11.1	ab	0.2	b	8.3	b	88.7	ef
OLYX13-331	91.8	ab	0.0		0.2		1.6	g	0.0	b	6.2	b	98.1	a
OLYS-1550	85.4	cd	0.0		1.3		13.1	a	0.0	b	0.3	c	85.5	f
LSD	**5.34**		**ns**		**ns**		**3.71**		**1.14**		**3.38**		**4.02**	
F-test	**<0.0001**		**0.4163**		**0.3174**		**<0.0001**		**0.0265**		**<0.0001**		**<0.0001**	

*Means followed by the same letter are not significantly different by Fishers Protected LSD (0.05). NS = not significant.

Stunting and stand loss in drip-irrigated onions - 2023

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Background

During 2021 and 2022, we documented differences in total yield and bulb size between the inner row adjacent to the drip line compared to the outer row. The inner row next to the tape experienced wetter and slightly colder soil conditions compared to the outer row. The inner row also experienced less compaction (poorer seed – soil contact), and more disease development; all of which may contribute to the stunting observed in the inner row. During 2023 we evaluated a series of three treatments to see if warming the seed row, firming the soil for better seed-soil contact, or shorter irrigation sets can alleviate the stunting and yield loss in onions closest to the drip tape.

Procedures:

Objective 1. Determine if soil conditions can be modified to warm and firm the zone where onion seeds germinate to promote more rapid early plant development and reduce stand loss. Also evaluate drip tape emitter volume as a way provide more uniform moisture and temperature conditions across the bed.

The experiment was conducted at the Parma Research and Extension Center in Parma, ID with the yellow onion cultivar Vaquero (BASF-Nunhems Seeds) in a field previously cropped with wheat. Individual plots were six rows wide (11 ft.) by 20 ft. long randomly assigned to four replications across the field. Onions were planted April 13 in double rows centered 16-inch apart, on 44-inch beds, with 3.5-inch in-row seed spacing. All herbicides and fertilizers were applied according to University of Idaho guidelines. The field was irrigated to maintain 65-70% soil moisture using a drip irrigation system.

The following four treatments were established at planting:

1. Check – Traditional planting and irrigation practices.
2. Soil warming – Pelleted biochar applied over the inner seed row.
3. Soil firming – Use of a packing wheel to firm the soil around the seed.
4. High flow drip tape – Increase tape output from current 0.25 gpm/100ft to 0.34 gpm/100ft to allow for faster movement of the wetting front.

The soil warming treatment was accomplished applying pelleted biochar by hand over a 2-inch strip covering the inner onion row. The rate of biochar was 367 grams per 20 feet of row, which is equivalent to 961 lbs/acre. The soil firming treatment was applied by running a sod roller filled with water (100 lbs total weight) over each bed on April 15 (2 days after planting). The high flow drip tape was installed with the onion planter at the same depth and location as used for the standard output tape. After the first irrigation to set the wetting front, the irrigation duration was reduced by 1/3rd so that the total amount of water applied in the standard and high output tape was the same.

Soil temperature.

A single measurement of surface soil temperature was taken with a FLIR infrared camera attachment at 11:30 am on April 18 (5 days after planting). This provided a visual comparison of the soil temperature in the biochar treated row with the temperature in the outer row that did not receive biochar.

Row compaction.
Soil compaction was measured in the inner and outer row using a SC900 Soil Compaction Meter (Spectrum Technologies, Inc, Aurora, IL). This instrument takes readings of soil resistance (pounds per square inch (psi) basis) in one-inch increments to a depth of 8 inches. Compaction measurements were taken on April 20 at eight locations per row in each of the check and soil firming treatment plots. The data from all eight locations were averaged and then analyzed as means of 3-inch increments to represent shallow (0-2 inch), mid (3-5 inch) and deep (6-8 inch) soil depths.

Plant stunting and final stand.
Plant development was evaluated on August 8. A sample of 25 plants from the inner row and 25 plants from the outer row of each plot were removed and total plant fresh weight (foliage and bulbs) was measured at that time to determine the extent of stunting.

Final plant stands were determined by counting the number of bulbs in the inner and outer rows of each plot at final harvest on September 18.

Bulb yield and grade.
Onions were lifted on September 5 and harvested on September 18. Bulbs from a 5-foot section of the middle bed were separated by inner and outer row, counted, and then graded according to standard practices. Average bulb weight was calculated by dividing the total weight of bulbs per plot by the number of harvested bulbs and was expressed on an ounces per bulb basis.

Objective 2. Determine if conditions within the onion bed interact with pink root disease pressure to influence the extent of stunting, stand loss, yield and bulb size.
The trial was conducted in the same field and using the same treatments and experimental design as outlined for objective 1 (i.e. 6 rows x 20 feet replicated 4 times). A section of the field that was fumigated in the fall of 2022 with 4 gal/acre of Strike 100CP was compared to a non-fumigated section in an effort to understand what role disease may be playing in reducing growth of onions located along the inside row.

Root health.
Root health was evaluated on August 8 by destructively harvesting 25 plants from the inner row and 25 plants from the outer row of each plot. Plants were removed with a shovel to preserve the root mass and classified by the proportion of pink root infected roots on a scale of 0 to 3 where: 0= no pink roots; 1= <10% roots pink; 2= 10-50% roots pink; and 3= >50% of roots pink. The pink root rating is the total score for all bulbs in the sample divided by 25.

Plant development.
Plant development was evaluated on August 8 as outlined for objective 1.

Bulb yield and grade.
Onion yield and grade were determined on September 18 by the same procedures as outlined for objective 1.

Results – Objective 1:
Soil temperature – The soil warming treatment was effective at increasing the soil temperature on the surface of the inside row during germination and early plant development. The soil temperature on April 18 (5 days after planting) was 53.5°F at the inside row where the biochar was placed, compared to 49°F at the outside row without biochar.

Soil compaction – The soil firming treatment increased soil compaction at the inside row location at all depths (Table 1). The increase in soil compaction compared to the check ranged from 15 psi at the 0 to 2-inch depth to 31 psi at the 6 to 8-inch depth. There was no change in soil compaction on the row closest to the outside edge of the bed.

Table 1. Effect of a soil firming treatment on compaction at three depths and two locations (inside = closest to drip tape, outside = furthest from drip tape) within a 44" bed for Vaquero onions growth at Parma, ID during 2023. Values are means of 8 observations per treatment and location.

Location	Treatment	0 to 2inch	3 to 5inch	6 to 8inch
Outside	Check	82.0	142.1	146.0
	Soil firming	90.6	146.1	155.6
	F Value	**0.145**	**0.704**	**0.216**
Inside	Check	84.4	127.8	146.9
	Soil firming	99.1	150.0	173.9
	F value	**0.011**	**0.011**	**0.053**

Plant population and development – Despite the success in increasing soil temperature along the inside row with biochar and improving soil compaction for better seed – soil contact with the press wheel, none of the treatments significantly affected plant population (Table 2). Reduced growth of plants located close to the drip tape compared to the outside row was observed during sampling on August 8 (Table 2). In previous years, we have observed both lower stands and less vigor in plants located along the inside row, but in 2023 the stunting was due to reduced vigor alone.

Yield and bulb size - Plants located in the inside row produced both lower total yield and a lower proportion of bulbs over 3 inches in diameter at harvest compared to the outside row (Table 2). The inside row yielded 183 cwt/acre lower and had 23% less large diameter onions than the outside row. On average, bulbs from the inside row weighed 3.2 oz less than bulbs from the outside row. The high flow drip tape tended to reduce the difference in total yield between row locations compared to the check and other treatments, but this interaction was not significant (Figure 1).

Table 2. Effect of a soil warming, soil firming and hi-flow drip tape treatments on final plant population, total yield, and proportion of bulbs > 3” diameter at two locations (inside = closest to drip tape, outside = furthest from drip tape) for Vaquero onions grown at Parma, ID during 2023. Values are means of 4 replications.

Location	Treatment	Plant population (# per 5ft) – Sept 13	Plant development (lbs per plant) – Aug 8	Total yield (cwt/acre)	% > 3” diameter	Ave bulb size (oz)
Outside	Check	21	0.68	739	88	12.1
	Soil warming	20	0.68	743	90	12.7
	Soil firming	21	0.71	737	87	11.6
	Hi-flow drip	23	0.63	803	89	11.7
	Average	21	0.68*	755*	89*	12.0*
Inside	Check	18	0.58	439	65	8.2
	Soil warming	21	0.62	566	62	9.4
	Soil firming	22	0.36	476	70	8.6
	Hi-flow drip	26	0.81	708	68	9.1
	Average	22	0.54*	572*	66*	8.8*
F Value						
	Treatment (T)	**0.1385**	**0.0116**	**0.4504**	**0.9912**	**0.8217**
	Location (L)	**0.7481**	**0.0001**	**0.0178**	**0.0026**	**0.0010**
	T x L	**0.6619**	**0.0224**	**0.7875**	**0.9436**	**0.9557**

*Indicates that the location averages are significantly different.

Results - Objective 2:

Pink root and plant development – The inside row consistently exhibited higher overall pink root ratings than the outside row due to a greater proportion of bulbs showing moderate disease (Table 3). Fumigation reduced disease ratings but did not alleviate the difference between the outside and inside row. Likewise, the inside row exhibited lower plant weights (indicating plant stunting) compared to the outside row, and this difference was not affected by the fumigation treatment.

Yield and bulb size – The inside row consistently had lower total yields compared to the outside row (Table 3). This difference was 183 cwt/acre in the non-fumigated soil and 178 cwt/acre in the fumigated soil. Likewise, the inside row produced a lower proportion of bulbs greater than 3 inches in diameter compared to the outside row and had a lower average bulb size. It did not appear that the reduction in pink root following fumigation was associated with any significant change in the differences in yield and size due to row location.

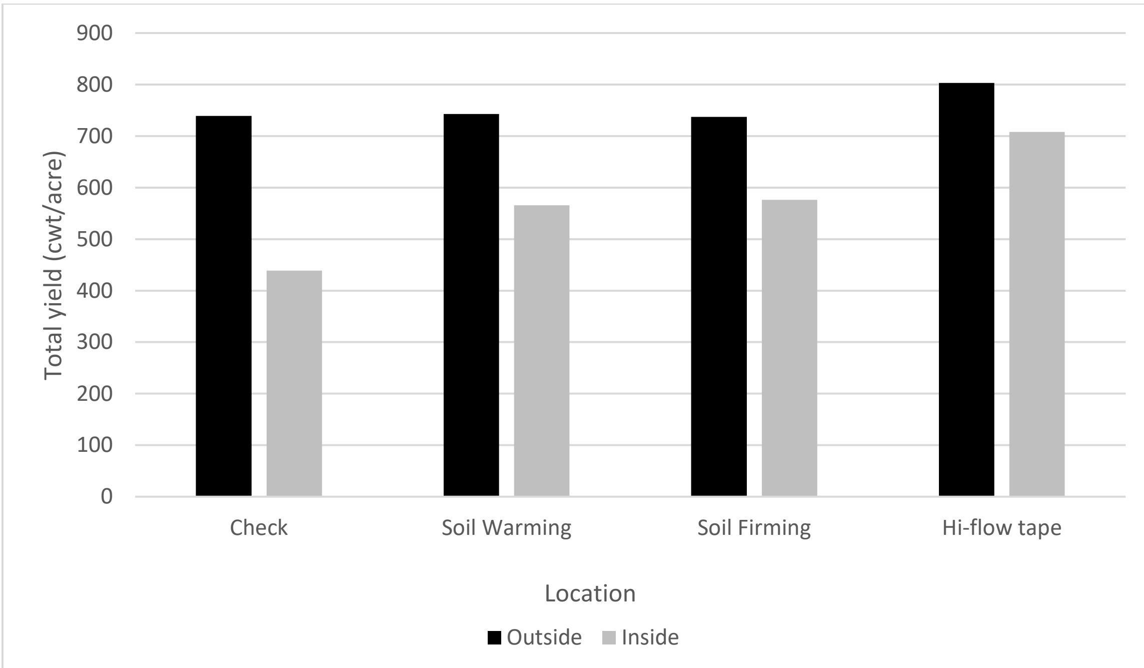
Table 3. Effect of fumigation on pink root rating, plant development, total yield, and proportion of bulbs > 3” diameter at two locations (inside = closest to drip tape, outside = furthest from drip tape) for Vaquero onions growth at Parma, ID during 2023. Values are means of 4 replications per treatment and location.

Location	Treatment	Pink root rating (0-3 scale) – Aug 8	Plant development (lbs per plant) – Aug 8	Total yield (cwt/acre)	% > 3” diameter	Ave bulb size (oz)
Outside	Check	1.63	0.71	755	89	12.0
Inside		1.81	0.54	572	66	8.8
	F value	**0.0543**	**0.0001**	**0.0178**	**0.0010**	**0.0010**
Outside	Fumigated	1.28	0.81	707	89	12.2
Inside		1.65	0.65	529	71	9.0
	F Value	**0.0001**	**0.0014**	**0.0002**	**0.0011**	**0.0002**

Summary:
The increases in pink root, reduction in total yield and smaller bulb size for onions closest to the drip tape found in 2023 closely match what we observed in both 2021 and 2022. While the soil firming and soil warming treatments did change the firmness of the soil around the seed and warmed the soil during emergence and early plant growth, they failed to provide any improvement in stunting and yield loss for onions in the inner row. From these results it does not seem likely that soil temperature and firmness are the main cause of the stunting we have observed. Likewise, fumigation reduced pink root levels but did not reduce the difference in yield or bulb size between the inner and outer rows. This indicates that pink root is probably not one of the main factors driving the stunting and reduced yields in inner rows. The high flow drip tape treatment tended to produce the highest bulb yields and minimize the difference between inner and outer row locations. This treatment should be evaluated for at least one additional year to confirm these results.

Acknowledgements:
We would like to express our gratitude to BASF for providing the seed for this trial and the McCain Foods onion agronomy group for assisting with treatment applications and data collection.

Figure 1. Effect of soil warming, soil firming and high-flow drip tape treatments on total yield at two locations (inside = closest to drip tape, outside = furthest from drip tape) within a 44” bed for Vaquero onions growth at Parma, ID during 2023. Values are means of 4 replications.



"Cheat the Heat": Influencing Soil Temperature to Maximize Onion Yield and Quality

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Mike Thornton, Ransey Portenier, Oksana Morgan – University of Idaho

Background

Conditions during the 2021 growing season resulted in an overall onion crop low in yield and small in size. There is speculation that the high temperatures in late June may have contributed to the decrease in yield, but this relationship has not been well understood nor well characterized. To better understand the relationship between bulb size and growing environment, we ran an extensive analysis comparing yields from the annual OSU Onion Variety Trial and weather data from the Parma Agrimet Weather Station. It is common for temperature-based yield models to utilize the entire growing season (i.e. total accumulated growing degree days), but these models typically only explain 70% of the observed variation in yield from year to year. By focusing on soil temperature during the first half of the growing season (Prior to July 1), we were able to generate models that explain over 99% of the observed variation in onion yield at the OSU Onion Variety Trial over the past 7 years (**Figure 1**). Further evaluation of this relationship suggests that:

1. Soil temperature is the main factor dictating onion yield in the absence of other biotic or nutrient stresses (Figure 1).
2. Soil temperature matters most during the last 10 days of June (**Figure 2**).
3. Soil temperatures below 83°F (at 2" depth) don't impact yield (**Figure 2,3**).

Though it is impossible for onion growers to change the weather, it may be possible to modify the soil heating process and mitigate soil temperatures when it matters most. It may be possible to "cheat the heat," which was the aim of this experiment.

Procedures

The experiment was conducted at the Parma Research and Extension Center in Parma, ID with the yellow onion cultivar 'Vaquero' grown on a Greenleaf silt loam soil previously cropped with wheat. Plots were not fumigated and measured six rows wide (11 ft.) by 20 ft. long. Onions were planted March 22 in double rows centered 16-inch apart, on 44-inch beds, with 3.5" in-row seed spacing.

All herbicides and fertilizers were applied according to University of Idaho guidelines. Thrips and Iris Yellow Spot Virus (IYSV) were controlled with a foliar program beginning when thrips populations reached the threshold of 1 to 3 per plant. The field was irrigated with a drip irrigation system scheduled to maintain available soil water content above 65-70%.

Vegetronix VH400 soil temperature sensors were installed June 16 at a frequency of 1 per plot. Sensors were placed at a depth of 2 inches, centered between one of the onion double rows. Soil data were collected using Vegetronix Logger8 data loggers set to record temperature every 15 minutes.

Table 1 outlines the treatments utilized to modify soil temperature in this experiment. The straw and pelleted biochar treatments were spread by hand whereas the Surround WP (kaolin clay) and charcoal powder treatments were applied using a Jacto HD400 4-gal backpack sprayer fitted with a Turbo TeeJet induction nozzle (TTI 04).

Pink root severity and incidence was evaluated on July 12 and Aug 3rd. On each date, a sample of 25 random plants per plot were removed with a shovel to preserve the root mass, and classified by the proportion of pink root infected roots per plant on a scale of 0 to 3 where:

0= no pink roots
1= <10% roots pink
2= 10-50% roots pink
3= >50% of roots pink

Onions were lifted on September 2 and harvested September 13. Two beds of each plot were mechanically topped and placed back into their initial beds. One bed by 20 feet of the topped onions were sacked and transported to McCain storage facility and kept at ambient temperature. On November 11, samples were run across a mechanical sizer and both weighed and counted to determine yield, bulb size distribution, and plant population. A 20 bulb sub-sample from each plot was cut and evaluated for single-centers. A 50-lb sack from each plot was collected and placed in cold storage for decay evaluations at a later date.

All data (except for soil temperature data) were analyzed by analysis of variance. When the F-test for treatment was significant at the 95% confidence level, means were separated by LSD.

Results

The 2022 trial experienced unusually cool-wet conditions through June, and unusually hot conditions throughout the rest of summer. There were no significant differences among the treatments on final plant stand, although the straw (Bed) treatment resulted is the highest plant population (108,098 plants/Ac) and the charcoal powder treatment resulted in the lowest (92,062 plants/Ac).

The highest 2" soil temperature in all treatments was recorded on June 27, so that date was chosen to illustrate the impact of the various treatments on soil temperature. The Straw and Surround WP treatments reduced the intensity and time that the sensors were above 83°F compared to the untreated check (**Figure 4**). The charcoal powder and pelleted biochar increased the intensity and time that the sensors were above 83°F (**Figure 5**). These were consistent patterns during daylight hours.

Pink root ratings ranged from 0.6 to 0.8 on the first sample date, then increased to 1.4 to 1.7 by early August (**Table 2**). At the second evaluation date, the treatments designed to darken the soil and increase soil temperature tended to have the highest pink root ratings, whereas the Surround WP treatment had the lowest, but these differences were not significant (F=0.4363).

There were no significant differences in the yield of bulbs smaller than 3.5” in diameter (**Table 3**). In general, treatments designed to cool the soil increased total yield and the yield of bulbs larger than 3.5” in diameter relative to the untreated check. The Straw (Bed) treatment resulted in the highest total yield at an average of 717 cwt/ac. On the other hand, treatments designed to warm the soil decreased total yield and the yield of bulbs larger than 3.5” in diameter relative to the untreated check. The charcoal powder treatment resulted in the lowest total yield at an average of 555 cwt/ac. For these larger size classes, there was no significant differences between the soil cooling treatments and the untreated check nor between the soil heating treatments and the untreated check. There were, however, significant differences between the soil cooling treatments and the soil heating treatments, particularly for the straw treatments (**Table 3**). There were no significant differences in percent single centers.

Summary

Crop year 2022 was cool and wet through most of June. Interestingly, the hottest recorded 2” soil temperature in all treatments occurred on June 27. July and August recorded much higher day time maximum air temperatures than late June, but never broke the soil temperature record. (**Figure 6**) While the highest recorded soil temperature did not correspond to the highest air temperature, it did correspond to the time period that received the most solar radiation. This seems to suggest that solar radiation is the primary influencer of soil temperature whereas air temperature is secondary influencer. Further, it is possible that the ongoing accumulation of canopy coverage naturally shades the soil around the base of the onion and thereby mitigates soil temperatures. This may help explain why extending the onion yield model beyond early July only degrades the model (**Figure 2**).

It has been reported that onion root tolerance to soilborne pathogens breaks down at soil temperatures above 83°F (UI Extension Bulletin 1000, Woodhall et. al.). However, we did not find any significant differences in pink root ratings at either date. This suggests that the mechanism that decreases onion yield in hot years is abiotic in nature, but further research is needed to confirm this. The treatments designed to cool the soil resulted in the highest yields. This result agrees with other studies that have found straw mulch applied mid-season to be beneficial to onions.

Acknowledgements

We thank BASF-Nunhems for providing the seed and Novasource for supplying the Surround WP used in this trial.

Table 1. Treatments utilized to modify soil temperature at Parma, ID in 2022.

Treatment	Applied	Rate (/Ac)	Details	Purpose
Control	NA	NA	NA	NA
Charcoal Powder	June 21	52 lbs	9" band centered on double row	Heat Soil
Pelleted Biochar	June 23	2.2 tons	9" band centered on double row	Heat Soil
Straw (Bed)	June 20	32 bales	Broadcast evenly between double rows	Cool Soil
Straw (Bed + Furrow)	June 20	53 bales	Broadcast evenly	Cool Soil
Surround WP	June 21	100 lbs	9" band centered on double row	Cool Soil

Table 2. Effect of soil treatments on average rating (0 to 3 scale where 0 = no infection, 3 = > 50% infected roots), pink root incidence (percentage of plants with any symptoms), and severity (percentage rated 3) for Vaquero onions grown at Parma, ID during 2022. Values are means of 3 replications.

Treatment	July 12st			August 3rd		
	Average Rating	Disease incidence	Severe Infection	Average Rating	Disease incidence	Severe Infection
Untreated	0.73	71.0	0.0	1.51	100	2.0
Surround WP	0.65	66.0	0.0	1.48	100	3.0
Activated Charcoal Powder	0.70	67.0	1.0	1.63	100	4.0
Pelleted Biochar	0.73	72.0	0.0	1.68	100	8.0
Straw (Bed only)	0.78	75.0	0.0	1.60	100	6.0
Straw (Bed + Furrow)	0.73	74.0	0.0	1.55	100	6.0
LSD	**ns**	**ns**	**ns**	**ns**	**-**	**ns**
F-Test	**0.8067**	**0.7988**	**0.5530**	**0.4363**	**-**	**0.1575**

Table 3. Effect of soil treatments on total yield and bulb size distribution for Vaquero onions grown at Parma, ID in 2022. Values are the means of 3 replications.

Treatment	<3"	3-3.25"	3.25-3.5"	3.5-4"		4-4.5"		Total Yield		Incentive 3.25-4.5"
	cwt/ac	cwt/ac	cwt/ac	cwt/ac		cwt/ac		cwt/ac		cwt/ac
Untreated	80	129	202	203	bcd	33	ab	647	ab	437
Surround WP	98	147	182	222	abcd	19	bcd	669	ab	423
Activated Charcoal Powder	82	125	159	183	cd	7	cd	555	c	348
Pelleted Biochar	98	141	186	171	d	5	d	601	bc	362
Straw (Bed only)	95	135	176	287	ab	25	abcd	717	a	487
Straw (Bed + Furrow)	71	117	194	250	abcd	28	abcd	660	ab	472
LSD	**ns**	**ns**	**ns**	**91.84**		**24.68**		**76.90**		**ns**
F-Test	**0.9551**	**0.3479**	**0.0830**	**0.0459**		**0.0485**		**0.0117**		**0.1296**

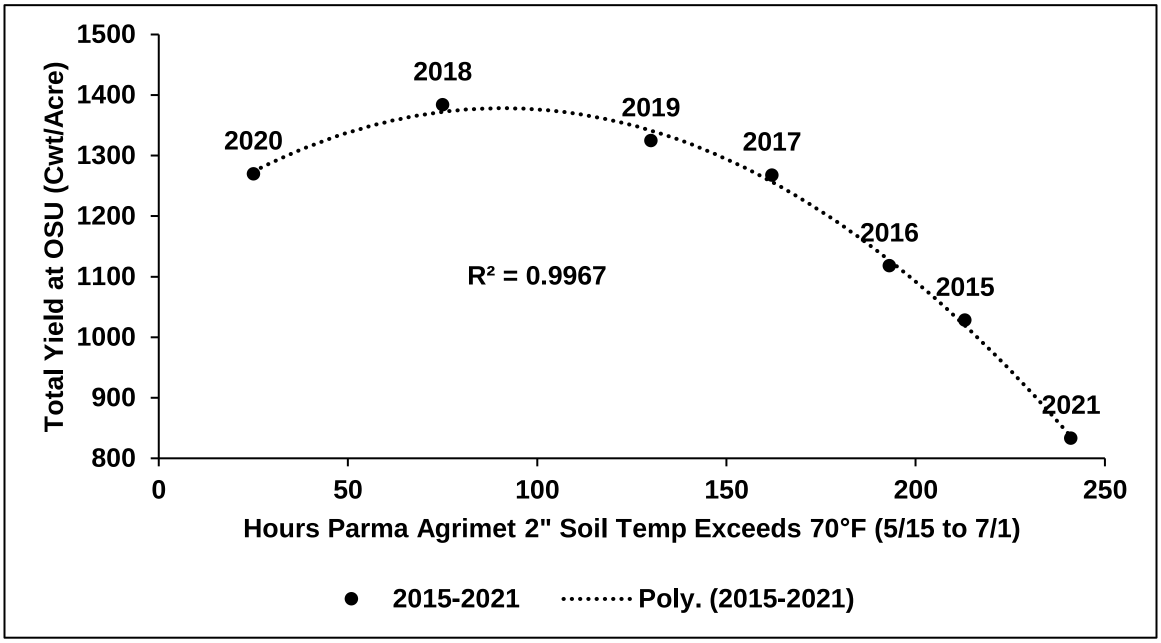


Figure 1. Total yield model for cv. Joaquin grown at the OSU Onion Variety Trial from 2015 to 2021. The Parma, ID Agrimet weather data was utilized because the Ontario, OR Agrimet does not record soil temperature.

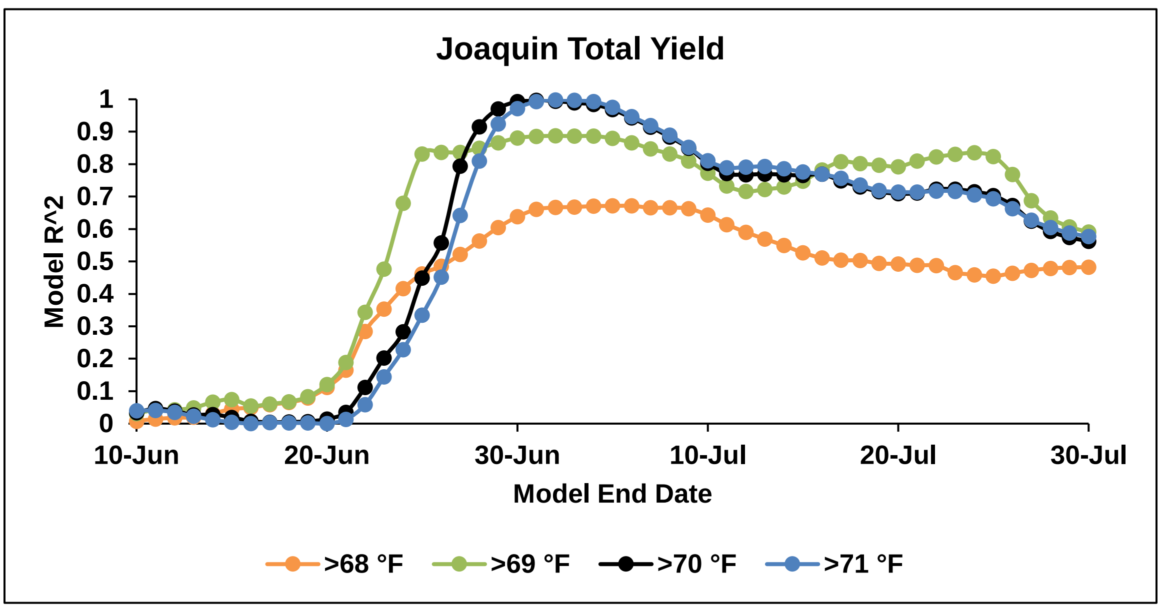


Figure 2. The change is the fit of the total yield model for cv. Joaquin as different soil temperature thresholds and different end dates were utilized. “Model end date” is the date when hours above the temperature threshold are no longer counted.

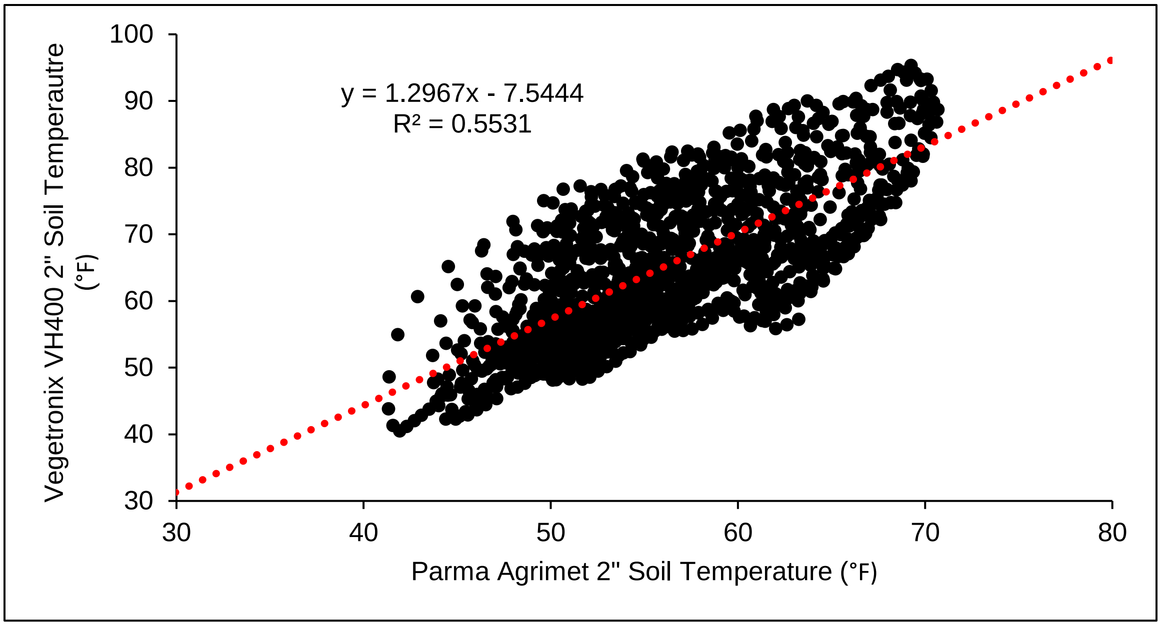


Figure 3. Relationship between the Agrimet and Vegetronix 2” soil temperature sensor readings at Parma, ID in 2021. There was less than 100 yards distance between the Agrimet weather station and the field where the Vegetronix sensors were installed. Note that and Agrimet reading of 70°F roughly corresponds to an 83°F reading in the onion plot.

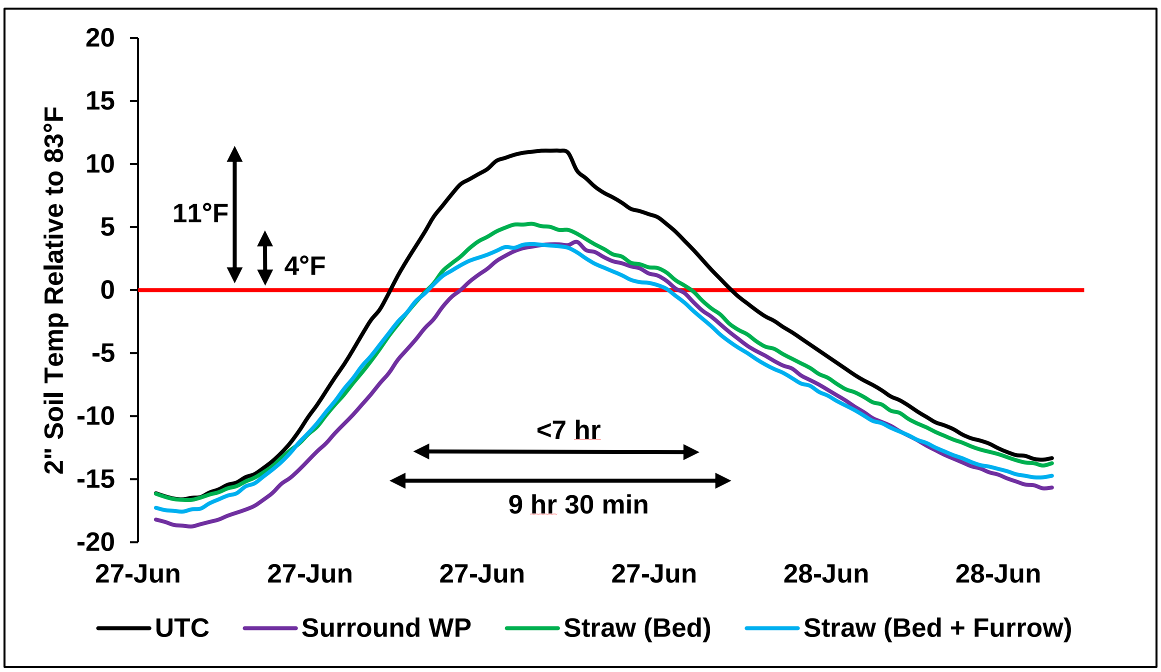


Figure 4. Soil temperature fluctuation on June 27 (hottest recorded for all treatments). Treatments designed to cool the soil reduced the intensity and duration of heat stress compared to the untreated check (UTC). Values are the means of 4 replications.

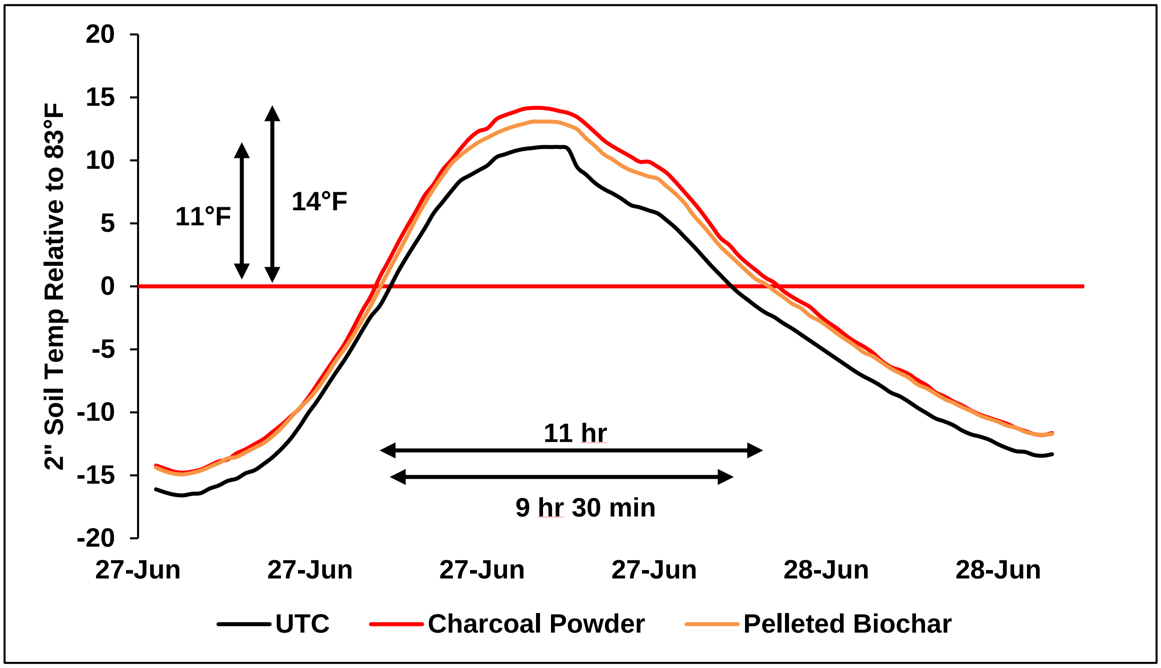


Figure 5. Soil temperature fluctuation on June 27 (hottest recorded for all treatments). Treatments designed to heat the soil magnified the intensity and duration of heat stress compared to the untreated check (UTC). Values are the means of 4 replications.

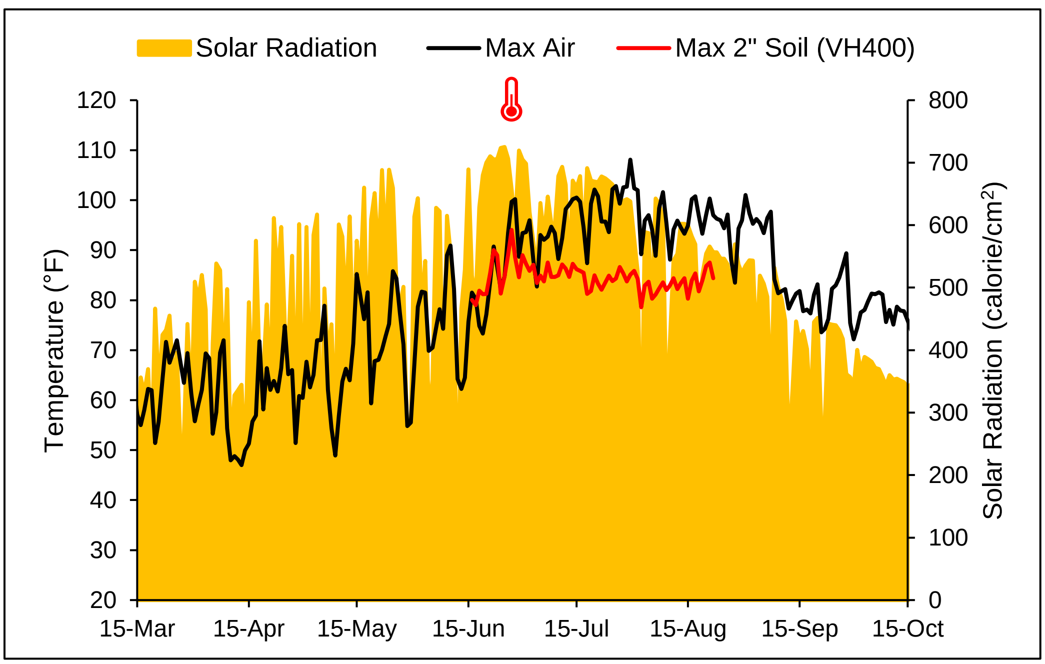


Figure 6. Daily global solar radiation and maximum air temperature recorded by the Parma, ID Agrimet weather station during 2022. The soil temperature readings are the values in the untreated check plots which were located less than 1 mile away from the weather station. The red thermometer icon indicates the date that the highest 2”soil temperature was recorded in all treatments.

Influencing Soil Temperature to Maximize Onion Yield and Quality – 2023

Jeff Michaels, Kyler Beck, Luca Distefano – McCain Foods
Mike Thornton, Ransey Portenier, Oksana Morgan – University of Idaho

Background

We have developed a model of onion yield focusing on soil temperature during the first half of the growing season (Prior to July 1) that explains over 99% of the observed variation in yield in the OSU Onion Variety Trial over the past 7 years. Though it is impossible for onion growers to change the weather, it may be possible to modify the soil heating process and mitigate soil temperatures when it matters most. In 2022, we evaluated several treatments that warm or cool the soil during the critical period right around bulb initiation to see if onion yields would respond as predicted by the soil temperature model. Experiments in 2023 were designed to evaluate these treatments for a second year.

Procedures

The experiment was conducted at the Parma Research and Extension Center in Parma, ID with the yellow onion cultivar 'Vaquero' grown on a Greenleaf silt loam soil previously cropped with wheat. Individual plots measured six rows wide (11 ft.) by 20 ft. long and were replicated four times. One set of plots (8 treatments x 4 reps = 32 total) were placed in a section of the field that had not fumigated, while a second identical set was placed in a section that was fumigated in the fall of 2022 with 4 gal/acre of Strike 100CP. Onions were planted across the entire experiment on April 13 in double rows centered 16-inch apart, on 44-inch beds, with 3.5-inch in-row seed spacing.

All herbicides and fertilizers were applied according to University of Idaho guidelines. Thrips and Iris Yellow Spot Virus (IYSV) were controlled with a foliar program beginning when thrips populations reached the threshold of 1 to 3 per plant. The field was irrigated with a drip irrigation system scheduled to maintain available soil water content above 65-70%.

Vegetronix THERM200 soil temperature sensors were installed on June 16 at a frequency of 1 per plot. Sensors were buried in the soil at a depth of 2 inches, centered between the onion double row on the south side of one of the 3 beds. Data was collected using Vegetronix Logger8 data loggers set to record temperature every 15 minutes. A FLIR One Pro thermal imaging camera was used to collect images of the plots to better understand where and onion bed captured and retained the most heat.

Table 1 outlines the treatments utilized to modify soil temperature in this experiment. The biochar (early) treatment was accomplished by applying Andersons BioChar DG by hand over a 2-inch strip covering the inner onion on April 15 (2 days after planting). The rate of biochar was 367 grams per 20 feet of row, which is equivalent to 961 lbs/acre. The soil firming treatment was applied by running a sod roller filled with water (100 lbs total weight) over each bed on April 15. The straw, Surround WP and biochar (late) treatments were applied on June 19 using a threshold of soil temperatures at 2-inch depth reaching

79°F for two consecutive days. The straw was spread by hand across the middle of the bed or along the south facing furrow at rates of 32 bales per acre. The Surround WP (kaolin clay) treatment was applied in a total water volume of 50 gallons per acre using a Jacto HD400 4-gal backpack sprayer fitted with a Turbo TeeJet induction nozzle (TTI 04). The biochar (late) treatment was sprinkled by hand in 9-inch bands, centered on each double row. The rate was 1652 grams per 20 feet of row, which is equivalent to 4328 lbs/acre. The high flow drip tape was installed with the onion planter at the same depth and location as used for the standard output tape. After the first irrigation to set the wetting front, the irrigation duration was reduced by 1/3rd so that the total amount of water applied in the standard and high output tape was the same.

Pink root severity and incidence was evaluated on August 8 by destructively harvesting 50 plants from the outer bed of each plot. Plants were removed with a shovel to preserve the root mass and classified by the proportion of pink root infected roots on a scale of 0 to 3 where: 0= no pink roots; 1= <10% roots pink; 2= 10-50% roots pink; and 3= >50% of roots pink. The pink root rating is the total score for all bulbs in the sample divided by 25, incidence is the total proportion of bulbs with a rating > 0, while severity is the proportion of bulbs with a rating of 3.

Onions were lifted on September 5 and harvested on September 18. Two beds of each plot were hand topped and placed back into their initial beds. One bed by 15 feet of the topped onions were sacked and transported to McCain storage facility and kept at ambient temperature. On November 17, samples were weighed and counted to determine yield, bulb size distribution, and plant population. A 20 bulb sub-sample from each plot was cut and evaluated for single-centers and decay. Approximately 50 bulbs from each plot were collected and placed into accelerated aging conditions (80°F and 80% relative humidity for 2 weeks) for decay evaluations on December 11.

All data (except for soil temperature data) were analyzed by analysis of variance. When the F-test for treatment was significant at the 95% confidence level, means were separated by LSD.

Results

The highest 2” soil temperature in all treatments was recorded on July 1, so that date and the two days prior were chosen to illustrate the impact of the various treatments on soil temperature. The straw and Surround WP treatments reduced the intensity and time that the sensors were above 83°F compared to the untreated check (**Figure 1**). The late-applied biochar slightly increased the intensity and time that the sensors were above 83°F (**Figure 2**). These were consistent patterns during daylight hours.

The 2023 trial experienced several extreme thunderstorms during the spring that led to stand loss in all plots. The variability in stands associated with these weather conditions impacted final yields and may have reduced the ability to identify treatment differences. There were no significant differences among the treatments on final plant stand (**Table 2**).

All the onion bulbs sampled exhibited mild to moderate symptoms of pink root on August 8, but there were almost no bulbs rated as severe. This prevented us from being able to statistically compare the effect of the treatments on pink root incidence or severity. In contrast, pink root ratings provide an indication of the overall proportion of bulbs that are exhibiting mild to moderate disease symptoms. Pink root ratings ranged from 1.3 to 1.9 in the non-fumigated section of the field and were slightly lower in the fumigated area (**Table 2**). None of the treatments significantly influenced pink root ratings compared to the control, although the high flow drip tape treatment had the numerically lowest pink root ratings under both fumigated and non-fumigated conditions.

None of the treatments significantly affected total bulb yield under fumigated and non-fumigated conditions (**Table 3**). Likewise, the treatments did not significantly alter yield in any of the bulb size classes. However, it is worth noting that the biochar (late) treatment was among the numerically lowest yielding treatments under both fumigated and non-fumigated conditions. This treatment also tended to produce the lowest yields of onions greater than 3.5 inches in diameter. These results are similar to what was seen in the 2022 trial.

All treatments, except the biochar (late) and high flow drip tape under non-fumigated conditions, produced bulbs with at least 90% single centers (Table 4). There wasn't a significant effect of soil treatments on the incidence of single centers, and these results match what was seen in 2022.

There was a significant effect of soil treatments on the incidence of decay on November 17^{th} under the non-fumigated conditions, but no effect under fumigation (**Table 4**). The biochar (early) and high flow drip tape treatments had significantly higher incidence of decay compared to the control. These same treatments had the numerically highest levels of decay on December 11 after the accelerated aging conditions, but these differences were not significant ($p=0.37$).

Summary

Four treatments (Control, Surround WP, Straw (Bed) and Biochar (late)) were included in both the 2022 and 2023 trials. In both years there was a trend for the late-applied biochar to increase the time that soil temperatures at the 2-inch depth remained above the 83^{o}F threshold, but this increase was less pronounced in 2023 than in 2022. This could have been caused by the fact that all sensors were placed on the South side of the bed, which naturally captures more heat than the North side in rows planted east to west (**Image 1)**. The biochar (late) treatment also tended to reduce total yield and bulb size compared to the control in both years (**Figure 3**). In contrast, the Surround and straw treatments decreased the time above the threshold and tended to increase total yield and improve yield in the largest size classes. Both of these results fit with the concept that the number of hours that soil temperatures remain above a threshold has a major influence on the productivity of the onion crop within a season. The fact that the results were not as strong during 2023 (when the growing season was relatively cool) as they were in 2022 (during extremely hot conditions) also fits well with this concept of soil temperature being a major determinant of onion yield. These studies should be repeated in 2024 to further establish the usefulness of soil cooling treatments across a range of growing seasons.

Image 1. A side-by-side comparison of an RGB and thermal image taken on April 14, 2023 at the Vaquero onion plots grown at Parma, ID. The thermal image illustrates how the south-facing ridges of the onion bed capture the most solar radiation and retain the most heat.

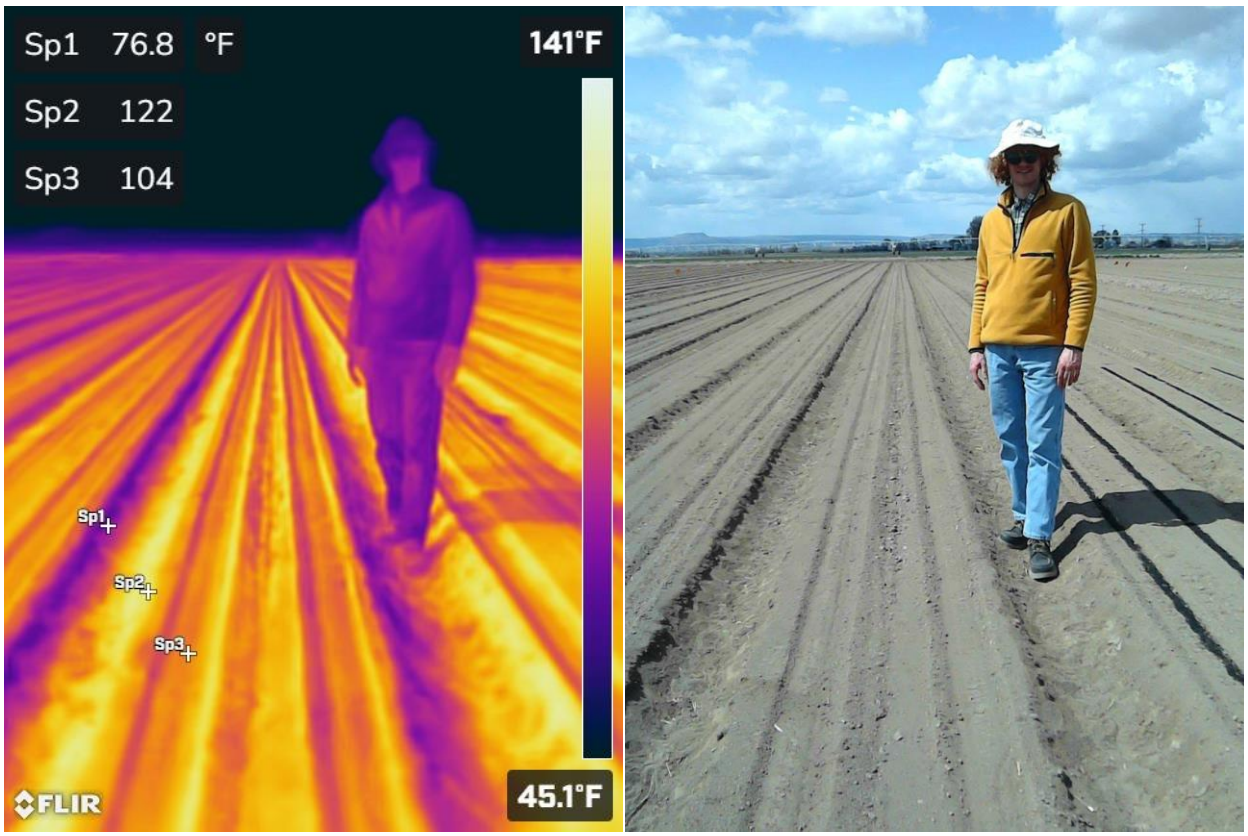


Table 1. Treatments utilized to modify soil temperature at Parma, ID in 2023.

Treatment	Applied	Rate (/Ac)	Details	Purpose
Control	NA	NA	NA	NA
Biochar (early)	April 15	961 lbs	2" band placed over inside row	Heat soil early
Press Wheel	April 15	NA		Firm soil early
Surround WP	June 19	100 lbs	9" band centered on double row	Cool soil late
Biochar (late)	June 19	4328 lbs	9" band centered on double row	Heat soil late
Straw (Bed)	June 19	32 bales	Broadcast evenly between double rows	Cool soil late
Straw (Furrow)	June 19	32 bales	Broadcast evenly along south side	Cool soil late
High Flow Tape	April 13	NA	0.34 gpm vs 0.25 gpm for standard	Uniform wetting

Table 2. Effect of soil treatments on final plant population, average pink root rating (0 to 3 scale where 0 = no infection, 3 = > 50% infected roots), incidence (percentage of plants with any symptoms), and severity (percentage rated 3) for Vaquero onions grown at Parma, ID during 2023. Values are means of 4 replications.

Non-fumigated				
Treatment	September 18	August 8		
	Final Plant Population (Bulbs/acre)	Average Rating	Disease incidence	Severe Infection
Control	83532	1.8	100	0.0
Biochar (early)	84326	1.6	100	0.0
Press Wheel	98677	1.8	100	0.7
Surround WP	82540	1.8	100	0.0
Biochar (late)	91072	1.9	100	2.7
Straw (Bed)	86905	1.8	100	0.0
Straw (Furrow)	96230	1.9	100	0.0
High Flow Tape	106746	1.3	100	0.0
LSD	ns	ns	---	ns
F-Test	0.1004	0.0970	---	0.5499

Fumigated				
Treatment	September 18	August 8		
	Final Plant Population (Bulbs/acre)	Average Rating	Disease incidence	Severe Infection
Control	104762	1.5	100	0.0
Biochar (early)	98611	1.4	100	0.0
Press Wheel	91865	1.4	100	0.0
Surround WP	87500	1.6	100	0.0
Biochar (late)	106350	1.5	100	0.0
Straw (Bed)	95238	1.5	100	0.0
Straw (Furrow)	102182	1.6	100	0.0
High Flow Tape	88294	1.3	100	0.0
LSD	ns	ns	---	---
F-Test	0.3699	0.3811	---	---

Table 3. Effect of soil treatments on total yield and bulb size distribution for Vaquero onions grown at Parma, ID in 2023. Values are the means of 4 replications.

	Non-fumigated						
Treatment	**<3”**	**3-3.25”**	**3.25-3.5”**	**3.5-4”**	**4-4.5”**	**Total Yield**	**Incentive 3.25-4.5”**
	cwt/ac	**cwt/ac**	**cwt/ac**	**cwt/ac**	**cwt/ac**	**cwt/ac**	**cwt/ac**
Control	80	71	99	272	74	601	521
Biochar (early)	82	73	140	227	63	584	502
Press Wheel	114	120	144	189	50	622	508
Surround WP	64	57	108	272	99	615	551
Biochar (late)	94	103	146	193	24	559	465
Straw (Bed)	68	78	122	292	81	648	580
Straw (Furrow)	96	82	142	266	55	644	548
High Flow Tape	104	96	144	265	68	675	571
LSD	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	
F-Test	**0.4250**	**0.2697**	**0.2562**	**0.3753**	**0.4108**	**0.5782**	

	Fumigated						
Treatment	**<3”**	**3-3.25”**	**3.25-3.5”**	**3.5-4”**	**4-4.5”**	**Total Yield**	**Incentive 3.25-4.5”**
	cwt/ac	**cwt/ac**	**cwt/ac**	**cwt/ac**	**cwt/ac**	**cwt/ac**	**cwt/ac**
Control	120	86	141	211	28	587	467
Biochar (early)	103	94	129	235	30	590	487
Press Wheel	113	111	117	166	82	591	478
Surround WP	96	78	96	214	38	525	429
Biochar (late)	148	114	142	156	2	561	413
Straw (Bed)	108	76	104	2131	19	521	413
Straw (Furrow)	109	103	156	237	45	650	541
High Flow Tape	91	67	114	240	93	604	513
LSD	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	
F-Test	**0.2839**	**0.3901**	**0.6050**	**0.4608**	**0.0811**	**0.6979**	

Table 4. Effect of soil treatments on proportion of single center bulbs and incidence of decay at two evaluation times for Vaquero onions grown at Parma, ID in 2023. Values are the means of 4 replications.

Treatment	Non-fumigated		
	November 17	November 17	December 11
	Single Centers (%)	Decay (%)	Decay* (%)
Control	90	4 b	29
Biochar (early)	91	13 a	35
Press Wheel	92	5 b	25
Surround WP	94	4 b	29
Biochar (late)	88	3 b	28
Straw (Bed)	93	1 b	33
Straw (Furrow)	91	1 b	28
High Flow Tape	86	10 a	44
LSD	**ns**	**6**	**ns**
F-Test	**0.7116**	**0.0043**	**0.3702**

*Samples were kept at 80oF and 80%RH for two weeks (accelerated aging) prior to evaluation.

Treatment	Fumigated		
	November 17	November 17	December 11
	Single Centers (%)	Decay (%)	Decay^ (%)
Control	95	9	
Biochar (early)	90	10	
Press Wheel	90	14	
Surround WP	93	15	
Biochar (late)	93	11	
Straw (Bed)	90	14	
Straw (Furrow)	91	6	
High Flow Tape	93	13	
LSD	**ns**	**ns**	
F-Test	**0.9710**	**0.8632**	

^Samples were not collected for the accelerated aging evaluation

Figure 1. Effect of soil cooling treatments on 2” soil temperature for Vaquero onions grown at Parma, ID 2023. Values are means of 4 replications.

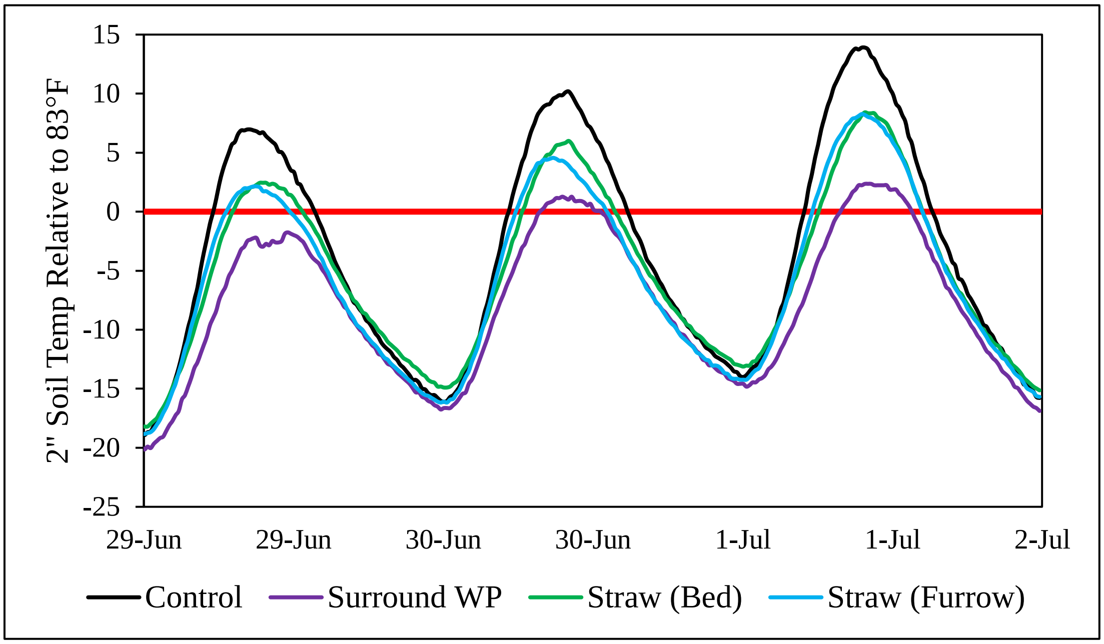


Figure 2. Effect of soil heating treatment on 2” soil temperature for Vaquero onions grown at Parma, ID 2023. Values are means of 4 replications.

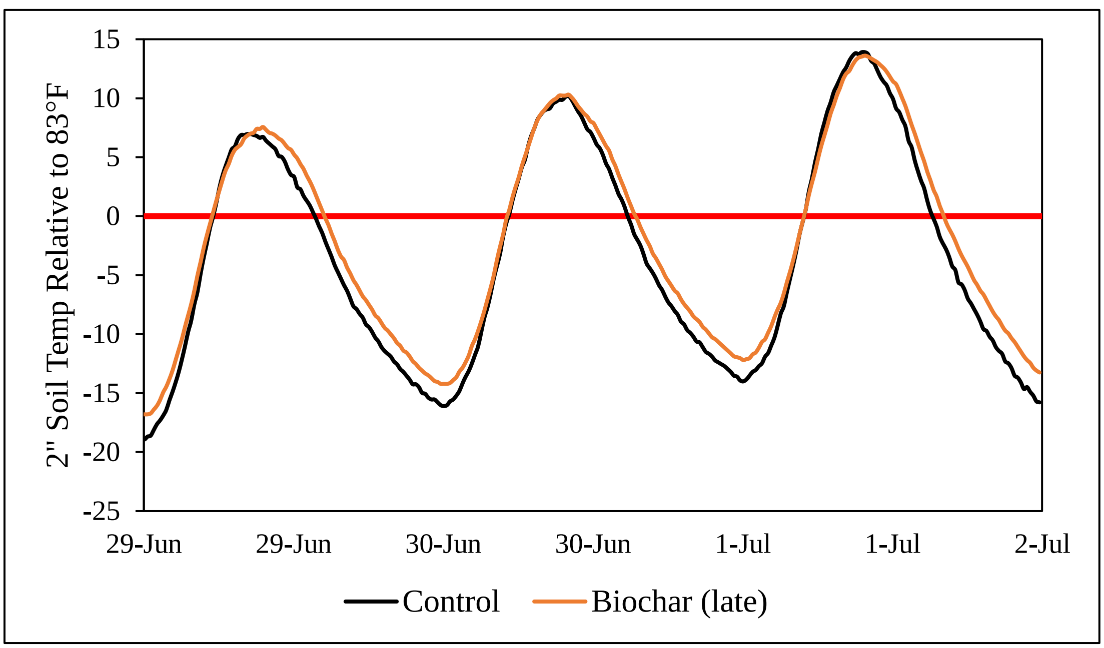
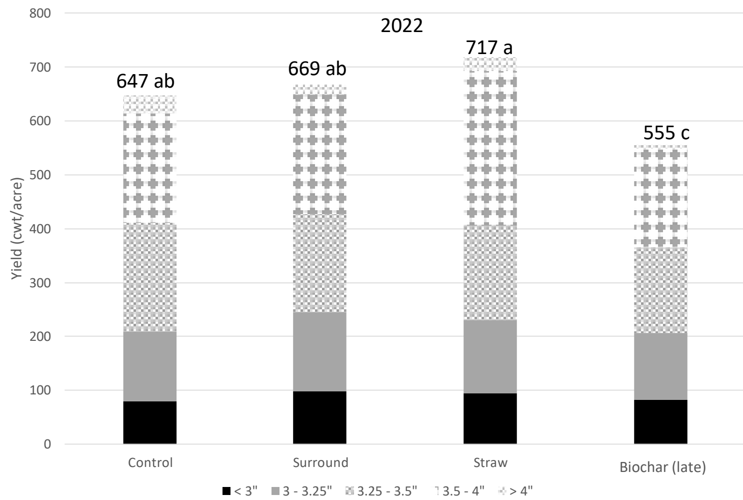
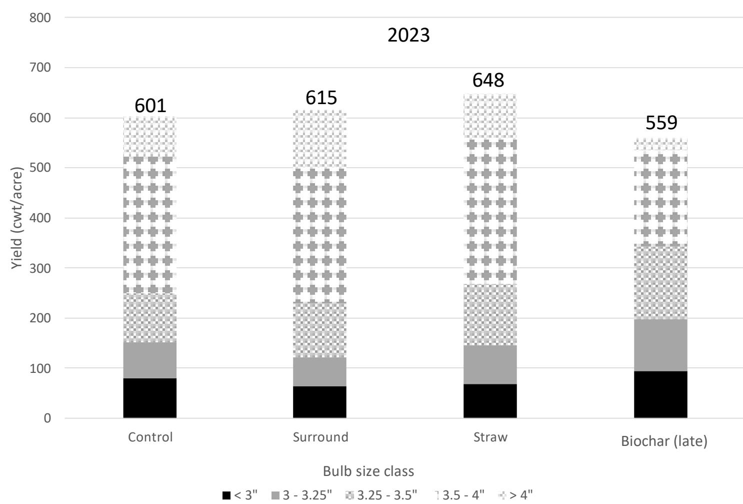


Figure 3. Effect of soil treatments on bulb size distribution and total yield for Vaquero onions grown at Parma, ID during 2022 and 2023. Values are means of 4 replications.





Grant Code: AN7304 **Annual Report**

TITLE: Determination of the impact of temperature and other curing parameters on onion bulb rot caused by co-infection of *Botrytis* spp. and *Pantoea* spp. in storage.

PERSONNEL: Dr. Brenda Schroeder **COLLABORATOR: Dr. James Woodhall**
ADDRESS: Brenda Schroeder, 875 Perimeter Drive, MS 2329, Moscow ID 83844-2329; phone: 509-339-5320; bschroeder@uidaho.edu

DURATION: Two-year project, FY 2024 is year one of the project.

JUSTIFICATION/RATIONAL:

In the US, storage onions (*Allium cepa*) are produced on >110,000 acres annually. This high-value vegetable crop produces >$900 million in annual farm receipts (USDA-NASS, 2004-2014). Storage onion acreage in the western US comprises ~66% of US onion production with 18% or more of the production occurring in OR and ID (NASS 2014). Production costs can be significant ($4,000/acre) making stakeholder losses to onion bulb rots during storage costly (http://www.ipmcenters.org/CropProfiles/docs/WAonions.pdf). More than 20 different bacterial and fungal pathogens cause onion losses under field and storage conditions resulting in up to 25-50% crop loss (Schwartz and Mohan, 2008). In most cases, bulb infection is usually asymptomatic prior to harvest (Schwartz and Mohan, 2008), and the infected bulbs go into storage undetected. These infections can develop into storage rot. Subsequently, an entire season of production and storage expenses has been incurred, resulting in significant financial losses during storage.

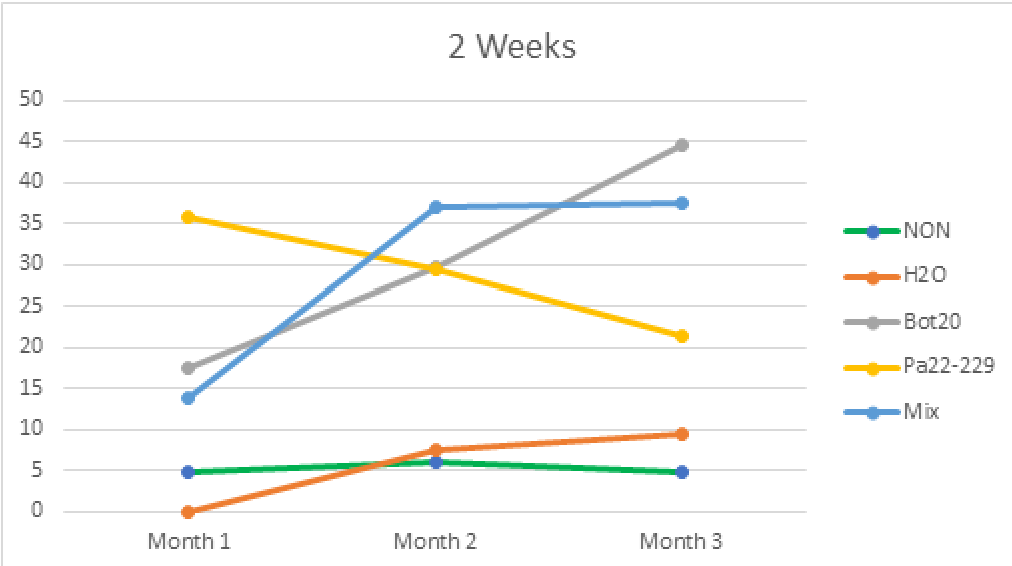
Recently, it has become evident that bulb rot pathogens are working in concert together to cause bulb rot of onion in the Treasure Valley. Dr. Woodhall's diagnostic team as part of the 'Stop the Rot Project' have frequently isolated numerous bacterial pathogens from the same onion bulbs exhibiting onion bulb rot. Anecdotal evidence from stakeholders as well as Drs. Woodhall and Schroeder observations of natural onion bulb rot also observed bacterial and fungal bulb rot pathogens isolated from the same onion bulb. Finally, Dr. Woodhall's diagnostic team is frequently isolating various *Pantoea* spp. from onion bulb rot and the potential of this bacterial bulb rot pathogen being present in combination with *Botrytis* spp., the neck and bulb rot pathogen.

Currently it is unclear what the impact of these pathogens are when present together in onion bulbs. In addition, there are limited control options for bulb rot pathogens, especially once the onion bulbs are latently infected. Bulb curing is commonly used to minimize the occurrence of both fungal and bacterial rot in storage. Onions are cured either in the field or artificially in a storage facility using forced air or heated forced air to dry down the neck and the outer layers of the onion (Brewster 2006, Opara, 2003). This results in dry wrapper scales helping to protect the onion bulb during storage. Farmers may use a combination of the two curing methods. The curing temperatures, the rate of ventilation, the rate of temperature change, and the overall curing duration can be modified as needed and studies have shown that these factors are pathogen specific. The knowledge of how these parameters impact bulb rot caused by *Botrytis* spp. and *Pantoea* spp. will provide a management tool to onion producers. Depending on the pathogens present, curing parameters can be manipulated to reduce the severity or eliminate disease development in onion bulbs (Schroeder et al. 2010, Schroeder and Dutoit, 2012, Vahling et al. 2016).

HYPOTHESIS & OBJECTIVES: The determination of the impact of temperature on onion bulb rot caused by *Botrytis aclada*. and *Pantoea* spp. in combination and the impact of curing parameters on onion bulb rot caused by these pathogens together in the onion bulb will provide the industry with much needed knowledge of how to manage onion crops in storage.

Objective 1. Determine the impact of temperature on onion bulb rot caused by *Botrytis* spp. and *Pantoea* spp. in combination and the impact of curing parameters on onion bulb rot caused by these pathogens in combination in onion bulbs in storage.

PROCEDURES:
To determine the impact of temperature on bulb rot caused by *Botrytis* spp. and *Pantoea* spp. in combination, onion bulbs (cv. Vaquero) were inoculated with *Botrytis aclada* and *Pantoea agglomerans* individually and in combination and incubated at 30°C for two weeks. Onion bulbs were stored at 5°C and assayed monthly to evaluate disease progress and determine how bulb rot caused by *Botrytis* spp. and *Pantoea* spp. in combination is impacted by temperature.



As demonstrated previously (Armstrong et al. 2016) onion bulbs inoculated with *Pantoea agglomerans* exhibit reduced amounts of disease the longer they are stored. Onion bulbs inoculated with *Botrytis aclada* exhibited increased amounts of bulb rot the longer they are stored. The bulbs inoculated with both pathogens exhibited bulb rot that was more than *Pantoea agglomerans* or *Botrytis aclada* alone at one month after storage. By three months of storage bulbs inoculated with both pathogens exhibited bulb rot that was more than *Pantoea agglomerans* but less than *Botrytis aclada*.

A large-scale assay of onions bulbs (cv. Vaquero) were inoculated with *Botrytis aclada* and *Pantoea agglomerans* individually and in combination and cured at 25, 30, and 35°C for each of two durations (2 days vs. 2 weeks) and placed in storage at 5°C in the fall of 2023. Bulbs will be cut down the center and evaluated for severity of storage rot after 4 and 6 months in storage. A water-inoculated bulbs along with non-inoculated bulbs and *Botrytis* spp. and *Pantoea* spp. individually will be used as controls. The onions were grown, cured and stored and evaluated at the Parma Research and Extension Center.

ANTICIPATED BENEFITS/EXPECTED OUTCOMES/INFORMATION TRANSFER:
Understanding the impact of temperature on disease progress of onion bulb rot caused by *Botrytis* spp. and *Pantoea* spp. in combination and ultimately the impact of curing temperature and duration on bulb rot caused by a fungal and bacterial bulb rot pathogen in combination will provide critical knowledge to stakeholders to aid in the management of this storage rot problem.

Cost of Onion Production in Idaho and Eastern Oregon 2023

General Procedure

A link to a survey of production practices is distributed to Idaho-Eastern Oregon onion growers by the first week of December each year. Results from the anonymous survey are combined with information from crop consultants, ag supply companies, and extension personnel to develop a set of production practices for use in the annual cost of production estimates. If you are not receiving the annual survey and would like to participate, please email greenwayresearch@outlook.com to be added to the email list.

Preliminary hard copy cost of production reports are distributed to Idaho Eastern Oregon onion growers by mid-February of each year. Adjusting entries are recorded based on feedback from industry. Questions or comments pertaining to the report can be submitted to greenwayresearch@outlook.com. Final cost of production reports and downloadable spreadsheets are made available electronically in spring of each year. To better track the production costs over time, an additional document has been introduced. A short 5-year comparison report was developed from historical cost of production reports /data; the summary report is available as a separate standalone document and is produced annually using 5 year rolling average data.

Procedural Changes from the 2022 to the 2023 production cycle

Direct comparisons with previously published estimates should not be made without accounting for differences in procedures, product use, and assumptions. In 2023 labor for set up and removal of drip irrigation systems was moved from the irrigation category to the labor category. This change was also incorporated into the 5-year summary documents. As a result, the labor and irrigation categories were reconciled in the summary document from 2019-2023 to allow for accurate comparisons over time.

The labor categories in the Malheur County budgets were adjusted to incorporate provisions for compliance with HB4002 which changed the requirement for overtime pay in agriculture. As of January 1, 2023, employers must pay overtime to agricultural workers after they work 55 hours in one workweek. The agricultural overtimes phase in will move the threshold to 48 hours per week in 2025, and 40 hours per week in 2027. The estimates reported in this document are designed to capture a representative cost to the industry and can be used as a starting point for capturing and thinking about the cost of overtime moving forward. Estimates in this document cannot capture the exact impact experienced by each individual farm. Estimates reported in this document are not intended as a resource for compliance with labor law and growers should seek independent legal advice regarding overtime obligations and issues associated with labor law compliance.

In 2023 the cost of packing was raised from $4.25 to $4.75. The interest charge in the packed budget was calculated using a different formula than has been used in previous production cycles. The level of opportunity cost associated with borrowed capital was adjusted downward to avoid overstating the expense. Due to the formula change caution must be exercised when comparing the 2022 production cycle with the 2023 production cycle.

The general labor category was adjusted to incorporate the effective wage rate for H2A labor rather than the effective rate for domestic labor to better reflect increasing use of the guest worker program. The 2023 budgets also incorporated an increase in the overall number of acres planted to onions in the model farm. In 2023, onion acres were increased by 50; the model farm is now based on 250 acres of onion production. Even though fixed costs increased in 2023, the costs were spread over a greater volume of acres resulting in a net decrease in fixed costs per acre when compared to previous production cycles when the costs were spread over fewer acres. It is always my goal to accurately capture ownership costs in an economically efficient manner. Equipment that is under-utilized results high fixed costs, while equipment with too many hours of use results in unrealistically low ownership costs.

Objectives and Limitations

The goal of this project is to provide consistently calculated unbiased estimates of the cost of growing onions in Idaho and Malheur County and to provide industry stakeholders tools for estimating and understanding the costs incurred by onion producers. The first budget (Appendix A) is representative of Malheur County, is based on **marketable yields** and includes the cost of packing, storing and month over month break even analysis. Appendix C is based on **marketable yields,** includes the cost of packing, storage costs, and monthly break-even analysis and is representative of Idaho. Budgets represented in (Appendix B Malheur County, and Appendix D Idaho) are based on **field run** yields and **omit** packing and storage charges.

The estimates developed in this document are intended to capture typical production practices and input use of Treasure Valley onion growers but **cannot capture the exact cost structure and resource use of each individual farm.** Onion prices used to generate the revenue sections of the are based on **adjusted historical averages.** Practices outlined in this document are not endorsements or recommendations for any particular product or practice used in the production of onions. Farm size, acres planted to onions, equipment choice, rotation, irrigation practices, and management will vary and are unique to each individual operation.

Farm Size and Rotations

The costs and returns estimates for Treasure Valley onion production estimated in this document are based on a hypothetical 1,200 acre "model" farm. The hypothetical farm produces onions on 250 acres irrigated with a drip system designed for a "conventional" bed. In addition to onions, the model farm represented in this budget produces sugarbeets, dry beans, corn, and wheat. Choice of rotation crops and length of rotation will vary by producer, field conditions, and the whole farm plan.

Yield and Price Considerations

Yields vary based on soil type, variety, location, and weather. Yields used in the Malheur County and Idaho field run budgets (Appendix B and D) are based only on preliminary estimates. The yields are adjusted after reports by the United States Department of Agriculture National Agricultural Statistics Service (USDA-NASS) are released in late February. As a result of limited reporting, the preliminary yields reported in the budget may deviate from actual yields by a significant degree.

Marketable yields used in (Appendix A Malheur County) and (Appendix C Idaho) are calculated by adjusting the field run yields discussed above. Adjustments were based the assumption that on average in 2023, 8% of the crop graded in the super colossal size class, 10% of the crop graded in the colossal size class, 35% of the crop graded in the jumbo size class, 30% of the crop graded in the medium size class and 17% of the crop was culled.

Prices used in Appendix A are based on **historical season averages** from the USDA **Agricultural Marketing Service Market News Reports.** The simple average of weekly high and low (FOB prices) by size class for **50# sacks** of yellow onions shipped from Idaho and Malheur County Oregon from October of 2021 through December 9 of 2023 are reported under the price heading of the budget. Actual price received will depend on **timing of sales** and can deviate **above or below the simple average reported** in the budget. **When using this document, caution must be exercised to apply pricing that is representative and accurate to each individual operation being considered.** The field run budgets are based on a proxy price of $6.00 per cwt in Idaho and Malheur County (Appendixes B and D).

Seed

Seed costs will vary based on variety, seeding rate, treatment and coating applied. Seed costs were budgeted at $712.80 per acre, up $73.92 per acre (12%) when compared to the $638.88 per acre estimate reported in 2022. When budgeting for the 2024 production cycle growers should plan for a 7%-9% increase in seed costs.

Fertilizer

Fertility needs will vary with location and soil type. Soil tests are required to determine precise nutrient needs for individual producers. The cost of soil testing in 2023 was budgeted at $5 per acre, no change from the 2022 production cycle. Overall fertilizer requirements were estimated based on use of nitrogen, phosphorous, and potassium. A small allowance was made to capture the cost of micronutrients and/or use of sulfuric acid. The actual price paid in 2023 will vary by individual producer and will be highly dependent on the timing of the purchase. In 2023 total fertilizer costs were estimated to be about $319.35 per acre, a decrease of $51.25, (14%) when compared to the $370.60 per acre budgeted for the 2022 crop year.

Plant Protection

Fumigation

The price of Vapam applied in Fall of 2022 in preparation for the 2023 crop was estimated to range between $8.25 and $8.50 per gallon, this budget used an estimated price of $8.25. Growers using Chloropicrin would have paid about $85.00 per gallon. Custom fumigation services were budgeted at $48.00 per acre. Fall 23 fumigation costs used in preparation for the 2024 crop cycle experienced significant increases, Vapam prices increased to $8.95 per gallon and chloropicrin prices increased to $89 per gallon. Custom application costs also increased in Fall of 2023 ranging from $54-$60 per acre.

Weed Control

Herbicides

In this budget, a combination of chemical applications, mechanical cultivation, and use of hand crews are assumed for suppression of weeds. A total of $104.82 per acre was budgeted for herbicides in 2022. In 2023 herbicide costs were budgeted at $103.11 per acre. The relatively stable herbicide costs were attributable to price decreases in some commonly used herbicides offsetting price increases in other commonly used herbicides incorporated in the budget. Adjuvants represent an important consideration within the overall plant protection plan. The cost of adjuvants will depend on the product used. The cost of adjuvants has been underreported in previous production cycles. In order to more accurately capture the costs, the 2023 budget adjusted the adjuvant pricing upward by $1.00 per pint and is found in the last line of the Plant Protection section of the budget.

Cultivating

In 2023 the onions were assumed to be cultivated 3 times for weed control, no change in comparison to the 2022 production cycle. Tractor hours and fuel use are estimated based on using a 160 horsepower (HP) wheel tractor and a 4 bed onion cultivator. Fuel, labor, and machinery costs for cultivating are accounted for and discussed in the “Machinery” and “Labor” sections of the budget.

Hand Weeding

The 2023 budget assumed hand weeding crews were used twice during the growing season at a charge of $150 per acre, no change from the 2022 budget. The cost of hand crews for weeding appears in the “Custom and Consultants” section of the budget and can vary widely based on location and individual farm.

Insects

For Treasure Valley onion growers one of the most serious concerns is thrips and thrips transmitted Iris yellow spot virus (IYSV). Thrips pressure will vary from year to year, field to field, by location, and with environmental factors. Management costs will depend on severity of pressure, and choice of products used. The 2023 production cycle assumed seven insecticide applications, no change from the product mix used in the 2022 production cycle. The total estimated cost of insecticides was $340.99 per acre a $19.74 increase (6%) from the estimated cost of $321.26 per acre estimated in 2022.

Diseases & Other Treatments

Six fungicide applications were budgeted for 2023, no change in the product mix or number of applications as compared to the 2022 production cycle. A total of $190.69 was budgeted in 2022. In 2023 the cost for the same product mix was estimated to be $193.02 reflecting relatively stable fungicide pricing.

Use of chlorine dioxide for maintenance of the drip lines was budgeted at $36 per gallon in 2023, a $7 increase when compared to the $29 per gallon budgeted for this expense in 2022. One application of MH-30 at a cost of $45.22 was budgeted in 2023 to help with control of in storage sprouting. The cost of MH-30 in 2023 was up $2.66 when compared to the $42.56 budgeted for this expense in 2022.

Year over Year Comparisons Plant Protection Category

In 2022 total plant protection costs (herbicides, insecticides, fungicides, fumigant, and other treatments-MH-30 and Chlorine Dioxide) were estimated to be about $1,054.33 per acre. In the 2023 production cycle plant protection costs were estimated to be $1,125.34 per acre. Overall, expenses in the plant protection category were estimated to increase $71 per acre. The 7% increase in 2023 as compared to 2022 is primarily due to increases in insecticide pricing, the significant jump in chlorine dioxide for maintenance of drip lines and increases in fumigation costs.

Fuel

All fuel charges that appear in the budget are estimated using pricing from the United States Energy Information Administration. Fuel tax adjustments are applied to retail pricing for Number 2 diesel and used as a proxy for the dyed (off road) diesel price. Fuel prices often fluctuate, and **actual price paid will depend on when fuel is purchased**. To arrive at a representative figure for fuel pricing and to help smooth variation associated with the timing of fuel purchases, a nine-month average is used in the budget. The calculated nine (Jan 2022-Sept 2022) month average of $4.53 per gallon was used in the 2022 budget, the 2023 budget uses an adjusted (Jan 2023-Sept 2023) nine-month average of $3.82 per gallon, a $0.71 per gallon decrease in comparison to the 2022 production cycle.

On road diesel was estimated using the eight-month (March 2022-October 2022) retail average price of $4.39 per gallon, a $0.94 per gallon decrease when compared to the 2022 production cycle. On road gasoline pricing was based on the eight-month (March 2022-Oct 2022) retail average price of regular gas in the Rocky Mountain region of $3.67, a $0.72 per gallon decrease in comparison to the 2022 production cycle.

Irrigation

Water Assessment
Surface water assessments are based on fees charged by irrigation districts in the region. A charge of $75.00 per acre is budgeted for Malheur County, while a charge of $68.00 is budgeted for Idaho.

Pumping Charge

This budget assumes the pump used to supply the drip system with water is powered by a diesel engine. Energy requirements for operating the pump are estimated using standard agricultural engineering formulas that relate PSI, pumping lift, and irrigation application rates to the Nebraska Performance Criteria (NPC) water horsepower value for diesel fuel. Onions receive 30-acre inches of water throughout the growing season. A minimum of 20 gallons of diesel fuel per acre would be needed to power the pump. Applying the $3.82 per gallon dyed diesel charge to the 20 gallons of fuel results in a total charge of $76.40 per acre dedicated to fuel for powering the pump, a decrease of $14.20 per acre when compared to the 2022 season. Those using an electric pump would have paid an estimated $60-$75 per acre to power the pump.

Growers should prepare for increases in power costs corresponding with Idaho power's filing of a general rate case. Irrigation costs are anticipated to increase 5.09%, small general service is expected to increase 4.89%, and large general service is expected to increase by 2.01% going into 2024. Increases in residential rates are estimated at 4.90% and may impact housing costs for H2A labor. More information pertaining to the general rate case can be found at https://www.idahopower.com/about-us/company-information/rates-and-regulatory/idaho-general-rate-case/#:~:text=The%20settlement%20also%20calls%20for,fixed%20costs%20among%20residential%20customers.

Irrigation Repair

Repair and maintenance on the pump are estimated to cost $6.00 per acre, up a buck from the 2022 production cycle.

Drip Supplies and Labor for Setting Up the Drip System

Drip tape and supplies are budgeted at $325.00 per acre, a (3%) decrease from the 2022 production cycle. Labor for setting up and removing the drip irrigation system is budgeted at 8 hours per acre, no change from the 2022 production cycle. While the number of budgeted hours did not change from the 2022 production cycle to the 2023 production cycle the hourly rate did increase in both Idaho and Malheur County. In the 2023 budget the **effective** rate for H-2A labor used to set up the drip irrigation system is estimated to be $24.26 per hour in Malheur County, and $21.17 per hour in Idaho. Detailed descriptions of wage rates are outlined in the "labor" section of this document. The $14 per acre charge to cover drip tape disposal expenses was held flat in 2023 as compared to 2022. When budgeting for the 2024 production cycle, growers can expect pricing for irrigation supplies to remain flat and plan for pricing similar to the 2023 production cycle.

Machinery

Variable Costs of Machinery

The operating or variable cost categories that appear under the Machinery heading in the budget include charges allocated to off road (dyed) diesel for tillage, spraying, planting, and harvest operations. A small charge to cover road gas and diesel for pickups and service trucks used on the farm is allocated to the budget. Machinery repairs, lube, and custom hauling charges also appear under the machinery heading of the budget.

Tillage and Harvest Practices Used to Calculate Fuel Requirements

Tillage, harvest, and pesticide application practices used to calculate fuel requirements were assumed to be the same in the 2022 production cycle when compared to the 2023 cycle.

Fuel Consumption Calculations Appearing in the Machinery Section of the Budget

Fuel consumption per hour for all field and harvest operations that are not custom applied are estimated using agricultural engineering equations. Horsepower is related to fuel consumption per hour using a factor of 0.044 for diesel. An example calculation for per hour fuel consumption is provided for a 160 HP tractor (160 X 0.044 = 7.04 gallons per hour of use). Fuel costs per hour are calculated by using the estimated fuel consumption of each operation multiplied by the cost of diesel fuel. Using the previous example ($3.82 X 7.04=$26.89 per hour).

Acres per hour calculations are used as intermediary step in estimation of final costs used in the budget and apply the following agricultural engineering formula.

$$\frac{\text{Speed (mph) x machine width (ft) x machines field efficiency (\%)}}{8.25}$$

In the budget, all machinery hours (tractor + implement) are aggregated to arrive at a single per acre value before applying the cost of diesel fuel. In 2023, estimated fuel use was budgeted at 42.17 gallons per acre, no change in the amount budgeted in the previous year. However, use of efficient tank mixes, or fewer overall applications could reduce overall fuel consumption resulting in lower costs than are estimated in this budget. The $3.82 per gallon price for dyed diesel is applied to the estimated 42.17 gallons per acre to arrive at an estimated total cost of $161.09 per acre for fuel in the 2023 growing season. The estimated charge represents a decrease of $29.94 per acre when compared to the 2022 production cycle.

Repairs & Maintenance

The repair factor was slightly higher in the 2023 crop cycle when compared to the 2022 cycle and budgeted at $78 per acre.

Lube

Lubrication costs are estimated using the standard ag engineering coefficient of 15 percent of estimated fuel costs. In 2023 the costs were estimated to be about $27.24 per acre, a decrease of $5.09 per acre when compared to the 2022 production cycle.

Hauling Charge

In 2023 the custom hauling charge was budgeted at $9 per ton, a $1.00 per ton decrease in comparison to 2022. Considerable variation in hauling charges can exist based on distance of the haul, but reasonable estimates should range between $7-$10 per ton. While the hauling charge per ton was down, the overall number of tons hauled was up because of yields that were more typical than have been achieved in the previous two production cycles.

Overall, the fuel, lube, repair, and hauling charges appearing in the machinery category were budgeted at $640.09 in 2023, resulting about a 1% per acre increase over the cost allocated to the same category in the 2022 production cycle in Malheur County, and no significant change in Idaho. Decreases in fuel prices offset increases in the volume of onions hauled, but exact year over changes will depend on yields and actual cwt hauled.

Labor

Assumed wages include a base hourly rate plus adjustments for payroll taxes, workman's compensation, and benefits. Base H2-A hourly rates were $15.68 in Idaho, and $17.97 in Oregon in the 2023 growing season. In the 2022 budget the H-2A rate of $14.68 per hour was used in Idaho and $17.41 was used for Malheur County. When planning for 2024 growers need to adjust base H2-A labor rates in Idaho using the $16.54 AEWR rate. Malheur County producers will need to adjust the base rate to $19.25 Additional information regarding Adverse Effect Wage Rates can be found via the US Department of Labor Website https://flag.dol.gov/wage-data/adverse-effect-wage-rates#current-aewrs

For locally sourced labor used in the irrigator category, a base rate of $16.00 is used for Idaho. In Oregon, locally sourced irrigators are paid a base rate of $18.25. General labor is figured using the H2A-rates for Oregon and Idaho respectively. The rate for locally sourced truck drivers in Idaho is factored at $21 per hour. In Oregon, truck drivers are paid a base rate of $22 per hour. Sorters and pickers are paid at a base rate of $15.68 per hour in Idaho, and $17.97 in Oregon. Locally sourced machinery (tractor and harvest equipment operators) are paid a base rate for skilled labor of $23.50 in both Idaho and Oregon in 2023. The increases in labor costs reflect the competitiveness and scarcity of labor in 2023 and are calculated using local data, information from the H2-A guest worker program, and the USDA farm labor report.

All base labor rates are adjusted by the appropriate percentage overhead factor to capture the EFFECTIVE wage rate being paid. The H-2A labor rate is adjusted by a factor of 35%, a 5% increase over the 2022 production cycle. The adjustment is made to cover meals, transportation, and housing resulting in an effective rate of $21.17 per hour in Idaho, and a $24.26 per hour effective rate in Oregon in the 2023 budgets. A 15% adjustment (to cover payroll taxes and workman's compensation) is applied to the base rate for irrigators, truck driver labor, and sorting labor categories resulting in effective rates of $18.40, $24.15, and $18.03 per hour in the 2023 budget for Idaho. The effective rates for the same labor classes in Oregon are estimated to be $20.99, $25.30 and $20.67 respectively. The labor rate for machinery (tractor and harvest equipment) operators is adjusted by a factor of 25% to cover workman's compensation, payroll taxes, and benefits resulting in an effective wage rate of $29.38 per hour in 2022. The tractor/harvest equipment labor is classified as skilled labor and based on the assumption that the rate is representative of market conditions for skilled operators in both Idaho and Oregon and is applied to the machinery labor category in both the Malheur County and Idaho Budgets.

Overtime Calculations in the Malheur County budgets are computed using the 55 hour per workweek threshold specified by HB4002. The calculations are based on the assumption that equipment operators are part of the farms salaried workforce who met the salary and duties test requirements to qualify for the white-collar exemption. Those seeking white collar exemptions need to be sure the employee meets the proper qualifications (salary and duties test), and that proper documentation to support the exemption is in place. As a result of the white collar exemption, no overtime is calculated for the equipment operator class of labor. This budget assumes the general labor category is held to 55 hours per week or less, thus no overtime accrues. Overtime hours are assumed to accrue for irrigators, sorters/pickers, truck drivers, and those who to set up drip irrigation systems. The assumptions in this budget are based on using locally sourced labor in the irrigator, sorting/picking, and truck driving categories. The overtime calculations use the effective rate paid to capture the impact of overtime on payroll taxes. In the case of H2A labor used for the drip irrigation set up category, the overtime rate is figured at 1.5 times the base H2A rate of $17.97 not the effective rate. The hourly effective rate used for non-overtime hours already captures the overhead costs (such as housing, paperwork etc) associated with use of the guest worker program, and it is assumed that those costs would not change significantly because of qualifying overtime hours.

Storage & Packing

Storage costs in this budget were unchanged from the 2022 to the 2023 production cycle, however some producers experienced increases in binning fees and should adjust the storage section to match with fees incurred. The budgeted charge for bin rental and storage operating costs was $1.00 per cwt stored. The charge for packing was estimated at $4.75 per **50# sack, a $0.50 (per sack) increase over the previous year.**

Fees & Crop Insurance

The allocations for crop insurance and assessments remained unchanged from the 2022 to the 2023 production cycle. Crop Insurance was budgeted at $84.00 per acre. The assessment fee for onions grown under the federal marketing order in the Idaho-Eastern Oregon region was $0.05 per cwt. Growers should plan for an increase in assessments moving into the 2024 production cycle. The budget also included a $17 per acre allocation to cover the costs of compliance with GAP audits, a $2 increase over the 2022 production cycle.

Operating Interest

Operating Interest in the field run budget is based on a borrowing period of 6 months and is calculated at 10.0% of total operating costs. Operating interest in 2023 was 3% higher than the 7% rate applied to the 2022 production cycle. The interest charge in the packed budget was calculated using a different formula than has been used in previous production cycles. The level of opportunity cost associated with borrowed capital was adjusted downward to avoid overstating the expense. Due to the formula change caution must be exercised when comparing the 2022 production cycle with the 2023 production cycle.

Overall Operating Costs per acre in Appendix A were estimated to be $2,363.86 per acre higher in 2023 for Malheur County when compared to the estimates calculated in Appendix A of the 2022 production cycle. The significant jump in costs is attributable to yields returning to an average level; the greater overall yields resulted in increased binning fees, packing fees and assessments. When compared on a per sack basis **the operating cost were $0.40 per PAID 50# sack lower than in the 2022 production cycle. The per unit reduction in costs is attributable to spreading costs over a greater yield in 2023 as compared to the previous two years of abnormally low yields.** In Idaho, overall operating costs per acre in Appendix C were estimated to be $2,109.09 per acre higher in 2023 when compared to Appendix A of the 2022 production cycle. The significant jump was due to increased yields resulting in increases in binning fees, packing/storing charges, and assessments. **When compared on a per sack basis operating costs were still $0.38 per PAID 50# sack lower when compared to 2022. Actual yields will vary by location altering the cost per paid 50# sack estimates. Those using this document should apply yields representative of their operation.**

Overall operating costs per acre in Appendix B (field run budgets no storage) were estimated to be $234.56 per acre higher in Malheur County when compared to the estimates calculated in Appendix B (field run no storage) of the 2022 production cycle. In Idaho overall operating costs per acre were $206.88 per acre higher in 2023 when compared to the estimates calculated in Appendix D (field run no storage) of the 2022 production cycle. The 4-5% increase in both regions was driven primarily by increases in operating interest, labor, and seed costs. When compared on a per hundredweight basis, 2023 operating costs in Malheur County were $1.23 lower than in the 2022 production cycle but were based on a yield 165 cwt greater than was documented in the previous production cycle. Caution must be exercised when interpreting the per unit figure over time because of the extreme variability in yield over the last few production cycles. In Idaho operating costs were $1.08 per cwt lower than the 2022 production cycle but based on a yield of 785 cwt per acre, an estimate that is 150 cwt greater than the yield of 635 cwt used for the calculation in the previous year. The volatility in yields has resulted in a highly pronounced cost changes when measured on a per cwt basis which should be interpreted with caution when making comparisons over time.

Fixed Costs

Fixed costs categories for onion production in the Treasure Valley include:

(1) Depreciation and interest on machinery

(2) Machinery insurance and housing

(3) Land Rent

Equipment values are representative of a mix of new and used equipment. The USDA Prices Paid Index for farm machinery was used to make valuation adjustments from the 2022 to the 2023 production cycle.

Interest is an opportunity cost of capital and is charged for all capital outlay not just the amount borrowed. The interest rate in the fixed cost section of the budgets is estimated at 8%, up from the 7.5% figured in the 2022 production cycle. The cost of borrowed capital will depend on loan terms and timing of purchases. If some of the equipment and other borrowed capital in the fixed cost section were financed at lower (fixed) interest rates the cost of capital will be lower than the estimates presented in this budget.

Housing and Insurance are estimated at 1% of the Average Annual Investment calculated for each piece of equipment used on the farm.

Land Rent

The cash land rent in the 2023 production cycle was budgeted to be $375 per acre in Malheur County and $400 in Idaho and is based on adjusted USDA cash land rent surveys and local land rent surveys. The estimates used in this budget are based on limited data and should be interpreted with caution. The cash land rent reported in this document does not accurately capture the costs associated with land ownership.

Overhead Cost & Management Fee

Overhead costs are calculated at 3% of total operating costs no change from the 2022 production cycle. The overhead allocation accounts for office expenses, accounting fees, and utilities. The allocation to management is estimated at 5% of operating costs. The management fees in appendix A and C are based on adjusted variable costs (variable costs – packing charges).

Total Costs

Total (Fixed + Operating) costs in Malheur County (Appendix A-marketable yield with packing costs) were estimated to be $13,466.01 per acre, an increase of $2328.47 per acre when compared to the 2022 production cycle. Even though total costs per acre were up, total costs per paid 50# sack were $0.76 lower than in 2022 when compared on a per paid 50# sack basis. Total (Fixed + Operating) costs in Idaho (Appendix C) were estimated to be $13,298.23 per acre, an increase of $2,093.62 per acre when compared to the 2022 production cycle. When compared on a PAID 50# sack basis, costs were $0.71 per sack lower than in the 2022 production cycle. Total (Fixed + Operating) costs (field run no storage) in Malheur County (Appendix B) were estimated to be $6,013.41 an increase of $154.41 per acre when compared to the 2022 production cycle. When compared on a per hundredweight basis, costs were $1.79 per cwt lower than in the 2022 production cycle. The decrease in per cwt costs is due to significantly greater yields. In Idaho, total (Fixed + Operating) costs (Appendix D) were estimated to be $5,955.13 an increase of $130.05 per acre when compared to the 2022 production cycle. When compared on a per hundredweight basis, costs were $1.59 per cwt lower than in the 2022 production cycle. The nature of the cost decrease is due to costs being spread over significantly more cwt of onions when compared to the previous two production cycles.

Acknowledgements

I want to extend my most sincere appreciation to all segments of the onion industry for providing information to support this work. Funding provided by the Idaho-Eastern Oregon Research Committee makes this analysis possible.

Appendix A Cost of Production with Storage and Packing, **Marketable Yields Malheur County**

	Quanity	Unit	Price	$/acre			
Super Colossal	126	50 # Sack	$18.90	$2,373.84			
Colossal	157	50 # Sack	$16.30	$2,559.10			
Jumbo	550	50 # Sack	$14.00	$7,693.00			
Medium	471	50 # Sack	$7.96	$3,749.16			
Total	1,303	50 # Sack	$12.57	$16,375.10			
Seed							
Seed	0.33	pail	$2,160.00	$712.80	2022	$ Change	% Change
Subtotal Seed				$712.80	$638.88	$73.92	12%
Fertilizer:							
Dry Nitrogen - Pre-plant	50	lb	$0.86	$43.00	$49.00	-$6.00	-12%
Dry P2O5	115	lb	$0.69	$79.35	$96.60	-$17.25	-18%
Micronutrients/Sulfuric Acid	1	ac	$38.00	$38.00	$35.00	$3.00	9%
K20	100	lb	$0.66	$66.00	$74.00	-$8.00	-11%
Liquid Nitrogen	100	lb	$0.93	$93.00	$116.00	-$23.00	-20%
				$319.35	$370.60	-$51.25	-14%
Plant Protection:							
Vapam	40.0	gal	$8.25	$330.00	$300.00	$30.00	10%
Select	16.0	fl oz	$0.89	$14.24	$12.80	$1.44	11%
Dual Magnum	2.0	pint	$10.63	$21.26	$20.14	$1.12	6%
Roundup	22.0	fl oz	$0.28	$6.16	$10.12	-$3.96	-39%
Outlook (2x)	21.0	fl oz	$1.28	$26.88	$26.46	$0.42	2%
Brox	1.5	pint	$7.38	$11.07	$11.04	$0.03	0%
Goal Tender (2x)	10	fl oz	$1.05	$10.50	$10.50	$0.00	0%
Prowl H2O (2x)	2	pint	$6.50	$13.00	$13.76	-$0.76	-6%
Radiant (2x)	16	fl oz	$8.20	$131.20	$121.28	$9.92	8%
Lannate LV (1x)	3	pint	$11.00	$33.00	$33.00	$0.00	0%
Movento (2X)	10	fl oz	$11.05	$110.50	$109.30	$1.20	1%
AZA-Direct	16	fl oz	$2.34	$37.44	$30.56	$6.88	23%
M-Pede	1	qt	$16.25	$16.25	$15.04	$1.21	8%
Agrimek	3.5	fl oz	$3.60	$12.60	$12.08	$0.52	4%
Manzate Max (2X)	4.8	qt	$10.50	$50.40	$47.62	$2.78	6%
Zing	30	fl oz	$0.69	$20.70	$19.80	$0.90	5%
Pristine (1x)	16	fl oz	$3.75	$60.00	$58.40	$1.60	3%
Fontellis	24	fl oz	$2.13	$51.12	$54.00	-$2.88	-5%
Badge SC	1.5	pint	$7.20	$10.80	$10.88	-$0.07	-1%
Chlorine Dioxide (drip lines)	1	gal	$36.00	$36.00	$29.00	$7.00	24%
MH30 Sprout Inhibitor	1.33	gal	$34.00	$45.22	$42.56	$2.66	6%
Adjuvants (11X)	11	pint	$7.00	$77.00	$66.00	$11.00	17%
				$1,125.34	$1,054.33	$71.01	7%
Custom & Consultants:							
Custom Fertilize	2	ac	$18.00	$36.00	$21.00	$15.00	71%
Custom Fumigate - Deep	1	ac	$48.00	$48.00	$48.00	$0.00	0%
Hand Weed	2	ac	$150.00	$300.00	$300.00	$0.00	0%
Soil Testing	1	ac	$5.00	$5.00	$5.00	$0.00	0%
Custom Aerial Application	2	ac	$15.00	$30.00	$30.00	$0.00	0%
				$419.00	$404.00	$15.00	4%
Irrigation							
Water Assessment	1.00	acre	$75.00	$75.00	$70.00	$5.00	7%
Irrigation Fuel pump (diesel)	20.00	gal	$8.82	$176.40	$90.60	$85.80	95%
Irrigation Repair (pump)	1.00	ac	$6.00	$6.00	$5.00	$1.00	20%
Drip Tape/Supplies	1.00	ac	$325.00	$325.00	$335.00	-$10.00	-3%
Drip Tape recycling/haul away	1.00	ac	$14.00	$14.00	$14.00	$0.00	0%
Total Irrigation				$596.40	$514.60	$81.80	16%
Machinery							
Equipment Fuel	42.17	gal	$3.82	$161.09	$191.03	-$29.94	-16%
Road Gas	2.00	gal	$3.67	$7.34	$8.78	-$1.44	-16%
Road Diesel	3.00	gal	$4.39	$13.17	$15.69	-$2.52	-16%
Repairs	1.00	ac	$78.00	$78.00	$75.00	$3.00	4%
Lube				$27.24	$32.33	-$5.09	-16%
Hauling charge	785	cwt	$0.45	$353.25	$310.00	$43.25	14%
Total Fuel, Lube, Repairs				$640.09	$632.83	$7.26	1%
Labor							
Equipment Labor	5.22	hrs	$29.38	$153.36	$146.96	$6.40	4%
Irrigation Labor	1.25	hrs	$20.99	$26.24			
OT Irrigation	0.25	hrs	$31.49	$7.87			
Total Irrigation	1.50	hrs		$34.11	$31.05	$3.06	10%
Sorting/Pickers Labor	2.00	hrs	$20.67	$41.34			
	0.50	hrs	$31.01	$15.50			
Total Sorting/Picking	2.50	hrs		$56.84	$50.05	$6.79	14%
Truck Drivers	4.50	hrs	$25.30	$113.85			
	0.50	hrs	$37.95	$18.98			
Total Truck Driving	5.00	hrs		$132.83	$120.75	$12.08	10%
General Labor	3.50	hrs	$24.26	$84.91	$72.45	$12.46	17%
Irrigation Set-up/Removal Labor	7.75	hrs	$24.26	$188.02			
	0.25	hrs	$26.96	$6.74			
Subtotal Irrigation	8.00	hrs		$194.76	$181.04	$13.72	8%
Total General, Equipment & Harvest Labor				$656.80	$602.30	$54.50	9.0%
Packing :							
Bin Rental	785	cwt	$1.00	$785.00	$620.00	$165.00	27%
Packing	1,303	50#	$4.75	$6,189.73	$4,267.00	$1,922.73	45%
Storage & Packing Subtotal				$6,974.73	$4,887.00	$2,087.73	43%
Other (Fees and Insurance):							
Crop Insurance	1	ac	$84.00	$84.00	$84.00	$0.00	0%
Assessments	785	cwt	$0.05	$39.25	$31.00	$8.25	27%
GAP Audit	1	ac	$17.00	$17.00	$15.00	$2.00	13%
Subtotal Fees				$140.25	$130.00	$10.25	8%
Subtotal Variable Costs				$11,584.76	$9,234.53	$2,350.23	25%
Interest on Operating Capital				$337.89	$324.26	$13.63	4%
Total Operating Costs				$11,922.65	$9,558.79	$2,363.86	25%

Appendix A (Continued) Cost of Production with Storage and Packing, **Marketable Yields Malheur County**

Fixed Costs						
Depreciation, Interest, Housing & Insurance On Equipment			$524.03	$640.00	-$115.97	-18%
Land	1.00	$375.00	$375.00	$355.00	$20.00	6%
Management			$286.65	$266.09	$20.56	8%
Overhead			$357.68	$287.66	$70.02	24%
Total Fixed Costs			$1,543.36	$1,548.75	-$5.39	0%
Total Operating and Fixed Costs			$13,466.01	$11,137.53	$2,328.47	21%
Returns over operating costs			$4,452.45			
Returns over Total Costs			$2,909.09			
Operating Cost (Per PAID 50# sack)			$9.15	$9.55	-$0.40	-4%
Total Cost (per PAID 50# sack)			$10.33	$11.09	-$0.76	-7%
	-		+			
Price	15%	Paid Yield	15%			
Breakeven Yield 50# sack	1108	1303	1499			
Operating Cost 50# sack	$10.76	$9.15	$7.96			
Ownership Cost 50 # sack	$1.39	$1.18	$1.03			
TC	$12.16	$10.33	$8.99			
		Price				
Yield	$10.68	$12.57	$14.45			
Operating Cost 50# sacks	1116	949	825			
Ownership Cost 50# sacks	144	123	107			
TC	1261	1072	932			
Month over Month Breakeven with Packing and Storage						
November	$10.85					
December	$10.90					
January	$10.95					
February	$11.16					
March	$11.68					

Appendix B. Field Run Cost of Production NO Storage NO Packing Malheur County

	Quanity	Unit	Price	$/acre	2022	Yield Change	
Field Run Yield	785	cwt	$ 6.00	$4,710.00	620	165	27%
Seed						$ Change	% Chang
Seed	0.33	pail	$ 2,160.00	$712.80			
Subtotal Seed				$712.80	$638.88	$73.92	11.6%
Fertilizer:							
Dry Nitrogen - Pre-plant	50	lb	$0.86	$43.00	$49.00	-$6.00	-12%
Dry P2O5	115	lb	$0.69	$79.35	$96.60	-$17.25	-18%
Micronutrients/Sulfuric Acid	1	ac	$38.00	$38.00	$35.00	$3.00	9%
K20	100	lb	$0.66	$66.00	$74.00	-$8.00	-11%
Liquid Nitrogen	100	lb	$0.93	$93.00	$116.00	-$23.00	-20%
				$319.35	$370.60	-$51.25	-14%
Plant Protection:							
Vapam	40.0	gal	$8.25	$330.00	$300.00	$30.00	10%
Select	16.0	fl oz	$0.89	$14.24	$12.80	$1.44	11%
Dual Magnum	2.0	pint	$10.63	$21.26	$20.14	$1.12	6%
Roundup	22.0	fl oz	$0.28	$6.16	$10.12	-$3.96	-39%
Outlook (2x)	21.0	fl oz	$1.28	$26.88	$26.46	$0.42	2%
Brox	1.5	pint	$7.38	$11.07	$11.04	$0.03	0%
Goal Tender (2x)	10.0	fl oz	$1.05	$10.50	$10.50	$0.00	0%
Prowl H2O (2x)	2	pint	$6.50	$13.00	$13.76	-$0.76	-6%
Radiant (2x)	16	fl oz	$8.20	$131.20	$121.28	$9.92	8%
Lannate LV (1x)	3	pint	$11.00	$33.00	$33.00	$0.00	0%
Movento (2X)	10	fl oz	$11.05	$110.50	$109.30	$1.20	1%
AZA-Direct	16	fl oz	$2.34	$37.44	$30.56	$6.88	23%
M-Pede	1	qt	$16.25	$16.25	$15.04	$1.21	8%
Agrimek	3.5	fl oz	$3.60	$12.60	$12.08	$0.52	4%
Manzate Max (2X)	4.8	qt	$10.50	$50.40	$47.62	$2.78	6%
Zing	30	fl oz	$0.69	$20.70	$19.80	$0.90	5%
Pristine (1x)	16	fl oz	$3.75	$60.00	$58.40	$1.60	3%
Fontellis	24	fl oz	$2.13	$51.12	$54.00	-$2.88	-5%
Badge SC	1.5	pint	$7.20	$10.80	$10.88	-$0.07	-1%
Chlorine Dioxide (drip lines)	1	gal	$36.00	$36.00	$29.00	$7.00	24%
MH30 Sprout Inhibitor	1.33	gal	$34.00	$45.22	$42.56	$2.66	6%
Adjuvants (11X)	11.0	pint	$7.00	$77.00	$66.00	$11.00	17%
				$1,125.34	$1,054.33	$71.01	7%
Custom & Consultants:							
Custom Fertilize	2	ac	$18.00	$36.00	$21.00	$15.00	71%
Custom Fumigate - Deep	1	ac	$48.00	$48.00	$48.00	$0.00	0%
Hand Weed	2	ac	$150.00	$300.00	$300.00	$0.00	0%
Soil Testing	1	ac	$5.00	$5.00	$5.00	$0.00	0%
Custom Aerial Application	2	ac	$15.00	$30.00	$30.00	$0.00	0%
				$419.00	$404.00	$15.00	4%
Irrigation							
Water Assessment	1.00	acre	$75.00	$75.00	$70.00	$5.00	7%
Irrigation Fuel pump (diesel)	20.0	gal	$3.82	$76.40	$90.60	-$14.20	-16%
Irrigation Repair (pump)	1.00	ac	$6.00	$6.00	$5.00	$1.00	20%
Drip Tape/Supplies	1.00	ac	$325.00	$325.00	$335.00	-$10.00	-3%
Drip Tape recycling/haul away	1.00	ac	$14.00	$14.00	$14.00	$0.00	0%
Total Irrigation				$496.40	$514.60	-$18.20	-4%
Machinery							
Equipment Fuel	42.17	gal	$3.82	$161.09	$191.03	-$29.94	-16%
Road Gas	2.00	gal	$3.67	$7.34	$8.78	-$1.44	-16%
Road Diesel	3.00	gal	$4.39	$13.17	$15.69	-$2.52	-16%
Repairs	1.00	ac	$78.00	$78.00	$75.00	$3.00	4%
Lube				$27.24	$32.33	-$5.09	-16%
Hauling charge	785	cwt	$0.45	$353.25	$310.00	$43.25	14%
Total Fuel, Lube, Repairs				$640.09	$632.83	$7.26	1%
Labor							
Equipment Labor	5.22	hrs	$29.38	$153.36	$146.96	$6.40	4%
Irrigation Labor	1.25	hrs	$20.99	$26.24			
OT Irrigation	0.25	hrs	$31.49	$7.87			
Total Irrigation	1.50	hrs		$34.11	$31.05	$3.06	10%
Sorting/Pickers Labor	2.00	hrs	$20.67	$41.34			
	0.50	hrs	$31.01	$15.50			
Total Sorting/Picking	2.50	hrs		$56.84	$50.05	$6.79	14%
Truck Drivers	4.50	hrs	$25.30	$113.85			
	0.50	hrs	$37.95	$18.98			
Total Truck Driving	5.00	hrs		$132.83	$120.75	$12.08	10%
General Labor	3.50	hrs	$24.26	$84.91	$72.45	$12.46	17%
Irrigation Set-up/Removal Labor	7.75	hrs	$24.26	$188.02			
	0.25	hrs	$26.96	$6.74			
Subtotal Irrigation	8.00	hrs		$194.76	$181.04	$13.72	8%
Total General, Equipment & Harvest Labor				$656.80	$602.30	$54.50	9.0%
Other (Fees and Insurance):							
Crop Insurance	1	ac	$84.00	$84.00	$84.00	$0.00	0%
Assessments	785	cwt	$0.05	$39.25	$31.00	$8.25	27%
GAP Audit	1	ac	$17.00	$17.00	$15.00	$2.00	13%
Subtotal Fees				$140.25	$130.00	$10.25	8%
Subtotal Variable Costs				$4,510.03	$4,347.53	$162.50	4%
Interest on Operating Capital				$225.50	$153.45	$72.05	47%
Total Operating Costs				$4,735.54	$4,500.98	$234.56	5%

Appendix B. Continued **Field Run** Cost of Production NO Storage NO Packing Malheur County

Fixed Costs						
Depreciation, Interest, Housing & Insurance On Equipment			$524.03	$640.00	-$115.97	-18%
Land	1.00	$375.00	$375.00	$355.00	$20.00	6%
Management			$236.78	$226.89	$9.89	4%
Overhead			$142.07	$136.13	$5.93	4%
Total Fixed Costs			$1,277.88	$1,358.02	-$80.14	-6%
Total Operating and Fixed Costs			$6,013.41	$5,859.00	$154.41	3%
Returns over operating costs			-$25.54			
Returns over Total Costs			-$1,303.41			
Operating Cost (Per Cwt)			$6.03	$7.26	-$1.23	-17%
Total Cost (per cwt)			$7.66	$9.45	-$1.79	-19%
	-		+			
Price	15%	Yield	15%			
Breakeven	667	785	903			
Operating Cost	$7.10	$6.03	$5.25			
Ownership Cost	$1.92	$1.63	$1.42			
TC	$9.01	$7.66	$6.66			
		Price				
Yield	$5.10	$6.00	$6.90			
Operating Cost	929	789	686			
Ownership Cost	251	213	185			
TC	1179	1002	872			

Appendix C Cost of Production with Storage and Packing, Marketable Yields Idaho

	Quanity	Unit	Price	$/acre			
Super Colossal	126	50 # Sack	$18.90	$2,373.84			
Colossal	157	50 # Sack	$16.30	$2,559.10			
Jumbo	550	50 # Sack	$14.00	$7,693.00			
Medium	471	50 # Sack	$7.96	$3,749.16			
Total	1,303	50 # Sack	$12.57	$16,375.10			
Seed							
Seed	0.33	pail	$ 2,160.00	$712.80	2022	$ Change	% Change
Subtotal Seed				$712.80	$638.88	$73.92	12%
Fertilizer:							
Dry Nitrogen - Pre-plant	50	lb	$0.86	$43.00	$49.00	-$6.00	-12%
Dry P2O5	115	lb	$0.69	$79.35	$96.60	-$17.25	-18%
Micronutrients/Sulfuric Acid	1	ac	$38.00	$38.00	$35.00	$3.00	9%
K20	100	lb	$0.66	$66.00	$74.00	-$8.00	-11%
Liquid Nitrogen	100	lb	$0.93	$93.00	$116.00	-$23.00	-20%
				$319.35	$370.60	-$51.25	-14%
Plant Protection:							
Vapam	40.0	gal	$8.25	$330.00	$300.00	$30.00	10%
Select	16.0	fl oz	$0.89	$14.24	$12.80	$1.44	11%
Dual Magnum	2.0	pint	$10.63	$21.26	$20.14	$1.12	6%
Roundup	22.0	fl oz	$0.28	$6.16	$10.12	-$3.96	-39%
Outlook (2x)	21.0	fl oz	$1.28	$26.88	$26.46	$0.42	2%
Brox	1.5	pint	$7.38	$11.07	$11.04	$0.03	0%
Goal Tender (2x)	10	fl oz	$1.05	$10.50	$10.50	$0.00	0%
Prowl H2O (2x)	2	pint	$6.50	$13.00	$13.76	-$0.76	-6%
Radiant (2x)	16	fl oz	$8.20	$131.20	$121.28	$9.92	8%
Lannate LV (1x)	3	pint	$11.00	$33.00	$33.00	$0.00	0%
Movento (2X)	10	fl oz	$11.05	$110.50	$109.30	$1.20	1%
AZA-Direct	16	fl oz	$2.34	$37.44	$30.56	$6.88	23%
M-Pede	1	qt	$16.25	$16.25	$15.04	$1.21	8%
Agrimek	3.5	fl oz	$3.60	$12.60	$12.08	$0.52	4%
Manzate Max (2X)	4.8	qt	$10.50	$50.40	$47.62	$2.78	6%
Zing	30	fl oz	$0.69	$20.70	$19.80	$0.90	5%
Pristine (1x)	16	fl oz	$3.75	$60.00	$58.40	$1.60	3%
Fontellis	24	fl oz	$2.13	$51.12	$54.00	-$2.88	-5%
Badge SC	1.5	pint	$7.20	$10.80	$10.88	-$0.07	-1%
Chlorine Dioxide (drip lines)	1	gal	$36.00	$36.00	$29.00	$7.00	24%
MH30 Sprout Inhibitor	1.33	gal	$34.00	$45.22	$42.56	$2.66	6%
Adjuvants (11X)	11	pint	$7.00	$77.00	$66.00	$11.00	17%
				$1,125.34	$1,054.33	$71.01	7%
Custom & Consultants:							
Custom Fertilize	2	ac	$18.00	$36.00	$21.00	$15.00	71%
Custom Fumigate - Deep	1	ac	$48.00	$48.00	$48.00	$0.00	0%
Hand Weed	2	ac	$150.00	$300.00	$300.00	$0.00	0%
Soil Testing	1	ac	$5.00	$5.00	$5.00	$0.00	0%
Custom Aerial Application	2	ac	$15.00	$30.00	$30.00	$0.00	0%
				$419.00	$404.00	$15.00	4%
Irrigation							
Water Assessment	1.00	acre	$68.00	$68.00	$66.00	$2.00	3%
Irrigation Fuel pump (diesel)	20.00	gal	$3.82	$76.40	$90.60	-$14.20	-16%
Irrigation Repair (pump)	1.00	ac	$6.00	$6.00	$5.00	$1.00	20%
Drip Tape/Supplies	1.00	ac	$325.00	$325.00	$335.00	-$10.00	-3%
Drip Tape recycling/haul away	1.00	ac	$14.00	$14.00	$14.00	$0.00	0%
Total Irrigation				$489.40	$510.60	-$21.20	-4%
Machinery							
Equipment Fuel	42.17	gal	$3.82	$161.09	$191.03	-$29.94	-16%
Road Gas	2.00	gal	$3.67	$7.34	$8.78	-$1.44	-16%
Road Diesel	3.00	gal	$4.39	$13.17	$15.69	-$2.52	-16%
Repairs	1.00	ac	$78.00	$78.00	$75.00	$3.00	4%
Lube				$27.24	$32.33	-$5.09	-16%
Hauling charge	785	cwt	$0.45	$353.25	$317.50	$35.75	11%
Total Fuel, Lube, Repairs				$640.09	$640.33	-$0.24	0%
Labor							
Equipment Labor	5.22	hrs	$29.38	$153.48	$146.95	$6.53	4%
Irrigation Labor	1.50	hrs	$18.40	$27.60	$26.82	$0.78	3%
Sorting/Pickers Labor	2.50	hrs	$18.03	$45.08	$42.30	$2.78	7%
Truck Driver Labor	5.00	hrs	$24.15	$120.75	$115.00	$5.75	5%
General Labor	3.50	hrs	$21.17	$74.10	$66.78	$7.32	11%
Irrigation Set-up/Removal Labor	8.00	hrs	$21.17	$169.36	$152.64	$16.72	11%
Total General, Equipment & Harvest Labor				$590.36	$550.49	$39.87	7.2%
Packing :							
Bin Rental	785	cwt	$1.00	$785.00	$635.00	$150.00	24%
Packing	1,303	50#	$4.75	$6,189.73	$4,373.25	$1,816.48	42%
Storage & Packing Subtotal				$6,974.73	$5,008.25	$1,966.48	39%
Other (Fees and Insurance):							
Crop Insurance	1	ac	$84.00	$84.00	$84.00	$0.00	0%
Assessments	785	cwt	$0.05	$39.25	$31.75	$7.50	24%
GAP Audit	1	ac	$17.00	$17.00	$15.00	$2.00	13%
Subtotal Fees				$140.25	$130.75	$9.50	7%
Subtotal Variable Costs				$11,411.32	$9,308.22	$2,103.09	23%
Interest on Operating Capital				$332.83	$326.84	$5.99	2%
Total Operating Costs				$11,744.15	$9,635.06	$2,109.09	22%

Appendix C (Continued) Cost of Production with Storage and Packing, **Marketable Yields Idaho**

Fixed Costs						
Depreciation, Interest, Housing & Insurance On Equipment			$524.03	$640.00	-$115.97	-18%
Land	1.00	$400.00	$400.00	$375.00	$25.00	7%
Management			$277.72	$264.59	$13.13	5%
Overhead			$352.32	$289.95	$62.37	22%
Total Fixed Costs			$1,554.08	$1,569.54	-$15.46	-1%
Total Operating and Fixed Costs			$13,298.23	$11,204.60	$2,093.62	19%
Returns over operating costs			$4,630.95			
Returns over Total Costs			$3,076.87			
Operating Cost (Per PAID 50# sack)			$9.01	$9.39	-$0.38	-4%
Total Cost (per PAID 50# sack)			$10.21	$10.92	-$0.71	-7%
	-		+			
Price	15%	Paid Yield	15%			
Breakeven Yield 50# sack	1108	1303	1499			
Operating Cost 50# sack	$10.60	$9.01	$7.84			
Ownership Cost 50 # sack	$1.40	$1.19	$1.04			
TC	$12.01	$10.21	$8.87			
		Price				
Yield	$10.68	$12.57	$14.45			
Operating Cost 50# sacks	1100	935	813			
Ownership Cost 50# sacks	145	124	108			
TC	1245	1058	920			
Month over Month Breakeven with Packing and Storage						
November	$10.72					
December	$10.77					
January	$10.82					
February	$11.02					
March	$11.53					

Appendix D. **Field Run** Cost of Production NO Storage NO Packing Idaho

	Quanity	Unit	Price	$/acre	2022	Yield Change	
Field Run Yield	785	cwt	$ 6.00	$4,710.00	635	150	24%
Seed							
Seed	0.33	pail	$ 2,160.00	$712.80		$ Change	% Chang
Subtotal Seed				$712.80	$638.88	$73.92	12%
Fertilizer:							
Dry Nitrogen - Pre-plant	50	lb	$0.86	$43.00	$49.00	-$6.00	-12%
Dry P2O5	115	lb	$0.69	$79.35	$96.60	-$17.25	-18%
Micronutrients/Sulfuric Acid	1	ac	$38.00	$38.00	$35.00	$3.00	9%
K20	100	lb	$0.66	$66.00	$74.00	-$8.00	-11%
Liquid Nitrogen	100	lb	$0.93	$93.00	$116.00	-$23.00	-20%
				$319.35	$370.60	-$51.25	-14%
Plant Protection:							
Vapam	40.0	gal	$8.25	$330.00	$300.00	$30.00	10%
Select	16.0	fl oz	$0.89	$14.24	$12.80	$1.44	11%
Dual Magnum	2.0	pint	$10.63	$21.26	$20.14	$1.12	6%
Roundup	22.0	fl oz	$0.28	$6.16	$10.12	-$3.96	-39%
Outlook (2x)	21.0	fl oz	$1.28	$26.88	$26.46	$0.42	2%
Brox	1.5	pint	$7.38	$11.07	$11.04	$0.03	0%
Goal Tender (2x)	10.0	fl oz	$1.05	$10.50	$10.50	$0.00	0%
Prowl H2O (2x)	2	pint	$6.50	$13.00	$13.76	-$0.76	-6%
Radiant (2x)	16	fl oz	$8.20	$131.20	$121.28	$9.92	8%
Lannate LV (1x)	3	pint	$11.00	$33.00	$33.00	$0.00	0%
Movento (2X)	10	fl oz	$11.05	$110.50	$109.30	$1.20	1%
AZA-Direct	16	fl oz	$2.34	$37.44	$30.56	$6.88	23%
M-Pede	1	qt	$16.25	$16.25	$15.04	$1.21	8%
Agrimek	3.5	fl oz	$3.60	$12.60	$12.08	$0.52	4%
Manzate Max (2X)	4.8	qt	$10.50	$50.40	$47.62	$2.78	6%
Zing	30	fl oz	$0.69	$20.70	$19.80	$0.90	5%
Pristine	16	fl oz	$3.75	$60.00	$58.40	$1.60	3%
Fontellis	24	fl oz	$2.13	$51.12	$54.00	-$2.88	-5%
Badge SC	1.5	pint	$7.20	$10.80	$10.88	-$0.07	-1%
Chlorine Dioxide (drip lines)	1	gal	$36.00	$36.00	$29.00	$7.00	24%
MH30 Sprout Inhibitor	1.33	gal	$34.00	$45.22	$42.56	$2.66	6%
Adjuvants (11X)	11.0	pint	$7.00	$77.00	$66.00	$11.00	17%
				$1,125.34	$1,054.33	$71.01	7%
Custom & Consultants:							
Custom Fertilize	2	ac	$18.00	$36.00	$21.00	$15.00	71%
Custom Fumigate - Deep	1	ac	$48.00	$48.00	$48.00	$0.00	0%
Hand Weed	2	ac	$150.00	$300.00	$300.00	$0.00	0%
Soil Testing	1	ac	$5.00	$5.00	$5.00	$0.00	0%
Custom Aerial Application	2	ac	$15.00	$30.00	$30.00	$0.00	0%
				$419.00	$404.00	$15.00	4%
Irrigation							
Water Assessment	1.00	acre	$68.00	$68.00	$66.00	$2.00	3%
Irrigation Fuel pump (diesel)	20.0	gal	$3.82	$76.40	$90.60	-$14.20	-16%
Irrigation Repair (pump)	1.00	ac	$6.00	$6.00	$5.00	$1.00	20%
Drip Tape/Supplies	1.00	ac	$325.00	$325.00	$335.00	-$10.00	-3%
Drip Tape recycling/haul away	1.00	ac	$14.00	$14.00	$14.00	$0.00	0%
Total Irrigation				$489.40	$510.60	-$21.20	-4%
Machinery							
Equipment Fuel	42.17	gal	$3.82	$161.09	$191.03	-$29.94	-16%
Road Gas	2.00	gal	$3.67	$7.34	$8.78	-$1.44	-16%
Road Diesel	3.00	gal	$4.39	$13.17	$15.69	-$2.52	-16%
Repairs	1.00	ac	$78.00	$78.00	$75.00	$3.00	4%
Lube				$27.24	$32.33	-$5.09	-16%
Hauling charge	785	cwt	$0.45	$353.25	$317.50	$35.75	11%
Total Fuel, Lube, Repairs, Hauling				$640.09	$640.33	-$0.24	0%
Labor							
Equipment Labor	5.22	hrs	$29.38	$153.48	$146.95	$6.53	4%
Irrigation Labor	1.50	hrs	$18.40	$27.60	$26.82	$0.78	3%
Sorting/Pickers Labor	2.50	hrs	$18.03	$45.08	$42.30	$2.78	7%
Truck Driver Labor	5.00	hrs	$24.15	$120.75	$115.00	$5.75	5%
Irrigation Set-up/Removal Labor	8.00	hrs	$21.17	$169.36	$152.64	$16.72	11%
General Labor	3.50	hrs	$21.17	$74.10	$66.78	$7.32	11%
Total General, Equipment & Harvest Labor				$590.36	$550.49	$39.87	7%
Other (Fees and Insurance):							
Crop Insurance	1	ac	$84.00	$84.00	$84.00	$0.00	0%
Assessments	785	cwt	$0.05	$39.25	$31.75	$7.50	24%
GAP Audit	1	ac	$17.00	$17.00	$15.00	$2.00	13%
Subtotal Fees				$140.25	$130.75	$9.50	7%
Subtotal Variable Costs				$4,436.59	$4,299.98	$136.61	3%
Interest on Operating Capital				$221.83	$151.56	$70.27	46%
Total Operating Costs				$4,658.42	$4,451.54	$206.88	5%

Appendix D. Continued **Field Run** Cost of Production NO Storage NO Packing Idaho

Fixed Costs						
Depreciation, Interest, Housing & Insurance On Equipment			$524.03	$640.00	-$115.97	-18%
Land	1.00	$400.00	$400.00	$375.00	$25.00	7%
Management			$232.92	$224.09	$8.83	4%
Overhead			$139.75	$134.45	$5.30	4%
Total Fixed Costs			$1,296.71	$1,373.54	-$76.84	-6%
Total Operating and Fixed Costs			$5,955.13	$5,825.08	$130.05	2%
Returns over operating costs			$51.58			
Returns over Total Costs			-$1,245.13			
Operating Cost (Per Cwt)			$5.93	$7.01	-$1.08	-15%
Total Cost (per cwt)			$7.59	$9.17	-$1.59	-17%
	-		+			
Price	15%	Yield	15%			
Breakeven	667	785	903			
Operating Cost	$6.98	$5.93	$5.16			
Ownership Cost	$1.94	$1.65	$1.44			
TC	$8.92	$7.59	$6.60			
		Price				
Yield	$5.10	$6.00	$6.90			
Operating Cost	913	776	675			
Ownership Cost	254	216	188			
TC	1168	993	863			

Evaluating the effects of straw residue at various rates on direct-seeded onions in 2023

Plant Pathology and Diagnostics, Parma Research & Extension Center, University of Idaho

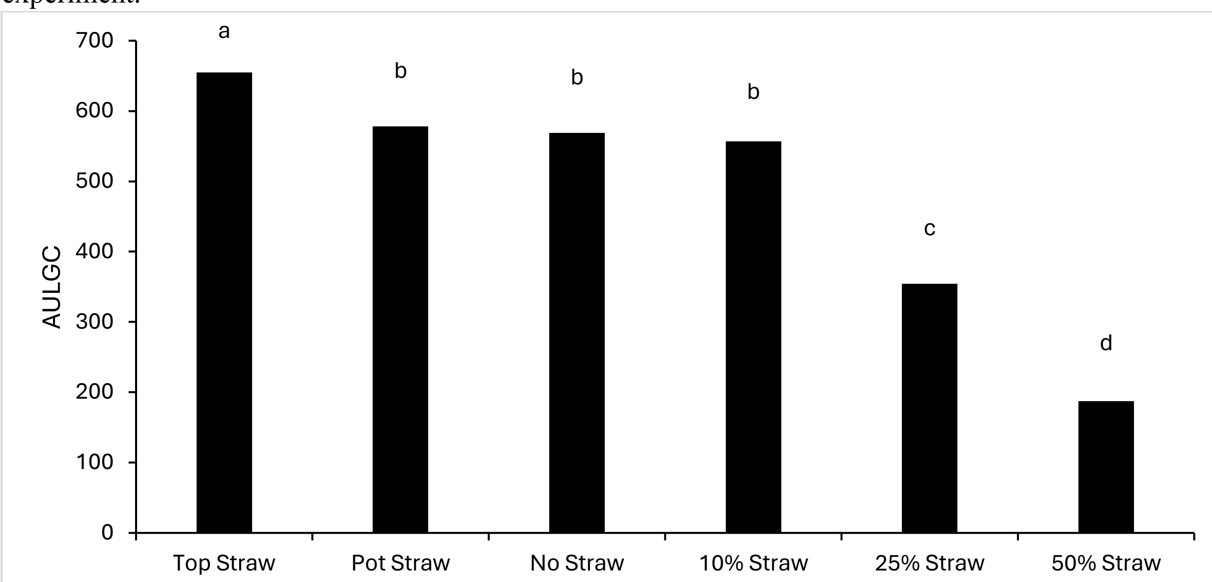
Introduction

In the 2021 growing season, severe stunting was observed in an onion crop after using a new low-till rototiller method to work the ground in the fall following wheat. After ruling out pathogen, irrigation, fertility, or herbicide causes, an initial greenhouse test found that wheat residue negatively impacted onion emergence and growth. A field trial was conducted to better determine the effects and thresholds of wheat straw residue on an onion crop.

Greenhouse study

Two experiments were conducted on the yellow onion cultivar 'Vaquero'. The treatments included: untreated control, 50% wheat straw w/w, 25% wheat straw w/w, 10% wheat straw w/w, top wheat straw, and compost tea (fermented wheat straw), for a total of 6 treatments with 8 replicates (pots) each. Emergence, height, and leaf count were recorded throughout the experiments. At the end of the 16-week period, the pots were harvested, and final measurements of height, weight, and leaf counts were taken.

Fig. 1. AULGC = (Area Under Leaf Growth Curve). Higher values = longer leaf length throughout experiment.



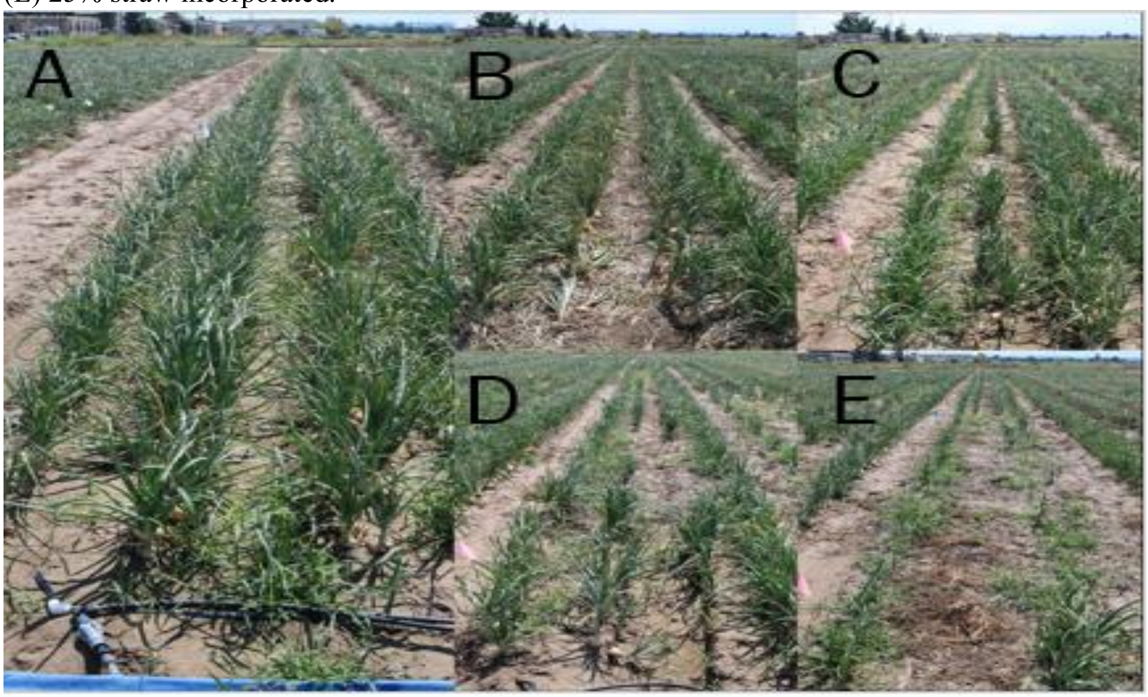
Preliminary Conclusions

In the first greenhouse experiment conducted the top straw treatment statistically had the highest AULGC (Area Under Leaf Growth Curve) value throughout the study. The untreated control, compost tea (labeled "pot straw"), and 10% straw incorporated had statistically less AULGC when compared to the top straw treatment. The 25% straw incorporated treatment had significantly less AULGC when compared to control. The 50% straw incorporated statistically had the lowest AULGC values. This warranted the need for a field trial to further investigate the negative impact of wheat residue on an onion crop.

Field Trial Material & Methods

The trial was set up using randomized complete-block design, with plot sizes of 4 row x 40 ft and five replications. On April 5th, two weeks before onion planting, wheat straw was spread and incorporated into the top 6” of soil at 5, 10, and 25% of straw per total soil volume. This was done using a rototiller tractor implement. An additional treatment added the same amount of straw to each plot as the 5% incorporated rate, but the straw was only spread on the soil surface after onion emergence. The top straw treatment was applied on June 8th. Yellow onion ‘Vaquero’ was planted April 19th. Local standard practices were used for fertilization, insect management, weed control, and irrigation. Plots were evaluated for emergence, vigor, plant height, leaf count, senescence and harvest yields and size categories. Onions were lifted September 7th, topped September 14th, and harvested September 18th.

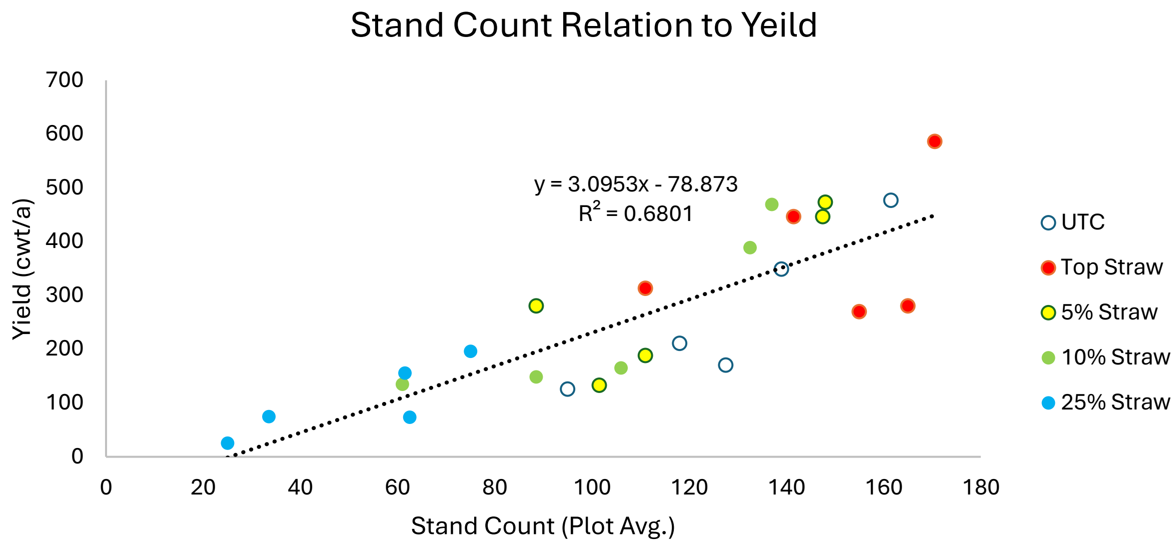
Fig. 2. Field trial plots (A) UTC, (B) top straw, (C) 5% straw incorporated, (D) 10% straw incorporated, (E) 25% straw incorporated.



Field Trial Results

Compared to the untreated control, the top straw and the 5% treatments did not reduce stands by a statistical margin. The 10% straw treatment had a 30 percent reduction in stand and the 25% straw treatment had a 50 percent reduction in stand. The 25% straw incorporated rate was statistically lower in all plant health assessments. There was no statistical difference in harvest yields, but numerical trends were observed. Numerical trends show an increase in yield for top straw and 5% straw incorporated treatments, while the 10 and 25% treatments had a reduction in yield, when compared to the untreated control.

Fig. 3. Stand count averages and total yield for each plot in the 2023 field trial.



Discussion

The studies conducted show that the higher the ratio of wheat residue to soil, the more likely we are to see a negative impact on onion growth. Wheat is known to have an allelopathic effect, though allelopathy may not be the main causal agent of the observed lower stand counts and yields. In the greenhouse studies and field trial there was no significant difference between the control, top straw, and fermented straw tea (only in greenhouse studies) treatments. We only observed significant differences when the straw was incorporated into the soil. There was a clear trend showing the higher the ratio of incorporated straw to soil, the more severe the stand and yield loss. We believe this is mainly due to the straw impeding the formation of a good seedbed. Further investigation is needed to differentiate between effects from poor seedbed conditions and those from wheat straw allelopathy.

Acknowledgements

We are grateful for the funding from the National Plant Diagnostic Network to fund the diagnostic and greenhouse experiments and the Idaho Eastern Oregon Onion Research Committee for funding the field trial work.

Evaluating the effects of heat, irrigation, and planting time on bacterial decay in storage onions in SW Idaho, 2023

Plant Pathology and Diagnostics, Parma Research & Extension Center, University of Idaho

Introduction

A key driver of onion quality can be weather conditions. Unusual conditions can promote the growth of certain pests and diseases although events such as thunderstorms and excess heat can have a profound effect on bulb quality alone. In 2021, record high temperatures over the summer resulted in reduced yields and smaller bulbs. A high incidence of bulb rot associated with bacterial diseases was also observed in 2021 although the mechanism for that is uncertain. Presently we do not understand how June temperatures can regulate onion yield and size. It may be physiological; onions are known to be more tolerant of higher temperatures when they have developed the bulb. It could be that earlier relatively higher temperatures in June impact the onion before it has bulbed. This project intends to investigate the mechanisms behind this phenomenon and develop decision support tools both to predict onion yield and quality as well as formulate best practices to combat yield and quality losses. A field trial was conducted at the Parma Research and Extension Center to determine the effects of increased heat, irrigation, and planting time on bulb rot in yellow storage onions.

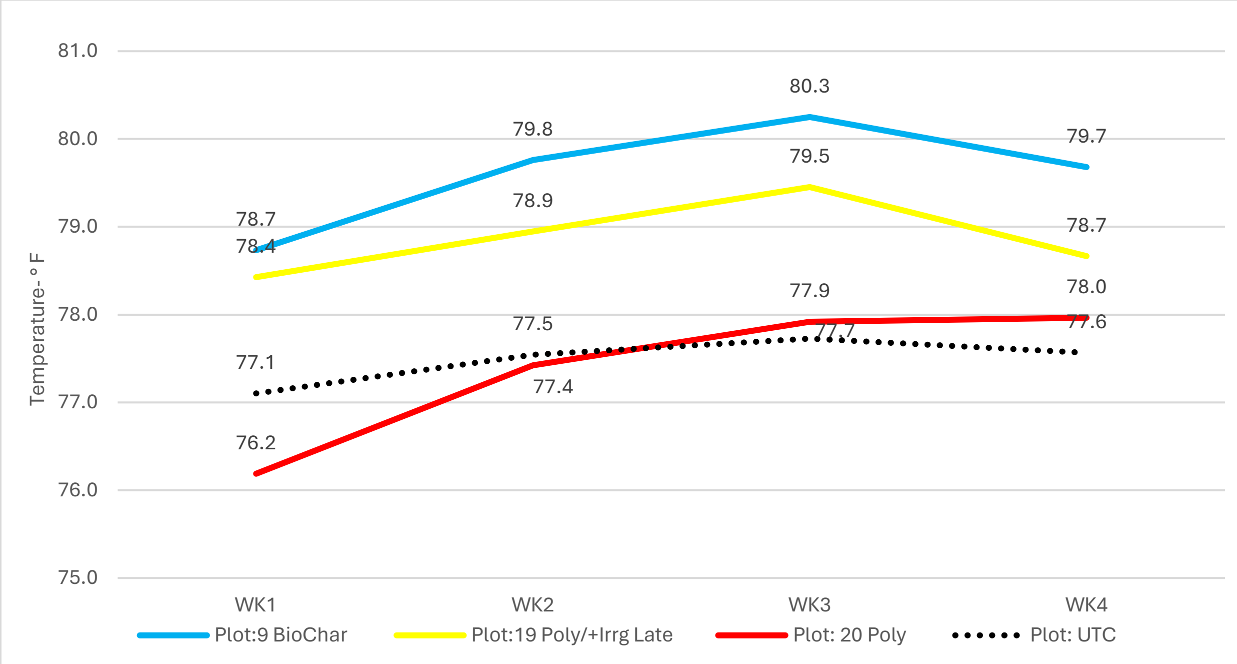
Material & Methods

The trial consisted of the following 5 treatments: uncontrolled check, poly tunnel with standard irrigation, poly tunnel with 2 weeks extra irrigation, no ploy tunnel with 2 weeks extra irrigation, and Biochar (standard irrigation). Planting time was an additional factor in the trial, with the above 5 treatments being planted both at a normal local standard date, or two weeks later for a total of 10 treatments with 4 replications and plot sizes of 3.665 feet (2 double rows) x 25 feet.

The yellow onion variety 'Vaquero' seed was planted in 4-row strips at both the "on-time" date of 12 Apr 2023 and the "late" planting on 26 April 2023. Both seeding times were done with the same gear-driven planter at a rate of 125,000 plants per acre to a depth of 0.5 inches on 22-inch rows. The "on-time" planting had 50% of the stand emerged on 1 May and 90% of the stand on 10 May. The "late" planting time had 50% emergence on 10 May and 90% of the stand on 18 May.

The application of extra heat was conducted by using perforated poly tunnels and Biochar. Poly tunnels were kept up for 4 weeks from 20 June 2023 to 26 July 2023. The entire 25 ft plot was covered with a poly tunnel that was 36 inches tall and 44 inches wide using metal hoops to support the poly film and keep it off the plants. There was a 6-inch gap at the bottom of the tunnels to allow air flow and prevent extreme heat from building up. The Biochar treatment was applied to the tops of the onion beds at a rate of 2.18 tons/Ac on 28 June 2023. The Biochar could not be removed due to the possibility of damaging the onions in those plots. The extra temperature was monitored and recorded using Davis Technologies soil temperature probes at 2 inches soil depth and TinyTag® temperature monitors to record the ambient temperature within plots foliage canopy 10 inches off the ground.

Figure 1. Average weekly soil temperatures of heat trial treatments



The entire field trial was inoculated shortly after bulb initiation and during bulb development with *Pantoea agglomerans*. Inoculations took place on 13 June 2023 & 28 July 2023 using a backpack CO_2 sprayer with Two Teejet 80.04 nozzles at 26 psi = 32 ml/s. One 10 s pass / plot = 320 ml/plot. 2 gelatin packets were added to each 3-gallon tank used, to help the bacteria stay in contact with the onion leaf surfaces. Plots were then sprayed with water using the same sprayer and rate to drive bacteria into the necks of the onions.

The extra irrigation applications were made through the drip-irrigation system, the tape used was 5/8" diameter, 8 mil tape wall thickness, 12-inch emitter Spacing, 0.22 GPM/100', Toro Aqua-Traxx®. The extra irrigation took place at the end of the season to potentially extend the growing time of those plots. The extra irrigation took place 1 Sept 2023 (6 hrs), 8 Sept 2023 (8 hrs),12 Sept 2023 (8 hrs). There was a summer rainfall during this time that reduced the extra irrigation that could be applied.

Leaf samples were taken on three different dates. On each date, a sample of 10 random plants per plot were sampled by cutting one leaf per plant. These samples were DNA extracted and qPCR tests were conducted to evaluate the levels of bacteria in the leaf tissue.

Standard local practices were used for tillage, fertilization, irrigation, and weed management. The insect management program was unable to be conducted during the time of the poly tunnel application, 4 applications of insecticides were missed during the growing season on the entire field trial. The “On Time” planted onions were lifted on 7 Sept 2023, topped 14 Sept 2023, and harvested 18 Sept. The “Late” planted onions were lifted on 14 Sept 2023, topped 19 Sept 2023, and harvested 21 Sept 2023. The entire 25 ft of the two double rows of onions were harvested, sorted, weighed by size, and stored for internal assessment.

Two bags of approximately100 bulbs each were stored from each plot to assess internal disease. Bacterial and Botrytis rots were scored for severity and overall incidence. The first cutting took place soon after harvest on 19-22 Sept 2023. The second cutting was done on 5 Jan 2024, after additional time in cold storage.

Results

Table 2. Yield and disease levels for heat treatments in yellow onion 'Vaquero'.

Treatment	Planting time	Total Yield	Botrytis Sept.	Botrytis Jan.	Bacteria Sept.	Bacteria Jan.
Product and Rate	Timing[z]	cwt / A[y]	Incidence	Incidence	Incidence	Incidence
Untreated control	A	478 a-d[x]	2.1% d	1.8%	3.1%	2.6%
Poly/ Standard Irrg.	A	522 ab	6.2% abc	4.8%	2.2%	4.0%
Poly/ +2 wk Irrg.	A	579 a	11.6% a	4.7%	2.1%	4.7%
No poly/ +2 wk Irrg.	A	502 abc	9.0% ab	3.5%	1.2%	3.8%
BioChar	A	449 bcd	4.3% bcd	2.8%	1.1%	2.5%
Untreated control	B	376 de	2.7% cd	1.7%	1.0%	4.5%
Poly/ Standard Irrg.	B	398 cde	1.3% d	1.3%	0.4%	1.8%
Poly/ +2 wk Irrg.	B	390 de	8.0% ab	3.7%	0.9%	4.3%
No poly/ +2 wk Irrg.	B	344 e	2.8% cd	3.3%	0.6%	2.8%
BioChar	B	233 f	1.6% cd	2.5%	0.7%	3.2%
LSD	-	104.3	3.5-6.0[w]	3.21	1.64-1.83[v]	3.21
P=	-	<0.01	<0.01	0.33	0.35	0.61

[z] Timings: A= 12 Apr 2023 B= 26 April 2023
[y] Hundredweight or 100 lb per acre
[x] Column numbers followed by the same letter or symbol are not significantly different at $P = 0.05$ as determined by Fisher's Least Significant Difference (LSD) test.
[w] Data transformed for statistical analysis: arcsine√(x)
[v] Data transformed for statistical analysis:log(x+1)

Discussion

Planting date had the greatest impact on yield. The poly tunnel with standard irrigation increased yields and disease incidence in the "on time" planting. The poly tunnel +2 wk irrigation increased Botrytis rot in both planting times and numerically increased yields. For onions planted on time, extra irrigation late in the season ("no poly tunnel + 2 wk irrigation") significantly increased disease incidence. Biochar compared poorly with the control in yield, reaching a statistical reduction in the late-planted onions.

Acknowledgements

Thank you to the Idaho-Eastern Oregon Onion Committee and ISDA specialty crop block grant for funding this work.

Evaluating the susceptibility of onion varieties on pink root

Plant Pathology and Diagnostics, Parma Research & Extension Center, University of Idaho

Introduction
Pink root is one of the most important diseases on onions in the Treasure Valley of Idaho and Oregon. The causal agent is *Setophoma terrestris*, this is a soil-borne fungus. The disease typically manifests itself through infected roots resulting in undersized bulbs. In severe infection, shriveled bulbs have also been observed. Marketable yield losses approaching 50%, have been reported although 10-25% loss is more common amongst susceptible varieties grown in the region. The aim of this study was to evaluate which specific varieties are highly susceptible to pink rot.

To determine which varieties were susceptible to infection 23 varieties were assessed over the 2022 and 2023 growing seasons at the Malheur Agricultural Experiment Station, Oregon State University. Ten plants were pulled from the discard rows from four replicated plots and rated for percentage of infected root area. This assessment took place during the first week of August in both years.

Results
23 varieties were assessed for disease including 15 yellow varieties (Table 1), six red varieties (Table 2) and two white varieties (Table 3).

Table 1. Average pink root percentage and yield (cwt/a) for yellow onion varieties.

Yellow onion	2022	2022	2023	2023
Variety	**Pink root (% roots)**	**Yield (cwt/a)**	**Pink root (% roots)**	**Yield (cwt/a)**
Sedona	20.3 de[z]	1118 cde	12.7	989 abc
Trident	41.3 a	932 g	24.9	765 g
Caldwell	39.8 ab	1105 cde	33.8	886 def
Caliber	17.9 e	1176 bc	25.2	919 b-e
Arcero	31.8 bc	1102 de	44.4	883 def
Campero	26.3 cde	1153 bcd	26.1	885 def
Granero	23.4 cde	1126 cd	24.8	968 a-d
Joaquin	27.8 cd	1258 a	16.9	1010 ab
Vaquero	23.3 cde	1222 ab	20.4	839 efg
Crusher	27.9 cd	1206 ab	29.1	1059 a
Tucannon	23.3 cde	1052 ef	25.4	913 cde
Legend	41.0 a	987 fg	-	-
Defender	-	-	31.0	810 fg
Pandero	-	-	22.8	855 efg
Hatchet	-	-	17.5	1038 a
LSD	9.1	72.0	25.4	96.8
P=	<0.01	<0.01	0.67	<0.01

[z] Column numbers followed by the same letter are not significantly different at $P = 0.05$ as determined by Fisher's Least Significant Difference (LSD) test.

Table 2. Average pink root percentage and yield (cwt/a) for red onion varieties.

Red onion Variety	2022 Pink root (% roots)	2022 Yield (cwt/a)	2023 Pink root (% roots)	2023 Yield (cwt/a)
Redwing	51 a[z]	572 b	41.1	569
Purple Haze	16.5 c	652 a	18.2	559
SV 4643NT	30.9 b	703 a	-	-
Red Bull	41.3 ab	565 b	-	-
Barolo	-	-	36.0	586
Red Beret	-	-	42.8	527
LSD	11.7	69.4	30.9-62.6[y]	80.9
P=	<0.01	0.01	0.67	0.45

[z] Column numbers followed by the same letter are not significantly different at P = 0.05 as determined by Fisher's Least Significant Difference (LSD) test.

[y] Data transformed for statistical analysis: log(x+1)

Table 3. Average pink root percentage and yield (cwt/a) for white onion varieties.

White onion Variety	2022 Pink root (% roots)	2022 Yield (cwt/a)	2023 Pink root (% roots)	2023 Yield (cwt/a)
Brundage	-	-	17.3[z]	903
Cometa	-	-	16.1	965
LSD	-	-	16.8	126.2
P=	-	-	0.84	0.22

[z] Column numbers followed by the same letter are not significantly different at P = 0.05 as determined by Fisher's Least Significant Difference (LSD) test.

Conclusions

Varieties vary in their susceptibility to pink root disease. Some consistency was seen in disease levels among varieties between the 2022 and 2023 seasons, but more data will need to be collected from future work to establish confidence in these preliminary trends- especially as white onion pink root data was only collected from the 2023 season. Establishing reliable disease susceptibilities and yield correlations is an important tool to manage pink root disease, along with molecular testing and disease modeling.

Acknowledgments

We are grateful to Malheur Experiment Station, OSU for allowing us to sample the variety trial and providing assistance. We thank the Idaho Eastern Oregon Onion Research Committee for funding.

5 Year Summary Onion Production Costs Idaho and Malheur County Oregon

The following tables summarize onion production costs in Idaho and Malheur County Oregon by major cost category from 2019 through 2023. The costs per acre are given in nominal dollars (not adjusted for inflation) for each cost category and summarized for total operating, total ownership (fixed), and total (operating +fixed) costs. The 5-Year cost change summaries do not include storage. Costs per hundredweight are also given for total operating, total ownership, and total costs. Reported yields are expressed on a field run basis (cwt/acre) as reported by the USDA for years (2019-2022), yields for 2023 are preliminary projected yields. When compared on a per hundredweight basis consideration needs to be given to the low yields recorded for 2021 and 2022 and significantly higher costs resulting in a very pronounced impact (**higher costs spread over fewer cwt)**. The dollar cost changes and the percentage cost changes from 2019 to 2023 are shown for each cost category, as well as per acre and per hundredweight values for total operating, total ownership, and total costs. The tables also show the year-over-year dollar and percentage changes for total operating, total ownership, and total costs per acre and per hundredweight. There are two bar graphs that compare only the ownership, operating, and total costs per acre for 2019 and 2023, and the percentage change between these years.

Table 1. Malheur County Onions Field Run-No Storage*: Production costs per acre for major cost categories, annual dollar and percentage changes for total operating and total cost per acre and per hundredweight, and 5-year dollar and percent changes from 2019 to 2023.

Item	2019	2020	2021	2022	2023	2019 to 2023 $ Change	2019 to 2023 % Change
Operating Inputs:							
Seed	569	592	604	639	713	$143.55	25.2%
Fertilizer	166	204	241	371	319	$153.80	92.9%
Chemiclas/Pesticides	897	943	942	1054	1125	$228.43	25.5%
Custom & Consultants	443	220	400	404	419	-$23.50	-5.3%
Irrigation	371	357	399	515	496	$125.63	33.9%
Machinery	488	440	510	632	640	$152.27	31.2%
Labor	451	454	540	602	657	$205.91	45.7%
Other	134	133	131	130	140	$6.25	4.7%
Operating Interest	110	91	94	152	226	$115.57	105.1%
Total Operating Costs per Acre	$3,628	$3,434	$3,860	$4,498	$4,736	$1,107.92	30.5%
$ Change from Previous Year	0	-194	426	638	237		
% Change from Previous Year	0.0%	-5.3%	12.4%	16.5%	5.3%		
Operating Costs per Cwt	$4.53	$4.37	$5.55	$7.25	$6.03	$1.50	33.0%
$ Change from Previous Year	$0.00	-$0.17	$1.19	$1.70	-$1.22		
% Change from Previous Year	0.0%	-3.7%	27.1%	30.6%	-16.8%		
Ownership Costs:							
Equip,Depreciation, Int, Housing Ins.	576	569	610	640	524	-$52.23	-9.1%
Land Rent	300	316	321	355	375	$75.00	25.0%
Overhead	91	86	116	136	142	$51.38	56.7%
Management Fee	181	172	193	227	237	$55.78	30.8%
Total Ownership Costs per Acre	$1,148	$1,143	$1,240	$1,358	$1,278	$129.93	11.3%
Ownership Cost per Cwt	$1.43	$1.45	$1.78	$2.19	$1.63	$0.19	13.4%
Total Costs per Acre	$4,776	$4,576	$5,100	$5,856	$6,013	$1,237.84	25.9%
$ Change from Previous Year	$0	-$199	$524	$756	$157		
% Change from Previous Year	0.0%	-4.2%	11.4%	14.8%	2.7%		
Total Cost per Cwt	$5.97	$5.82	$7.34	$9.45	$7.66	$1.69	28.3%
$ Change from Previous Year	$0.00	-$0.15	$1.52	$2.11	-$1.78		
% Change from Previous Year	0.0%	-2.5%	26.0%	28.7%	-18.9%		
Yield (cwt per acre)	800	786	695	620	785		

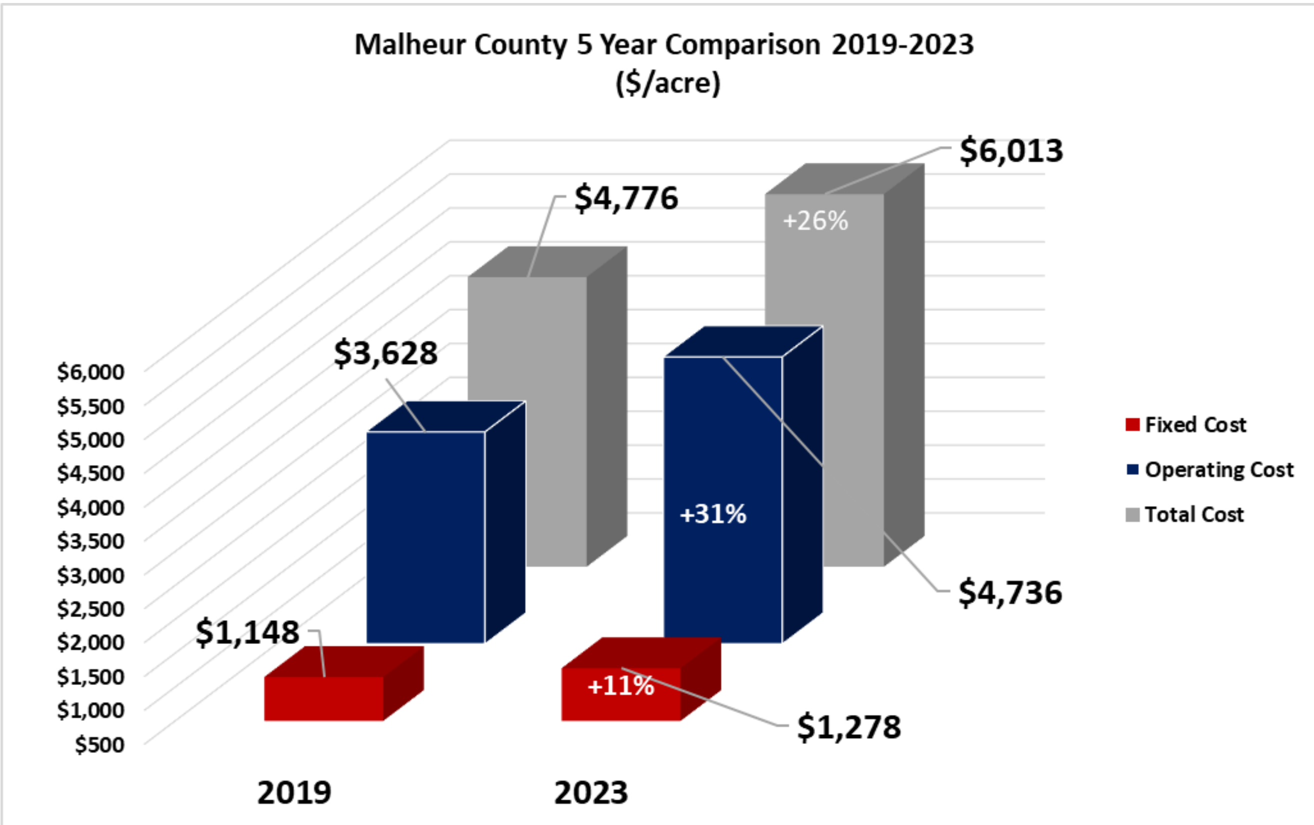
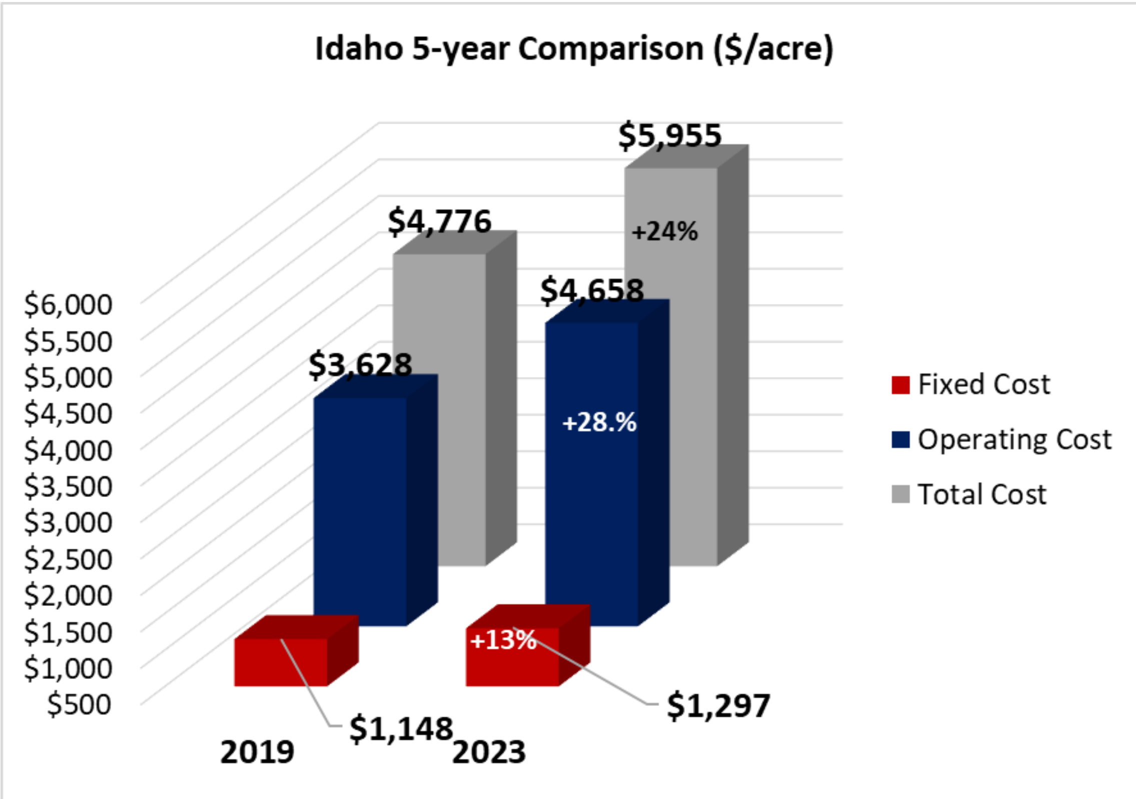

Malheur County 5 Year Comparison 2019-2023
($/acre)
$6,000
$5,500
$5,000
$4,500
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$4,776
$6,013
+26%
$3,628
+31%
$4,736
$1,148
+11%
$1,278
2019
2023
Fixed Cost
Operating Cost
Total Cost

Table 1. Idaho onions Field Run-No Storage*: Production costs per acre for major cost categories, annual dollar and percentage changes for total operating and total cost per acre and per hundredweight, and 5-year dollar and percent changes from 2019 to 2023.

Item	2019	2020	2021	2022	2023	2019 to 2023 $ Change	2019 to 2023 % Change
Operating Inputs:							
Seed	569	592	604	639	713	$143.55	25.2%
Fertilizer	166	204	241	371	319	$153.80	92.9%
Chemiclas/Pesticides	897	943	942	1054	1125	$228.43	25.5%
Custom & Consultants	443	220	400	404	419	-$23.50	-5.3%
Irrigation	371	357	391	511	489	$118.63	32.0%
Machinery	488	440	504	640	640	$152.27	31.2%
Labor	451	454	507	551	590	$139.47	30.9%
Other	134	133	130	130	140	$6.25	4.7%
Operating Interest	110	91	93	154	222	$111.90	101.8%
Total Operating Costs per Acre	$3,628	$3,434	$3,812	$4,452	$4,658	$1,030.80	28.4%
$ Change from Previous Year	0	-194	378	640	206		
% Change from Previous Year	0.0%	-5.3%	11.0%	16.8%	4.6%		
Operating Costs per Cwt	$4.53	$4.37	$5.61	$7.01	$5.93	$1.40	30.9%
$ Change from Previous Year	$0.00	-$0.17	$1.24	$1.41	-$1.08		
% Change from Previous Year	0.0%	-3.7%	28.3%	25.1%	-15.4%		
Ownership Costs:							
Equip,Depreciation, Int, Housing Ins	576	569	609	640	524	-$52.23	-9.1%
Land Rent	300	316	328	375	400	$100.00	33.3%
Overhead	91	86	114	133	140	$49.06	54.1%
Management Fee	181	172	191	221	233	$51.92	28.7%
Total Ownership Costs per Acre	$1,148	$1,143	$1,242	$1,369	$1,301	$152.71	13.3%
Ownership Cost per Cwt	$1.43	$1.45	$1.83	$2.16	$1.66	$0.22	15.5%
Total Costs per Acre	$4,776	$4,576	$5,054	$5,821	$5,955	$1,179.56	24.7%
$ Change from Previous Year	$0	-$199	$477	$767	$134		
% Change from Previous Year	0.0%	-4.2%	10.4%	15.2%	2.3%		
Total Cost per Cwt	$5.97	$5.82	$7.43	$9.17	$7.59	$1.62	27.1%
$ Change from Previous Year	$0.00	-$0.15	$1.61	$1.74	-$1.58		
% Change from Previous Year	0.0%	-2.5%	27.6%	23.3%	-17.2%		
Yield (cwt per acre)	800	786	680	635	785		


Idaho 5-year Comparison ($/acre)
$6,000
$5,500
$5,000
$4,500
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$4,776
$5,955
+24%
$3,628
$4,658
+28.%
+13%
$1,148
$1,297
2019
2023
Fixed Cost
Operating Cost
Total Cost