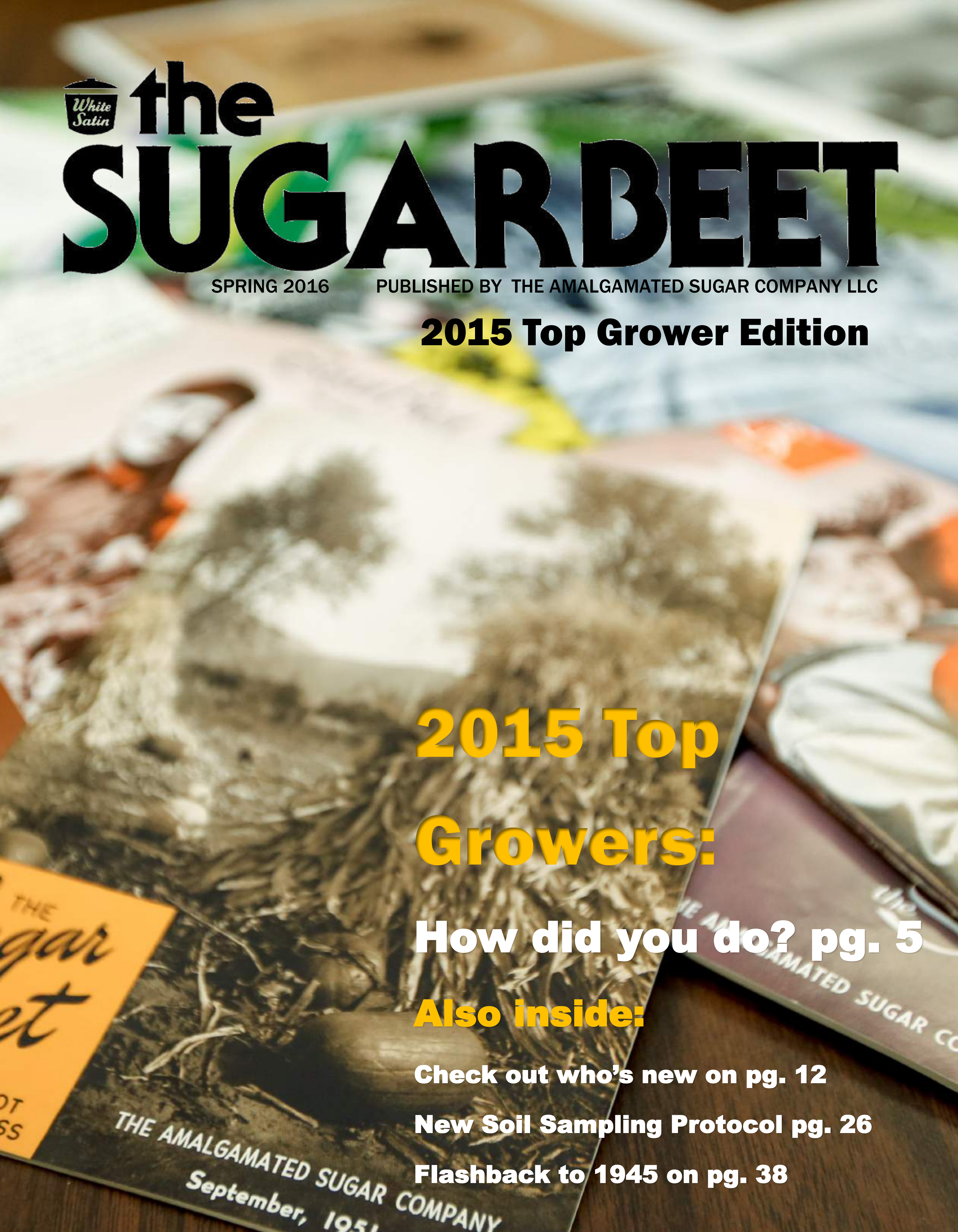

the SUGARBEET

SPRING 2016 PUBLISHED BY THE AMALGAMATED SUGAR COMPANY LLC

2015 Top Grower Edition

2015 Top Top Growers:

How did you do? pg. 5

Also inside:

Check out who's new on pg. 12

New Soil Sampling Protocol pg. 26

Flashback to 1945 on pg. 38

THE SUGARBEET

WWW.AMALSUGAR.COM

The Sugarbeet is a publication of The Amalgamated Sugar Company. The magazine is prepared by the Sugarbeet Quality Improvement (SBQI) Department to provide growers with up-to-date information on growing and harvesting sugarbeets. The magazine is also published to help upgrade the standards of the U.S. beet industry by providing a reliable source of information for agronomists, sugar company personnel, students, and other interested in this vital food crop.

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Please address all communications to the Editor, The Sugarbeet, 138 W Karcher Rd, Nampa, ID 83687

The Sugarbeet is a free publication published twice a year. Anyone can subscribe to the magazine by logging on to www.srcoop.com and clicking on The Sugarbeet icon, or under the "Members Only" tab on www.amalsugar.com. You can also subscribe via telephone by calling 208-468-6835.

The Sugarbeet Magazine is a publication of
The Amalgamated Sugar Company, LLC
138 W. Karcher Road
Nampa, ID 83687
208.468.6835

Printing and circulation by
Watkins Printing
110 West 1200 South
Logan, UT 84321
435.752.5235

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On the Cover: The Sugarbeet has been a regular publication of Amalgamated sugar since its first issue in 1923. The goal of The Sugarbeet has always been to provide the most up-to-date, pertinent, and useful information to sugarbeet growers. Photo courtesy of TASCO.

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THE

SUGARBEET

CONTENTS

3 Presidents Message

A summary of this year's spectacular annual meeting in Boise and some encouraging words for the future.

4 CHANGE THROUGH INNOVATION

Innovation is at the heart of the Amalgamated Sugar company's successful implemtation of effective change.

5 TOP GROWERS

Did you have goals this past year? Who hit those goals? Congratulations to our top sugar producers for 2015!

12 The New Beet

There have been a few new additions to the field staff at Amalgamated Sugar. See who they are and what they're all about.

15 One Hop at a time

New additions at the Nyssa Factory will help drive our new Curly Top Nursery to success.

17 TASCO FACTORY TOURS

Successful factory tours has growers feeling educated and appreciated. (The free mugs helped too).

19 No-Till

Challenge fields are an effective way for our field staff to work closely with growers on their own farm. Reed Bowen reports on his latest experiment.

21 FEATURE:

PROGRESS THROUGH INNOVATION

Nic Wittman takes on the old technology to try to increase the efficiency in our tare lab.

23 Petiole Sampling

Does petiole sampling have a place in sugarbeets? Some growers seem to think so. Aaron Firth gives some pointers and things to watch out for when sampling petioles.

26 Lets get serious

Did you know that The Amalgamated Sugar company provides a soil sampling service to our growers? Here is our updated protocol and what to expect when one of our field staff come onto your property.

30 WHERE'S MY WATER?

What happens when water becomes the limiting factor? Here are a few pointers for growing beets on short water years.

33 FACT SHEET:

Two-Spotted Spider Mites

Spider mites were hard on our beets last year. Here are some things to look out for in the coming season.

38 Flashback

The Sugarbeet has been a regular publication for a very long time. Many of the old articles are still applicable even today. See what George Demming had to say about your stand of beets in 1945.

41 NEMATODE SAMPLE SHEET

A copy of the University of Idaho nematode sampling protocol and sampling sheet is included in the back of this issue.

President's Message

John McCreedy
President, CEO

"We are blessed to be a part of a great company"

The Nineteenth Annual Meeting of the Members of Snake River Sugar Company was held on January 7, 2016 in Boise, Idaho. Approximately 275 Members and employees took advantage of the opportunity to learn more about their Company, each other and the domestic sugar industry.

Melanie Searle, Savannah Searle and Hadley Beck, participants in the Cassia County FFA 4-H Sugarbeet Project, gave professional and informative presentations about their projects. These young women were very impressive. If our industry can continue to attract employees with the dedication and work ethic of these young women, we will be in a very good position.

Liz Bingham and Stephanie Rovey, Biotech Spokeswomen, explained how genetically engineered sugarbeets are better for the consumer, the environment and the farmer. Liz and Stephanie helped our Members understand how to more effectively engage in fact driven dialogue about the tremendous value genetic engineering brings to our world. We are grateful for their leadership and commitment.

Courtney Gaine, Interim Present and CEO of The Sugar Association, and Jenn Ketterly, Director of Sports Nutrition for the University of Georgia, set the record straight regarding the role that sucrose plays in a healthy and balanced diet. Blaming America's health issues on sugar lacks persuasive evidence, and is convenient but misguided. Carbohydrates, including sugar, are the preferred source of the body's fuel for brain power, muscle energy and every natural process that occurs in every functioning cell. Dr. Gaine and Jenn did an excellent job of explaining the nutritional science of sugar to our Members.

Members and employees were also given an overview of the Company's improved performance metrics, the plan adopted by the Board of Directors to stay on the path of *continuous improvement,* and the role we all play in achieving that plan. In 2016, we (the Members and employees) must demonstrate that we can execute on the Board's plan. We are blessed to be part of a great Company. In 2016, we can make our Company even better.

CHANGE THROUGH INNOVATION

Pat Laubacher
Vice President of Agriculture

In the last issue, I commented that in order for us to continually improve we must be willing to make change part of the process. Last winter, not long after I had joined the Company, a young man from our IT department, Nic Wittman, contacted me about a project that he had been trying to get off the ground. Not willing to live with the "status quo", Nic wanted to improve and change the process that created a tare sample tag and the way the data was input once the sample reached the tare lab. Nic is a former Crop Consultant from the Twin Falls District and now works as a Business Analyst in our IT Department.

Nic's "Tare Lab Sample Card" project was presented as a way to reduce data errors and improve the capability to process more beet samples per day. The transaction error rate in 2014 was nearly 2%, yielding 3,900 errors while processing 201,000 transactions. We approved the project and Nic went to work. The results for 2015 were six total errors on 238,000 transactions processed.

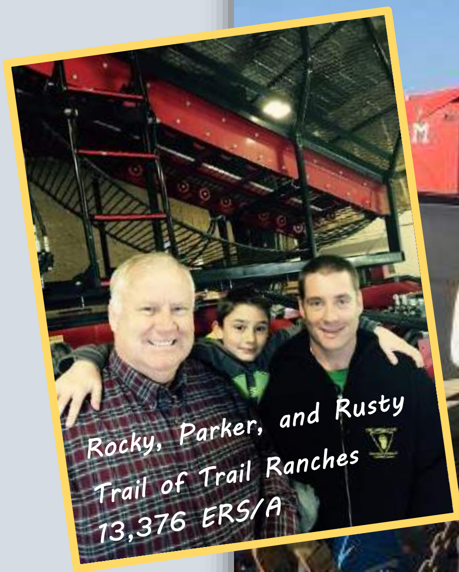
I would like to recognize Nic for proposing and successfully implementing a truly innovative project. His "Tare Lab Sample Card" project is discussed in more detail in this issue starting on page 21. This is an outstanding example of one individual driving successful change through innovation.

2015 TOP GROWERS

Another great crop year is behind us. Here is a glimpse at who produced the highest estimated recoverable sugar (ERS) per acre in each district…

Elwyhee

Elwyhee Dist.	ERS/A
Bruneau	
Ryan Johnson	9,396
Glenns Ferry	
Nomad Farms, Inc	13,788
Trail Ranches, Inc	13,376
Reverse	
Jack Post	13,155
Tim Healy	11,770
Jecko Futures – Eric Orr	11,759
Little Valley	
Fowers, Inc	13,395
Jett T. Fowers	12,995
Cinder Cone	
E&H Farms LLC	11,384
Grand View	
Jett T. Fowers	12,030
Huey Farms, Inc.	11,552
Murphy	
Huey Farms, Inc	13,260



Rocky, Parker, and Rusty
Trail of Trail Ranches
13,376 ERS/A

Jason Meyers of Nomad Farms, Inc.
13,788 ERS/A

Not Pictured: Fowers, Inc.
13,395 ERS/A

Mini Cassia

Mini Cassia Dist.	ERS/A
Adelaide	
BKS Farms LLC	12,732
Don Suhr	12,663
Brent D Griffin	12,442
Beetville	
Bowen Farms LLC	13,797
Bruce R. Bowen	12,513
Elcock	
Golden View, Inc.	13,793
Kenneth Turpin	13,038
Fingal/Aberdeen	
Aberdeen Farms, Inc.	14,018
Tyson Ruff	12,920
Golden Valley/Cranney	
Cranney Brothers	11,901
Triple Ace, Inc.	11,847
Hatch	
James Aaron Tayler	14,442
Golden View, Inc.	13,297
Bret L. Johnson	12,807
Hobson	
Mark Hobson	11,840
Hynes	
Claar Farms, Inc.	12,447
Triple Ace, Inc.	12,349
Idahome	
Harper Family Partnership	11,295
Kenyon	
Bean Brothers	13,744
Eugene Matthews	12,900
Liberty/Blackfoot	
Mecham Brothers	12,795
Blaine Evans	11,915

Upper Snake

Max	
Ida-Ridge Farms LLC	11,282
Meridian	
Brent D. Griffin	12,648
Derrick Maier	11,537
Minidoka	
Aaron Ball Farms, Inc.	13,343
North Pleasant Valley/Homestead	
Robert Giesbrecht	15,313
Burusco Farms	14,585
Paul Factory	
Bryan Jentzsch	12,499
D N Ag Corporation	11,962
Double H Ag, Inc.	11,831
Seagull Bay/American Falls	
Robert Giesbrecht	14,702
Gehring Agri-Business	14,492
South Pleasant Valley/Center PV	
US-2 Farms	13,022
Lance Funk Farms	12,363
Springfield	
Burusco Farms	14,721
Yale	
Flying W Farms, Inc.	11,928
Spring Farms General Partnership	11,795

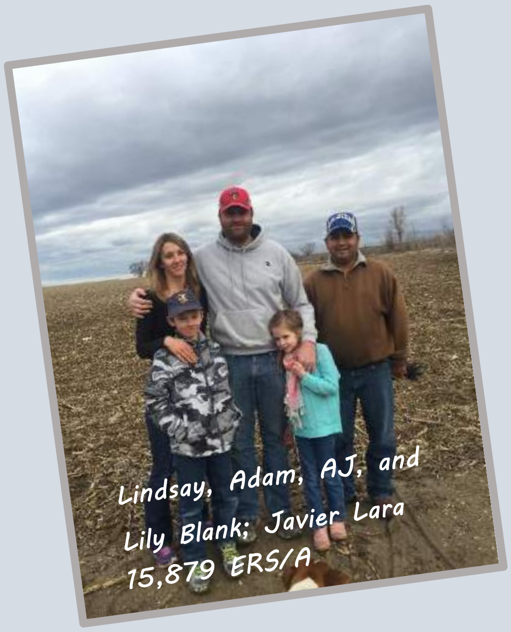

Robert Giesbrecht 15,182 ERS/A


Robert and John Burusco of Burusco Farms 14,149 ERS/A


Terrell Palmer of Aberdeen Farms, Inc. 14,018 ERS/A

Nampa

Nampa Dist.	ERS/A
Amsco	
24/7 Farms LLC	14,054
Sid Freeman	12,050
Freeseout Farm LLC	11,442
Bowmont	
Jerry Summerall Jr	15,605
Rasgorshek Farms, Inc.	15,385
S&K Farms, Inc.	15,157
Marsing	
T&K Farms, Inc	14,372
Mora	
Duane Yamamoto	12,769
Layne Thorton	12,445
Big D Ranch, Inc.	12,336
Nampa Factory	
Earnest Operations LLC	15,293
Schroll Farms LLC	14,365
M&S Farms, Inc.	13,712
Notus	
Adam Blank	15,879
Russell Klahr	14,552
Mike Skogsberg	14,523
Wilder	
Craig Paulsen Farms	15,139


Lindsay, Adam, AJ, and Lily Blank; Javier Lara
15,879 ERS/A

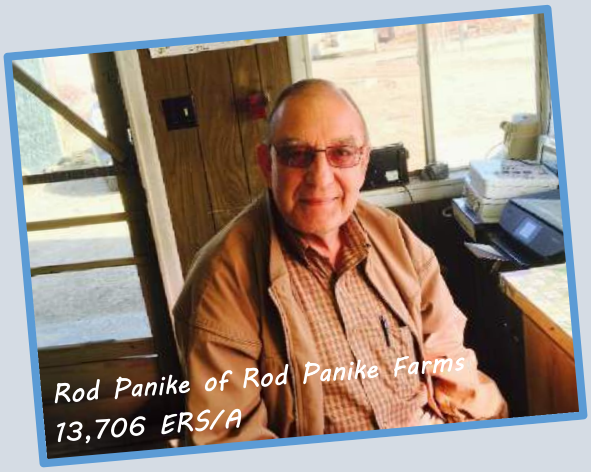

Jerry Summerall Jr.
15,605 ERS/A


Paul and Marilyn Rasgorshek of Rasgorshek Farms, Inc.
15,385 ERS/A

Nyssa


Steve Iida of Iida Farms, Inc.
15,052 ERS/A


Calvin and Curtis Hickey of Weiser River Packing, Inc.
14,096 ERS/A


Rod Panike of Rod Panike Farms
13,706 ERS/A

Nyssa Dist.	ERS/A
Apple Valley	
Winegar Farms, Inc.	12,669
Jeffery A. Hyatt	12,409
Stokes Brothers Farms LLC	12,384
Buckingham	
Rick and Robyn Purdum	12,996
Jeffrey A. Hyatt	12,982
Hall Poor Farm LLC	12,111
Homedale	
Ryan Rupp	13,128
Jamieson	
10th Avenue Holsteins	12,969
Y-1 Farms, Inc.	12,786
Estate of Fred Heid	8,871
La Grande	
John A. Frisch	13,317
Robert A. Beck	13,169
Weishaar Bros.	12,468
Luse	
Iida Farms, Inc.	15,052
Gressley Farms LLC	13,620
Tuckness Farms, Inc.	13,606
Nyssa Factory	
3B Hay and Straw	12,727
Bruce Corn	12,616
Mountain Valley Enterprises, Inc.	12,144
Overstreet	
Barlow Farms LLC	11,894
Parma	
Story Farms, Inc	13,677
Lewman Farms LLC	13,385
Payette	
DT Farms	12,490
Lower Snake River Farms	12,380
Nagaki Farms, Inc.	11,265

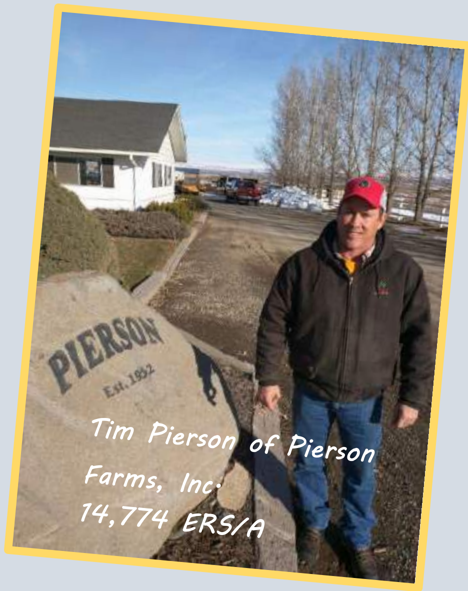
Nyssa (continued)	ERS/A
Vale	
Standage Farms, Inc.	11,843
Lower Snake River Farms	10,957
Gressley Farms LLC	10,933
Weiser	
Weiser River Packing, Inc.	14,096
Rod Panike Farms	13,706
Darin De Walker	13,300

Twin Falls Dist. ERS/A

Twin Falls Dist.	ERS/A
Black	
Claar Farms, Inc.	13,270
Ronald Buschhorn	12,930
Clark	
Mike Gott	14,163
Deitrich	
Star Gate Ranch	13,135
Filer	
Friesen Farms LLC	14,084
Gooding	
Pierson Farms, Inc.	14,774
Hidden Valley	
B&L Farms	11,499
Jerome	
4B's Farms, Inc.	12,945
King	
Jay Little	12,600
Magic Water	
Maurice H. Eckert & Sons, Inc.	13,927

Twin Falls (continued) ERS/A

Twin Falls



Tim Pierson of Pierson Farms, Inc.
14,774 ERS/A

Mike and John Gott
14,163 ERS/A

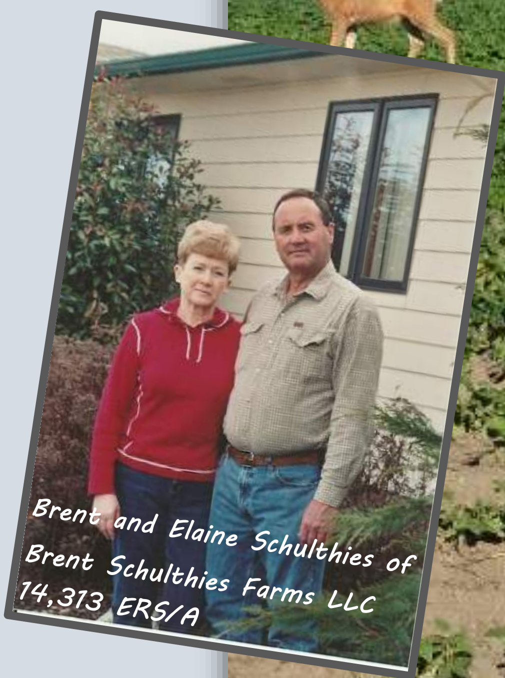
Not Pictured: Friesen Farms LLC
14,084 ERS/A

Murtaugh	
Craig Giles	12,693
Plateau	
Salmon Falls Land & Livestock Co.	13,483
Schodde	
B&L Farms	13,657
Paul Tateoka	12,894
Senter	
Tri-R Farms	11,661
Sugarloaf	
Dewitt Marshall	14,037
Twin Falls Factory	
Craig Giles	13,212

Washington

Taryn, Brent, and Troy Hartley of Brent Hartley Farms LLC
14,377 ERS/A

Washington Dist.	ERS/A
Sunheaven 2	
Brent Hartley Farms LLC	14,377
Sunheaven 3	
Brent Schulthies Farms LLC	14,313



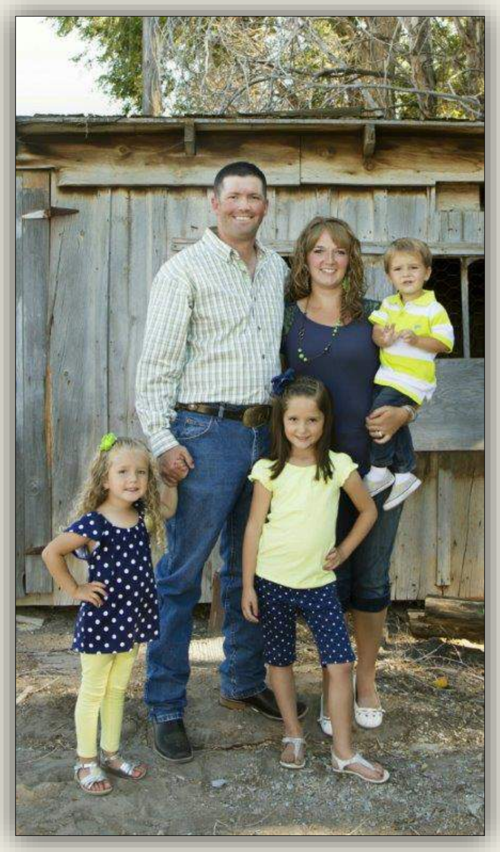
Brent and Elaine Schulthies of Brent Schulthies Farms LLC
14,313 ERS/A

The New Beet

There have been a lot of changes throughout the company over the past year or so, including new hires. Here's your chance to catch up….

Bryce Dayton

New Crop Consultant, Mini Cassia



Stations/Area
Adelaide and Meridian

Start Date
September, 2015

College
BYU Idaho
B.S. in Animal Science
Minor in Agronomy/ Ag business

High School
Minico High School in Paul, Idaho

Goals for the future
Learn and gain experience to be a more effective consultant. I want to be the first consultant that growers call with questions.

Committee involvement
None at this time

Hobbies
Spending time with family and friends hunting, fishing, camping, sports, reading, music, country dancing

Personal and Family
Wife, Courtine
Haylee age 8
Saydee age 5
Taydon age 3
Baby boy due March, 2016

Kevin Foulger

New Crop Consultant, Nyssa

Stations/Area
Vale, Jameson, Nyssa Factory

Start Date
February, 2015

College
Utah State
B.S. in Horticulture

High School
Weber High School in Pleasant View, Utah

Goals for the future
Continue to grow with company

Committee Involvement
Curriculum Committee

Hobbies
Snow skiing, dirt biking, mountain biking, camping, fishing and hunting

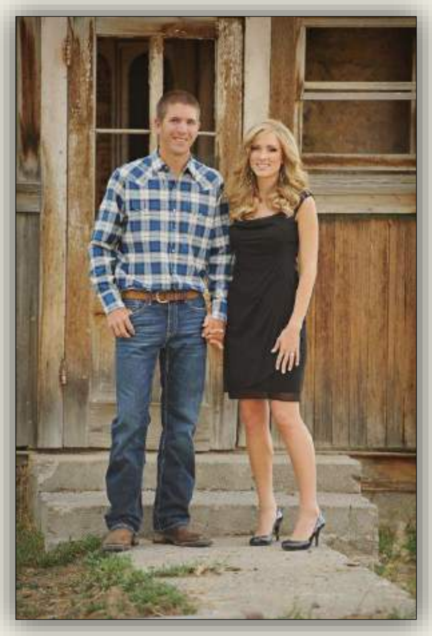
Personal and Family
Married for seven years to his wife Kinzee they have three children together:

Calum age 4
Ailee age 2
Miles age 6 mos.

Kyle Gelles

New Crop Consultant, Mini Cassia

Stations/Area
Max and Minidoka



Start Date
Seasonal during harvest in the Upper Snake area
Full time since October, 2015

College
Idaho State University
B.S. in Business Admin.
A.S. in Civil Engineering Technology

High school
Snake River High

Goals for the future
Learning as much information about the sugarbeet industry as possible, so that I can become a positive and valuable asset to both the company and my growers

Committee Involvement
None at this time

Hobbies
Spending time outdoors and around the family farm, favorite way to spend free time is fishing

Personal and Family
Wife, Jennifer

Aaron Searle

New Crop Consultant, Nyssa

Stations/Area
Weiser, Payette, and Buckingham

Start Date
August, 2015

College
CalPoly
B.S. in Ag business

High School
Yuma High in Yuma, AZ

Goals for the future
Build relationships with growers, to be the first person they call when it comes to questions they have. To become a productive member of Amalgamated Sugar and grow with in the company.

Involvement with Amalgamated Sugar
None at this time

Hobbies
Family, friends, being outdoors, sports

Personal and Family
Three children,
Logan age 14
Lindsey age 12
Blasé age 6

Evan Sonderegger

New Research Tech/Beet Quality Lab Supervisor

Stations
Tare Lab, Vented Piles

Start Date
January, 2016

College
BS from BYU-ID
MS from UNL in Agronomy

High School
Maddison High School
Rexburg, Id

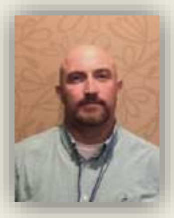
Goals for the future
Conduct research applicable to growers and the industry, optimize tare lab efficiency.

Committee Involvement
None at this time

Hobbies
Sports, outdoors, and gardening

Personal and Family
Married for eight and half years, three children.

We welcome these individuals and look forward to the addition of new skills and experience to the Amalgamated team and wish them the best of luck in reaching their goals within the company!



Write up by Aaron Searle, Crop Consultant, Nyssa.

ONE HOP AT A TIME

With the ever-changing atmosphere that exists within our industry and our company, and the continued emphasis on high quality but affordable research, the Amalgamated Sugar Company's SBQI team is proud to announce another new addition to our team. In the next few weeks Amalgamated Sugar will have up and running two new research greenhouses. The greenhouses, currently being installed at the Nyssa factory location will be the new home of thousands of beet leaf hoppers which will be raised and eventually become vectors of the Beet Curly Top Virus (BCTV). These hoppers will then be used in our ongoing curly top studies as well as the nursery.
Previously, the SBQI team "rented" hoppers from facilities run by other companies such as Betaseed in the Magic Valley and Syngenta in the Treasure Valley in order to run any Curly Top trials. Now that we have established a good quality nursery, and are continually trying to improve it and other studies involving curly top, we decided we would be best supported by raising and maintaining the leafhoppers in house.

Construction on the greenhouses began in mid-November, 2015. With the Certificate of Occupancy already in hand, we are finishing up the final touches.

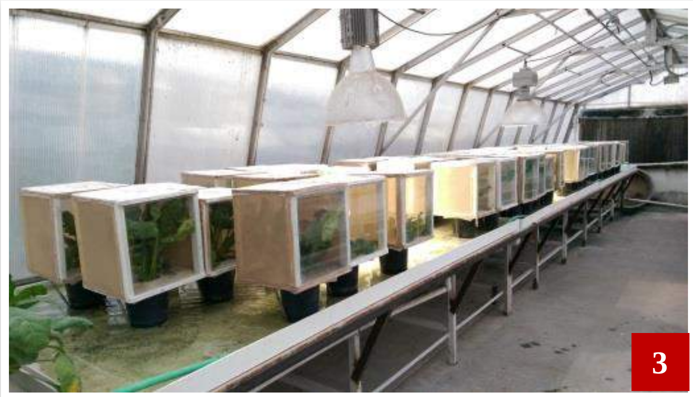
Curly Top in Short

BCTV is spread by the beet leafhopper**.** Once a leafhopper feeds on an infected plant, it becomes a vector and will carry the virus from plant to plant. The virus is not passed between hoppers so nymphs are not hatched with the virus, but once they feed on an infected plant they will carry the virus till death. Adults and nymphs have piercing sucking mouth parts they use to suck plant nutrients. They feed on a variety of plants but prefer to lay eggs on beets, tomatoes, beans and certain weeds. Eggs hatch and develop into adults in 2 to 3 months.

Within a couple days of being infected with the BCTV, the leaves of the plant begin to pucker and roll inwards. Necrosis of leaf tissue begins and eventually the plant shrivels and dies. A cross section of the root will also reveal necrosis and blackening of the vascular tissue. Damage from BCTV has the potential to be very severe and can cause extensive crop loss.

Nancy Cutler
Agricultural Research Support, Nyssa
Photos: Nancy Cutler and Clarke Alder

1



1. The research facility (greenhouses) at the Nyssa factory are currently underway.

2. The healthy feeder plants and the hopper cages will be kept separate in different houses to avoid contamination of the feeder plants.

3. Hopper cages attach directly to the plants containing feeder plants. The plants are watered from the bottom up via a large tray that is filled with water.

4. Construction on the Greenhouses began in mid-November, 2015. Greenhouses are located in the northeast corner of the old parking lot at the Nyssa factory.

5. Beet infected with BCTV. Leaves roll inward and develop a leathery look. Veins swell unevenly on the backside of the leaves.

6. Plants of all stages are needed to maintain healthy feed stock for the beet leafhoppers.

7. Beet leafhoppers are very small. Often, there could be up to 2,000 in a cage at a time. At the time of release on the plots in the curly top nursery, the cages contain approximately 1,000 hoppers.

8. Beet seedlings started in flats of cone-tainers, then transferred to larger pots.

TASCO FACTORY TOURS

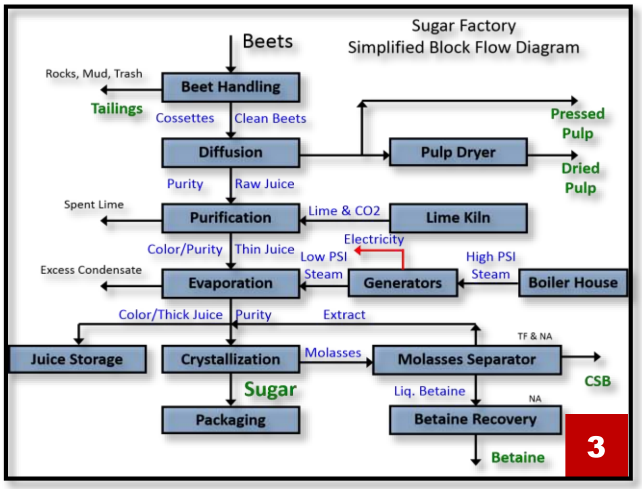
A new or updated experience for many

Kendal Henderson
Crop Consultant, Twin Falls
Photos: Clarke Alder

Back in early December, The Amalgamated Sugar Company conducted tours of each of their factories. The tours were open to the public and were designed to provide an educational experience not only to the growers of the coop, but also to satisfy other curious individuals in the community. The tours through the Nampa, Mini-Cassia, and Twin Falls factories were well attended bringing in approximately one third of the sugarbeet growers in the state. A few growers even toured other factories not located in their growing district, to see the differences in operation types between factories. The factory tours at all three locations began with the factory manager giving an informational and educational discussion on the dynamics of producing White Satin sugar. Problems the beet sugar industry is facing and directions for the future of processing were also discussed. Growers and visitors also received an explanation of the several by-products from beets that are produced to help add additional sources of revenue, other than the sugar we produce. Once the discussion portions of the tours were completed, the participants were taken through the factories to visually explore the process within. It was good for the growers to see the improvements that

have been made in the factories that help the factories process beets a little quicker and more efficiently. Some of the favorites were the new lime filters at the Mini Cassia factory and the molasses separator and tailings recovery systems at Nampa. The growers also appreciated being able to see how their money has been used to bring improvements to the different factories. Growers commented that the information presented at each tour was very insightful and informational to both growers and visitors.

In summary, the tours were a good chance to bridge the gap between the agricultural and processing sides of the company. TASCO looks forward to continuing to provide the tours in the future. TASCO would like to thank those who attended this year's tours and invites all who missed the tours this year to come and participate next year.



1. **This display showed attendees what exactly is produced from each ton of beets processed – including 303 lbs. of white sugar, 107.59 lbs. of dried pulp, 0.73 gal. molasses, 3.02 gal. concentrated separator byproduct (CSB), 1.81 lbs. betane, and 180.72 gal. of water.**

2. **Attendees were divide into several small groups who were then led by factory engineers and plant managers for in-depth tours of the factories.**

3. **Diagram of the sugar making process.**

4. **Plant managers gave a presentation prior to each tour explaining the processing of the beets and the packaging process.**

5. **Several byproducts are created when processing sugar from beets. Among those are beet pulp which is sold as a feed product.**

6. **Highlights on the tours included new additions such as the new lime filters at the Mini Cassia Factory. Growers were pleased to see improvements for efficiency in the factories.**

No-Till Challenge Field

Reed Bowen
Crop Consultant, Twin Falls
Photos: Reed Bowen

In the last few years there has started to be renewed interest in no-till farming. In so many magazines, you see articles on how cover crop and no-till farming is better for the soil and saves water. At the same time, it tends to be dismissed by sugarbeet growers on the basis that beets need a nicely worked seed bed for good germination. With this in mind, Brian Kossman of Schaeffer Farms and I decided to put in a challenge field. We were out to see if no-till beets would work and if there would be water saved.

For the purpose of this article we will just look at how the beets were planted and raised under the no till production system. More work will be done on it the next year to gather more data on the water savings under no till. The project was set up on a pivot that was split. One half of the pivot was conventional tillage. The conventional side was disked twice in the fall. In the spring it was ripped, roller-harrowed, bedded, and dammer-diked. On the no-till side a harrow was run through the straw to try to spread out the chaff trail as the straw was laid down in a windrow. The stubble was watered for regrowth; after the regrowth had reached about a foot tall, it was sprayed and killed off.

In the spring after the tillage had been completed on one half of the pivot the field was pre-watered. The tilled side was planted about 5 days later. The no-till side had to wait two more days as the stubble kept the moisture levels high. The beets were planted with a standard John Deere planter. Row cleaners were used in front of each planting unit. The cleaners were set up to just barely touch the soil. Seed firmers were also used to apply the phosphorus fertilizer around the seed. For the most part, this system worked very well. There was some enveloping of seed in straw, but there appeared to be enough moisture in the soil for those seeds to sprout. Also, after the pre-irrigation only one additional watering was needed to establish a stand. Both sides had excellent stands. The seeds were planted on six inch spacing and stands of 170 to 190 were found in

Tightly packed soil from trucks during previous barley harvest.

both systems. There were a few places where the stand was lower, probably because the soil was packed tight from the trucks running across the field during barley harvest. These spots still seemed to yield well.

The problem with no-till is the ability to get fertilizer in the root zone without moving too much soil. For this project all nitrogen was applied through the irrigation system. The nitrogen was applied from May to June. Both sides were fertilized and irrigated the same to be able to keep all things constant. Phosphorous is a real challenge. The field chosen for this project had decent levels of phosphorous, so a starter fertilizer was all that was needed. Fields with low levels of phosphorus may need a 2x2 placement or something similar to get the fertilizer in the root zone. There was a notable difference in how the water was absorbed on both sides. At times water would be standing on the conventional tillage whereas on the no-till, no standing water was observed. Even with no notice of standing water, the no-till side stayed at a more constant moisture level. Also, there was no noticeable disease coming from higher moisture levels.

The resulting yields on both sides were quite close. The no-till side came out yielding 37.89 tons and an average sugar content of 18.14%. The conventional side yielded 35.05 tons and had a sugar content of 17.83%. Both sides were consistent with yields in surrounding fields, leading to the conclusion that it is possible to raise no-till beets and they can do well. There does need to be caution taken though, as this is the result of just one year's data and the challenge will be repeated for verification of the data.

Above, John Deere planter with row cleaners in front of each unit. Cleaners were set up to just barely contact the soil. Below, a stand of beets can be seen on May 17.

PROGRESS THROUGH INNOVATION

“I knew years ago that there had to be a better way.”

Nic Wittman
Business Analyst, TASCO
Contributor: Natalie Podgorski, Associate, Gallatin Public Affairs
Photos: Clarke Alder

At Amalgamated Sugar we test a lot of beets. As a matter of fact, in a 10 week period during harvest we process over a quarter million sample bags of beets. Our lab operates 24-7 during the harvest campaign. Our goal is to test one third of all loads delivered. During that testing, we analyze sugar content, nitrate levels and tare weight, among other things. We do these tests in order to reward our growers for their focus on quality. When testing that many beets, every second counts so during our most recent harvest, we developed a new system that has helped to maximize our efficiency.

In the past, we were losing precious time each day due to an outdated sample identification system. When growers would come to our receiving stations and we would collect a sample, we would identify it by writing down the date, grower, field, station and piler numbers on a piece of card stock and placing that card in a ‘pocket’ on the sample bag. When the sample was sent to the beet quality lab another individual would have to read that information from the hand-written tag and enter it into the system. That data entry had to be completed in under 20 seconds to ensure we tested the maximum amount of samples for the day. The Beet Quality Lab has the capacity to test 8100 samples every 24 hours and we were not hitting that number. Because of the hand-written information and the speed at which the operator had to enter the data, we also had problems with incorrect numbers being entered into the system. Every day, we had one employee spending four to five hours making corrections to ensure we had the right sample matched up with the field that it belonged to.

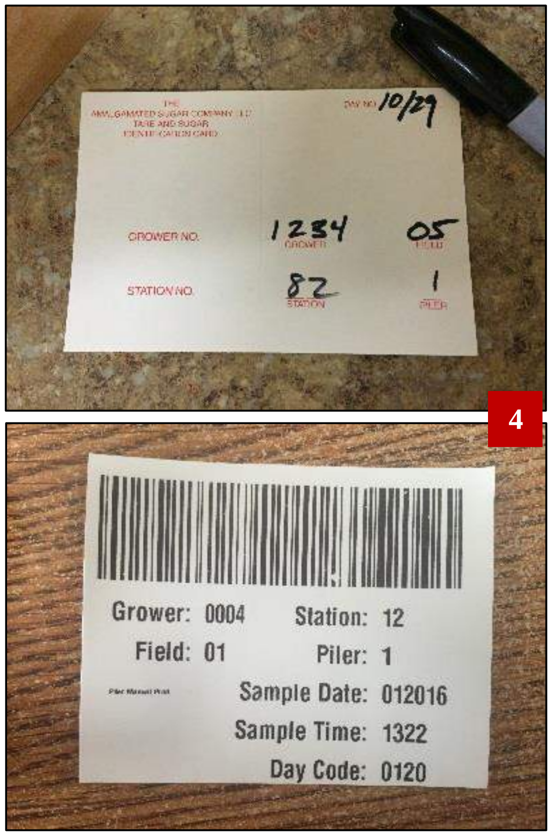
One of our business analysts, Nic Wittman, knew the system needed to be improved and he brushed off some work that had previously been done in a proof of concept a number of years earlier and worked to figure out how to make it a reality. “I knew years ago that there had to be a better way,” said Wittman. “I was a crop consultant before so I knew the process and knew the challenges. We never want to miss the chance to send a sample down the line to be tested. I saw a way for us to improve efficiency and accuracy."

Wittman guided the development of a new system that allows the sample to be entered into a computer system when it is collected at the receiving station. At the receiving station, there is more time to gather information and enter it into an electronic tablet. Instead of writing down a series of numbers on paper, employees simply print a ticket from the tablet. The ticket has a barcode that can be scanned when it arrives at the lab – no more data entry from hand-written tare cards.

To make the change, we had to purchase 130 ticket printers for all of the pilers at the receiving stations. Wittman said the biggest challenge was finding paper that could handle the elements and not tear when it got wet. As a hunter and fisherman, Wittman was inspired by the material the Idaho Department of Fish and Game uses for its licenses. Today, that same material is being used in our new ticket process.

Since the new system has been in place, there were less than 10 corrections made by Beet Quality Lab personnel for the entire harvest. We no longer need someone to spend more than half of their day correcting mistakes. Instead, we have been able to direct their attention to other important matters. Not only are we increasing our efficiency and ensuring we are testing as many beet quality samples as possible but we are giving our growers increased peace of mind by removing chances for human error. With our new system, they can be confident when their quality samples are sent off to be tested the results that come back will belong to them.

This new ticket system is just one more effort to make every second count for our company and our growers.



1. The original setup consisted of a scalehead and a box of tare sample cards. Contract numbers were manually written on the cards then typed into the scalehead, allowing two points of user error.

2. The current setup consists of a tablet application with dropdown menus to avoid manual contract number entry and a printer which automatically prints the new tare sample card.

3. The paper for the printers is a special paper that can withstand the elements and is supplied in a roll that fits inside the printer.

4. The original tare cards (top) were all handwritten with many areas where potential errors could occur. The new barcode system eliminates those errors all together (Bottom).

Petiole Sampling and Nitrogen Management

Aaron Firth
Crop Consultant, Mini Cassia

As a critical element in overall plant growth and leaf development, plant available nitrogen (N) directly affects early season canopy development. A sufficient amount of plant available N will aid in expediting maximum light interception [photosynthesis] in the critical months of May and June to facilitate large root yields.

Fertilizer practices vary by grower according to soil types, irrigation systems, crop history, fertilizer prices, tillage preferences, and many other factors. Primary nutrients phosphorus (P) and potassium (K) are supplementary to N, aiding root development and sugar storage.

In general, most plants utilize a storage mechanism commonly referred to as a "sink." Sinks store nutrients and make them available as needed during the growing season (Gardner, 1985). Sugarbeets store N in the leaves and relocate it as the season progresses. Beginning early in the season, old leaves relocate N to young leaves and later, as the crop matures and N supplies become further depleted, beets begin the process of senescence and prepare the root for storage. Nutrients then begin to relocate from foliage to the root—a process which can ultimately determine root yield and sugar content (Cooke, 1993). **Excess N at this stage can translate to low sugar, high nitrate roots.** In-season monitoring of N content in the leaves, through petiole sampling and analysis, can be a helpful tool in managing this process.

Petiole sampling for N is a practice used in potato production and, for many, has found a place in sugarbeets. Proper sampling methods are critical to obtaining reliable results:

1. Select a representative area of the field to sample. Avoid low lying areas, ridges, flooded areas, and end rows. Sample multiple rows of beets.
2. Sample the same representative area weekly for best results. Doing so will provide reliable, consistent data.
3. Sample during the earlier hours of the day. Warm summer afternoons dehydrate plants and may skew results.
4. Collect the petiole from the first fully matured leaf on the plant. These leaves provide the most accurate data for determining N levels in the plant. Older leaves are often N deprived while younger leaves are N rich.
5. Collect the entire leaf and break the leaf from the petiole or stem. Sample approximately 15-30 petioles, combine, and submit to the laboratory for analysis. Samples should be submitted as soon as possible to provide accurate data.

Many growers in the Amalgamated Sugar growing area have found petiole sampling to be a useful tool in N management. Monitoring N levels within their sugarbeet crop while observing general trends over multiple weeks provides growers an additional resource for making in-season N application decisions by allowing them to see how N is being used by the crop.

Several growers in the Min-Cassia area asked me to collect petiole samples from their fields during the summer of 2015. Four fields were selected from 35 to provide working examples. All four fields are located south of Burley. Crop history and basic agronomic data are listed for each field along with yield and quality results. Fields 1 and 2 contain dark, clay loam soils with high organic matter and a pH ranging from 7.1-7.5. Fields 3 and 4 contain sandy loam soils with low organic matter and a pH ranging from 8-8.3.

The petiole results are plotted on a graph and are indicated by the letter "N". Also included on each graph is the petiole curve found in the Guide Book published by The Amalgamated Sugar Company. Each horizontal axis displays sampling dates while the vertical axis displays petiole nitrate levels in parts per million (PPM).

Implementing in-season petiole sampling provides growers an additional reference when making nitrogen application decisions. Sufficient early-season nitrogen availability supports timely canopy development—maximizing photosynthesis and directly influencing crop performance.

Field 1	
Agronomics	
Previous Crop:	Potatoes
Soil Test Nitrogen (N):	130 Units N
Pre-Plant N:	30 Units N
Top-Dress N:	0 Units N
In-Season N:	30 Units N
Planting Date:	29-Mar-15
Variety:	Crystal 399NT
Irrigation System:	Wheel Lines

Field 1	
Harvest Data	
Harvest Completed:	14-Oct-15
Yield (tons/acre):	47.11 (+10.10)
Mini-Cassia Average (2015):	37.01
Sugar:	18.72% (+1.13)
Mini-Cassia Average (2015):	17.59%
Nitrates (ppm):	77 (-133.6)
Mini-Cassia Average (2015):	210.6

Field 2	
Agronomics	
Previous Crop:	Potatoes
Soil Test Nitrogen (N):	130 Units N
Pre-Plant N:	30 Units N
Top-Dress N:	0 Units N
In-Season N:	30 Units N
Planting Date:	29-Mar-15
Variety:	Crystal 399NT
Irrigation System:	Wheel Lines

Field 2	
Harvest Data	
Harvest Completed:	15-Oct-15
Yield (tons/acre):	47.48 (+10.47)
Mini-Cassia Average (2015):	37.01
Sugar:	17.95% (+0.36)
Mini-Cassia Average (2015):	17.59%
Nitrates (ppm):	113 (-97.6)
Mini-Cassia Average (2015):	210.6

Field 3	
Agronomics	
Previous Crop:	Potatoes
Soil Test Nitrogen (N):	130 Units N
Pre-Plant N:	30 Units N
Top-Dress N:	0 Units N
In-Season N:	30 Units N
Planting Date:	29-Mar-15
Variety:	Crystal 399NT
Irrigation System:	Wheel Lines

Field 3	
Harvest Data	
Harvest Completed:	13-Oct-15
Yield (tons/acre):	38.86 (+1.85)
Mini-Cassia Average (2015):	37.01
Sugar:	17.47% (-0.12%)
Mini-Cassia Average (2015):	17.59%
Nitrates (ppm):	245 (+34.4)
Mini-Cassia Average (2015):	210.6

Field 4	
Agronomics	
Previous Crop:	Wheat
Soil Test Nitrogen (N):	60 Units N
Pre-Plant N:	100 Units N
Top-Dress N:	100 Units N
In-Season N:	30 Units N
Planting Date:	29-Mar-15
Variety:	Seedex RR1534
Irrigation System:	Pivot

Field 4	
Harvest Data	
Harvest Completed:	19-Oct-15
Yield (tons/acre):	35.80 (+1.21)
Mini-Cassia Average (2015):	37.01
Sugar:	18.76% (+1.17%)
Mini-Cassia Average (2015):	17.59%
Nitrates (ppm):	111 (99.6)
Mini-Cassia Average (2015):	210.6

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I 'm excited to roll out to the growers our new Amalgamated Soil Sampling Protocol. The protocol outlines our procedure for how to properly take a soil sample and demonstrates our commitment to providing a professional soil sampling service. Soil samples are one of the most important decision-making tools for a grower's farm; therefore, a soil sample needs to be an accurate and complete representation of which plant nutrients are available in a field. Because sugar beets have deep reaching tap roots, we encourage soil sample cores of three feet in depth to be analyzed for nitrates, allowing farmers to refine their nitrogen management. The concept of maximizing efficiencies on the farm in our highly competitive day and age cannot be stressed enough. As a Crop Consultant, I hope every grower can use his soil samples to minimize his costs and maximize yields. To that end, I encourage you to read this Soil Sampling Protocol thoroughly for the betterment of your future sugar beet crops.

Jonathan Shurtliff
Crop Consultant, Mini Cassia
Photos: Jonathan Shurtliff

LET'S GET SERIOUS

Maximizing crop efficiency through proper soil sampling

The Amalgamated Sugar Company LLC
Soil Sampling Protocol

Mission statement: The Amalgamated Sugar Company LLC is committed to providing top quality soil sampling services for its Grower/Owners. Quality soil sample results assist in making the best management decisions, which are necessary to accomplish the highest possible sugar yields per acre. The key to sampling success is taking consistent, representative soil samples.

MAP GENERATION

1. TASCO Crop Consultants will make arrangements with growers to determine which fields are to be sampled and when the grower wants them sampled (Fall or Spring). For best results, growers should have their samples taken at the same time every year.
2. Maps are generated using a "Google Maps" style format and should include the following details derived in connection with the Grower:
    i. Labeled roads, GPS coordinates, houses, canals, and other "sure fire" identifiers for locating the exact fields.
    ii. Within the field image should be noted any rock piles, covered rock piles, valleys, ridges, swampy areas, small patches of white chalky ground or other areas that should not be sampled as it does not represent the average growing area. The goal is to obtain a representative sample from the most prevalent soil type in the field.
    iii. A grower with a field that has a different soil type, growing condition, or previous crop from one side of the field to the other should consider getting two or more separate soil samples.
    iv. The following agronomic data should be included on the map for each field as follows:
        1. **Grower name and phone number.**
        2. **Date requested by Grower for the soil samples to be completed by.**
        3. **Sample identity / Field name.**
        4. **Historic sugar beet yield.** (tons/acre) The term "yield goal" is also used interchangeably with the term "historic yield" on soil sample bags. Caution should be employed when using the term "yield goal" to ensure that a number is not set that exceeds the realistic growing potential of that particular field.
        5. **Acres.** This is referring to the number of acres in the field. This term is an additional identifier of the field itself since it assists in determining the minimum number of cores to be drilled to collect a representative sample.
        6. **Previous crop.** Although a more detailed crop history would be helpful, only one year of previous crop history should be labeled on the map to prevent confusion.
        7. **The type of sample requested for the lab to run.** TASCO currently pays for the first 12 inch N, P, K soil sample tests as well as the 24 inch and 36 inch nitrate sample. The Crop consultant may suggest a grower run a "complete" test on the first foot. Added costs for additional soil sample testing will be reflected on the grower's beet check.
        8. **Residue levels from previous crop.** (tons/acre)
        9. **Previously applied amounts of manure**. Tons/acre applied, type of and years when manure was applied.
        10. **Previously applied amounts of fertilizer/nutrients**. (lbs./acre)
        11. **Nematode Sample request indicated on a per field basis.** Nematode sampling can take place in conjunction with the soil sampling if the timing and conditions are right. If Nematode samples cannot take place in conjunction with the soil sampling, they should be taken as indicated in: "*Sampling Procedure to Diagnose Nematode Infestations*" by Saad L. Hafez*. This document has been adopted as our procedure for taking Nematode samples. While TASCO does not pay for the testing of nematode samples, nematode sampling is, however,

encouraged in suspect fields and the cost associated would be reflected on the grower's beet check.

12. **Name of the crop consultant who made the maps.**
13. **Date the maps where created.**

b. The Crop consultant will file and save the maps for future reference. The soil sampling employee has the responsibility to maintain a working copy of all soil sampling maps received. He is also to mark on his map(s) the approximate sampling pattern/route taken across the field, and store said maps safely in the file box provided to him.

TAKING A SOIL SAMPLE

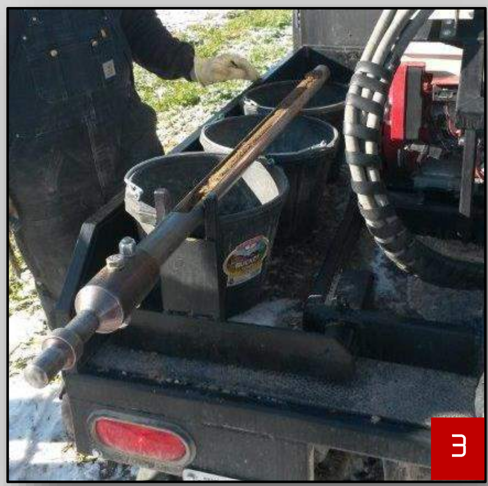
Before a soil sampling employee can take soil samples they must be trained. This training should include safety training and soil sampling protocol procedures. The District Safety Manager will outline the specifics of the safety training. The Crop consultant will outline and be responsible for the implementation of the soil sampling protocol procedures.

1. Steps to taking a quality soil sample:
   a. Before the soil sampling employee gets to the field they should **call the Grower to coordinate the final soil sampling plan**. The finalized plan should include a review of the details with the grower on the soil sample map. The soil sampling employee should make note of any changes to the original instructions and report them to the crop consultant. (Growers are not always readily available to monitor such changes).
   b. Using the field map, a rough sampling pattern may be outlined and marked on the map to ensure a complete, even and **representative distribution of sample cores taken randomly throughout the entire field.** (Soil samples are not to be taken near rock piles, valleys, ridges, swampy areas, or ends of the field where equipment turns around. Review "no go zones" on the soil sample field map.)
   c. Drill a sample core approximately every 5 acres with a minimum number of 15 cores per field when using the AMS Hammer probe. For soil sampling employees using Amity probes or hand augers, a minimum of 20 cores must be taken. Drilling more cores than this will often be necessary to obtain enough soil to fill the sample bag.
   d. Before probing the ground, the soil sampling employee should scrape/remove any surface debris including, piles of straw, thatch, manure, broadcast fertilizer and accumulated salts. No effort should be made to remove organic matter already evenly incorporated into the soil. If manure, compost, and/or broadcast fertilizer has been found that has not already been accounted for on the soil sample map a call to the crop consultant and grower should be made by the soil sampling employee to update all the parties involved.
   e. Some fields may have already been bedded and may have fertilizer incorporated into the soil beds. Do not drill cores in any portion of these beds; instead take the cores in the valleys between the beds.
   f. Extreme care is needed so as not to mix or cross contaminate different depths of the soil sample. Make sure each soil depth is probed at exactly 12 inch increments and that a minimum of soil "sluffing" occurs between each foot of sub sample. Appropriate label marks per foot should be maintained on the probes or drills being used.
   g. The soil from each foot of depth is deposited into individual labeled buckets and mixed by hand in between each core location. When the field is complete the evenly mixed soil is to be poured into the soil sample bags. Use preprinted labels and a sharpie to write legibly on the soil sample bags. Fill in all of the questions on the soil sample bag.
   h. Some soils cannot be sampled at a depth of 3 feet due to a restrictive layer. Soil sampling employees should inform the crop consultant when this occurs and **accurate records as to the actual average depth that was drilled should be marked on the sample bag and map.**

2. The soil sampling employee should give himself enough time at the end of the day to deliver the sample bags to the lab or to a corresponding pick-up location. The soil sampling employee needs to double check sample bags to confirm that everything written on the bag is still legible and ready for pick-up.

3. It is the crop consultant's responsibility to **stay in contact with both the grower and the soil sampling employee to make certain that fields are sampled** and soil sample results/recommendations are delivered in a timely manner. **Crop consultants** should periodically observe how their soil sampling employee is taking samples to **confirm that sampling quality is holding to a high standard.**

*A copy of Saad Hafez's "Sampling Proceedures to Diagnose Nematode Infestations" is included at the back of this magazine.



1. On the factory sampler, samples can be taken to a depth of 3 feet using a hydraulic press.
2. The control panel features easy to use controls that keep the operator out of the way of the soil probe.
3. Once the probe is brought out of the ground, the soil can easily be separated into 1, 2 and 3 foot sections of the profile.

"Water is…the most important resource a grower needs to…complete the job they set out to do."

Where's My Water?

Clarke Alder
Agronomist
Photos: Clarke Alder

The past few seasons have dealt a fairly hard blow to many farmers in the west. Sugarbeet growers in our own cooperative were certainly not excluded from the near crisis situations some experienced. With higher than normal temperatures throughout the region and lower than normal precipitation and snowpack, growers have had to step up their game in terms of organization and planning in order to get the highest possible production out of their farm while being extremely limited on a very important resource—water.

Water is not only an important resource for growers, it is arguably the *most* important resource a grower needs to have in order to complete the job they set out to do, that is, growing food for the rest of us. It doesn't matter where a person farms or what they want to grow, water—that is two hydrogen atoms and one oxygen atom, is an essential fuel for the process we call photosynthesis; a process that without such, producing most anything from the kingdom, Plantae, is impossible. This then begs a very important question for those growers struggling to find the water they need: Without water, what *can* a grower do?

Fortunately for the growers in Southwestern Idaho and Eastern Oregon, the water supply, although very low over the past couple of seasons, has never completely disappeared. This means there are still a few things a grower can do to get through the season and hopefully take his sugarbeet crop with him.

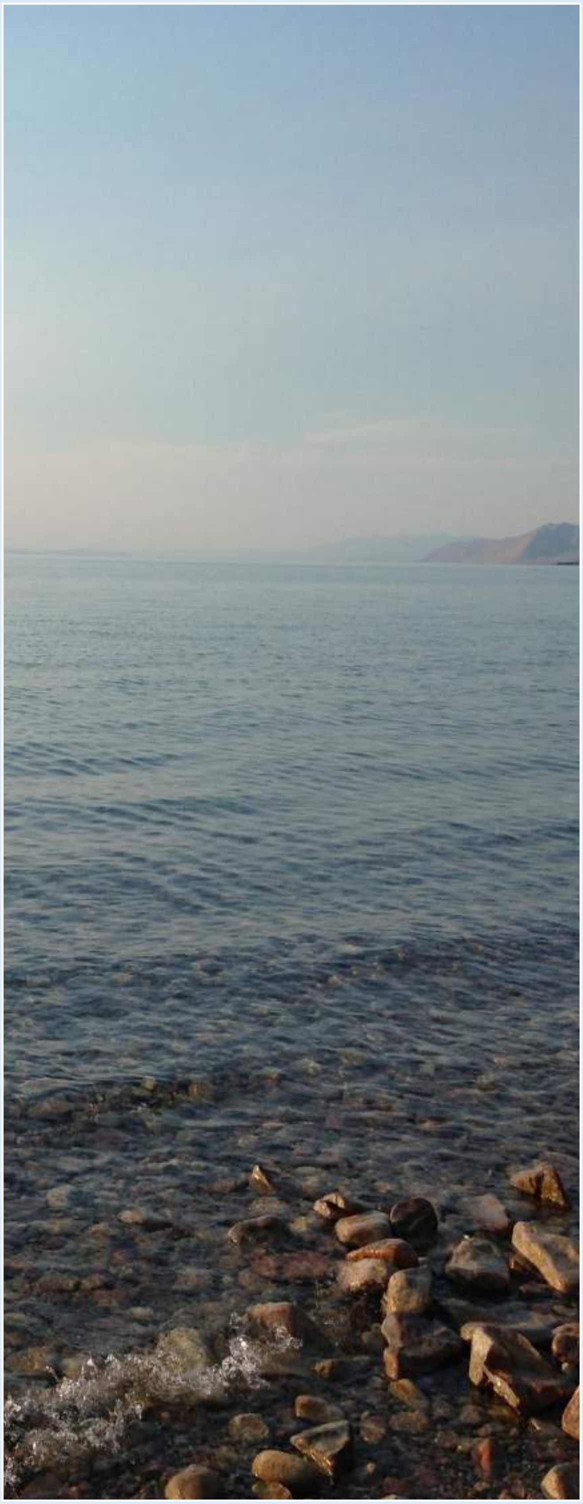
Most rotations in our growing area include a fairly diverse variety of crops which can vary quite a bit on the amount of water they need. Corn, onions, and sugarbeets, very common crops grown in our area, are among the highest water users in that rotation. On a short water year, most growers are reduced to growing crops that utilize the least amount of water such as seed peas and wheat. So, if a grower wants to stick with sugarbeets (which we highly recommend), here are a few guidelines to follow when things start to get a bit dry.

Make Room

In 2014, many growers in Southwestern Idaho and Eastern Oregon worried that this was the worst drought situation they'd seen in over 40 years. Many were unsure of what to do at first because onions were the cash crop but they were also a relatively high water user. Their solution—move the onions to where there was water. And they did. A lot of ground was left idle that year, but the end result was that most of them got an onion crop. Certainly the recommendation is not to push all other crops to the wayside to make way for sugarbeets, but if the price is right, it makes sense in a rotation, and it fits within all of the other contracts a grower has in place that year, it is possible to make sugarbeets work. Make sure the sugarbeets are in a place with heavier soil with higher water holding capacity and where they will have water for most, if not the entire season.

Monitor the Water

Traditionally, many growers in the Southwestern Idaho and Eastern Oregon growing area have been and still are furrow irrigated over much of their land. Although there is a lot of progress toward forms of overhead irrigation (and drip in the case of onions) in the area, the vast majority of the ground is still this way. When it comes to monitoring soil moisture and scheduling irrigation on a field by field basis, many find it difficult because furrow irrigation poses some difficulties in efficiency. It is much easier to have a set watering schedule where a certain field is watered every ten days as part of the rotation on the ditch. Although it may be easier, it is also good way to overwater a crop. This will unnecessarily waste water as well as lead to other problems such as weeds, disease, and early season damp off. That said, plant health is key and proper early season irrigation is the first and most important step in getting there. A reasonably good stand is essential to making the best use of water and nutrients (Neibling, Tarkalson and King, 2012), so don't under-irrigate early on either. Filling the soil profile while there is water available is essential, especially in center pivot systems where they may not be able to keep up mid-



season when temperatures rise. After the profile is filled make sure the ground and the crop gets only the water it needs to allow more time and water for other crops on the farm. There are many options for monitoring soil moisture content being successfully implemented across the entire sugarbeet growing area including several different soil moisture sensor systems. There are also abundant resources if a grower is seeking knowledge on those different options. Whether a shovel, a thumb test, a moisture sensor, or a combination of all of those are the preference, the idea is the same. Keep the profile full, but don't overwater.

Don't Panic

Sugarbeets are a fairly self-sufficient crop once established. Studies have shown that beets can be stressed mid-season (getting only 70-80% of necessary water) (Neibling) without any major yield reduction. This means that during a dry season, sugarbeets will likely be affected less than shallow rooted crops (Miller, 2001). By mid-season, the roots of the beet can be up to four feet deep, so the soil profile, if filled correctly early on, will serve as a supplement to the sugarbeets as they mine for more water. Obviously the longer water is available, the better the crop will be, however, if water is set to run out in late July or early August, the goal should be to fill the profile with the last watering. The beets will be able to make use of this water fairly effectively as this water moves through the profile to where the current active root zone of the beets exist. If the water is gone from the ditch in early August, growers shouldn't be discouraged. There will likely be some yield loss (Yonts, 1996), but yield should still be high enough to make a crop and the sucrose content should stay steady in medium to fine textured soils (Carter et al., 1980). A study by Kaffka et. al. (1995) even showed maximum sucrose content was achieved when water was shut off 7-9 week prior to harvest in a heavy, organic soil. Unfortunately, in light, coarse textured soils, the yield and sucrose losses will be greater due to reduced water holding capacity.

On the whole, the answer is the same during a short water year as it would be for a year with sufficient water supply: 1) Fill the profile, 2) establish the crop early, 3) feed the root zone by watering according to the crop's needs, 4) fill the soil profile with the final watering, and 5) let the beets do the rest. The results may not be perfect, but certainly will be better than some of the alternatives.

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Two-spotted spider mite on sugarbeet

Importance, identification and management

Oliver T. Neher
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James Barbour
University of Idaho, Parma, ID
Photos: Oliver Neher

In the past two-spotted spider mites (TSSM) were a minor but reoccurring pest problem on sugarbeets grown in Idaho, Oregon and Washington. However, since 2012, these production areas saw a significant increase in TSSM populations resulting in localized, severe crop losses. This observation is not fully understood, but a number of factors most likely contributed to the increase in mite populations. These factors include a shift to more corn acres to accommodate the growing dairy industry, the use of broad-spectrum insecticides to control other insects, the loss of spider mite-targeted products from the market, potential miticide resistance in TSSM populations, and climate change resulting in warmer springs and summers. TSSM occur in production areas with warm dry summers such as Europe and parts of North America. Pest pressure and associated damage increase with hot temperatures in combination with dusty conditions and reduced relative humidity or drought conditions. Under severe pest pressure losses up to 25-30% or more are not uncommon when not controlled by acaricide applications. Crop losses include decreased tonnage and percent sucrose. In addition, stressed plants will experience increased losses during storage due to elevated respiration.

Symptoms

Because TSSM are small and generally feed on the underside of leaves populations often go unnoticed until serious damage has occurred. Foliar symptoms caused by TSSM often appear first on field edges and areas close to other infected hosts (alfalfa seed, corn, bean, etc.). Damage initially appears as a light stippling of leaves caused by TSSM piercing individual cells (figure 1) and sucking the cell content which allows the cells to be filled with air. Continued feeding results in silvering and bronzing of leaves (figure 2), and eventually in dying of affect leaves as well as potential defoliation of the whole plant. TSSM infested plants show reduced plant vigor, tonnage and sucrose content as a consequence of inhibited photosynthesis and sugar production.

Figure 1. Initial damage caused by two-spotted spider mites. Left leaf healthy. Right leaf shows signs of stippling caused by pierced plant cells filled with air.

Figure 2. Advanced symptoms (silvering and bronzing) of two-spotted spider mite feeding damage. Left leaf healthy. Right leaf showing bronzing and silvering.

In addition to signs of feeding damage, TSSM produce distinct webbing at the underside of sugarbeet leaves that can hinder control efforts. Foliar symptoms of bronzing in conjunction with wilting can be misdiagnosed as drought stress especially on field edges.

Description

Despite their name, two-spotted spider mites (*Tetranychus urticae* Koch) are only related to spiders (*Araneae*) and belong to their own order (*Acarina*). The main distinguishing feature is the fusion between thorax and head giving the body a sac-like appearance. Adult TSSM females are oval, 1/64 of an inch long (0.4-0.5 mm) whereas males are 1/72 of an inch (0.34 mm) with a pointed abdomen. Adult mites have eight legs and two district black spots (figure 3) reaching from the middle of the abdomen to its end. The color of TSSM can range from yellow to yellow-green to green-brown. Under drought conditions or in the fall, mites often turn orange or reddish-brown.

Figure 3. Adult two-spotted spider mite (upper right corner) showing characteristic black spots on abdomen and nymph stages (lower middle and upper left corner).

Immature TSSM stages include a larva and two nymph stages (protonymph and deutonymph) (figure 3). Larvae possess six legs whereas nymphs have eight legs. Both stages are smaller than the adults. Larvae can appear translucent but become yellow-green to green as they begin feeding with earlier described black spots faint or absent. Protonymphs and deutonymphs are progressively larger than the larvae. They are more deeply green and the characteristic black spots on the abdomen are more pronounced.

Eggs are clear to milky-white spheres about 1/150 of an inch (0.18 mm) in diameter (figure 4), and usually laid on the underside of leaves or beneath the protective webbing.

Figure 4. Eggs of two-spotted spider mites laid on the underside of a sugarbeet leaf.

Host range and environmental conditions

TSSM have an extensive host range (more than 200 plant species), including many weeds, field and horticultural crops, as well as ornamental plants. Just to name some of crops grown in Idaho, Oregon and Washington that can serves as hosts to TSSM: all varieties of beans and corn, sugarbeet, hops, mint, potatoes, many seed crops such as alfalfa or carrot, as well as many fruit trees and shrubs. Perennial crops such as alfalfa or mint may play an important role in the life cycle of TSSM since they serve as an overwintering refuge.

The life cycle (figure 5) of TSSM is highly driven by environmental conditions. A minimum temperature of 55°F (13°C) with an optimum of 63°F (17°C) in combination with low precipitation (1.9-2.7 inches / 50-70 mm) is needed for TSSM to become active in the spring. Hot, dry (35-40% relative humidity) weather favors rapid population increase and increased damage that is exacerbated by water stress and dusty conditions.

Life cycle

TSSM overwinter as dormant (diapause) adult females on dead vegetation, in cracks and crevices in tree and shrub bark and fence posts and rails, and other protected areas such as soil or plant crowns (figure 5).

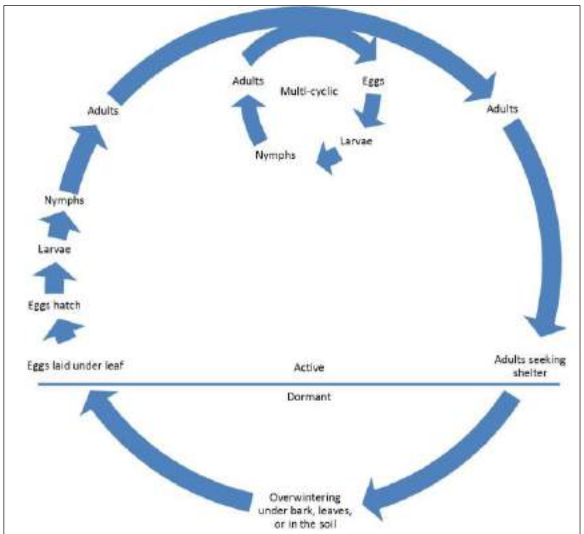


Figure 5. Life cycle of the two-spotted spider mite. (Adapted from *Fundamentals of entomology and plant pathology*, Louis L. Pyenson, 1977)

In the spring, females emerge from overwintering sites as temperatures reach 63°F (17°C). They immediately begin feeding and depending on environmental conditions and availability of food, begin laying eggs within two days of emergence. Fertilized eggs will give rise to female mites whereas males will emerge from unfertilized eggs. Two to five days after eggs are deposited, first instar, or larvae, will emerge from eggs. TSSM develop through two additional molts, the second instar, or protonymph, and the third instar or deutonymph, before becoming adult mites. Each transition between molts is preceded by one to two days of inactivity during which mites are very resistant to chemical control. Under optimum conditions, the development from egg to adult can take 6-7 days. Earlier in the season or under adverse conditions, the life cycle can take more than three weeks. In the Treasure Valley of Idaho, reproduction may be continuous from early spring until late fall with each female laying up to 90-120 eggs per mite. The eggs hatch in about 2-10 days, and eight to twelve overlapping mite generations can develop during the spring and summer months. In late August and September, under the influence of shortening day length, orange-colored, diapause-form female spider mites appear and begin moving to overwintering sites (figure 5). Male spider mites do not over winter. Depending on environmental condition, female mites can live up to five weeks, whereas males only live for about three weeks.

Management

Small mite populations are not a management concern. However the potential rapid population increase under optimal environmental conditions can result in very serious damage and yield loss in a very short period of time. Sugarbeet fields can be rapidly infested with damaging levels of TSSM as mites migrate from senescing (naturally senescing or senescing as a result of spider mite feeding damage) or heavily infested crops from neighboring fields.

Disease monitoring and timing of control measures

Scouting is an important tool to determine mite pressure and to estimate the need for applications. Sugarbeet fields need to be checked as soon as temperatures reach 63°F (17°C) and relative humidity drops below 40% (figure 6). Fields should be scouted weekly when surrounding crops start to senesce or show signs of mite infestation and hot, dry conditions are predicted. Initially, mites can be found on the underside of lower leaves, but as infestation progresses, mites, webbing and feeding damage can be observed on all plant surfaces.

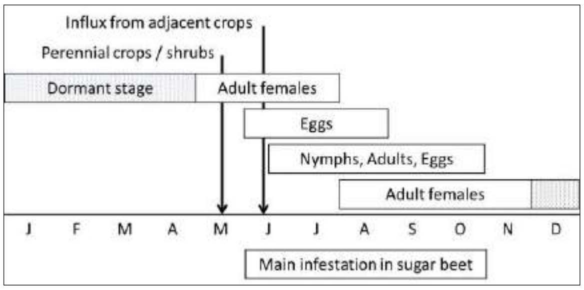


Figure 6. Scouting schedule for the detection of twospotted spider mites in sugarbeet.

A simple method to assess TSSM infestation is to shake a leaf over a white sheet of paper. Using a hand-lens (at least 10x magnification) the number of TSSM per leaf can be assessed. It is important to repeat this with multiple leaves across the whole field and to keep records of the individual counts. An increase in mite populations in combination with conducive weather conditions can warrant miticide applications. However, mite populations can increase as fast as they can decline and it is important to consider future weather patterns (cold and wet conditions can lead to a reduction of the population). Growing areas in France relay on a threshold based on 10% of plants showing silvering or bronzing and the appearance of the pest that will trigger applications. In Turkey, sugarbeet growers will start spraying when 5 TSSM per 100 leaves are observed. However, no economic threshold is established for sugarbeets grown under Idaho conditions.

Cultural practices

Cultural practices will only indirectly influence TSSM population dynamics. In general, overhead irrigation (hand or wheel-lines, pivots) often have fewer mites because of less favorable environmental conditions. Efforts to reduce dust and infection with powdery mildew will minimize hiding places for mites. In addition, avoiding plant stress caused by drought or excess nitrogen will help to reduce the infestation by decreasing the reproductive rates and slowing the development of TSSM.

Chemical control

Two-spotted spider mite populations cannot be effectively managed using the broad spectrum insecticides currently available because of mite resurgence. Resurgence occurs when a pesticide treatment while reducing the pest population, also kills, repels, irritates or otherwise reduces natural enemies of TSSM. When the residual activity of the insecticide expires the pest population is able to increase rapidly and to a level of higher abundance because natural enemies are absent or in low abundance. Resurgence can also be the result of exposure to sub-lethal doses of insecticides that can cause an increase in fertility or oviposition and thus to a significant increase in mite abundance.
Resurgence is a general phenomenon of broad spectrum insecticides use such as organophosphates (chlorpyrifos, methyl parathion, naled, oxydmeton-methyl, or phorate) or insecticides using ineffective compounds (azadiractin, garlic oil, paraffin oil, potassium salts of fatty acids, and sorbitol or sucrose octanoate). Even Sulfur, labeled for control of TSSM in sugarbeet, is known to cause resurgence of mite populations. Generally, resurgence is not seen when selective miticides such as hexythiazox are used.
Hexythiazox is a selective growth-regulator-miticide specifically targeting mites that has not been observed to cause mite resurgence.
In case broad spectrum insecticides need to be used, only field edges or hot spots should be treated to slow down and prevent further spread in the field.

Biological control

Low number of TSSM might be controlled by using soft or biological products such as azadiractin, garlic oil, paraffin oil, potassium salts of fatty acids, and sorbitol or sucrose octanoate. In addition, many natural enemies can help to either keep TSSM numbers low or to slow down the population increase. Beneficial insects can include green lacewing (*Chrysoperla carnea*), ladybeetle / mite destroyer (*Stethorus punctillum* and *S. picipes*), minute pirate bugs (*Orius* spp.), predatory mites such as the western predatory mite (*Galendromus occidentalis* and *Neoseiulus fallacis*), and thrips (*Cryptothrips nigripes* and *Scolothrips longicornis*).

However, if natural enemies are desired in the field, broad spectrum insecticides such as organophosphates, carbamates and pyrethroids need to be avoided.

Glossary

Acaricide:	a pesticide that specifically targets members (mites and ticks) of the arachnid subclass *Acarina.*
Acarina:	a subclass under the arachnida class which includes mite and ticks.
Arachnida:	a class of joint-legged invertebrates which have eight legs. The class arachnida includes spiders (*Araneae*), scorpions, ticks, mites (*Acarina*), etc.
Araneae:	an order within the arachnida class including spiders
Deutonymph:	third motile immature (instar) stage of twospotted spider mites
Diapause:	a period of dormancy enforced by physiological processes
Instar:	a life stage between two successful molts
Larva	first motile immature (instar) stage of twospotted spider mites

Further reading

Harveson, R. M., Hansen, L. E. and Hein, G. L., eds. 2009. *Compendium of Beet Diseases and Pests*, 2d ed. American Phytopathological Society Press, St. Paul.

Flashback

March 1945 Issue

Saving a Reduced Stand of Sugar Beets *vs.* Replanting

By G. W. DEMING

George Warren Deming was an Associate Agronomist at the Ag Experiment Station at Colorado State University in Ft. Collins. He did extensive work involving wheat, oat, millet, sorghum, and corn breeding and production as well as being a member of the Division of Sugar Plant Investigations, specifically under sugarbeet.

Sources:

Stephens, E. 1938. Directory of Organization and Field Activities of the Department of Agriculture. Misc. Pub. No. 304.

Deming, G.W. 1943. Eight Observations on Segmented Seed. Through the Leaves. P 11-16.

A thin, uniformly distributed stand of sugar-beet plants is necessary if the efficiencies of the sheared seed method are to be realized. In spite of the recent advances in improving quality of sheared seed and in planter design, adverse conditions for germination may sometimes result in poor initial stands just as was the case when whole seed was planted at heavy seeding rates. The chance of occurrence of stands that are below optimum will always be with us. When initial stands are below normal the grower must decide whether to try to obtain a more or less scanty stand from the planting made at the proper time, or to replant. Replanting has the obvious disadvantage of lateness. It is the common experience that late plantings show strongly reduced yields in comparison with earlier plantings.

Frequently, a careful examination of an apparently very sparse initial stand will reveal that a fairly good thinned stand can be saved, and with a considerable saving in time for the thinning job. Such stands should not be replanted. In other cases, a stand of thinned plants considerably below a full stand is all that is possible to obtain. Some appraisal, therefore, of the effects of reduced stands on yield is needed to assist the grower in judging whether the thinned stand he will obtain from the sparse initial stand should be saved or whether replanting is desirable.

Experiments conducted in replicated plots at Ft. Collins, Colo., have given information on the effects of reduced stands on sugar-beet yields and give also a comparison of yields from reduced stands with those obtained from replanting.

In the first series of experiments, three space intervals in the row were employed, and by cutting out of plants at random, three stand levels, full, 70 per cent and 40 per cent (approximately) for the respective space intervals were obtained (table 1). For the purpose of this report, the effects of space interval in the row need not be stressed, and attention may be given to the number of plants left in 100 feet of row which ranged from 136 to as low as 31. In all cases some reduction in yield resulted when stands were below a full stand. However, the reduction in yield was relatively small if the average stand was not reduced below 70 plants per 100 feet of row. The drop in yield is not at all proportionate to reduction in stand since beets adjacent to skips were larger than those that grew in a full stand. As an average of the 3 years, the yield obtained with a stand of 31 beets per 100 feet of row was 11.67 tons of roots and 3,182 pounds of gross sugar per acre. This yield from the reduced stand was about 2/3 of the highest yield obtained from any stand.

A good seed bed. Much of the failure to secure good sugar-beet stands traces to improperly prepared seed beds.

Table 1.—Effect of stand on acre-yields of roots and sugar and on sucrose percentage of sugar beets grown in 16-inch, 12-inch, and 8-inch spacings. (Tests made at Ft. Collins, Colorado, in 1937, 1938, and 1939, with results given as 3-year averages.)

Average stand of roots harv 100 feet of row	Type of stand sought	Initial spacing in row	Acre-yield Gross Sugar	Acre-yield Roots	Sucrose
		Inches	Pounds	Tons	Per cent
136.7	Full	8	4,636	16.20	14.14
103.7	70 per cent	8	4,447	15.61	14.13
95.3	Full	12	4,715	16.55	14.15
72.0	Full	16	4,650	16.33	14.22
70.7	70 per cent	12	4,546	15.91	14.19
61.0	40 per cent	8	3,931	13.85	14.11
53.3	70 per cent	16	4,177	14.84	14.00
40.7	40 per cent	12	3,600	12.92	13.90
31.0	40 per cent	16	3,182	11.67	13.56
Difference required for Significance; Odds 19:1			241	0.61	0.35

In planting-date tests, as an average of 2 years, heavy loss of yield resulted when plantings were delayed until the middle of May. The yields were approximately 2/3 of the yields obtained from plantings made about a month earlier (April 20). Hence, the late plantings (full stands) gave about the same yield as was obtained from a timely planting having only 31 beets per 100 feet of row.

In experiments conducted in 1941, 1942, and 1943 timely planting with stand levels of approximately 100, 70, 50, and 30 plants per 100 feet of row were contrasted with full stand replantings made 32 days, 38 days, and 49 days later in the respective years. The dates of replanting in 1941 and 1942 (May 13, May 14) were similar to those employed by growers near Ft. Collins, Colo. In 1943, the date employed (May 25) was unusually late because rain delayed the operation, but such a situation could occur in practice in any year. The results of the test are shown in table 2 as averages for the 3 years. On the basis of these tests a grower may expect from a 70 per cent stand about 9/10 of the yield from a full stand; from a 50 per cent stand about ¾ the yield, and from a 30 per cent stand about 2/3 of the crop from a full stand. These are the comparisons based on timely planted beets. He may also expect, as an average, from a full stand of replants about ¾ of the crop he would have obtained from a full stand planted earlier and at a timely date. Early replanting will, of course, tend to minimize the loss in yield that results from delay in getting the sugar beets started at the proper time.

Fun Fact: The data in this article support recent research done by TASCO's SBQI department from 2011-2014. Similar to the article, TASCO data reported best yields resulted from planting early. TASCO data also showed no significant differences in yield or sugar content for uniform stands of beets between 95 beets/100 ft of row and 255 beets/100 ft of row. Stands below 95 beets/100 ft of row however, did show a significant reduction in yield and sugar content and should be considered for replanting depending on the time of the year. For more information on this or other studies, contact your TASCO Crop Consultant or a member of SBQI for further details.

Table 2.—Acre-yields and sucrose percentage of early planted and replanted sugar beets. The stands of early planted beets were made to conform approximately to the stand levels shown: The stands of replanted beets were approximately full stands. Data were obtained from 5 plots of each treatment, in 1941, 1942, and 1943.

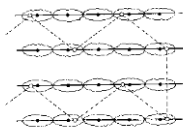
(Results are given as summary of the 3 years of test.)

Type of planting	Stand level (Approx.)	Acre-yields Gross Sugar	Acre-yields Roots	Sucrose
		Pounds	Tons	Per Cent
Early	100	4,147	15.32	13.60
Early	70	3,717	14.10	13.21
Early	50	3,140	12.30	12.84
Early	30	2,383	9.81	12.21
Replant	100	3,122	10.98	14.44
Difference required for significance				
	Odds 19:1	181	0.47	0.38

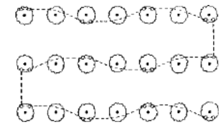
In judging possible returns, certain items of cost in growing the crop must be considered. It must not be overlooked that in retaining a first planting with its reduced stand very material saving in thinning time and some saving at harvest from handling fewer beets may accrue. These are in addition to the saving from not having to repeat the operations of fitting the land and planting.

It seems probable in the light of data obtained that any yield increase from a good stand of replanted beets over the yield obtainable from a stand averaging from 50 to 70 beets per 100 feet of row saved from a timely planting will be offset by the costs of replanting and the additional time spent in thinning and harvesting a good stand of replants. Under present conditions any possible saving in labor is of importance. Therefore the conclusion indicated by these tests is that the grower when faced with the unfortunate condition of an apparently poor initial stand of sugar beets should be reluctant to replant even if no more than 50 beets per 100 feet of row can be saved from the timely planting.

Editor's note: Mr. Deming is an associate agronomist of the U. S. Department of Agriculture. He is stationed at the Sugar Plant Field Laboratory, Ft. Collins, Colo., and works in cooperation with the Colorado Agricultural Experiment Station. He has prepared, at our request, this brief digest of a report of his investigations published in the 1942 Proceedings of the American Society of Sugar Beet Technologists, and has included a summary of results from later experiments. Agronomic investigations of the Division of Sugar Plant Investigations in Colorado are conducted in cooperation with the Colorado Agricultural Experiment Station.



Sampling Procedure to Diagnose Nematode Infestations



Saad L. Hafez

Introduction

Nematodes are minute, worm-like animals that may damage plants but are often difficult or impossible to detect with the unaided eye and are sometimes called the "unseen enemy." The word "nematode" when literally translated means "thread-like." Other names commonly used include "roundworm," "eelworm," or "nema."

Plant parasitic nematodes require the presence of living plants for reproduction and long-term survival. No plant or plant part is totally free from nematode attack, and annual economic losses in the United States have been estimated at 10 percent of the total agricultural crop values. Worldwide, over 2,000 plant parasitic nematode species have been identified and they occupy every available niche provided by plants. When nematodes feed on plant roots the uptake of water and nutrients is reduced, debilitating the entire plant.

Nematode sampling has become increasingly important in modern agriculture as the concepts of Integrated Pest Management (IPM) and Integrated Crop Production are developed and utilized. Scientists concerned with nematode populations have improved methods for their assay; however, data from the best extraction methods are of limited value if the sample is not representative of the area. Effective diagnostic sampling may involve rating plant roots (e.g., galls caused by *Meloidogyne* spp.), bioassays, or visually assessing above-ground growth for effects of foliar pathogens in addition to collecting soil and root samples for nematode counts.

Objectives

Primary objectives of nematode sampling include: diagnosis of disease problems, general detection and surveys; providing advice in IPM programs; and fulfilling research needs, e.g., evaluating different management practices.

Diagnosis

Sampling for nematodes is an increasingly important component of plant disease diagnosis, especially for high value crops and nursery stock. Without confirmation through sampling, poor plant growth because of nematodes may be misinterpreted as nutrient deficiencies or other maladies. The art and practice of collecting representative root and/or foliage tissue as well as soil samples is a critical component of diagnostic sampling. For example, sampling from adjacent, healthy-appearing plants may be just as important as collecting samples from the most severely affected ones.

Detection and survey

Nematode sampling is the basis for determining the occurrence and distribution of many plant parasitic nematodes. Quarantine or phytosanitary regulations of many countries, or political subunits, require that planting materials be produced on land certified free from nematodes. Soil sampling for certification of widely distributed planting materials requires extreme precision for detection of quarantined pests. Although the objective of detection seems simple, a negative result does not necessarily prove absence of the pest, but only indicates that a nematode population is below the detection level.

Advisory

The fact that initial numbers of nematodes can be related to the yield of annual crops has enabled nematologists to develop functional advisory programs, even though relationships between nematode numbers and crop damage may be modified by environment. Because of the importance of reliable detection, most sampling for advisory purposes is conducted when population densities are near their maximum levels, often at the end of the growing season after harvest. Sampling at the time of planting, however, theoretically will give a better estimate of the initial nematode problem where population levels are high enough for detection. Follow-up sampling may be necessary with perennials because low, nondetectable populations sometimes increase over time to damaging levels.

Research needs

Research is conducted to evaluate the effectiveness of different management practices in reducing nematode populations and plant damage. Extra effort in sampling plant tissues and soil is required to obtain accurate results. The accuracy in determining relative numbers and developmental stages of nematodes may be greatly affected by sample handling or extraction. Design and management for sampling may need to be modified for each specific type of study.

Considerations in designing sampling procedures

1. Nematode distribution patterns will influence the results and must be considered.
2. The capacity of the nematode species to move or be moved by man or other carriers.
3. A majority of nematodes in most annual cropping systems are found in the upper layer of soil (to 15 inches).
4. The influence of biology, feeding habits, and environmental interactions of the nematode species involved.
5. The effect of crop rotation and cultural practices.

How to sample for nematodes

Making the proper management decision for a nematode problem depends on the correct diagnosis, which also depends on proper sample collection, handling, labeling, packaging and shipment. Population densities of plant parasitic nematodes vary greatly in time and space. Population densities are often affected by climate, crops grown, weed hosts, chemicals used, and other factors that may lead to patchy distributions. Patchy or aggregated nematode distributions and changes in the species composition of the nematode communities over time pose major sampling problems. Collection of representative soil samples is the primary component of sampling for diagnosis.

The following recommendations are presented as general guidelines and may require modification for specific field situations.

Time of sampling

a. Sampling should be done before any treatment or management decision is made and before planting.
b. Sampling should occur when nematodes are active and at high populations.
c. Soil should be moist but not excessively wet or frozen.
d. If nematicides are applied to manage a known nematode problem, samples should be taken following application but before planting to determine the effectiveness of treatment.
e. The best time for nematode sampling to make management decisions is usually before harvest (early fall) in preparation for the following season crops, especially sugarbeets or potatoes.

Field mapping

The distribution of nematodes is seldom uniform or constant and changes may occur rapidly. Most of the time nematode distribution is patchy. For these reasons, the field to be sampled should be mapped into subdivisions. Any observable variation in previous crop growth, soil texture, moisture and draining patterns, or cropping history will constitute a subdivision. An effective sampling map may then be constructed.

Sampling Pattern

The sampling pattern is based on the sampling map and should be designed to obtain a reliable representative sample with as little sampling error as possible. An example of a recommended soil sampling pattern for fallow ground or an established crop is shown in Figure 1.

Number, size, and cost of samples

Sample size depends on the area and crop being sampled, the crop's value and any supplementary information to be gathered during sampling. Sample size is measured in terms of the number of cores of soil constituting the sample. The precision of the resulting nematode estimates can be improved by increasing the number of soil cores in the sample. This is also less expensive than increasing the actual number of samples. A useful rule-of-thumb for estimating cost is to consider allocating 1 percent of the crop's total production expense on nematode sampling.

A good approach in sampling is to bulk soil cores in a clean bucket, mix thoroughly, and submit one quart of the mixture for processing. One sample may be used to represent up to five acres of a uniform field subdivision as determined by mapping. Each sample should contain at least 20 individual cores, or if representing less than five acres, at least four cores per acre. Place the sample in a sturdy, moisture-retaining bag and clearly identify with a tag attached to the outside of the bag. Tags or labels inside the bags may get wet and discolor easily.

Where to take samples

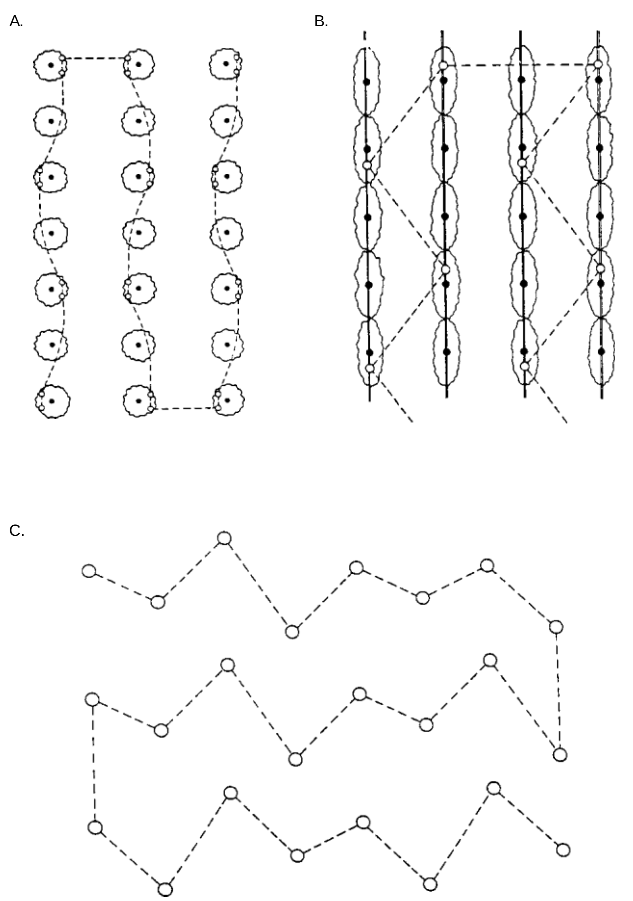
Soil samples should be taken from the plant root zone. If the crop has not been planted, take samples to fit the intended crop's root zone. Plant samples should be taken from the plant parts showing symptoms, if present. Soil or plant samples should be taken from problem areas showing symptoms and from unaffected areas for comparison.

Before planting annual crops, sample cores from a fallow field should be taken by first removing the upper two inches of soil, and then sampling to a depth of 15 to 20 inches. Deeper cores, up to 30 inches, should be taken after prolonged fallow, dry or freezing conditions.

Sampling equipment

Equipment for collecting soil samples for nematode assays includes shovels, soil augers or tubes, and motorized samplers. The typical cylindrical tube sampler designed by soil scientists serves as the standard equipment. Representative sampling tools are shown in Figure 2.

Figure 1



Background information

Include name, location, soil type and texture, observable symptoms (yellowing, necrosis, root rotting, galling, wilting, etc.), cropping history (past several years, current, anticipated), and date of last treatment with a nematicide. This information is invaluable for diagnosis and identification of nematode problems. Refer to the Nematode Diagnostic Laboratory Check Sheet (Figure 3, page 4) for examples of pertinent information.

Storage and delivery

Even the most carefully taken samples may yield inferior results if not stored and delivered properly. Keep the sample <u>*cool*</u>, ideally at 50 to 55° F. Do not leave the sample in direct sunlight, car trunk or other areas that may heat excessively. An insulated cooler is convenient for sample protection. Deliver or mail the sample immediately to the processing laboratory. Use First Class, UPS, Greyhound or other express delivery and pack well in a sturdy cardboard box or coffee can. *Remember*—Samples must be clearly labeled and accompanied by complete background information. Diagnostic services are available at the University of Idaho, Parma Research and Extension Center, Parma, ID 83660. Telephone: (208) 722-6701.

Figure 2

Figure 1, left: Recommended soil sampling patterns. A. and B., Patterns for perennial plants; C., Pattern for annual crop or fallow field.

Figure 2, above: Examples of soil sampling tools to diagnose nematode infestations.

Figure 3, page 4: Sample form used by the University of Idaho Nematology Laboratory, "Nematode Diagnostic Laboratory Check Sheet."

Figure 3

NEMATODE DIAGNOSTIC LABORATORY CHECK SHEET

Nematode — 061-Y160

Clinic # (to be filled in by clinic)

- -

Requested Analysis and Cost:

O Soil (Cyst not included) $20.00
O Root or Seed $20.00
O Soil & Root: $35.00
O Complete Soil Test: $30.00 (Cyst included)
O R.K.Identification of Species Additional $10/species

- -

Date Collected ___________________________ Location____
(Town) (County) (Farm)

Grower_________________________________Submitted by ____

____
(Mailing Address) (Phone)

Field Identity ______ # Acres per Sample ______ Sample Type: Soil _ Root _

Crop History: _______________ ____________ ____________ ____________ ____________
Present or Intended Last Year 2 Years Ago 3 Years Ago 4 Years Ago

Previous Nematode Occurrence ____

Current Soil Treatment: Fumigant or other__________________________Date____________________
Rate/Acre_________________Application Method _____________________
(chisel, plow, blade, etc.)

Nematodes Present: Per 500 cc Soil (Approximately 1 pint) Clinic Sample #

Common Name	**/Genus**						Remarks
Northern R.K.	*Meloidogyne hapla*						
Columbia R.K.	*chitwoodi*						
Root-Lesion	*Pratylenchus*						
Stubby Root	*Trichodorus*						
Stunt	*Tylenchorhync*						
Spiral	*Helicotylenchus*						
Pin	*Paratylenchus*						
Dagger	*Xiphinema*						
Stem	*Ditylenchus* spp.						
Ring Nema.	*Criconemella* spp.						
Sheath	*Hemicycliphora* spp.						
Other							
Cyst	*Heterodera*						
Viable							
Empty							
Larvae							
Eggs							

Date Completed ____________________________________ ______________________________

Dr. Saad L. Hafez Nematode Lab Director

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NOTE: FAILURE TO DETECT A NEMATODE SPECIES IN A SAMPLE IS NOT PROOF FIELD IS FREE. NEMACH7A\LEF\HAFEZ4

University of Idaho Extension

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Charlotte V. Eberlein, Director of Cooperative Extension System, University of Idaho, Moscow, Idaho 83844.

1000, 2-97; reprinted 1,000, 12-03 $1.00

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