SDSU Extension

iGrow Soybean

BEST MANAGEMENT PRACTICES

Chapter 7:
What's in The Soybean Genetic Pipeline

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There are many companies selling soybean seed in South Dakota. In this chapter, Monsanto, Pioneer, and the SDSU soybean breeding program completed a survey related to products that are currently offered or are planned for release in the near future. The survey requested information on drought tolerance, flooding tolerance, aphid resistance, soybean cyst nematode resistance, iron deficiency chlorosis resistance, phytophthora rot root tolerance, and dicamba resistance in soybeans. If information from your company of choice is not provided, we recommend that you contact them for information. This information is provided for readers convenience and does not imply endorsement.

Figure 7.1. Typical poor stand and plant health resulting from the overabundance of water during the early growing season. (Photos courtesy of Stephanie Hansen, SDSU)

The purpose of this chapter is to provide reference information that can be used for: 1) comparison with the trait packages on your current varieties; and 2) improving the long-term sustainability of your production system.

Drought tolerance is also an ongoing concern, as evidenced by the 2012 growing season with many areas of the U.S. experiencing extreme heat coupled with abnormally low precipitation. Drought stress reduces a plant's ability to defend itself against opportunistic diseases. To mitigate the opportunistic diseases that often occur during droughts, Monsanto, Pioneer, and Syngenta offer competitive lines of stress-tolerant and disease-resistant soybeans.

- https://www.dekalbasgrowdeltapine.com/en-us/asgrow.html
- http://www.agseedselect.com
- https://www.pioneer.com/home/site/us/products/soybean/
- http://cornandsoybeandigest.com/seed/syngenta-pipeline-new-technologies-future-traits

In addition, South Dakota State University (SDSU) breeders are working in conjunction with the University of Minnesota breeding program, and have released "Davison," which has exhibited some degree of drought tolerance.

In the next decade, farmers may see biotechnology offerings for drought tolerance, similar to new corn varieties, as well as more seed treatments and varieties that specifically address these issues. At SDSU, researchers are using genomics, proteomics, and metabolomics to identify key compounds and genes associated with drought effects and tolerance in soybeans.

- https://www.pioneer.com/home/site/us/products/corn/seed-traits-technologies-corn/optimum-aquamax-hybrids/
- https://monsanto.com/

Managing too much water (flooding)

Cultivation and drainage systems are used to manage wet soils. Fall tillage can be used to expose the soil to optimize drying in the spring; however, this also leads to soil erosion and a gradual decrease in the soils yield potential. Most current soybean varieties grow poorly in wet soils (Figure 7.1). In the future, it may be possible to manage for problems associated with wet soils when you select your variety. Currently, Monsanto, Pioneer, and Syngenta offer seed treatment options to protect soybeans from early seedling diseases that are associated with wet soils.

- https://www.acceleronsts.com/Soybeans/Pages/Soybean-Products.aspx
- https://www.pioneer.com/home/site/us/products/soybean/seed-treatments/
- http://www.farmassist.com/Blogs/articledetail.aspx?id=167940

In addition, ARS has identified flood-tolerant soybean germplasm with root systems that can better cope with flooding than currently available soybean varieties. SDSU researchers are screening sources for waterlogging tolerance to add to their established breeding program.

- http://www.ars.usda.gov/is/AR/archive/jul12/soybeans0712.htm

Aphid Resistance/Rag (resistance to Aphis glycines) genes (Chapter 35)

The traditional approaches to manage aphid problems include diligent field scouting, application of fungicides, use of biological controls, and selecting appropriate traits. Aphid tolerance/resistance is found in several *"Rag"* genes. Alone, a single *"Rag"* gene in a plant slows aphid population growth; used in combination, they almost halt population growth. However, aphid biotypes resistant to both of the currently used genes (*Rag1* and *Rag2*) exist.

- http://extension.sdstate.edu
- https://www.pioneer.com/home/site/us/agronomy/crop-management/soybean-insect-disease/soybean-aphid

Pioneer and Monsanto offer product lines that incorporate genetic resistance to aphids. This resistance is available in the varieties found in their online catalogs.

- https://www.farmprogress.com/soybeans/more-aphid-ammunition-soybeans-genetic-aphid-protection-squelch-no-1-soybean-pest

- https://www.pioneer.com/us/products/soybeans.html
- http://www.agseedselect.com

SDSU researchers are investigating genes relating to plant architecture dealing with pest resistance, in addition to evaluating resistant varieties to develop new cultivars and germplasm lines, particularly a newly identified source of resistance gene *Rag3* and other genes that are still effective against soybean aphids. In private sector research, aphids may be a future target as a Biodirect application.

- http://www.monsanto.com/products/Pages/biodirect-ag-biologicals.aspx

Pioneer's team of researchers continue to look for novel genes and other forms of aphid control.

- https://www.pioneer.com/home/site/us/agronomy/library/template.CONTENT/guid.069BE58A-CCEA-CE6C-A77D-3E5B02A320EB

Resistance genes *rag1c*, *Rag3*, *rag4*, and *Rag5* have been pinpointed in source lines (Bonin, 2012) and are being developed for future use. These new resistance genes will provide resistance to the biotypes that can overcome *Rag1* and *Rag2* genes. Monsanto and Pioneer will launch the 2nd generation of aphid resistant products incorporating novel genes for aphid resistance in the near future.

- https://monsanto.com/
- https://www.pioneer.com/us/products/soybeans.html

Soybean Cyst Nematode (SCN) resistance (Chapter 57)

SCN is a pest that many producers do not know about and would not recognize its effects. This pest reduces yields even if foliar symptoms are not observed. There are currently no known methods effective in eradicating SCN from infested soils. The traditional control mechanisms include using soil sampling to confirm the presence of SCN in the soil, planting resistant varieties, practicing crop rotation, using appropriate seed treatments, and minimizing spread through contaminated equipment.

- https://www.pioneer.com/us/agronomy-science.html

Monsanto currently has different seed treatment options to specifically address SCN and other nematodes.

- https://monsanto.com/
- http://www.acceleronsas.com/Solutions/Nematicides/Pages/default.aspx

Varieties going back to PI 88788 or Peking typically demonstrate SCN resistance. Private companies offer varieties that convey varying levels of SCN resistance.

- https://www.pioneer.com/home/site/us/agronomy/library/template.CONTENT/guid.392C2D2E-71F2-4C0E-881F-2A6B142A3262

Over 95% of Monsanto's pipeline has genetic resistance to SCN through the PI88788-source. An additional 3% have resistance from an alternative source of resistance, from the public variety Peking. Future Monsanto options will possibly include Biodirect applications, as well as varieties incorporating novel and diverse sources of genetic resistance to SCN.

- https://monsanto.com/

Pioneer continues to improve cyst nematode resistance in their soybeans through native variation and non-transgenic (including both PI88788-source and Peking), which are resistant to multiple races of SCN.

- https://www.pioneer.com/home/site/us/agronomy/library/template.CONTENT/guid.2C1FE674-5E95-A269-0441-81A2B1783B89/

SDSU researchers are screening varieties for SCN resistance and have developed segregating populations demonstrating SCN resistance. Most populations used in the SDSU breeding program incorporate the resistance genes *rhg1* and *Rhg4*.

Iron deficiency chlorosis (Chapter 26)

Iron Deficiency Chlorosis (IDC) is indicated by yellowing of the leaves with green veins. The traditional approaches to managing IDC include using EDDHA chelated seed treatment, planting resistant varieties and/or a companion crops, and reducing weed and other stresses.

- https://www.pioneer.com/us/agronomy/iron_deficiency_chlorosis.html

The SDSU cultivar Sodak is a soybean variety with IDC tolerance.

- https://www.sdstate.edu/agronomy-horticulture-plant-science

Additional varieties with IDC tolerance are available from Asgrow.

- http://www.asgrowanddekalb.com/products/soybean/Pages/Genuity-Roundup-Ready-2-Yield.aspx/
- http://www.agseedselect.com

Varieties with IDC tolerance are also available from Pioneer.

- https://www.pioneer.com/us/products/soybeans.html

Syngenta/NK Brands also offer varieties with IDC tolerance.

- http://www.syngenta.com/

Ongoing research at SDSU involves screening varieties for IDC resistance and identifying new sources for tolerance. This work involves identifying genetic resistance in wild soybean lines. Breeders are using different sources of tolerance in their variety development, and future offerings will combine those different sources to deliver a higher IDC tolerance. Monsanto research and development is working to understand and dissect the components of IDC, in order to better deliver solutions to farmers in the next decade.

Figures 7.2 and 7.3. (Left) Typical discoloration of the stem associated with root and stem rot. (Right) Leaf wilting and plant death due to Phytophthora root and stem rot. (Photos courtesy of Daren Mueller, Iowa State University, Bugwood.org)

Phytophthora root/stem rot (Chapter 59)

The current management practices for phytophthora root rot are field drainage, seed treatments, and seeding tolerant varieties (SDSU Soybean Disease Guide).

- https://www.pioneer.com/home/site/us/agronomy/crop-management/soybean-insect-disease/prr/

Seed treatments are available from Monsanto and Pioneer.

- https://www.acceleronsts.com/Soybeans/Pages/Soybean-Products.aspx
- https://www.pioneer.com/home/site/us/products/soybean/seed-treatments/

The current genetic defense is available from the *Rps* genes (e.g., 1a, 1c, 1k). However, this resistance may be overcome by aggressive races of the pathogen.

The SDSU soybean breeding program has developed Phytophthora-resistant varieties/lines, such as recently-released "Brookings" and "Deuel" with *Rps1k*, "SD06-525" with *Rps1c*, and potential line "SD03-2154" with *Rps1k*. Monsanto offers varieties with single-gene and stacks of single genes in their product lineup.

- http://www.asgrowanddekalb.com/products/soybean/Pages/Genuity-Roundup-Ready-2-Yield.aspx/
- http://www.agseedselect.com

Future offerings from Monsanto will include stacks of novel genes to further protect the soybean from this quickly changing pathogen.

- https://monsanto.com/

Pioneer also offers several varieties with multiple approaches for resistance and tolerance.

- https://www.pioneer.com/home/site/us/template.CONTENT/guid.2F72EBEE-DF8A-2B9B-8C5C-1ACECFE8CE3E

Pioneer is working towards stacking genes and providing producers with more varieties to choose from in the fight against rot diseases.

- https://www.pioneer.com/home/site/us/template.CONTENT/guid.2F72EBEE-DF8A-2B9B-8C5C-1ACECFE8CE3E

SDSU will predominantly use their released lines and introduce new lines carrying different Rps genes found in soybean lines from other breeding programs, such as ND07-2019 and ND07-3761 that contain Rps6, which is resistant to three or four races.

Dicamba resistant varieties

Monsanto is developing the Roundup Ready® Xtend Crop System*, which is designed to provide farmers with more consistent, flexible control of weeds—especially tough-to-manage and glyphosate-resistant weeds—to maximize crop yield potential. Pending regulatory approvals, the Roundup Ready Xtend Crop System will consist of two components: innovative trait solutions and advanced herbicide formulations. Roundup Ready® 2 Xtend soybeans include tolerance to both glyphosate and dicamba herbicides.

Monsanto is also developing an enhanced, low volatility dicamba and glyphosate herbicide premix, to be branded as Roundup® Xtend that will enable farmers to manage weeds before planting and as an over-the-top-option during the season. XtendiMax™ will be the brand name for a low-volatility dicamba herbicide. Monsanto is seeking regulatory approval to use both the premix and single herbicide products pre-, at, and post-planting with Roundup Ready 2 Xtend soybeans.

There are multiple ways to achieve sustainable weed management programs in the field and a significant number of farmers have found that using combinations of herbicides and herbicide-tolerant crops is a way to achieve this in both conservation and conventional tillage systems. Dicamba is one of the most economical herbicides that controls a wide spectrum of broadleaf weeds. Dicamba is not a standalone or a replacement of the Roundup Ready PLUS weed management system.

Residual herbicides and multiple modes of action are still recommended as part of a diversified weed management plan. Dicamba is another tool for farmers to use in their weed management program. More information on Monsanto and weed management can be found at RoundupReadyPLUS.com.

Pending regulatory approvals, the Roundup Ready 2 Xtend Soybean Crop System is expected to be available to U.S. farmers for the 2014 growing season. Once approved, the Roundup Ready Xtend Soybean Crop System will be available in all Monsanto soybean brands and broadly licensed.

**This information is for educational purposes only and is not an offer to sell Roundup Ready® 2 Xtend, Roundup® Xtend or XtendimaxTM. Roundup Ready 2 Xtend, Roundup Xtend and Xtendimax are not yet deregulated, registered, or approved for sale or use anywhere in the United States.*

Table 7.1. Contact information for South Dakota Monsanto and Pioneer agronomists who can provide assistance with their products.

Company	Title	First Name	Last Name	Mobile	Email
Monsanto	Territory Agronomist	Jeff	Fuls	605-651-1795	jeffrey.g.fuls@monsanto.com
Monsanto	Territory Agronomist	Jeff	Spieler	605-214-3075	jeff.d.spieler@monsanto.com
Monsanto	Technology Development Representative	Jesse	Barthel	605-237-4678	jesse.r.barthel@monsanto.com
Monsanto	Technology Development Representative	Kyle	Broughton	605-941-4567	kyle.s.broughton@monsanto.com
Pioneer	Field Agronomist	Kyle	Christensen	605-214-5629	kyle.christensen@pioneer.com
Pioneer	Product Agronomist	Wade	Gubrud	605-520-2506	wade.gubrud@pioneer.com
Pioneer	Field Agronomist	Curt	Hoffbeck	605-759-4995	curt.hoffbeck@pioneer.com
Pioneer	Product Agronomist	Ryan	Nuttall	605-695-0210	ryan.nuttall@pioneer.com
Pioneer	Field Agronomist	Larry	Osborne	605-695-7809	larry.osborne@pioneer.com

References and additional information

Bonin, C. Thesis dissertation: Evaluation of soybean aphid resistance, yield QTL confirmation, and genetic gain in soybean. University of Illinois, 2012.

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Hansen, S., J. Narvel, J. Yates, M. Devries, B. Anderson, and G. Jiang. 2013. What's in the soybean genetic pipeline. In Clay, D.E., C.G. Carlson, S.A. Clay, L. Wagner, D. Deneke, and C. Hay (eds). iGrow Soybeans: Best Management Practices for Soybean Production. South Dakota State University, SDSU Extension, Brookings, SD.