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Research Report**

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Research Updates

Funding research seems like a no-brainer. The Northarvest Bean Growers Association invests dollars every year into projects that are designed to improve the quality, quantity and variety of dry edible beans in this region. This focus on research and development is critical because it leads to innovation in the field. Ultimately, that R & D emphasis is a dollars-and-cents effort to boost profitability on our farms.

In this edition of *BeanGrower*, you'll find updates on the latest research projects at North Dakota State University. These projects range from the development of SCN resistant varieties to plant stand studies. As a committee, we value the work done by these researchers.



Keep in mind, we always appreciate your input on these research projects. Contact Tim Courneya, executive vice president, Northarvest Bean Growers Association, or any of the board members with your input.

Sincerely,

Norm Krause

Chairman

Research Committee

Northarvest Bean Growers Association

TABLE OF CONTENTS 2017 Research & Resource Guide

3	Starting Point		
5	Bean Researchers & Research Leaders		
6-15	Seed Bean Suppliers & Commercial Buyers	28	Evaluation of Selected Plant Nutrition Treatments and Establishment Factors in Dry Bean
16	Bean Organizations	30	Development of Soybean Cyst Nematode Resistant Dry Bean Breeding Material
2017 DRY BEAN RESEARCH UPDATE		32	Dry Edible Bean Disease Research - 2017
18	Improving Salinity and Waterlogging Stress Resilience in Edible Dry Beans	2016 DRY BEAN VARIETY TRIALS	
23	Dry Bean Improvement for the Northern Plains	37-50	North Dakota Dry Bean Variety Trial Results for 2016

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2017 Northarvest Resource Directory

Seed Bean Suppliers & Commercial Buyers

Company Name	Address	Ph/Fax/Email/Website	Beans
ADM Edible Bean Specialties, Inc.	P.O. Box 124 550 W Christenson Ave Appleton, MN 56208	Ph: 320-289-2430 Fax: 320-289-2008 Email: bob.kieffer@adm.com	Navy
ADM Edible Bean Specialties, Inc.	P.O. Box 249 1804 Front St. Casselton, ND 58012	Ph: 701-347-5321 Fax: 701-347-5552 Email: thomas.stadler@adm.com	Pinto, Navy
ADM Edible Bean Specialties, Inc.	9451 Hwy. 18 P.O. Box 676 Cavalier, ND 58220	Ph: 701-265-8385 Fax: 701-265-4804 Email: richard.dinger@adm.com	Pinto, Navy
ADM Edible Bean Specialties, Inc	PO Box 98 108 MN Ave. W. Galesburg, ND 58035	Ph: 701-488-2214 Fax: 701-488-2538 Email: larry.erickson@adm.com	Pinto, Navy
ADM Edible Bean Specialties, Inc	PO Box 25 77 East 3rd St. Grafton, ND 58237	Ph: 701-352-1030 Fax: 701-352-3430 Email: pete.houdek@adm.com	Pinto
ADM Edible Bean Specialties, Inc	PO Box 437 Northwood, ND 58267	Ph: 701-587-5900 Fax: 701-587-5927 Email: jeff.ellingson@adm.com	Pinto, Navy
ADM Edible Bean Specialties, Inc	PO Box 149 215 22nd St. N. Olivia, MN 55277	Ph: 320-523-1637 Fax: 320-523-5683 Email: mitchell.lothert@adm.com	Navy
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CHS Harvest States, Lankin, ND
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Hatton Farmers Elevator, Hatton, ND
Contact Alan at (701) 543-3773

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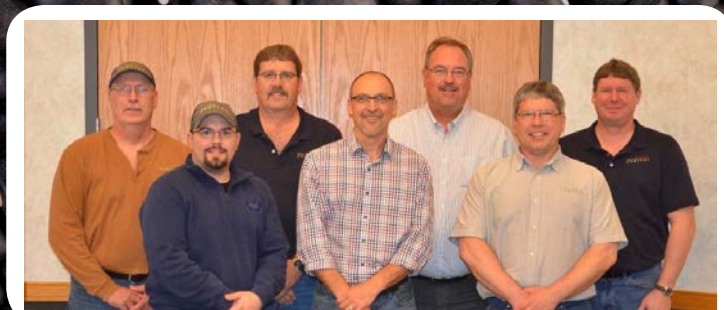
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AGT Foods - Minot	625 42nd St NE Minot, ND 58703	Ph: 701-839-7530 Fax: 701-839-7532 Email: trade@agtfoods.com	Black, Pinto, Dark Red Kidney, Light Red Kidney, Navy
AGT Foods - Williston	505 26th Avenue NE Williston, ND 58801-6309	Ph: 701-572-4070 Fax: 701-572-4071 Email: trade@agtfoods.com	Black, Pinto, Dark Red Kidney, Light Red Kidney, Navy
Alliance Valley Bean, LLC	PO Box 566 111 Elevator Road Larimore, ND 58251	Ph: 701-343-6363 Fax: 701-343-2842	Black
Allied Energy dba Allied Grain	260 Elevator Road - Barlow, ND Carrington, ND 58421	Ph: 701-984-2617 Fax: 701-984-2616 Email: kathy@alliedag.com Web: www.alliedag.com	Pinto
American Bean LLC	105 Oak Street Oslo, MN 56744 Web: www.ambean.com	Ph: 218-695-3040 Fax: 218-695-1305 Email: craig@ambean.com julie@ambean.com	Black, Pinto, Cranberry, Pink, Small Red
American Bean LLC	101 1st Ave, P.O. Box 82 Petersburg, ND 58272 Web: www.ambean.com	Ph: 701-345-8264 Fax: 701-345-8263 Email: julie@ambean.com craig@ambean.com	Black, Pinto, Cranberry, Pink, Small Red
B T R Farmers Co-op	6001 60th Ave NE Leeds, ND 58346	Ph: 701-466-2281 Fax: 701-466-2022 Email: btr@gondtc.com Web: btrfarmerscoop.com	Pinto

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Bollingberg Seeds Co.	5353 Highway 15 Cathay, ND 58422	Ph: 701-984-2486 Fax: 701-984-2485 Email: kurt@bollingbergseeds.com Web: www.bollingbergseeds.com	Pinto
Bonanza Bean LLC	PO Box 164 8 Industrial Blvd Morris, MN 56267	Ph: 320-585-2326 Fax: 320-585-2323 Email: cork.fehr@bonanzabean.com Web: www.bonanzabean.com	Black, Dark Red Kidney, Light Red Kidney
C and F Foods, Inc.	PO Box 55 502 3rd Street Manvel, ND 58256	Ph: 701-696-2040 Fax: 701-696-2042 Web: www.cnf-foods.com Email: dkenna@cnf-foods.com	Black, Pinto
Cando Farmers Grain & Oil	Box 456 101 9th Street Cando, ND 58324	Ph: 701-968-4446 Fax: 701-968-4447 Email: candofarmers@gondtc.com	Pinto
Cavalier Bean Co.	PO Box 297 308 Industrial Park Cavalier, ND 58220	Ph: 701-265-8495 Fax: 701-265-8576 Email: cbc@polarcomm.com	Pinto
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Chippewa Valley Bean Co., Inc	N2960 730th St. Menomonie, WI 54751	Ph: 715-664-8342 Fax: 715-664-8344 Email: cbrown@cvbean.com Web: www.cvbean.com	Dark Red Kidney, Light Red Kidney
Columbia Bean Co.	P.O. Box 67, 1920 Hwy 32 N. Walhalla, ND 58282	Ph: 701-549-3721 Fax: 701-549-3725 Email: Dberg@columbiagrains.com	Black, Pinto
Columbia Bean Co.	7400 55th Street, S. Grand Forks, ND 58201	Ph: 701-775-3317 Fax: 701-775-3289 Email: Jberthold@columbiagrains.com	Black, Pinto, Small Red
Diversified Bean Inc.	41744 US Hwy 75 SW Climax, MN 56523	Ph: 320-808-0891 Email: gbalgaard@gmail.com Web: www.diversifiedbean.com	Black, Pinto, Dark Red Kidney, Light Red Kidney, Small Red, Cranberry
Engstrom Bean & Seed	6131 57th Ave NE Leeds, ND 58346	Ph: 701-466-2398 Fax: 701-466-2076 Email: briane@engstrombean.com	Black, Pinto
Farmers Elevator Co. of Honeyford	2472 30th St. NE Gilby, ND 58235-9711	Ph: 701-869-2466 Fax: 701-869-2456 Email: fechoney@polarcomm.com Web: www.honeyford.com	Navy
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Grafton Farmers Co-op Grain Company	129 E 6th Street Grafton, ND 58237	Ph: 701-352-0461 Fax: 701-352-0280	Pinto
Great Northern Ag	P.O. Box 128, 6373 39th St NW Plaza, ND	Ph: 701-497-3082 Fax: 701-497-3355 Email: micheller@greatnorthernag.com	Pinto
Green Valley Bean	58473 St., Hwy 34 Park Rapids, MN 56470	Ph: 218-573-3400 Fax: 218-573-3434 Email: mhgvblc@arvig.net	Dark Red Kidney, Light Red Kidney, Pink, White Kidney
Haberer Foods	41591 180th Street Morris, MN 56267	Ph: 320-795-2468 Fax: 320-795-2986 Email: randyh@runestone.net Web: Habererfoods.com	Black, Dark Red Kidney, Light Red Kidney
Healthy Food Ingredients	4666 Amber Valley Parkway Fargo, ND 58104	PH: 701-356-4106 FAX: 701-356-4102 WEB: www.skfood.com EMAIL: skfood@skfood.com	Black, Pinto, Cranberry, Dark Red Kidney, Great Northern, Light Red Kidney, Navy, Small Red
JM Grain, Inc.	12 N Railroad Street PO Box 248 Garrison, ND 58540-0248	Ph: 701-463-7261 Fax: 612-435-4868	Pinto
Johnstown Bean Co.	PO Box 5 Gilby, ND 58235	Ph: 701-869-2680 Fax: 701-869-2692 Email: jbc@polarcomm.com	Black, Pinto
Joliette Ag Systems, Inc.	15866 Highway 5 Pembina, ND 58271	Ph: 701-454-6226 Fax: 701-454-6244 Email: jwarner@polarcomm.com	Black, Pinto
Kelley Bean Company	PO Box 99 703 Division Avenue So. Cavalier, ND 58220	Ph: 701-265-8328 Fax: 701-265-8533 Email: tsmith@kelleybean.com Web: www.kelleybean.com	Black, Pinto, Dark Red Kidney, Light Red Kidney, Navy, Pink
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Kelley Bean Company	131 7th Ave. NE PO Box 253 Perham, MN 56573	Ph: 218-346-2360 Fax: 218-346-2369 Email: dmitchell@kelleybean.com Web: www.kelleybean.com	Dark Red Kidney, Light Red Kidney, Pink

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Kelley Bean Company	524 S. 7th St. PO Box 290 Oakes, ND 58474	Ph: 701-742-3219 Fax: 701-742-3520 Email: dmaasjo@kelleybean.com Web: www.kelleybean.com	Black, Pinto, Dark Red Kidney, Light Red Kidney, Navy
Kirkeide's Northland Bean Co.	4520 12th St. NE Fessenden, ND 58438	Ph: 701-547-3466 Fax: 701-547-3539 Email: knbc@gondtc.com	Black, Pinto, Navy
Klindworth Seed & Bean Co.	2139 Highway 30 Fessenden, ND 58438-9441	Ph: 701-547-3742 Fax: 701-547-2592 Email: ksb@stellarnet.com	Pinto
Larson Grain Co.	100 2nd Ave Englevalle, ND 58033	Ph: 701-683-5246 Fax: 701-683-4233 Email: nick.shockman@larsongrain.com Web: www.larsongrain.com	Black, Pinto

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2017 Northarvest Resource Directory

Seed Bean Suppliers & Commercial Buyers

Company Name	Address	Ph/Fax/Email/Website	Beans
Legume Matrix LLC	PO Box 1028 901 14th Ave SE Jamestown, ND 58402	Ph: 701-252-4757 Fax: 701-252-4757 Email: legume.matrix@gmail.com Web: legumematrix.com	Black
Manvel Bean Co.	2875 18th St. NE Manvel, ND 58256	Ph: 701-696-2271 Fax: 701-696-8266	Pinto
Miller Elevator Company	Box 844 149 4th St. NE Valley City, ND 58072	Ph: 701-845-2013	Pinto
North Dakota Bean LLC	2120 North Washington Street Grand Forks, ND 58203	Ph: 701-203-8088 Fax: 701-203-8089 Email: brett@nebraskabean.com	Pinto
Northwood Bean Co. Inc.	301 Potato Road Northwood, ND 58267	Ph: 701-587-5206 Fax: 701-587-5650 Email: nbc@polarcomm.com	Black, Pinto
O'Brien Seed, Inc.	PO Box 505 945 3rd St. S.E. Mayville, ND 58257	Ph: 701-788-9118 Fax: 701-788-9119 Email: larry@obrienseed.com	Black, Pinto, Pink, Small Red
Scoular	P.O. Box 85, 415 Hwy. 32, So. St. Hilaire, MN 56754	Ph: 218-964-5407 Fax: 218-964-6415 Web: www.scoularspecialcrops.com	Black, Pinto, Cranberry, Dark Red Kidney, Great Northern
SRS Commodities	411 2nd Avenue NE PO Box 386 Mayville, ND 58257	Ph: 701-786-3402 Fax: 701-786-3374 Email: rick@srscommodities.com	Black, Pinto
SRS Commodities Ltd-Falkirk	101 Main St. Washburn, ND 58577	Ph: 701-462-8111 Fax: 701-462-8112 Email: rick@srscommodities.com, adam@srscommodities.com Web: www.srscommodities.com	Pinto
Star of the West Milling Co.	4082 22nd Ave, NE Larimore, ND 58251	Ph: 701-397-5261 Fax: 701-397-5783 Email: sotwbean@polarcomm.com Web: www.starofthewest.com	Black, Pinto, Navy
Stony Ridge Foods Inc.	715 Atlantic Avenue Benson, MN 56215	Ph: 320-842-3401 Fax: 320-842-3403 Email: joe-jessica@stonyridgefoods.com or dhughes@stonyridgefoods.com	Black, Dark Red Kidney, Light Red Kidney, Navy



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2017 Northarvest Resource Directory

Seed Bean Suppliers & Commercial Buyers

Company Name	Address	Ph/Fax/Email/Website	Beans
The Bean Mill	42631 450th Ave. Perham, MN 56573	Ph: 218-346-2151	Dark Red Kidney, Light Red Kidney, Pink
Thompsons USA Limited	PO Box 374 41703 Highway 2 SW East Grand Forks, MN 56721	Ph: 218-773-8834 Fax: 218-773-9809 Email: jvrolyk@thompsonslimited.com	Pinto, Dark Red Kidney, Navy
TMT Bean & Seed Farm	3718 67th Ave SE Cleveland, ND 58424	Ph: 701-763-6544 Fax: 701-763-6545 Email: terrytmtfarms@daktel.com	Pinto
Trinidad Benham	308 Front Ave Colgate, ND 58046	Ph: 701-945-2580 Fax: 701-945-2634 Email: mfranko@trinidadbenham.com Web: www.trinidadbenham.com	Black, Pinto, Great Northern, Navy, Pink
Tronson Grain Co.	115 W. 1st St. Doyon, ND 58327-2807	Ph: 701-398-3512 Fax: 701-398-3609	Pinto

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Bean Organizations

Company Name	Address	Phone/Fax
Northarvest Bean Growers Assn. (NHBGA)	50072 E. Lake Seven Road Frazee, MN 56544-8963	Ph: 218-334-6351
North Dakota Dry Bean Council	50072 E. Lake Seven Road Frazee, MN 56533-8963	Ph: 218-334-6351
Minnesota Dry Bean Research & Promotion Council	50072 E. Lake Seven Road Frazee, MN 56544-8963	Ph: 218-334-6351
California Bean Shippers Association (CBSA)	1521 I Street Sacramento, CA 95814	Ph: 916-441-2514
California Dry Bean Advisory Board (CDBAB)	531-D, N-Alta Dinuba, CA 93618	Ph: 559-591-4866
Colorado Dry Bean Administrative Committee (CDBAC)	31221 Northwoods Buena Vista, CO 81211	Ph: 219-395-3505
Idaho Bean Commission (IBC)	821 W State Street, Boise, ID 83720-0015	Ph: 208-334-3520
Idaho Bean Dealers Association	PO 641, Buhl, ID 83316	Ph: 208-731-1702
Michigan Bean Commission (MBC)	Joe Cramer 516 South Main Street, Suite D Frankenmuth, MI 48734	Ph: 989-262-8550 jcramer@michiganbean.com
Michigan Bean Shippers Association (MBSA)	1501 North Shore Drive, Suite A East Lansing, MI 48823	Ph: 517-336-0223
Nebraska Dry Bean Commission (NeDBC)	4502 Avenue I, Scottsbluff, NE 69361	Ph: 308-632-1258
New York State Bean Shippers Assn. (NYSBSA)	Seneca Castle, NY 14547	Ph: 585-526-5427
North Central Bean Dealers Assn. (NCBDA)	PO Box 391, Thompson, ND 58278-0391	Ph: 701-335-3988
North Dakota Dry Edible Bean Seed Growers Assn.	PO Box 5607, Fargo, ND 58105	Ph: 701-231-8067
Rocky Mountain Bean Dealers Assn. (RMBDA)	Vickie Root 2074 Wimbledon Drive Loveland, CO 80538	Ph: 970-667-4949 RMBDA1@gmail.com
United States Dry Bean Council (Executive Director)	Rebecca Bratter 8000 West Drive #833 North Bay Village, FL 33141	Ph: 202-492-0522 rebecca@usdrybeans.com
United States Dry Bean Council (Government Relations)	Gordley Associates 600 Pennsylvania Ave, NE, Suite 320 Washington, D.C. 20003	Ph: 202-969-8900
Washington Bean Dealers Assn. (WaBDA)	PO Box 122, Moses Lake, WA 98837	Ph: 509-765-8893

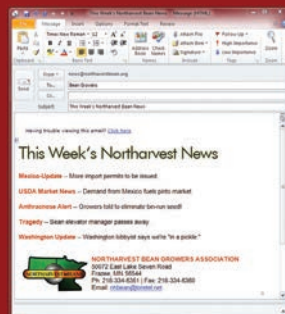
North Dakota Certified Bean Seed Growers

For a list of certified bean seed growers in North Dakota, visit www.nd.gov/seed, then click on "Field Seed Directory" on the top bar, then click on 2015 Field Bean.



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YOUR CHECKOFF DOLLARS AT WORK

2017 Dry Bean Research Update



Improving Salinity and Waterlogging Stress Resilience in Edible Dry Beans

Principal Investigator: Dr. Kalidas Shetty, Professor Dept. of Plant Sciences, Founding Director Global Institute of Food Security and International Agriculture (GIFSIA), NDSU.

Co-investigator: Dr. Juan Osorno, Professor Dept. of Plant Sciences, NDSU, Dr. Dipayan Sarkar, Research Associate, Dept. of Plant Sciences, NDSU

Graduate Students: Jordan Orwat (MS Student) & Ramnarain Ramakrishna (Ph.D student). Cereal Science Program, Department of Plant Science, NDSU.

Background: Edible dry beans are extremely susceptible to both salinity and constantly varying waterlogging stresses, especially at early growth stages during spring. These extreme environmental conditions are significantly affecting the growth and productivity of dry beans. Therefore, improving salinity and waterlogging stress resilience of edible dry bean is critical for sustainable production and to ensure higher economic return to the dry bean growers of the Northern Plains. Stress adaptive responses of food crops including dry beans to salinity and waterlogging stress, in part involves stimulation of the biosynthesis of secondary metabolites such as phenolics and induction of endogenous antioxidant enzyme responses. This is regulated through the up-regulation of critical defense related anabolic pathway, such as gateway pentose phosphate pathway (PPP) (Figure 1). We have targeted novel seed elicitation strategy using natural bioprocessed elicitors to enhance such phenolic and

antioxidant-linked defense responses in edible dry beans to improve salinity and waterlogging stress resilience. Therefore, the primary aim of this study was to evaluate the effects of two seed elicitor treatments for the improvement of salinity and waterlogging stress resilience of four dry bean market class (black, kidney, pint, and navy) through up-regulation of gateway PPP. In this study, five genotypes for salinity stress and six genotypes for waterlogging stress from each dry bean market class were selected. The ultimate aim was to screen salinity and waterlogging stress resilient edible dry bean genotypes based on metabolic regulation involving endogenous defense responses of edible dry bean plants. Further to improve salinity and waterlogging stress resilience in both susceptible and tolerant genotypes using novel seed elicitation strategy. The specific objectives were

Objective 1: To improve seed vigor, early emergence, establish-

ments and associated crop productivity increases in edible dry beans under salinity and constantly varying waterlogging stress.

Objective 2: To improve abiotic stress resilience in edible dry beans during seed germination and early establishments through stimulation of plants endogenous defense responses with natural bioprocessed elicitors.

RESEARCH ACTIVITIES

Preliminary Salinity experiment: One of the initial goals of the salinity experiment was to set up and maintain a constant electrical conductivity in pots for screening cultivars of edible dry beans and to evaluate the optimum salinity tolerance of dry beans. For this study different ranges of electrical conductivity (0, 2, 4, 6, 8, 10, & 12 ds/M) was established and maintained for extended periods as a preliminary experiment (year 2015). In this preliminary study dry edible bean performed better (better germination

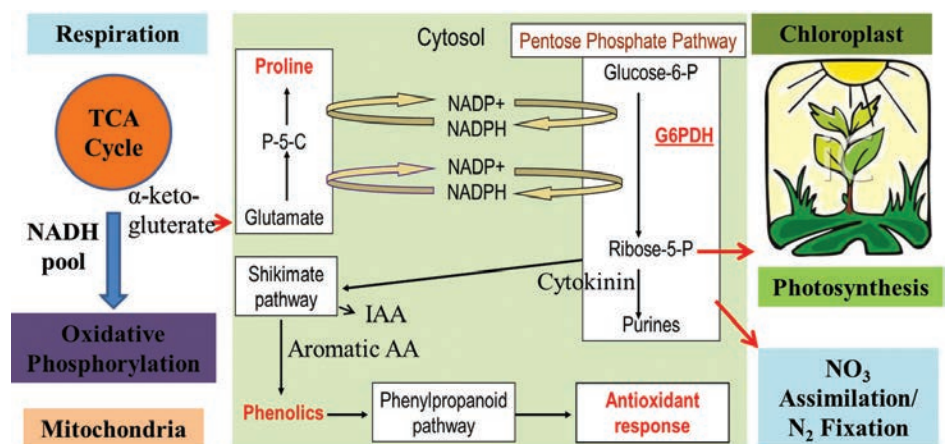


Figure 1. Gateway pentose phosphate pathway (PPP) mediated stress adaptive responses of plant involving secondary metabolite biosynthesis and antioxidant enzyme responses under abiotic stresses (such as salinity and waterlogging stress).

and early establishments) in potting mix and was selected for further experiments. Five genotypes from each market class and four market classes of edible dry beans were used for salinity screening (Table 1). Dry edible plants were germinated separately and then transplanted in saline soil 8-10 days after germination.

Seed Elicitors: Two natural bioprocessed elicitors were used as seed treatment for salinity and waterlogging experiment: soluble chitosan oligosaccharide- vitamin C (COS-C), and marine peptide hydrolysate (Gro-Pro), derived from seaweed and marine fish extracts, respectively. The elicitors and subsequent concentrations were selected based on previous optimization that indicated significant elicitation of stress associated gateway PPP at the selected concentrations. COS was investigated using a 1% solu-

Edible Dry Bean Market Class			
Black Cultivars	Pinto Cultivars	Navy Cultivars	Kidney Cultivars
Eclipse	Windbreaker	Medalist	Montcalm
Zorro	La Paz	T9905	Redhawk
Loretto	Lariat	Ensign	Pink Panther
Zenith	Stampede	Vista	Roise
T-39	Monterrey	Avalanche	Talon

Table 1. Cultivars from four edible dry bean market classes for salinity stress experiment.

tion (1 g COS-C / 1 L distilled water) and Gro-Pro as well in a 1% solution (1 mL Gro-Pro / 1 L distilled water). Solution was prepared ahead of time prior to seed incubation. Elicitor solutions were stored for up to two weeks in the refrigerator at 0-4°. All solutions were brought to room temperature prior to seed incubation.

Seed Treatments: The ratio of 100 seeds (30 g) to 200 mL elicitor stock solutions (mL) was used for all dry bean genotypes. Seeds (30 g) were weighed and surface sterilized

by being soaked in a 0.5% hypochlorite solution for two minutes. Soaked beans were then drained and rinsed using a colander several times to remove any remaining 0.5% hypochlorite solution. Washed seeds were then added to previously prepared treatment solutions in separate 250 mL beakers, with Para film used to lightly seal each beaker. Each beaker was placed into a ThermoShaker for eight hours using the setting of 180 RPM at 23°.

Preparation of Saline Soil: Four salts were selected for this study in order to simulate salts common in the Northern Plains region: sodium chloride (NaCl), magnesium sulfate (MgSO₄), sodium sulfate (Na₂SO₄), and calcium sulfate (CaSO₄). Electrical Conductivity (Ec) was used to determine salt concentrations within the soil through use of an EcProbe. Using the aforementioned salts, three levels of soil salinity was investigated: Control with no salt added (Ec: 0.5-1.0 ds/M), mild salinity stress (Ec: 2.0-3.0 ds/M), and high salinity stress (Ec: 5.0-6.0 ds/M). Each salt was measured (g) according to salt stock calculations to produce 12 L of 0.035M (mild salinity stress) and 0.1M (moderate salinity stress) stock solutions, with each salt used in equal molar concentrations. Using a separate sterlite plastic bin for each saline treatment, professional grade potting mix was combined

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with the previously prepared 12 liters of stock salt solution, mixed thoroughly, sealed, and allowed to equilibrate for 12 hours. Initial Ec baseline measurement was then taken to ensure it was within specifications. Soil was then transferred to individual, pre-labeled, six inch-wide standard greenhouse pots. The fertilizer 'Osmocote 15-9-12 (3-4 Month)' was added at a ratio of 1.5 teaspoons per individual pot and mixed thoroughly.

Germination and Transplanting: Two starter trays (1.5in x 2in x 1in dimensions, each holding 24 individual beans) were prepared for each elicitor treatment prior to sowing. All starter trays were filled with professional-grade potting mix and soaked with distilled water until field capacity was achieved, and then allowed to equilibrate 6-8 hours prior to sowing of treated beans. After 8 hour incubation, treated beans were drained and transferred to starter trays in the greenhouse using commonly accepted dry bean planting practices. Bean seeds were allowed to germinate and grow until they reached the two-leaf stage. Individual bean seedling was then directly transferred to saline treated pots, with a total of 5 separate replications (pots) for each elicitor/saline soil treatment

Edible Dry Bean Market Class					
	Pinto	Great Northern	Red	Black	Navy
Tolerant	CDC_Camio	Sawtooth	USRM_20	Ac black diamond	Schooner
	Arapaho	BelNeb-RR_1	UI_228	Shiny crow	Morales
	Chase	Emerson	Amadeus_77	CDC Jet	Verano
Susceptible	JM_126	Belmineb_1	TARS09_RR004	ICB_3	Midland
	Jackpot	JM_24	UI_37	Raven	Huron
	Croissant	Matterhorn	CENTA_Pupil	Aifi_Wuriti	Albion

Table 2. Cultivars from Mesoamerican dry bean market classes for waterlogging experiment.

combination. After transplanting, 100 mL of saline solution was added near the bean roots of each individual plant to bring Ec into specifications. All experimental groups were subjected to identical conditions in order to control extraneous variables. A randomized complete block design (RCBD) was selected using a split-split plot arrangement.

Greenhouse Growing Conditions: Greenhouse temperature was kept constant between 25-30 . A photoperiod split of 14 hours light and 10 hours dark was selected for optimal bean growth and development. Beneficial nematodes were used to minimize various forms of common biotic greenhouse pests and were applied every week. Insecticide applications were additionally applied twice a week. Due to salt mixes in natural water supply, a water filtration system was attached to the greenhouse water source to minimize the effect of unaccounted dissolved salts that are common in North Dakotan public water systems.

Waterlogging Experi-

ment: In the greenhouse experiment, plants were germinated under well drained condition at the start of V2 phenological stage and then plants were exposed to flooding stress. For another study dry bean plants were directly sown in waterlogged pots. Flooding stress was applied for 2 to 10 days (1 cm water above the soil level, full saturation,

and field capacity) and then stressed pots were drained. Tolerant and susceptible genotypes were identified based on their survival along with photosynthetic activity and root scores. For further investigations with natural elicitor seed treatments, three susceptible genotypes and three tolerant genotypes (Mesoamerican genotypes)

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from each market class were selected and then similar studies with water logging was carried out in the greenhouse (Table 2). Seedlings germinated from waterlogged pots were collected for biochemical analysis from 15 days old to full maturity. For field experiment 40 different dry bean genotypes (20 genotypes from Middle-American gene pool and 20 genotypes from Andean gene pool) were used with three replications using randomized complete block design (RCBD) for screening. The field experiment was conducted at NDSU Plant Science research plots near AES greenhouse in Fargo, ND. Dry beans plants were flooded for 10 days (at V2 developmental stage) and then drained in the field and plants were allowed to grow. Control without flooding was carried out in adjacent plots. Photosynthetic activity, plant height, biochemical analysis involving PPP regulation and antioxidant enzyme activity were determined after flooding stress.

KEY RESEARCH FINDINGS

- The stress adaptive responses of dry edible beans against salinity and waterlogging stress varied significantly among edible dry bean genotypes and dry bean market class.
- Among edible dry



Figure 2. Black bean (*Eclipse*) plants (30 days old) under different levels of salt stress (0-1, 2-3, 5-6 ds/M EC) without seed elicitation treatments.



Figure 3. Pinto Bean (*Lariat*) seedlings (15 days after transplanting) treated with COS and Gro-Pro) under high salt stress (5-6 ds/M EC).

bean market class, pinto beans performed better under salinity stress followed by kidney, black, and navy bean genotypes.

- The optimum salinity stress tolerance level for most edible dry bean plants varied between 2-4 ds/M electrical conductivity (Figure 2).
- Monterrey pinto bean genotype performed best under high salinity stress.
- Under waterlogging stress, significant differences in germination percentage, survival rate,

seedling growth, and photosynthetic activity were observed between susceptible and tolerant genotypes of all edible dry beans.

- Improved seed vigor and early establishment of dry edible bean were observed with natural bioprocessed elicitors as seed treatments (COS & Gro-Pro) (Figure 3).
- Higher resilience against salinity and waterlogging was observed with Gro-Pro seed treatments (Gro-Pro treated plants

survived extra 10-20 days when compared to COS treated and without seed elicitation treated dry bean plants under high salinity).

- Under waterlogging stress improved seedling growth was observed in edible dry bean plants after Gro-Pro seed treatment.
- Higher antioxidant enzyme response (superoxide dismutase & catalase activity) was also observed with Gro-Pro seed treatment, both under salinity and waterlogging stress.

• Higher photosynthetic activity, improvement in plant height, number of leaves/branches and improvement in total seed weight (after harvest) were observed with COS seed treatments under mild salinity stress (2-3 ds/M EC).

- Stimulation of endogenous stress associated defense responses through up-regulation of gateway PPP was also observed in COS treated edible dry beans with and without salinity and waterlogging stress.

• Water logging stress tolerant genotypes had significantly higher photosynthetic activity, higher protein content, and higher antioxidant enzyme activity under flooding when compared to susceptible genotypes (Figure 4).

- Seed elicitation with

Continued on Next Page

Gro-Pro and COS resulted in significant improvement in overall fitness and resilience against salinity and waterlogging stress in edible dry beans and such novel elicitation strategy has potential to be utilized in wider field conditions.

Research Progress: Based on these findings we are currently repeating salinity and waterlogging experiments in the greenhouse and in the field with seed elicitations. Salinity experiments have already been repeated two times with black bean and pinto beans in the greenhouse and second repetition for navy and kidney bean salinity and entire waterlogging experiments are currently in progress.

Field experiments under saline and waterlogging stress with seed elicitation will be conducted in 2017 cropping year for further evaluation.

Acknowledgement: The support from Northharvest Bean Growers association is critical for this dry bean salinity and water logging climate resilience study. We are also thankful to Dr. Juan Osorno as both salinity and waterlogging experiments were conducted in close collaborations with his team. We are also grateful for the continuous support we have received from the College of Agriculture, Food Systems, and Natural Resources (Dean's office, NDSU) and



Moderately tolerant bean genotype after waterlogging stress.



Extremely susceptible bean genotype after waterlogging stress.

Figure 4. Growth of moderately tolerant and susceptible dry bean genotypes after flooding in the field.

AES greenhouse manager (Julie Hochhalter) and staffs. We also want to thank ND Specialty Crop Block Grant Award for

providing us support to continue the researches on dry bean bioactive enrichments for human health applications.

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Principal Investigator: Juan M. Osorno,
Project Leader

Research Specialists:
A. Jody Vander Wal and
Michael Kloberdanz

Research Assistants:
Stephan Schroder and Ali
Soltani

Graduate Students:
Kiran Ghising, Jose
Vasquez, Katelynn Walter,
Luz Montejo, Carlos Maldonado,
Daniel Restrepo,
Federico Velazquez.

OBJECTIVES

The objective of the dry bean breeding program at NDSU is to develop high yielding, high quality dry bean genotypes adapted to the Northern Great Plains. This involves many characteristics of dry beans and different disciplines of research (e.g. genetics, pathology, physiology, soils, nutrition, etc.). The main priority is to improve pinto, navy, and black market classes, but also great northern, kidney, red and pink. Crosses involve adapted cultivars grown in the Northern Plains, breeding lines developed at NDSU, and germplasm possessing desirable traits from other breeding programs. Each year, the breeding program evaluates material from around the world as

possible sources of resistance to white mold, rust, root rot, anthracnose, virus, and bacterial blights, among others. As shown in the 2015 grower's survey, approximately 15% of the MIN-DAK region devoted to pinto bean production used NDSU varieties. Also, 83% of the black bean acreage was planted with Eclipse.

2016 SEASON

The beginning of the growing season started with above-normal precipitation during the months of May, June, and even early July, which caused the total loss of variety trials at Forest River as well as the loss of ~75% of breeding nurseries at Johnstown. Hail damage was observed at Carrington variety trials. During flowering and pod filling stages, the most common diseases observed were of bacterial origin (mostly common bacterial blight and halo blight), as well as rust at the end of the growing season, which actually helps in the drying down of the plants as defoliation is one of the defense mechanisms of the plant. The dry conditions during and after flowering did not allow for the devel-

opment of severe white mold conditions. Rainfall during harvest made difficult to timely collect the seed yield data and seed samples from our field trials. Nonetheless, the quality of the information collected was good and the stress conditions at some locations offered a good opportunity to discard undesirable and/or underperforming lines.

2016 RESEARCH ACTIVITIES

The Dry Bean Variety Trials grown at more than 8 locations in North Dakota and two in Minnesota includes all the public and private varieties plus few breeding lines at final stages of testing. This is a great decision tool not only for growers but for public and private breeding programs when deciding about a new variety release. The NDSU dry bean breeding program continues to test and screen every year thousands of early generation genotypes, hundreds of preliminary and advanced breeding lines, commercial cultivars, and other germplasm. This breeding pipeline is grown in field experiments across five locations in North Dakota and two locations

in Minnesota. During the 2016 growing season, the program had 41 acres (9,718 total plots) of field experiments distributed across the entire region. In addition, variety testing is made in collaboration with the NDSU Research and Extension Centers (REC) across the state, so bean growers have a better idea of how each available cultivar may perform in their own region. Results of these variety trials can be found in the NDSU-Extension publication A-654-16.

Breeding activities mainly involved selection at early generations, yield testing of preliminary and advanced breeding lines, and some genetic/agronomic studies. Breeding targets include high seed yield and quality, disease resistance, early maturity, plant architecture for efficient mechanical harvest, and canning quality, among others. Greenhouse activities complement the field work by doing disease screening (bean rust, common bacterial blight, BCMV, anthracnose, among others), crossings, and seed increases. Inoculum for disease screening is provided

Continued on Next Page

by the Plant Pathology Dept. (Dr. Julie Pasche). The crossing block in the new greenhouse facilities involved approximately 300 new parental combinations. Winter nurseries were made at Puerto Rico (1924 rows), and New Zealand (240 rows), in order to speed up the breeding process, especially at the early generations. The results and new findings were always reported in peer reviewed journals,

grower meetings, field days, bulletins, magazines, phone calls, and informal conversations with all the stakeholders. Greenhouse screening for disease resistance have allowed the identification of some genotypes with improved resistance to some of the most important pathogens in the area, especially for bean rust, white mold, common bacterial blight, and anthracnose. Moreover,

few breeding lines appear to have combined/multiple disease resistance to rust, anthracnose, and common bacterial blight. Unfortunately, agronomic performance of these lines in field trials has been inferior compared with commercial checks. A selected group of lines will be re-tested during the 2017 growing season in order to decide if they will be released either as improved germplasm or

new varieties.

Talon dark red kidney and Rosie light red kidney continue to show higher seed yields than the commercial checks given their agronomic performance and quality, as well as intermediate resistance to the root rot complex and bacterial blights. The results from 2016 field trials keep confirming the superior performance of

Continued on Page 27

2016 NDSU DRY BEAN PROJECT TRIALS

Acres	Trial	Exp. Design	# of Entries / TRT	# of Reps	# of Plots	# of Rows/ Plot	Type of Material
CARRINGTON, ND							
4.6	BAYT	RCBD	44	3	132	2	Advanced
	GNAYT	RCBD	24	3	72	2	Advanced
	NAYT	RCBD	24	3	72	2	Advanced
	PAYT	RCBD	36	3	108	2	Advanced
	RPAYT	RCBD	18	3	54	2	Advanced
	SDPAYT	RCBD	14	3	42	2	Advanced
	F4 PR (slow darkening pinto)	PLANT ROWS	86	1	86	1	F4
	F4 PR (pinto)	PLANT ROWS	230	1	230	1	F4
	F4 PR (slow darkening pinks)	PLANT ROWS	10	1	10	1	F4
	F4 PR (reds & pinks)	PLANT ROWS	80	1	80	1	F4
	F4 PR (great northern)	PLANT ROWS	53	1	53	1	F4
	F4 PR (navy)	PLANT ROWS	132	1	132	1	F4
	F4 PR (black)	PLANT ROWS	233	1	233	1	F4
	F6 PR (slow darkening)	PLANT ROWS	89	1	89	1	F6
	F6 PR (pinto)	PLANT ROWS	236	1	236	1	F6
	F6 PR (great northern)	PLANT ROWS	68	1	68	1	F6
	F6 PR (reds & pinks)	PLANT ROWS	148	1	148	1	F6
	F6 PR (navy)	PLANT ROWS	19	1	19	1	F6
	F6 PR (black)	PLANT ROWS	5	1	5	1	F6
	F7 PR (navy)	PLANT ROWS	57	1	57	1	F7
	F7 PR (black)	PLANT ROWS	93	1	93	1	F7
FOREST RIVER, ND							
2.5	PVT	RCBD	28	4	112	4	Variety
	NVT	RCBD	26	4	104	4	Variety
	BVT	RCBD	25	4	100	4	Variety
	MVT	RCBD	20	4	80	2	Variety

Acres	Trial	Exp. Design	# of Entries / TRT	# of Reps	# of Plots	# of Rows/ Plot	Type of Material
JOHNSTOWN, ND							
5.2	BAYT	RCBD	44	3	132	2	Advanced
	GNAYT	RCBD	24	3	72	2	Advanced
	NAYT	RCBD	24	3	72	2	Advanced
	PAYT	RCBD	36	3	108	2	Advanced
	RPAYT	RCBD	18	3	54	2	Advanced
	SDPAYT	RCBD	14	3	42	2	Advanced
	BPYT	LATTICE	81	2	162	2	Preliminary
	GNPYT	RCBD	44	2	88	2	Preliminary
	NPYT	RCBD	55	2	110	2	Preliminary
	PPYT	LATTICE	81	2	162	2	Preliminary
	SDPPYT	RCBD	44	2	88	2	Preliminary
	MDR	RCBD	52	2	104	2	Advanced
HATTON, ND							
3	PVT	RCBD	36	4	144	4	Variety
	NVT	RCBD	27	4	108	4	Variety
	BVT	RCBD	27	4	108	4	Variety
	MVT	RCBD	25	4	100	2	Variety
HATTON, ND (NURSERY)							
10.9	BAYT	RCBD	44	3	132	2	Advanced
	GNAYT	RCBD	24	3	72	2	Advanced
	NAYT	RCBD	24	3	72	2	Advanced
	PAYT	RCBD	36	3	108	2	Advanced
	RPAYT	RCBD	18	3	54	2	Advanced
	SDPAYT	RCBD	14	3	42	2	Advanced
	BPYT	LATTICE	81	2	162	2	Preliminary
	GNPYT	RCBD	44	2	88	2	Preliminary
	NPYT	RCBD	55	2	110	2	Preliminary
	PPYT	LATTICE	81	2	162	2	Preliminary
	SDPPYT	RCBD	44	2	88	2	Preliminary
	MRPN	RCBD	18	3	54	2	Advanced
	Observation Rows	PLANT ROWS	48	1	48	1	Variety
	MDR	RCBD	52	2	104	1	Advanced
	F2 Space Plants (slow darkening pinto)	SPACED PLANTS	41	1	41	2	F2
	F2 Space Plants (pinks)	SPACED PLANTS	9	1	9	2	F2
	F2 Space Plants (great northern)	SPACED PLANTS	31	1	31	2	F2
	F2 Space Plants (reds & pinks)	SPACED PLANTS	66	1	66	2	F2
	F4 PR (slow darkening pinto)	PLANT ROWS	86	1	86	1	F4
	F4 PR (pinto)	PLANT ROWS	230	1	230	1	F4
	F4 PR (slow darkening pinks)	PLANT ROWS	10	1	10	1	F4
	F4 PR (reds & pinks)	PLANT ROWS	80	1	80	1	F4
	F4 PR (great northern)	PLANT ROWS	53	1	53	1	F4
	F4 PR (navy)	PLANT ROWS	132	1	132	1	F4
	F4 PR (black)	PLANT ROWS	233	1	233	1	F4
	F6 PR (slow darkening)	PLANT ROWS	89	1	89	1	F6

Acres	Trial	Exp. Design	# of Entries / TRT	# of Reps	# of Plots	# of Rows/ Plot	Type of Material
HATTON, ND (NURSERY)							
	F6 PR (pinto)	PLANT ROWS	236	1	236	1	F6
	F6 PR (great northern)	PLANT ROWS	68	1	68	1	F6
	F6 PR (reds & pinks)	PLANT ROWS	148	1	148	1	F6
	F6 PR (navy)	PLANT ROWS	19	1	19	1	F6
	F6 PR (black)	PLANT ROWS	5	1	5	1	F6
	F7 PR (navy)	PLANT ROWS	57	1	57	1	F7
	F7 PR (black)	PLANT ROWS	93	1	93	1	F7
PROSPER, ND							
6.7	Variety Strip Trial	RCBD	9	1	9	4	Variety
	BAYT	RCBD	44	3	132	2	Advanced
	GNAYT	RCBD	24	3	72	2	Advanced
	NAYT	RCBD	24	3	72	2	Advanced
	PAYT	RCBD	36	3	108	2	Advanced
	RPAYT	RCBD	18	3	54	2	Advanced
	SDPAYT	RCBD	14	3	42	2	Advanced
	BPYT	LATTICE	81	2	162	2	Preliminary
	GNPYT	RCBD	44	2	88	2	Preliminary
	NPYT	RCBD	55	2	110	2	Preliminary
	PPYT	LATTICE	81	2	162	2	Preliminary
	SDPPYT	RCBD	44	2	88	2	Preliminary
	Foliar CBB Study	RCBD	12	4	48	4	Variety
	Architecture CBB Study	RCBD	8	6	48	4	Variety
	Rhizobium Study	RCBD	16	9	144	4	Variety
	MDR	RCBD	52	2	104	2	Advanced
PARK RAPIDS, MN							
4.1	KVT	RCBD	31	4	124	4	Variety
	MVT	RCBD	20	4	80	4	Variety
	KAYT - Dark Kidney	RCBD	30	3	90	2	Advanced
	KAYT - Light Kidney	RCBD	20	3	60	2	Advanced
	KPYT - Dark Kidney	RCBD	52	2	104	2	Preliminary
	KPYT - Light Kidney	RCBD	57	2	114	1	Preliminary
	F2 Space Plants (slow darkening LRK)	SPACE PLANTS	10	1	10	2	F2
	F2 Space Plants (kidney)	SPACE PLANTS	79	1	79	2	F2
PERHAM, MN							
4	KVT	RCBD	30	4	120	4	Variety
	MVT	RCBD	20	4	80	4	Variety
	KAYT - Dark Kidney	RCBD	30	3	90	2	Preliminary
	KAYT - Light Kidney	RCBD	20	3	60	2	Preliminary
	KPYT - Root Rot Observation	RCBD	103	1	103	1	Preliminary
	Seed Treatment Study - McGregor	RCBD	11	6	66	4	Variety
	Seed Treatment Study - Biostimulant	RCBD	11	4	44	4	Variety
41	TOTAL ENTRIES:		5785	TOTAL PLOTS:		9718	

these two kidney varieties that will have significant economic impact in the region. The long-term economic support from the dry bean commodity groups such as the Northharvest bean growers association has been of key importance for the success of this breeding program.

Additional research conducted by graduate students and postdoc-

toral scientists focuses on seed coat slow darkening and plant architecture (in collaboration with USDA-ARS), genetic resistance to halo blight, multiple disease resistance in collaboration with USDA-ARS (common bacterial blight, anthracnose, rust, white mold, and bean common mosaic virus), as well as genetic resistance to root rots in

large-seeded types (kidney). Just this last year, new potential sources of resistance have been identified for waterlogging tolerance, root rots, halo blight, common bacterial blight, white mold, and anthracnose through some of these studies. Additional research is also underway (in collaboration with Dr. B. Nelson) on genetic resistance to soybean cyst nematode (see separate report about this project in this magazine), and Biological Nitrogen Fixation (BNF) in collaboration with Dr. A. Chatterjee. In collaboration with Dr. P. McClean, studies are focused on the use of molecular markers to improve the efficiency of selection within the breeding program such as Genome-Wide Association Mapping (GWAS) and Genotyping by Sequencing (GBS) methods.

ACKNOWLEDGEMENTS

The support from Northharvest bean growers association, NDSU, and the North Dakota Dry Edible Bean Seed Growers Association (NDDEBSGA) has been fundamental for the long-term success of the dry bean breeding program at NDSU and the growers of the Northharvest region. Other funding agencies include USDA-ARS, USDA-NIFA, ND Department of Agriculture, and the United States Agency for International Development (USAID).

Last but not least, we want to thank the following growers for allowing us to do research trials in their farms: Paul Johanning (Park Rapids-MN), Mark Dombeck (Perham-MN), Jim Karley (Johnstown-ND), Brian Shanilec (Forest River-ND), Tim Skjoiton (Hatton-ND), and Mark/Jim Sleeten (Hatton-ND).

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Evaluation of Selected Plant Nutrition Treatments and Establishment Factors in Dry Bean

Principal Investigators: Greg Endres, Hans Kandel and Mike Ostlie

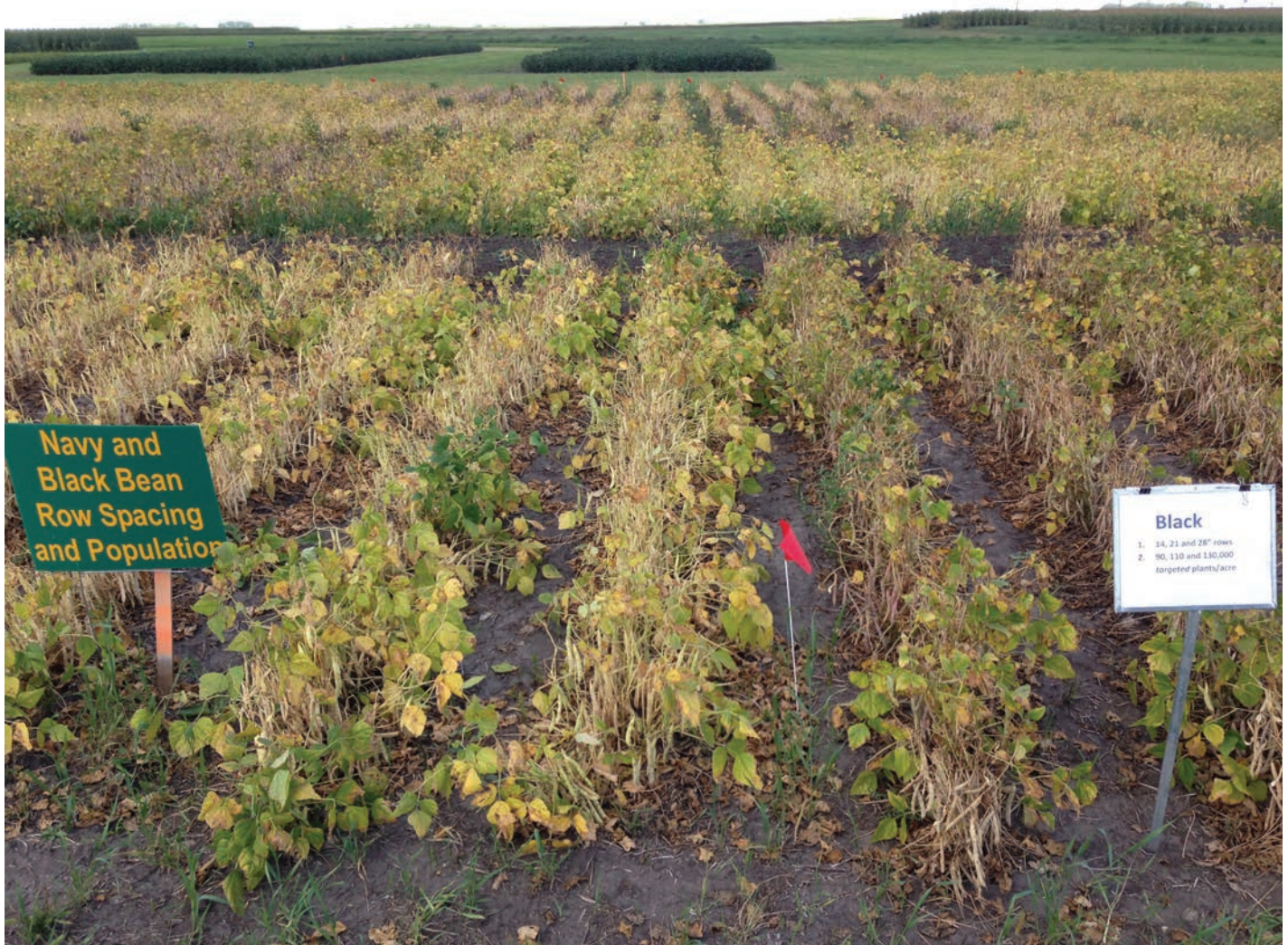
Field trials were continued by North Dakota State University in 2016 to examine pinto bean response to selected fertilizer treatments, and black and navy bean response to row spacing and planting rates.

Response to fertilizer: Field trials have been conducted since 2009 at the Carrington Research

Extension Center (CREC) to examine pinto bean response to various fertilizer rates, types, and placement methods. The 2016 trial was established at the CREC on a conventionally-tilled loam soil with 3.7% organic matter, 7.9-8.2 pH, low phosphorus (7 ppm; Olsen test) and low zinc (0.52 ppm). 'Lariat' was planted in 22-inch rows on June 1 with 2- by 0-inch from seed (band) or in-furrow (IF) applied

liquid fertilizer. Fertilizer treatments included: 1) untreated check; 2) 10-34-0 band applied at 3 gpa; 3) 10-34-0 IF applied at 3 gpa; 4) NWC Zn (Northwest Chemical; 9.5% N, 4% S, and 10% Zn chelate) IF applied at 0.25 gpa plus water at 2.75 gpa; 5) 10-34-0 IF applied at 2.75 gpa plus NWC zinc at 0.25 gpa; 6) 6-24-6 (Gavilon) IF applied at 2.75 gpa plus NWC zinc at 0.25 gpa; 7) 3-18-18-1 (Nachurs) IF

applied at 2.75 plus Zn (Nachurs; 9% chelated) at 0.25 gpa; 8) 10-34-0 IF applied at 3 gpa followed by post-emergence (POST) applied MAX-IN Ultra ZMB (Winfield; 3.6% S, 0.1% B, 3% Mn and 4% Zn) at 32 fl oz/A; 9) 10-34-0 IF applied at 3 gpa followed by POST applied MAX-IN Ultra ZMB at 32 fl oz/A plus Ascend (Winfield; growth promoter) applied at 6.4 fl oz/A; and 10) 10-34-0 IF applied at 2.75 gpa



2016 planting rate by row spacing trial at Carrington

plus NWC Zn at 0.25 gpa followed by POST applied MAX-IN S (Winfield; 0-0-19-13) at 64 fl oz/A. POST applications were at R2-5 plant stages on July 29. Hail damage occurred to the trial on July 9 prior to plant flowering resulting in an estimated <10% leaf loss.

Results from the 2016 trial indicated plant stand was similar among fertilizer treatments and the untreated check, with the trial averaging 62,400 plants/acre, though stands generally tended to be reduced with in-furrow placed fertilizer. Plant development (emergence,

first flower and maturity), canopy closure, and lodging also were similar among treatments. Seed yield was similar among fertilizer treatments and the untreated check.

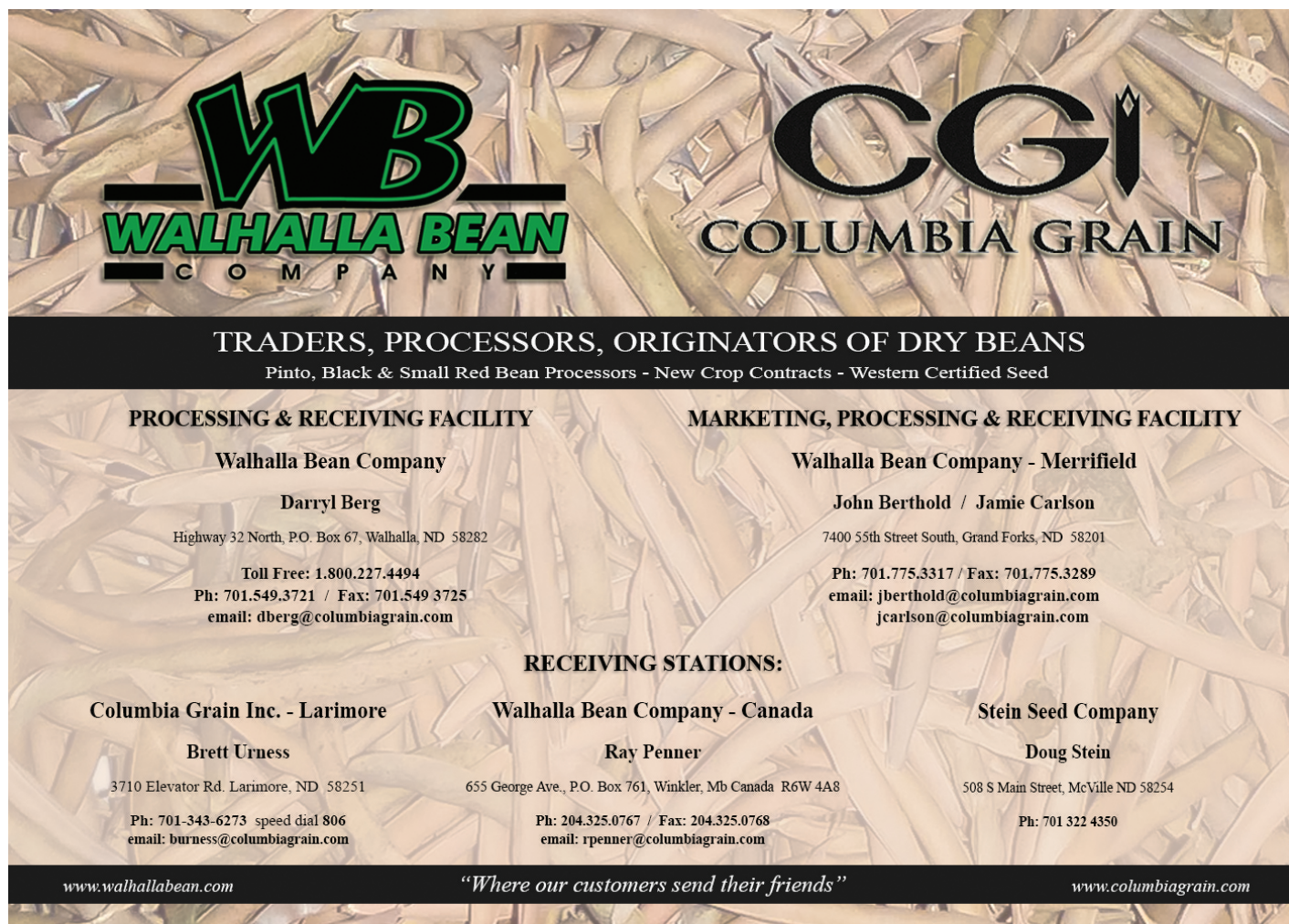
Averaged over seven-site years (2009-13 and 2015-16), 10-34-0 band applied at 3-6 gpa increased pinto bean seed yield 2.3 cwt/acre compared to the untreated check, while band- and IF-applied 10-34-0 had similar yield. Averaged over three years (2014-16), IF-applied 6-24-6 at 4.5 gpa and 10-34-0 at 3 gpa had similar plant stand and yield. Averaged over


three years (2014-16), the foliar application of the commercial nutrient mixture plus growth promoter following IF-applied 10-34-0 did not increase yield compared to yield with only IF-applied 10-34-0.


The research will continue in 2017 to build databases of selected fertilizer treatments plus test several new fertilizer strategies.

Row spacing and planting rate: NDSU currently recommends an established stand of 90,000 plants/acre for small-seeded market types. This multi-year study, which was initiated in 2014, continues to explore if

higher plant populations plus narrower row spacing (less than 30-inch rows) will economically increase black and navy bean seed yield. In 2016, 'Eclipse' black bean and 'Avalanche' navy bean were planted at the CREC in 14-, 21- and 28-inch rows, and at Prosper in 14-inch rows with targeted plant stands at both locations of 90,000, 110,000 and 130,000 plants/acre. Preliminary data indicates yield increase with narrow rows and the intermediate plant density. The study is planned to be continued in 2017 to further build the database.







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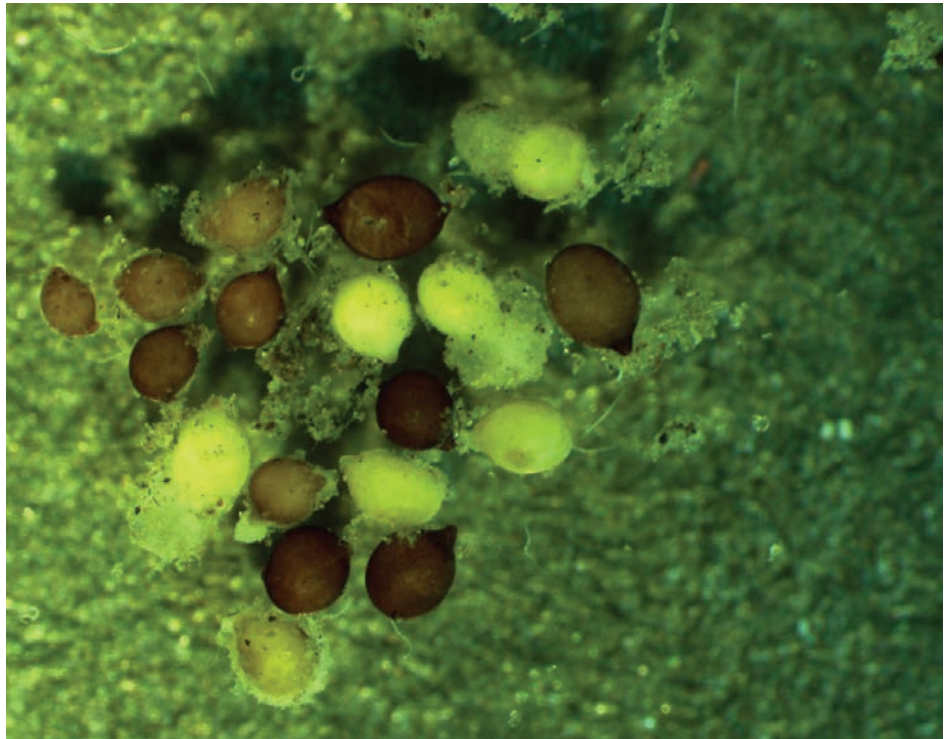
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Development of Soybean Cyst Nematode Resistant Dry Bean Breeding Material

Principal Investigators: Dr. Berlin D. Nelson, Dept. Plant Pathology, Dr. Juan M. Osorno, Dry Bean Breeder, Dept. Plant Sciences, and Dr. Shalu Jain, research scientist, Plant Pathology, NDSU, P.O. Box 6050, Fargo, ND 58108.

Objectives: Development of soybean cyst nematode resistant breeding lines for navy, pinto and kidney beans and finding sources of resistance in existing dry bean breeding material. This is a three year project initiated in July 2015.

Soybean cyst nematode (SCN; *Heterodera glycines*) has now spread into major dry bean growing areas in North Dakota and in northern Minnesota. In North Dakota, at least 20 counties in the eastern part of the state are known to have SCN. SCN survives very well in our soils and the nematode egg numbers can increase to high levels with our two susceptible crops, soybeans and dry bean. SCN also can interact with other root rot pathogens to cause increased damage to roots. Crop rotation to non-hosts can reduce egg numbers, but research has shown that egg levels can persist for many years in absence of a host, and it is almost impossible to eliminate SCN from the soil. Even moderately resistant cultivars can increase SCN populations over the years. The most effective way to manage SCN is through the use of highly resistant varieties as is commonly employed in soybeans. In research supported by the Northarvest Bean Growers Association, we have demonstrated



Soybean cyst nematodes from roots (about 1/32 inch in dia.). Light colored cysts are live females and the brown cysts are dead females. All are filled with eggs.



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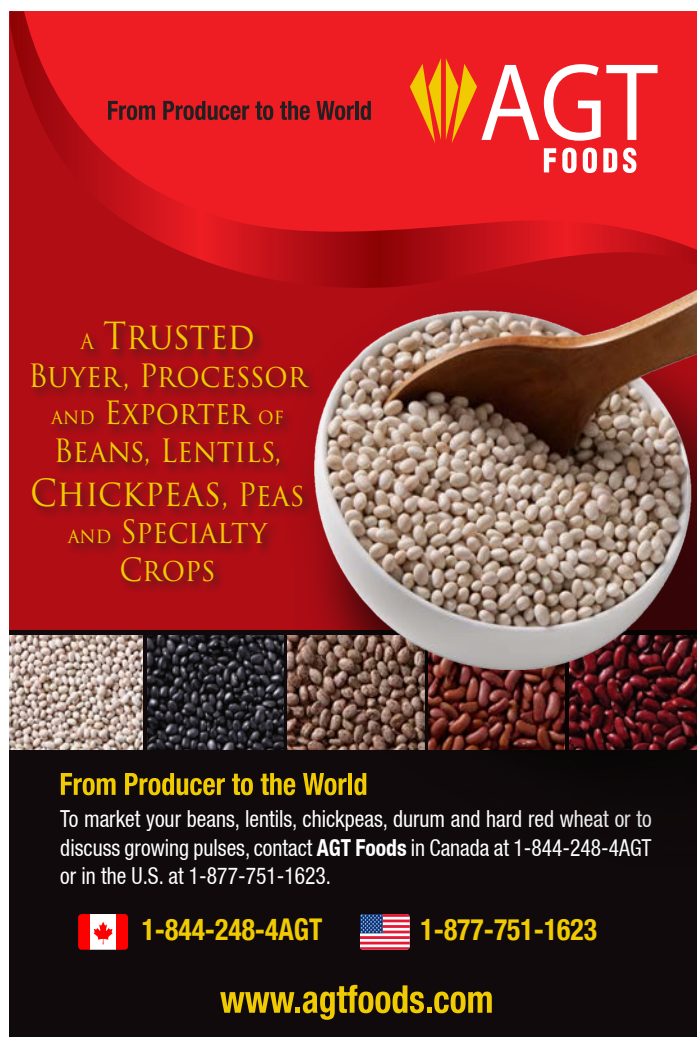
the following over a number of years of investigation on SCN and dry beans: 1) SCN reproduces to high levels in the field on major dry bean classes grown in this area, 2) SCN can reduce yields of pinto, navy and kidney beans, 3) There are differences in the levels of susceptibility among market classes, 4) resistance to SCN in exotic/tropical germplasm has been identified to use in breeding for resistance, 5) the resistance identified will control HG type 0 SCN, the most common type in this area, but resistance to other HG types has also been identified,

and 6) resistance to SCN appears to be controlled by multiple genes or quantitative trait loci (QTL). A video made by North Dakota State University titled Soybean Cyst Nematode – A Big Threat to Dry Bean Production, gives an overview of this problem. The video can be seen at https://youtu.be/abOt45qj_2E

There is little information about the resistance levels in commercial bean cultivars grown in ND or MN, especially in pinto, kidney, and navy beans. It is important to remember that there has not been an effort in major dry bean

growing areas to breed for SCN resistance since SCN has not been reported or was not a common pathogen in those areas. The most important US dry bean production area of ND and MN is only now facing the problem. There is serious concern that SCN could become a major problem for common bean production in the North Dakota-Minnesota region. Due to this potential threat of SCN to dry bean production in North Dakota, breeding efforts at North Dakota State University were initiated to incorporate SCN resistance into bean germplasm for eventual production of SCN resistant varieties. In our efforts thus far, we have made crosses of SCN resistant plant introductions from the USDA germplasm collection with commercial varieties of pinto and kidney bean classes (GTS-900 and Red Hawk) and developed populations segregating for SCN resistance containing ~200 individuals in each population. Kidney bean lines were planted in the winter nursery at New Zealand for agronomic evaluations. Screening for SCN resistance in the F5 generation identified plants in these crosses with high levels of resistance. Lines with good agronomic qualities and high resistance to SCN will be used as breeding

material. Some of these interesting/superior lines will be used for additional crosses within the breeding program and lines will be re-evaluated in the field during summer 2017. Pinto bean lines will be planted in field this summer and screening will be conducted in greenhouse. In addition, 187 advanced breeding lines from different market classes from Dr. Juan Osorno's breeding project were screened with SCN to identify the level of susceptibility/resistance in those advanced lines prior to release as commercial varieties. Approximately 22% of the advanced breeding lines belonging to pinto, light red, dark red and white kidney, great northern, navy, and black bean market classes have a female index less than 10 indicating high levels of resistance to SCN. However, additional screening will be required to confirm these results. The results of this research will help us select the superior dry bean lines with SCN resistance for future release of commercial dry bean cultivars. The use of resistant varieties will allow growers to manage SCN and avoid yield loss, plus help lower populations of SCN in the soil. We thank the Northarvest Bean Growers Association for supporting research on the control of soybean cyst nematode in dry beans.





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Dry Edible Bean Disease Research - 2017

Principle investigators: Julie Pasche and Sam Markell

PROJECT GOALS

The overall goal of the dry bean disease program is to enhance the management of diseases of dry beans to provide producers with effective management options for economically important diseases of dry beans. In 2016, our specific goals were to determine the efficacy of foliar applications for the control of common bacterial blight (CBB) under field conditions, to evaluate the management of root rot pathogens using in-furrow fungicide applications and to monitor pathogens and diseases in dry bean crops in the region. We continue to work

closely with the NDSU dry bean breeding program to aid in enhancing disease resistance in germplasm and varieties adapted to this region. We also work with industry partners to evaluate fungicides for the control of foliar diseases including rust and white mold.

EFFICACY OF FOLIAR APPLICATIONS FOR THE CONTROL OF BACTERIAL BLIGHT

Field trials were performed by PhD student Amanda Beck at three sites to evaluate the efficacy of 10 bactericidal products for the management of bacterial blight (Table 1). These products included traditional copper-based and less-tradi-

tional products that have shown promise in trials conducted in other dry bean growing areas of the US. Trials were performed on the main research station in Fargo, at the Oakes irrigated research station and at the Prosper research station. In all trials, disease incidence was enhanced by injuring the plant foliage via sand-blasting and inoculating with a suspension of the Common Bacterial Blight (CBB) pathogen. CBB, Brown Spot and Halo Blight severity was evaluated two or three times during the growing season and yield was determined at harvest.

Varying levels of each of the three bacterial blight diseases were observed at the three trials through-

out the season, including nearly 100% total bacterial blight in the non-treated control (Figure 1A). At all three trials, total bacterial blight severity was decreased significantly by the application of some of the products evaluated; however, significant yield increases were not observed in any of the trials (Table 1). The lack of significant yield differences was partially due to interference from the presence of other diseases, particularly at Fargo and Oakes. Disease severity was most consistently reduced by the application of Oxidate 2.0 (BioSafe Systems), a hydrogen peroxide product (Fig. 1). Kocide 3000 (Certis USA) was among the best performers at the trial conducted in Pros-



Figure 1. Non-treated (A), Oxidate 1% (B) and Kocide (C) treated plots at Prosper, ND on September 1.

per (Fig 2.). These results are based on one year of trial data, and therefore should be viewed with caution. Further testing is required to determine if these products will provide a valid option for the management of bacterial blights in dry beans in ND and MN.

MANAGING ROOT ROT PATHOGENS USING IN-FURROW FUNGICIDE APPLICATIONS

Replicated trials were conducted to further evaluate the effect of in-furrow fungicide applications for the control of Rhizoctonia and Fusarium root rot. Two trials were conducted at the Carrington Research and Extension Center in cooperation with Michael Wunsch and two were conducted on the main NDSU station in Fargo. One trial at each

Table 4. Root rot severity on 7/13/2016 and yield in dry bean trials conducted in Fargo and inoculated with *Fusarium solani* and *Rhizoctonia solani*.

Treatment	Rhizoctonia		Fusarium	
	Root rot severity (1-9)	Yield (lb/A)	Root rot severity (1-9)	Yield (lb/A)
Non-Inoculated Control	2.4 d	1215 a	2.7 a	890 a
Inoculated Control	2.9 ab	1109 a	2.9 a	896 a
Apron MAXX RTA	3.1 a	969 a	2.8 a	1053 a
Quadris	2.8 bc	976 a	2.8 a	1059 a
Headline	2.6 cd	987 a	3.0 a	1004 a
Proline	2.7 bc	982 a	2.7 a	961 a
Vertisan	2.6 c	1022 a	2.9 a	1117 a
Velum Prime	2.7 bc	953 a	2.8 a	812 a
Pr>F	<.0001	0.7905	0.1519	0.8326
CV	35.7	32.0	32.0	28.6

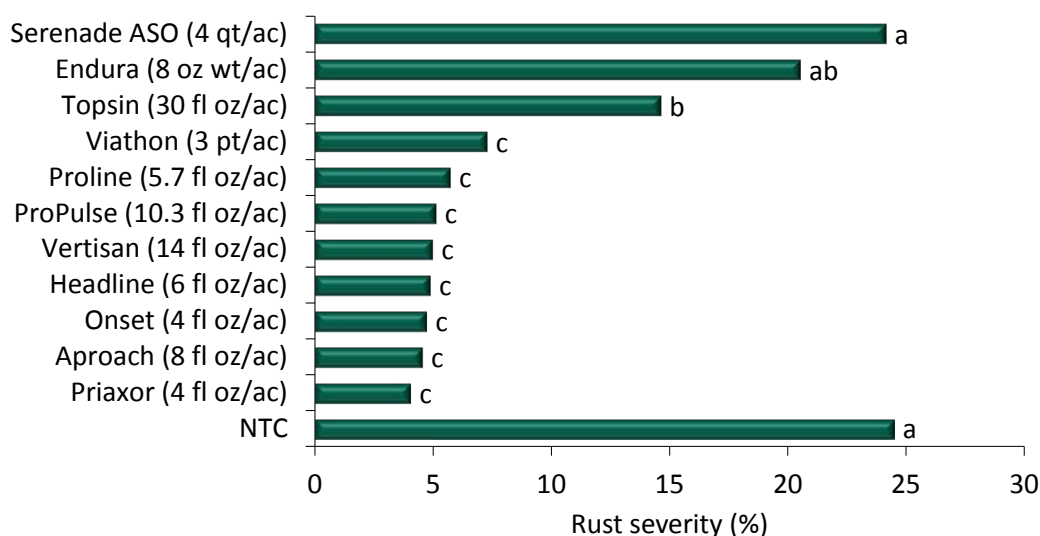
Means within a column followed by the same letter are not significantly different ($P < 0.05$).

site was inoculated with grain infested with either *Fusarium solani* or *Rhizoctonia solani*. Six fungicides were applied in-furrow and evaluated based on plant emergence, vigor, root rot severity and yield in all four trials (Table 2). Comparisons were made to non-inoculated/non-treated and inoculated/non-treated controls as

well as Apron Maxx RTA (Syngenta Crop Protection) seed treatment. The application of in-furrow fungicides significantly increased emergence and vigor over the seed treatment only in the Rhizoctonia inoculated trial conducted at Carrington (data not shown). In that trial, all in-furrow fungicides increased emergence and

vigor except Velum Prime (Bayer CropScience). Root rot severity was reduced significantly by the application of in-furrow fungicides in all trials except the *Fusarium* inoculated trial performed in Fargo (Table 3 and 4). At Carrington, the greatest reductions in Fusarium root rot were observed with the application of Headline (BASF), while all in-furrow fungicides reduced Rhizoctonia root rot over the seed treatment except Velum Prime (Table 3). At Carrington, yield increases were observed with the application of Vertisan (DuPont Crop Protection) in the Fusarium trial, and with all in-furrow fungicides except Velum Prime in the Rhizoctonia trial. Rhizoctonia root rot was reduced by all in-furrow fungicides

Figure 2. Rust severity following the application of fungicides at Fargo.



Continued on Next Page

in Fargo, but no significant reductions were observed in Fusarium root rot at that site (Table 4). Significant differences in yield were not observed in either of the trials performed in Fargo. Some of these products are not labelled for in-furrow use in dry beans, always follow label instructions. This is the third year trials have been conducted to evaluate in-furrow fungicide applications for root rot management. Results have not always been consistent across sites, but this strategy shows promise for root rot management.

MONITOR PATHOGENS AND DISEASES IN DRY BEAN CROPS IN THE REGION

In 2016, 40 dry bean fields in 11 counties were scouted for foliar diseases during the second and third week of August. Bacterial blight was observed in all 40 fields with in-field disease incidence ranging from 35% to 100%. Bacterial blight is common in dry bean fields in the region most years, but the high frequency and severity of fields with blight this year was in great part due to the widespread heavy thunderstorms and hail. Other diseases

observed were rust in 25 and white mold in 15 of 40 fields. In fields where rust was observed, incidence ranged from 5% to 100% and white mold incidence ranged from 1% to 55% in those fields where white mold was observed. No anthracnose was observed during our scouting efforts and we did not receive any reports of anthracnose from growers or consultants. Root rot was not evaluated during this survey.

The increase in rust severity and incidence of the past three years prompted our interest in determining if changes were occurring in the rust

pathogen population in the region. In 2008, a significant shift occurred in the dry bean rust population and the resistance incorporated into many common varieties was no longer effective against the new race of the pathogen. Rust was observed from 2008 to 2013, but it typically was first reported late in the growing season and resulted in little to no yield losses. Beginning in 2014, rust was reported much earlier in the growing season and resulted in yield losses. In 2016, rust was observed across the major growing regions, and in some areas was widespread and severe.



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Growers applied fungicides for control and yield losses were substantial in some areas.

In 2015, we began collecting rust isolates from fields across the major growing regions on North Dakota to determine if a pathogen shift had again occurred. Rust samples from 26 fields in 2015 and another 35 in 2016 were evaluated for virulence phenotype by PhD student Cecilia Monclova-Santana to determine which resistance genes are effective. Fortunately, no additional resistance genes are overcome by the current races of rust present in North Dakota. These findings have sev-

eral implications. Resistance genes are available that are effective against the races currently found in North Dakota and are being incorporated into the germplasm. Also, if the rust population has not changed, the increased incidence and severity of rust may be due to increased pathogen inoculum, and the weather favorable for disease development. We will continue to monitor pathogen races and rust disease severity to enable a rapid response to disease management including assisting with evaluations of genetic resistance and other management strategies.

GERMPLASM AND VARIETY DEVELOPMENT FOR ENHANCED DISEASE RESISTANCE

In 2016 we continued to evaluate material from the NDSU breeding program for CBB as well as other germplasm collections for Rhizoctonia and Fusarium root rot under greenhouse conditions. These evaluations are extremely important in the development of sustainable dry bean production utilizing varieties with resistance to pathogens of economic importance in the region.

FUNGICIDE EVALUATIONS WITH INDUSTRY PARTNERS

The NDSU dry bean pathology group thanks industry partners for cooperation and support for the evaluation of fungicides for the management of white mold and rust. In 2016, rust and white mold fungicide nurseries were established in Fargo, ND and with a cooperator near Northwood, ND, respectively. Results from these trials were very consistent with results from 2015. In each case, twelve common fungicides were evaluated. Severe rust infection was observed in the rust nursery and excellent data were collected; however, white mold severity was too low to effectively differentiate chemical efficacy. The

most effective fungicides for rust management continue to be found strobilurin (Headline, Aproach, etc.) and triazole (tebuconazole products, Proline, etc.) (Fig. 2). In general, fungicides that are more commonly applied for white mold did not perform as well against rust (Endura, Topsin, etc.).

ACKNOWLEDGEMENTS

We would like to thank Northarvest Bean Growers Association, the North Dakota Department of Agriculture Crop Protection Product Harmonization and Registration Board and Specialty Crop Block Grants, and our industry partners for providing funding for this research. We would like to thank research specialists Robin Lamppa, Scott Meyer, Jessica Halvorson, and Chryseis Tvedt, post-doctoral researchers Kristin Simons and Kim Zitnick-Anderson, PhD students Amanda Beck and Cecilia Monclova-Santana and the many undergraduate students on our teams for their work on these projects. Thank you also to our collaborators, Juan Osorno, Dry Bean Breeder, Michael Wunsch, Extension Plant Pathologist; Carrington Research and Extension Center, and Kelly Cooper, Oakes Irrigated Research Center and all associated with their research programs.

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2016 Dry Bean Variety Trials

North Dakota Dry Bean Variety Trial Results for 2016

Compiled by Hans Kandel, NDSU Extension Agronomist

Information about dry bean variety performance can be accessed online at www.ag.ndsu.edu/varietytrials, the site with all variety trial data from all NDSU Experiment Station locations for all crops. The agronomic data presented in this publication are from replicated research plots using experimental designs that enable the use of statistical analysis. The LSD (least significant difference) numbers beneath the columns in tables are derived from the statistical analyses and only apply to the

numbers in the column in which they appear. If the difference between two varieties exceeds the LSD value, it means that with 90 to 95 percent probability (0.10 and 0.05 level, respectively), the higher-yielding variety has a significant yield advantage. If the difference between two varieties is less than the LSD value, then the variety yields are considered similar.

The abbreviation NS is used to indicate no significant difference for that trait among any of the varieties. The CV is a measure of variability in the trial. The CV stands for coefficient of variation and is expressed as

a percentage. Large CVs mean a large amount of variation that could not be attributed to differences in the varieties.

In the tables, the “mean” indicates the average of the observations in the column. Only compare values within the table and look for trends for the desired trait among different experimental sites and years. In the tables, the dry bean varieties are arranged in alphabetical order within market class. Footnotes provide more detailed information about data in the table under which they appear. Characteristics to evaluate for selecting a dry bean variety

include marketing class, yield potential in your area, test weight, reaction to problematic diseases and maturity date.

When selecting a high-yielding and good-quality variety, use data that summarize several years and locations. Choose a high-quality variety that, on average, performs the best at multiple locations near your farm during several years.

Information contained in this publication is based on research conducted by North Dakota Agricultural Experiment Station scientists. We want to express our thanks to the dry bean growers who assisted with the on-farm variety testing.

Trials are supported in part by fees collected from entrants of the private varieties. We acknowledge the support for Juan Osorno’s breeding project from the Northharvest Bean Growers Association.

Presentation of data for the varieties tested does not imply approval or endorsement by the authors or agencies conducting the tests. NDSU approves the reproduction of any table in this publication only if no portion is deleted, appropriate footnotes are given, the order of the data is not rearranged, and NDSU is credited for the data.

Table 1. North Dakota Dry Edible Bean Harvested Acreage, 2003 to 2016.

Year	Acreage
2003	520,000
2004	475,000
2005	565,000
2006	640,000
2007	665,000
2008	640,000
2009	580,000
2010	770,000
2011	380,000
2012	685,000
2013	430,000
2014	615,000
2015	635,000
2016	570,000

Table 2. North Dakota Dry Edible Bean Production by Commercial Class, 2003 to 2015.

Year	Pinto (Cwt)	Navy (Cwt)
2003	5,864,000	1,164,000
2004	3,561,000	650,000
2005	6,530,000	1,330,000
2006	4,988,000	1,585,000
2007	7,606,000	1,636,000
2008	6,660,000	2,087,000
2009	6,106,000	1,263,000
2010	7,543,000	1,958,000
2011	2,709,000	1,125,000
2012	7,610,000	2,215,000
2013	4,765,000	1,299,000
2014	5,677,000	1,622,000
2015	4,932,000	1,694,000

Source: North Dakota Agricultural Statistics Service – USDA.

2016 Pinto Bean Variety Trial - Hatton, N.D. - Authors, J. Osorno, J. VanderWal and M. Kloberdanz.

Variety	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
Centennial	101	26	40.4	2,860
Cowboy	94	29	40.9	2,980
El Diablo Fu	92	26	41.1	2,830
GTS-904	98	21	41.6	3,130
GTS-907	92	21	37.4	2,820
La Paz	96	28	35.5	3,130
Lariat	102	26	40.2	2,860
Maverick	93	21	40.5	2,840
Monterrey	96	27	37.5	3,240
ND-307	97	24	43.0	3,010
Othello	94	16	40.7	2,370
ND Palomino	100	24	41.6	2,950
Radiant	95	28	39.3	2,960
Rough Rider (SV6533GR)	93	26	40.8	2,830
Santa Cruz	96	28	39.2	3,090
Sinaloa	99	27	41.3	3,290
Stampede	97	24	40.7	3,070
SV6139GR	91	24	35.2	3,200
Torreon	93	28	40.9	2,830
Vibrant	95	26	40.8	3,000
Windbreaker	91	20	40.3	3,220
Mean	95	25	39.9	2,977
CV %	3.0	7.0	6.7	12.2
LSD 0.05	4	7.0	3.7	500
LSD 0.10	3	5.9	3.1	419

Planted: June 8. Previous crop: sugarbeet.

2016 Dry Bean Variety Trial - Hatton - Authors, J. Osorno, J. VanderWal and M. Kloberdanz.

Variety	Market Class	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
GTS-104	Dk Red Kidney	101	22	45.8	1,680
Aries	Gr Northern	93	23	39.2	2,500
Draco	Gr Northern	106	22	40.2	2,630
Matterhorn	Gr Northern	101	22	38.4	2,030
Orion	Gr Northern	99	21	40.8	2,500
Powderhorn	Gr Northern	89	23	34.0	2,110
Taurus	Gr Northern	102	21	40.7	2,690
Samurai	Otebo	105	24	30.8	3,230
Floyd	Pink	90	17	34.5	1,830
Rosetta	Pink	97	23	37.4	2,420
Sedona	Pink	99	20	41.9	2,190
Merlot	Small Red	98	22	41.2	2,050
Ruby	Small Red	104	21	34.6	2,770
Viper	Small Red	103	23	31.8	2,860
Mean		99	22	38.0	2,392
CV %		4.0	7.0	5.2	10.3
LSD 0.05		5	6.0	2.9	350
LSD 0.10		4	5.0	2.4	293

Planted: June 8. Previous crop: sugarbeet.

¹Days after planting.

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2016 Navy Bean Variety Trial - Hatton - Authors, J. Osorno, J. VanderWal and M. Kloberdanz.

Variety	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
Alpena	98	26	20.3	3,300
Blizzard	98	28	21.6	3,170
DS105W0	101	27	21.9	3,180
Ensign	100	24	23.2	2,880
Fathom	103	24	22.3	3,140
Light House	101	23	23.1	2,900
Medalist	99	24	20.7	3,290
Mist	103	22	23.4	2,720
Nautica	102	25	20.3	2,970
OB-1723-03	103	28	19.7	3,140
SV1893GH	103	23	23.9	2,810
T9903	97	22	24.9	3,100
T9905	102	27	24.6	3,690
Vigilant	95	26	21.9	2,850
Vista	103	25	19.5	2,700
Mean	101	25	22.1	3,056
CV %	3.0	7.0	6.3	12.3
LSD 0.05	4	6.0	2.0	NS
LSD 0.10	3	5.0	1.7	NS

Planted: June 8. Previous crop: sugarbeet.
¹Days after planting.

2016 Black Bean Variety Trial - Hatton - Authors, J. Osorno, J. VanderWal and M. Kloberdanz.

Variety	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
Black Cat	97	25	20.5	2,920
Eclipse	94	24	21.3	2,880
GTS-1103	102	24	20.6	2,790
Jet	96	22	22.3	2,220
Knight Rider	102	23	22.1	2,750
Loreto	103	22	22.5	2,770
Obsidian (SV6894GB)	95	23	23.8	2,810
Super Jet	95	23	22.3	2,410
T-39	97	20	21.4	2,480
Zenith	100	23	21.8	2,420
Zorro	97	24	22.4	2,100
Mean	98	23	21.9	2,595
CV %	2.0	7.0	4.0	15.3
LSD 0.05	3	6.0	1.2	580
LSD 0.10	3	5.0	1.0	485

Hatton - Planted: June 8. Previous crop: sugarbeet
¹Days after planting.

2016 Kidney Bean Variety Trial - Park Rapids, Minn. - Authors, J. Osorno, J. VanderWal and M. Kloberdanz.

Variety	Market Class	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
Cabernet	Dk Red Kidney	91	15	41.1	1,190
Chaparral	Dk Red Kidney	94	15	40.0	1,700
Dynasty	Dk Red Kidney	95	20	52.7	2,140
GTS-104	Dk Red Kidney	94	18	45.3	1,930
Montcalm	Dk Red Kidney	93	17	46.1	1,750
Red Rover	Dk Red Kidney	91	18	43.9	1,460
Redhawk	Dk Red Kidney	90	17	41.0	1,250
Talon	Dk Red Kidney	92	17	42.4	1,660
Big Red	Lt Red Kidney	90	17	49.8	1,920
Celrk	Lt Red Kidney	86	13	48.2	1,070
Foxfire	Lt Red Kidney	89	16	44.4	1,860
Inferno	Lt Red Kidney	97	19	53.4	2,250
Pink Panther	Lt Red Kidney	91	17	51.7	1,960
Ronnie's Red	Lt Red Kidney	94	20	53.7	2,020
Rosie	Lt Red Kidney	101	19	47.7	1,660
Beluga	White Kidney	95	18	44.7	1,270
Snowdon	White Kidney	85	15	49.6	1,490
Yeti	White Kidney	96	18	46.9	1,400
Mean		92	17	46.8	1,666
CV %		3.0	7.0	4.7	17.6
LSD 0.05		4	4.0	3.1	420
LSD 0.10		3	3.3	2.6	352

Planted: June 2. Previous crop: corn.
¹Days after planting.

2016 Kidney Bean Variety Trial - Perham, Minn. - Authors, J. Osorno, J. VanderWal and M. Kloberdanz.

Variety	Market Class	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
Cabernet	Dk Red Kidney	92	15	44.4	800
Chaparral	Dk Red Kidney	94	17	38.6	1,750
Dynasty	Dk Red Kidney	94	20	52.7	1,490
GTS-104	Dk Red Kidney	97	20	45.9	1,380
Montcalm	Dk Red Kidney	99	19	48.4	1,300
Red Rover	Dk Red Kidney	91	19	43.4	1,070
Redhawk	Dk Red Kidney	90	18	42.2	940
Talon	Dk Red Kidney	93	17	44.7	1,040
Big Red	Lt Red Kidney	90	17	50.9	1,340
Foxfire	Lt Red Kidney	92	18	43.5	1,260
Inferno	Lt Red Kidney	102	19	51.1	1,580
Pink Panther	Lt Red Kidney	93	17	51.7	1,580
Ronnie's Red	Lt Red Kidney	94	21	53.2	1,540
Rosie	Lt Red Kidney	103	19	46.1	1,650
Beluga	White Kidney	93	19	41.8	880
Snowdon	White Kidney	87	19	54.6	1,530
Yeti	White Kidney	93	19	46.8	1,150
Mean		94	18	47.1	1,311
CV %		3.0	7.0	4.7	20.8
LSD 0.05		3	5.0	3.1	380
LSD 0.10		3	4.2	2.6	318

Planted: June 2. Previous crop: corn.

¹Days after planting.

2016 Dry Bean Variety Trial - Park Rapids, Minn. - Authors, J. Osorno, J. VanderWal and M. Kloberdanz.

Variety	Market Class	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
Eclipse	Black	94	22	19.5	2,580
GTS-1103	Black	94	22	21.5	2,480
Jet	Black	92	19	19.7	1,710
Knight Rider	Black	104	17	19.3	1,460
Loreto	Black	94	22	19.7	2,000
Super Jet	Black	92	17	19.7	1,670
Medalist	Navy	93	22	16.8	2,430
OB-1723-03	Navy	103	20	17.2	2,760
T9905	Navy	97	22	21.7	2,160
El Diablo Fu	Pinto	89	18	35.0	1,820
GTS-904	Pinto	96	16	37.7	1,990
GTS-907	Pinto	91	18	33.9	1,670
La Paz	Pinto	93	19	36.0	1,880
Lariat	Pinto	94	20	37.4	1,830
Monterrey	Pinto	93	21	35.0	1,760
ND Palomino	Pinto	93	20	35.6	1,850
Sinaloa	Pinto	92	20	34.9	1,990
Stampede	Pinto	93	19	33.7	1,920
Windbreaker	Pinto	92	18	37.9	2,530
Mean		94	20	28.0	2,026
CV %		2.0	7.0	6.5	14.9
LSD 0.05		3	5.0	2.5	430
LSD 0.10		3	4.2	2.1	360

Planted: June 2. Previous crop: corn.

¹Days after planting.

Variety	Market Class	Days to Maturity (DAP) ¹	Plant Height (inch)	100 Seed Weight (gram)	Seed Yield (lb/a)
Eclipse	Black	94	25	21.3	2,500
GTS-1103	Black	94	23	25.3	2,890
Jet	Black	96	22	21.0	1,650
Knight Rider	Black	102	22	20.7	1,790
Loreto	Black	96	22	21.4	1,500
Super Jet	Black	95	21	21.0	1,640
Medalist	Navy	96	24	19.8	1,850
OB-1723-03	Navy	95	22	17.9	2,390
T9905	Navy	95	23	23.7	1,770
El Diablo Fu	Pinto	87	22	38.9	2,090
GTS-904	Pinto	95	23	43.5	2,320
GTS-907	Pinto	92	20	39.5	2,400
La Paz	Pinto	94	27	39.7	2,290
Lariat	Pinto	95	22	38.6	1,970
Monterrey	Pinto	94	24	39.9	2,140
ND Palomino	Pinto	96	23	39.1	2,170
Sinaloa	Pinto	93	22	35.3	2,110
Stampede	Pinto	94	20	37.8	1,890
Windbreaker	Pinto	92	20	40.0	2,480
Mean		94	22	30.8	2,097
CV %		2.0	8.0	5.4	18.7
LSD 0.05		3	6.0	2.3	550
LSD 0.10		3	5.0	1.9	460

Planted: June 2. Previous crop: corn.

¹Days after planting.

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2016 Dry Bean Variety Trial - Dryland - Carrington - Authors, M. Ostlie, B. Schatz and G. Endres.

Variety	Market	Maturity (DAP) ⁴	Growth	Direct	Seed	Seeds/	Test	100 Seed	Seed Yield	
	Class		Habit ¹ (1-9)	Harvest ² (%)	Protein (%)	Pound (seeds)	Weight (lb/bu)	Weight (gram)	2016 (lb/a)	3-yr. Avg. ³ (lb/a)
Eclipse	Black	99	8.0	89	20	2,288	61.9	19.8	2,613	2,337
Loreto	Black	104	7.5	90	21	2,202	62.8	20.6	2,183	1,963
Zorro	Black	99	8.3	90	22	2,433	61.8	18.8	2,467	2,340
Montcalm	Dark Red Kidney	107	8.0	83	19	910	57.9	50.0	2,514	--
Talon	Dark Red Kidney	104	7.8	81	19	936	58.2	48.6	2,427	--
Pink Panther	Light Red Kidney	104	8.0	84	19	799	56.8	56.9	2,430	--
Rosie	Light Red Kidney	107	7.8	85	20	915	58.5	49.7	2,346	--
Ensign	Navy	102	5.0	75	22	2,127	63.0	21.4	2,769	2,215
Medalist	Navy	102	7.8	89	21	2,223	62.5	20.4	2,855	2,233
T9905	Navy	104	6.5	85	22	2,081	63.5	21.8	2,985	2,445
Vista	Navy	103	6.3	88	23	2,388	63.0	19.0	2,884	2,329
Rosetta	Pink	94	8.0	88	19	1,459	60.7	31.3	2,423	--
La Paz	Pinto	96	7.5	88	21	1,374	59.7	33.1	2,083	2,395
Lariat	Pinto	99	6.0	89	20	1,173	58.8	39.1	3,096	2,729
Maverick	Pinto	96	5.0	79	19	1,166	58.5	39.0	3,169	2,621
Monterrey	Pinto	99	7.3	88	20	1,277	60.3	35.6	2,712	--
ND-307	Pinto	100	7.3	85	21	1,090	57.1	42.3	3,243	2,589
ND Palomino	Pinto	98	7.0	84	22	1,204	58.9	37.7	3,217	--
Stampede	Pinto	97	7.8	89	20	1,240	59.0	36.7	3,090	2,634
Windbreaker	Pinto	95	5.0	83	21	1,167	57.8	39.0	3,385	2,729
Merlot	Small Red	98	7.0	87	19	1,217	60.2	37.4	2,575	2,178
Mean		100	7.1	85	20	1,508	60.0	34.2	2,736	2,410
CV %		2.4	10.2	3.5	3.1	5.5	0.9	5.2	12.7	11.3
LSD 0.05		3	1.0	4	0.9	121	0.7	2.4	486	456
LSD 0.10		3	0.9	3.5	0.8	101	0.6	2.0	406	378

Planted: May 20. Harvested: Sept. 14. Previous crop: corn.

¹Growth Habit: Scored on scale of 1 to 9; 1 = longer vine, low-stature plant, pods lower to ground; 9 = very upright plant stature, pods held well off ground.

²Direct Harvest: A relative score to estimate the percent of beans that would be harvested successfully in a direct/straight harvest system.

³Three-year average is for 2013, 2015 and 2016 because no data are available for 2014.

⁴Days after planting.

2016 Dry Bean Variety Trial - Irrigated - Carrington - Authors, M. Ostlie, B. Schatz and G. Endres.

Variety	Market Class	Maturity (DAP) ⁵	Growth Habit ¹ (1-9)	Direct Harvest ² (%) ¹	White Mold ³ %	Seed Protein (%)	Seeds/ Pound (seeds)	Test Weight (lb/bu)	100 Seed Weight (gram)	Seed Yield 2016 (lb/a)	Seed Yield 3-yr. Avg. ⁴ (lb/a)
Eclipse	Black	104	5.0	79	10	19.5	2,235	61.2	20.4	2,380	2,554
Loreto	Black	108	4.3	76	4	20.2	2,170	61.3	21.0	2,541	2,535
Zorro	Black	102	5.8	84	39	20.6	2,588	61.3	17.6	1,670	2,361
Montcalm	Dark Red Kidney	106	5.5	68	16	19.6	952	57.3	48.0	2,121	--
Talon	Dark Red Kidney	106	3.5	49	20	18.7	979	57.6	46.4	2,348	--
Pink Panther	Light Red Kidney	101	5.0	73	50	19.4	891	55.9	51.0	2,103	--
Rosie	Light Red Kidney	112	3.8	73	7	18.9	902	56.4	50.4	2,274	--
Ensign	Navy	104	2.5	61	25	22.4	2,072	61.9	22.0	2,548	2,701
Medalist	Navy	109	2.8	73	4	19.5	2,329	62.0	19.5	2,881	2,865
T9905	Navy	107	4.0	70	9	22.4	1,951	61.6	23.3	2,944	3,000
Vista	Navy	109	2.8	70	9	21.6	2,350	60.8	19.3	2,412	2,639
Rosetta	Pink	100	6.0	84	9	19.8	1,264	59.7	36.0	2,663	--
La Paz	Pinto	105	4.8	75	16	19.6	1,162	59.0	39.1	3,277	3,236
Lariat	Pinto	104	2.3	69	19	20.0	1,038	57.4	44.0	2,713	3,097
Maverick	Pinto	101	1.0	55	25	20.1	1,101	57.6	41.4	2,450	2,818
Monterrey	Pinto	105	5.3	81	14	19.8	1,165	58.4	39.0	2,835	--
ND-307	Pinto	103	3.0	69	18	21.4	1,041	55.6	43.7	2,456	2,632
ND Palomino	Pinto	104	3.5	73	9	22.0	1,188	57.0	38.2	2,137	--
Stampede	Pinto	103	2.3	68	19	20.6	1,067	55.8	42.8	2,357	2,890
Windbreaker	Pinto	100	1.5	56	33	20.8	1,183	57.0	38.5	2,447	3,054
Merlot	Small Red	103	3.0	71	11	20.2	1,084	58.7	42.0	2,744	2,650
Mean		105	3.7	70	17.3	20.3	1,462	58.7	35.4	2,491	2,788
CV %		1.3	22.8	7.4	46.2	2.5	4.4	1.3	4.3	10.1	14.9
LSD 0.05		2	1.2	7	11	0.7	91	1.1	2.1	355	697
LSD 0.10		2	1.0	6	9	0.6	76	0.9	1.8	296	578

Planted: May 20. Harvested: Sept. 19. Previous crop: sugarbeet. The trial experienced a significant degree of hail damage on July 9.

¹Growth Habit: Scored on scale of 1 to 9; 1 = longer vine, low-stature plant, pods lower to ground; 9 = very upright plant stature, pods held well off ground.

²Direct Harvest: A relative score to estimate the percent of beans that would be harvested successfully in a direct/straight harvest system.

³White Mold: An assessment of the incidence of plants that expressed some level of white mold (sclerotinia).

⁴Three-year average is for 2013, 2015 and 2016 because no data are available for 2014.

⁵Days after planting.

2016 Dry Bean Variety Trial - Irrigated - Oakes (Carrington REC) - Authors, K. Cooper, L. Besemann and H. Eslinger.

Variety	Market Class	Maturity (DAP) ¹	Seeds/ Pound (seeds)	100 Seed Weight (gram)	Test Weight (lb/bu)	Seed Yield	
						2016	3-yr. Avg.
						(lb/ac)	
La Paz	Pinto	87	1,388	32.8	61.4	3,407	3,348
Lariat	Pinto	90	1,215	37.5	58.8	2,829	3,490
Maverick	Pinto	87	1,219	37.3	59.1	3,301	3,204
Monterrey	Pinto	88	1,305	34.9	61.3	2,947	--
ND-307	Pinto	89	1,108	41.0	57.0	3,534	--
ND Palomino	Pinto	91	1,155	39.3	55.2	2,633	--
Stampede	Pinto	85	1,262	36.1	60.2	3,438	3,347
Windbreaker	Pinto	85	1,181	38.5	59.6	3,830	3,709
Mean		88	1,228	37.2	59.1	3,240	3,419
CV %		2.1	4.0	3.8	1.6	9.8	--
LSD 0.05		3	71	2.1	1.4	465	--
LSD 0.10		2	59	1.7	1.1	385	--
Ensign	Navy	87	2,307	19.7	64.7	3,053	3,111
Medalist	Navy	90	2,609	17.5	65.1	2,271	2,920
T9905	Navy	89	2,221	20.5	65.3	2,987	3,251
Vista	Navy	89	2,664	17.1	65.3	2,593	2,903
Mean		89	2,450	18.7	65.1	2,726	3,025
CV %		2.9	5.2	5.3	0.7	13.3	--
LSD 0.05		4	205	1.6	0.7	579	--
LSD 0.10		3	166	1.3	0.6	469	--
Eclipse	Black Bean	83	2,497	18.2	63.9	3,130	3,114
Knight Rider	Black Bean	89	2,570	17.8	62.9	2,705	--
Loreto	Black Bean	89	2,543	17.9	63.1	2,734	3,051
Zorro	Black Bean	84	2,536	17.9	63.9	2,844	--
Montcalm	Dark Red Kidney	89	964	47.2	57.2	2,650	2,645
Talon	Dark Red Kidney	90	1,032	44.1	58.7	2,754	--
Pink Panther	Light Red Kidney	87	876	51.9	56.7	2,868	2,634
Rosie	Light Red Kidney	94	994	45.7	56.9	2,616	--
Rosetta	Pink	86	1,410	32.2	62.6	3,222	--
Merlot	Small Red	89	1,295	35.1	60.3	3,472	3,295
Mean		88	1,672	32.8	60.6	2,899	2,948
CV %		2	5.1	5.0	1.9	12.4	--
LSD 0.05		3	123	2.4	1.7	520	--
LSD 0.10		2	102	2.0	1.4	431	--

Planted: May 24. Harvested: Aug. 29, late maturing Sept. 6. Previous crop: spring wheat.

¹Days after planting.

2016 Dry Bean Variety Trial - Cavalier - (Langdon REC) - Authors, B. Hanson, T. Hakanson and L. Henry.

Variety	Market Class	100 Seed Weight (gram)	Seed Yield				
			2014	2015	2016 (lb/a)	2-yr. Avg.	3-yr. Avg.
Eclipse	Black	19.5	1,655	2,077	2,229	2,153	1,987
Loreto	Black	18.5	1,472	1,841	1,871	1,856	1,728
Zorro	Black	19.5	1,131	1,876	2,451	2,163	1,819
Dynasty	Dark Red Kidney	63.6	--	1,994	2,188	2,091	--
Montcalm	Dark Red Kidney	49.5	795	1,732	2,016	1,874	1,514
Talon	Dark Red Kidney	42.5	726	1,470	1,582	1,526	1,259
OAC Inferno	Light Red Kidney	52.5	--	2,101	2,647	2,374	--
Pink Panther ¹	Light Red Kidney	54.5	646	1,655	1,635	1,645	1,312
Rosie	Light Red Kidney	45.0	976	2,018	1,827	1,923	1,607
Ensign	Navy	21.5	1,426	1,964	2,121	2,043	1,837
Fathom	Navy	21.0	--	1,945	2,138	2,041	--
Medalist	Navy	18.5	1,793	1,452	1,775	1,613	1,673
Mist	Navy	21.5	--	1,963	2,161	2,062	--
Nautica	Navy	17.5	1,419	2,038	2,072	2,055	1,843
T9905	Navy	21.5	1,697	2,001	2,450	2,225	2,049
Vista	Navy	17.5	1,773	1,950	2,304	2,127	2,009
Rosetta	Pink	34.0	--	--	2,223	--	--
La Paz	Pinto	34.5	2,039	2,961	2,710	2,836	2,570
Lariat	Pinto	39.5	1,790	2,725	2,430	2,578	2,315
Maverick	Pinto	38.5	1,783	2,185	2,664	2,424	2,211
Monterrey	Pinto	37.0	--	--	2,901	--	--
ND Palomino	Pinto	37.0	--	--	2,590	--	--
Stampede	Pinto	35.0	1,579	2,519	2,505	2,512	2,201
Windbreaker	Pinto	39.0	1,812	3,130	2,325	2,727	2,422
Merlot	Small Red	38.5	1,558	2,106	1,890	1,998	1,851
Mean		33.5	1,448	2,077	2,228	2,129	1,900
CV %		--	12.3	14.0	10.7	10.7	13.0
LSD 0.05		--	262	496	394	475	411
LSD 0.10		--	315	413	328	393	342

Planted: May 25. Harvested: Sept. 29.

¹Pink Pather had some preharvest shatter in 2015 and 2016.

2016 Dry Bean Variety Trial - Hettinger - Authors, J. Rickertsen and R. Olson.

Variety	Type	Plant Height (inch)	Plant Lodge (0-9) ²	Test Weight (lb/bu)	Yield	
					2016 (lb/a)	3-yr. Avg. (lb/a)
Eclipse	Black	16	2	51.7	1,429	1,773
Loreto	Black	16	3	53.8	1,284	1,586
Zorro	Black	17	2	51.5	1,333	--
Montcalm	Dark Red Kidney	16	3	47.9	937	--
Talon	Dark Red Kidney	16	3	47.2	952	--
Pink Panther	Light Red Kidney	17	4	44.9	1,025	--
Rosie	Light Red Kidney	16	3	49.2	1,196	--
Ensign	Navy	16	3	52.1	1,360	1,584
Medalist	Navy	16	2	52.5	1,282	1,512
T9905	Navy	16	3	51.8	1,438	1,698
Vista	Navy	17	3	54.1	1,251	1,560
Rosetta	Pink	17	3	50.4	1,261	--
La Paz	Pinto	17	5	48.7	1,318	1,827
Lariat	Pinto	16	7	48.1	1,252	1,785
Maverick	Pinto	16	5	48.6	1,070	1,536
Monterrey	Pinto	20	4	48.1	1,454	--
ND Palomino	Pinto	16	5	46.9	1,099	1,545
ND-307	Pinto	17	5	47.0	1,122	1,583
Stampede	Pinto	18	5	47.2	1,382	1,777
Windbreaker	Pinto	14	5	48.6	1,069	1,534
Merlot	Small Red	17	4	48.6	1,230	1,595
Mean		17	4	49.5	1,226	1,635
C.V. %		8.5	18.9	1.5	9.8	6.7
LSD 0.05		2	1.0	1.1	170	182
LSD 0.10		2	0.8	0.9	142	151

Planted: May 23. Harvested: Sept 13. Previous crop: canola.

¹Days after planting.

²0 = no lodging, 9 = lying flat on ground.

2016 Dry Bean Variety Trial - Minot - Authors, E. Eriksmoen, J. Tarasenko and J. Effertz.

Variety	Market Class	Maturity (DAP) ¹	Plant Height (inch)	Plant Lodge ² (0-9)	Test Weight (lb/bu)	100 Seed Weight (gram)	2016 (lb/a)	Yield 2-yr. Avg. (lb/a)	3-yr. Avg. (lb/a)
Eclipse	Black	95	26	1	59.8	19	2,759	2,595	--
Loreto	Black	96	25	3	60.6	18	1,803	2,021	--
Zorro	Black	95	25	1	61.1	19	2,356	2,399	--
Montcalm	Dark Red Kidney	105	21	2	56.1	50	1,785	1,543	--
Talon	Dark Red Kidney	103	20	3	56.3	54	1,677	1,808	--
Pink Panther	Light Red Kidney	104	20	1	55.5	61	2,318	1,880	--
Rosie	Light Red Kidney	104	24	2	57.8	47	1,785	1,921	--
Ensign	Navy	98	25	5	60.2	21	2,639	2,374	2,038
Medalist	Navy	100	28	5	60.2	19	2,167	1,992	1,689
T9905	Navy	103	29	4	60.1	22	2,582	2,324	1,934
Vista	Navy	99	21	5	59.6	19	2,131	2,272	1,909
Rosetta	Pink	100	25	4	58.9	33	2,087	--	--
La Paz	Pinto	95	26	3	57.8	40	2,554	2,747	2,356
Lariat	Pinto	95	31	4	56.4	39	3,024	3,158	2,586
Maverick	Pinto	92	27	7	55.8	39	2,648	2,561	2,069
Monterrey	Pinto	94	29	4	58.2	37	2,986	--	--
ND Palomino	Pinto	98	29	5	55.5	41	2,519	--	--
Stampede	Pinto	95	30	1	56.5	39	2,731	2,477	2,123
Windbreaker	Pinto	95	24	6	55.7	41	2,922	2,962	2,454
Merlot	Small Red	97	25	6	58.3	38	2,627	2,368	--
Mean		98	26	4	58.0	35	2,405	2,318	2,129
C.V. %		2.5	14.6	47	1.3	6.5	9.0	12.5	11.6
LSD 0.05		4	6.0	3	1.2	4	359	615	425
LSD 0.10		3	5.0	2	1.0	3	299	507	350

Planted: June 2. Harvested: Sept. 19. Previous crop: spring wheat

¹Days after planting.

²Lodging: 0 = no lodging, 9 = lying flat on ground.

2016 Pinto Bean Variety Trial - Irrigated - Williston - Authors, J. Jacobs and T. Tjelde.

Variety	Maturity	Canopy Height	Plant Lodge	Test Weight	100 Seed Wt.	Seeds/Pound	Yield	
	(DAP) ¹	(inch)	(0-9)	(lb/bu)	(gram)	(seeds)	2016	2-yr. Avg.
La Paz	98	18	3	63	31.8	571	4,366	3,911
Lariat	98	17	3	61	35.4	513	3,945	3,924
Maverick	95	14	4	60	34.3	529	3,999	3,690
Monterrey	97	18	2	63	30.7	592	4,646	-
ND Palomino	99	16	2	59	35.3	514	4,686	3,808
ND-307	99	16	2	58	37.8	480	3,669	3,109
Stampede	95	17	1	61	31.0	586	3,097	3,259
Windbreaker	95	15	2	60	35.7	509	3,698	3,181
Mean	97	17	2	60	34.0	537	4,013	3,555
C.V. %	1.2	10.3	39.3	0.5	2.2	2.2	12.8	-
LSD 0.05	1.8	2.5	1.3	0.5	2.8	17.7	756	-
LSD 0.10	1.5	2.1	1.1	0.4	2.3	14.6	625	-

2016 Navy Bean Variety Trial - Irrigated - Williston - Authors, J. Jacobs and T. Tjelde.

Variety	Maturity	Canopy Height	Plant Lodge	Test Weight	100 Seed Wt.	Seeds/Pound	Yield	
	(DAP) ¹	(inch)	(0-9)	(lb/bu)	(gram)	(seeds)	2016	2-yr. Avg.
Ensign	99	17.0	3	65.0	19.0	962	3,823	3,029
Medalist	98	17.0	1	65.0	16.5	1,098	4,261	3,300
T9905	100	17.0	2	64.0	19.7	921	4,632	3,411
Vista	98	17.0	1	65.0	16.3	1,112	4,451	3,448
Mean	98	16.9	2	64.8	17.8	1,030	4,042	3,165
C.V. %	2.4	7.8	28.4	0.6	4.0	3.5	7.7	-
LSD 0.05	4	2.1	0.8	0.6	2.8	57.4	528	-
LSD 0.10	3	1.7	0.6	0.5	2.3	46.5	428	-

2016 Dry Bean Variety Trial - Irrigated - Williston - Authors, J. Jacobs and T. Tjelde.

Variety	Market	Maturity	Canopy Height	Plant Lodge	Test Weight	100 Seed Wt.	Seeds/Pound	Yield	
	Class	(DAP) ¹	(inch)	(0-9)	(lb/bu)	(gram)	(seeds)	2016	2-yr. Avg.
Eclipse	Black	94	17.0	0	64.0	42	1,073	4,667	3,735
Loreto	Black	98	17.0	4	64.0	45	1,017	3,960	3,566
Zorro	Black	94	16.0	1	65.0	42	1,077	4,080	3,431
Montcalm	Dark Red Kidney	98	14.0	0	58.0	103	441	1,960	2,151
Talon	Dark Red Kidney	98	15.0	2	59.0	106	431	2,340	2,324
Pink Panther	Light Red Kidney	99	16.0	1	58.0	124	368	2,155	2,234
Rosie	Light Red Kidney	103	17.0	1	61.0	112	404	3,394	3,379
Rosetta	Pink	94	17.0	0	63.0	70	652	3,234	-
Merlot	Small Red	97	16.0	2	61.0	78	579	3,080	3,066
Mean		97	16.2	1	61.4	80	671	3,208	2,986
C.V. %		2.4	9.1	53.0	1.0	5.3	3.5	14.0	-
LSD 0.05		3	2.2	1.0	0.9	6.2	34.5	658	-
LSD 0.10		3	1.8	0.8	0.8	5.2	28.6	545	-

Planted: May 16. Harvested: Sept. 9. Previous crop: barley.

¹Days after planting.

Bean Variety Descriptions.

Class and Cultivar	Origin	RM ¹	Plant Type ²
PINTO			
Buster	Seminis	ME	UV
Centennial	Colorado State Univ.	L	UV
Cowboy	Provita	--	--
Croissant	CSU	L	V
Durango	Provita	E	V
El Diablo Fu	GenTec	ME	USV
Eldorado	MSU	L	USV
Galeena	Provita	L	V
GTS-904	GenTec	L	UV
GTS-907	GenTec	M	UV
La Paz	Provita	L	USV
Lariat	NDSU	L	USV
Long's Peak	CSU	L	USV
Marmot	Meridian Seeds	E	V
Maverick	NDSU	ME	V
Monterrey	Provita	ME	USV
ND Palomino	NDSU	ML	USV
ND-307	NDSU	M	UV
Odyssey	Idaho Seed Bean	ME	V
Othello	USDA-Prosser	E	V
Radiant	Provita	ML	USV
Roughrider	Seminis	--	--
Santa Cruz	Provita	M	USV
Santa Fe	MSU	M	USV
Sequoia	Idaho Seed Bean	ML	USV
Sinaloa	Provita	ML	USV
Sonora	Provita	E	V
Stampede	NDSU	M	USV
SV6139GR	Seminis	--	--
Torreon	Provita	M	USV
Vibrant	Provita	E	USV
Windbreaker	Seminis	M	UV
NAVY			
Alpena	MSU	ME	USV

Class and Cultivar	Origin	RM ¹	Plant Type ²
NAVY			
Avalanche	NDSU	ME	USV
Blizzard	Provita	M	USV
Bolt	Ag. Can.	M	USV
Cascade	Idaho Seed Bean	M	USV
CDC Whitecap	U. Sask	M	USV
DS105W0	Dow AgroSciences	--	--
Ensign	ADM-Seedwest	M	USV
Fathom	U. of Guelph	ML	USV
HY 4181	Hyland	E	USV
Indi	ADM-Seedwest	M	USV
Light House	U. of Guelph	M	USV
Lightning	U. of Guelph	M	UV
Medalist	Provita	M	UV
Merlin	Provita	M	USV
Mist	Ag. Can.	M	USV
Nautica	Ag. Can.	ML	USV
Norstar	NDSU	ME	USV
OB-1723-03	GenTec	--	--
Portage	Ag. Can.	ME	USV
Regent	Ag. Can.	ME	UV
Reliant	GenTec	ME/M	USV
Rexeter	U. of Guelph	L	USV
Seabiskit	ADM	ME	USV
SV1893GH	Seminis	--	--
T9903	Hyland	ME	USV
T9905	Hyland	M	USV
Vigilant	Provita	ME	USV
Viscount	GenTec	L	USV
Vista	Ag. Can.	ML	USV
SMALL RED			
Merlot	MSU	ME	USV
Rio Rojo	NDSU	ME	USV
Ruby	Provita	M	USV
Viper	Provita	M	USV

¹RM = Relative Maturity; E = Early; ME = Medium Early; M = Medium; ML = Medium Late; L = Late.

²V = Vine; UV = Upright Vine; USV = Upright Short Vine; B = Bush.

Bean Variety Descriptions.

Class and Cultivar	Origin	RM ¹	Plant Type ²
BLACK			
Black Cat	Provita	ME	USV
Blackhawk	MSU	L	USV
Carman Black	Ag. Can	E	USV
Eclipse	NDSU	M	USV
GTS-1103	GenTec	M	USV
Jet	U. Sask.	E	USV
Knight Rider	Meridian Seeds	ME	USV
Loreto	Provita	M	USV
Obsidian	Seminis	--	--
Super Jet	U. Sask.	ME	USV
T-39	U. Calif.	M	USV
Zenith	MSU	M	USV
Zorro	MSU	L	USV
PINK			
Floyd	Rogers	ML	V
Rosetta	MSU/ARS	M	USV
Sedona	MSU/ARS	M	USV
YELLOW			
Canario	U.C. Davis	L	V
FLOR DE JUNIO			
Desert Song	MSU	M	V
FLOR DE MAYO			
Gypsy Rose	MSU	ML	V
LIGHT RED KIDNEY			
Big Red	Provita	--	--
Blush	WSU/USDA	ML	B
California Early (CELRK)	U. Calif.	E	B
Chinook 2000	MSU	M	B
Clouseau	Seminis	M	B
Foxfire	Rogers	ME	B
OAC Inferno	U. of Guelph	ML	B
OAC Lyrik	U. of Guelph	ME	B
Pink Panther	Seminis	M	B
Rosie	NDSU	L	B

Class and Cultivar	Origin	RM ¹	Plant Type ²
LIGHT RED KIDNEY			
Ronnie's Red	Provita	ML	B
DARK RED KIDNEY			
Cabernet	Seminis	ML	B
Chaparral	Provita	ML	B
Dynasty	U. of Guelph	ML	B
GTS-104	GenTec	M	B
Majesty	Ag. Can.	ML	USV
Montcalm	MSU	ML	B
Red Rover	Seminis	ME	B
Redhawk	MSU	M	B
Talon	NDSU	M	B
WHITE KIDNEY			
Beluga	MSU	M	B
Silver Cloud	WSU/USDA	E	B
Snowdon	MSU	ME	B
Yeti	U. of Guelph	ML	B
GREAT NORTHERN			
Aries	Provita	ME	USV
Beryl	Rogers	M	V
Coyne	U. Nebraska	ML	V
Draco	Provita	M	USV
Gemini	Provita	E	V
Matterhorn	MSU	ME	USV
Orion	Provita	E	V
Powderhorn	MSU	M	USV
Taurus	Kelly Bean Co.	L	USV
CRANBERRY			
Bellagio	MSU	ML	V
OTEBO			
Fuji	MSU	E	B
Samurai	MSU	ML	UV

¹RM = Relative Maturity; E = Early; ME = Medium Early; M = Medium; ML = Medium Late; L = Late.

²V = Vine; UV = Upright Vine; USV = Upright Short Vine; B = Bush.

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