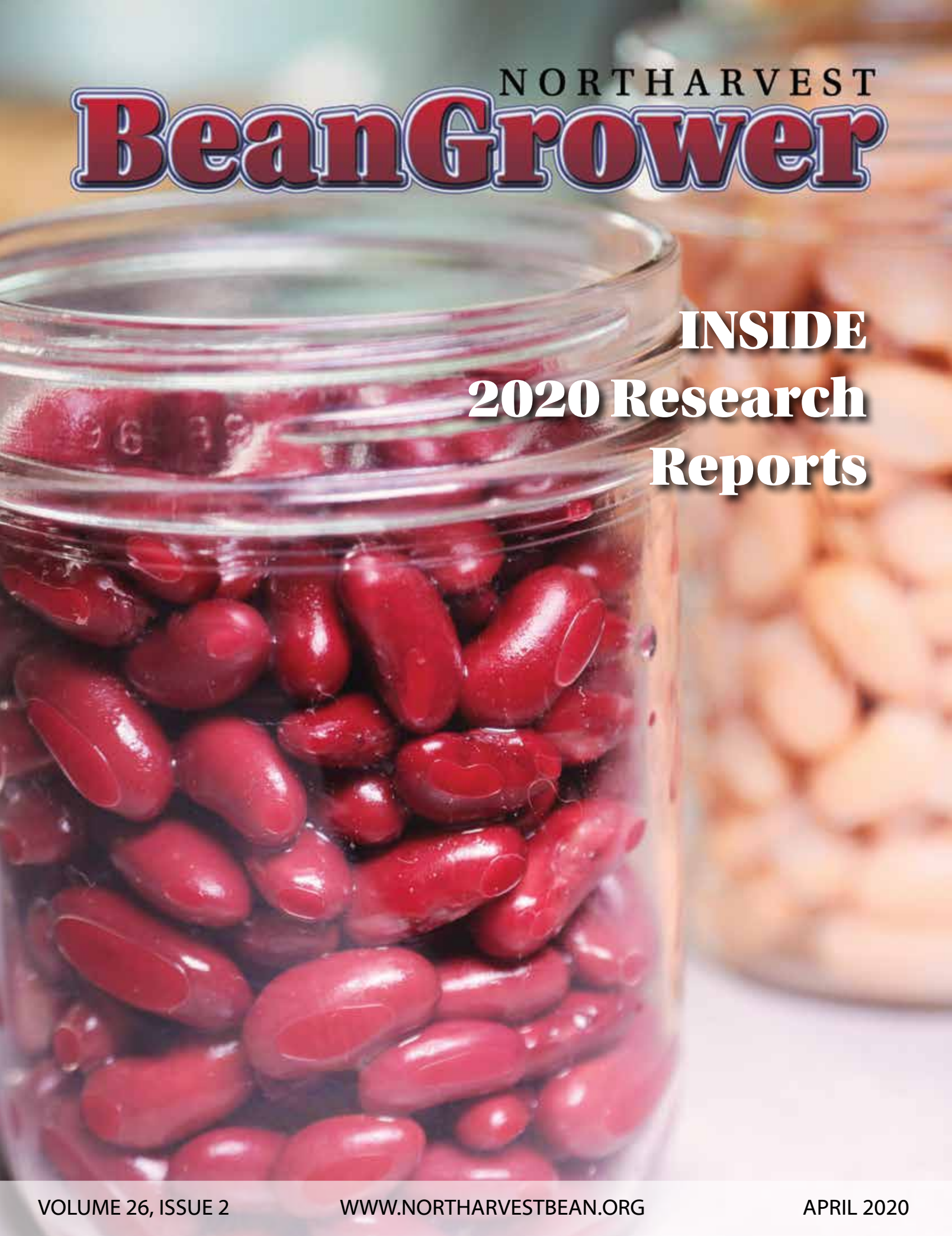
NORTHARVEST
BeanGrower



INSIDE
2020 Research Reports

VOLUME 26, ISSUE 2 WWW.NORTHARVESTBEAN.ORG APRIL 2020

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NORTHARVEST BeanGrower

The Northarvest Bean Grower is published five times a year by the Northarvest Bean Growers Association, 50072 E. Lake Seven Road, Frazee, MN 56544, Phone: (218) 334-6351, Website: www.northarvestbean.org, Email: nhbean@loretel.net.

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VOLUME 26 ISSUE 2

A HANDS-ON APPROACH TO RESEARCH

The Northarvest Bean Growers Association research committee takes a hands-on approach to steer research that will make a difference for dry edible bean production. Our committee meets with researchers and crop consultants each year to identify research projects that target our top production issues.

This past year, Northarvest budgeted nearly $290,000 for research. The research priorities include white mold management, Soybean Cyst Nematode resistance in dry bean breeding material and plant establishment. In this special edition of the *BeanGrower,* you'll find updates on these research projects.

The Northarvest region is fortunate to have a tremendous group of researchers and Extension specialists in our area. A big thank you is extended to these men and women for their dedication to dry edible bean research.

Remember, your feedback is always welcome. It helps drive the research growers want done to address industry issues. Contact Northarvest Bean Growers Association Executive Vice President Tim Courneyea or any of the board members with your ideas for research in the year ahead.

Sincerely,

Norm Krause
Research Committee Chairman
Northarvest Bean Growers Association

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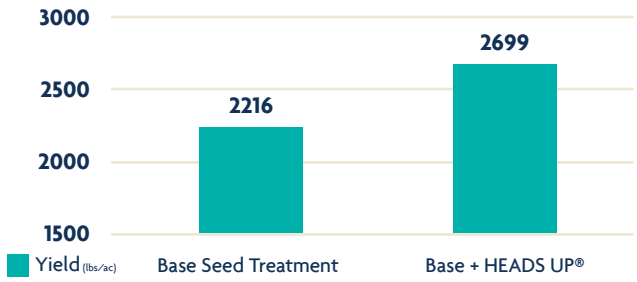

STUDY DETAILS
Location: Merrill, MI
Elevation: 660
Current Crop: Dry Beans, Navy
Previous Crop: Continuous Beans
Plot Size: 6' x 25', 4 reps, Harvest 3'x15'
Planting: 6/17/2019 – Late
Maintenance: 16oz Basagran, 4oz raptor, 8oz reflex, 12oz select max, 1% crop oil, 2lbs AMS, 9oz asana
Late Season: 70-75lbs N as Urea white mold & insect control sprayed at full bloom

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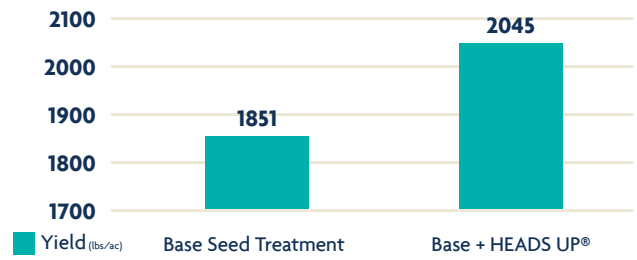

STUDY DETAILS
Location: Carrington, ND – NDSU Research Station
Elevation: 1,562
Current Crop: Dry Beans, DRK
Previous Crop: Spring Wheat
Plot Size: 5' x 30', 5 reps
Planting: 5/17/2019
Inoculum: Plots inoculated in-furrow with Rhizoctonia/Fusarium-infested proso millet and wheat, and Pythium-infested sorghum

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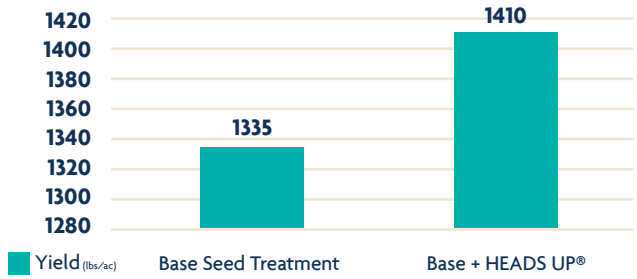

STUDY DETAILS
Location: Jerome, ID
Elevation: 3,672
Current Crop: Dry Beans, Cranberry
Previous Crop: Spring Wheat
Plot Size: 5' x 30', 4 reps
Planting: 6/11/2019

Data adapted from The McGregor Company 2019 Research Compendium

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YOUR CHECKOFF DOLLARS AT WORK

2020 Dry Bean Research Update

NORTHARVEST BEANS
MINNESOTA
NORTH DAKOTA

Optimizing Fungicide Applications for Improved Management of White Mold in Dry Edible Beans

Principal Investigator: Michael Wunsch, plant pathologist, NDSU Carrington Research Extension Center

Objective: Continued research at the NDSU Carrington Research Extension Center on optimizing fungicide applications for improved management of white mold in kidney, pinto, black and navy beans was focused on two objectives:

1. Optimizing fungicide spray droplet size.
2. Evaluating the use of adjuvants to improve performance of the widely used fungicide thiophanate-methyl (Topsin and generics).

Methods: Field trials were conducted at the NDSU Carrington Research Extension Center on fields with a previous history of white mold, with supplemental irrigation applied as needed to facilitate white mold pressure. Row spacing was 21 inches and seeding rate was 80,000 pure live seeds/ac (kidney beans), 90,000 pls/ac (pinto beans), 100,000 pls/ac (black and navy beans). Fungicides were applied at 8.9 mph in a spray volume of 15 gal/ac using a tractor-mounted CO2-pressured sprayer equipped with a pulse-width modulation system (Capstan AG; Topeka, KS).

The adjuvant study was conducted with TeeJet XR11006 flat-fan nozzles at 35 psi (medium droplets). To evaluate whether consistent results may be observed across nozzle manufacturers, the impact of droplet size was tested with nozzles from Wilger (Wilger Inc.; Lexington, TN) and TeeJet (Spraying Systems Co.; Glendale Heights, IL). To evaluate the consistency of results across a range of plant architectures, the impact of adjuvants was tested on two pinto and two black bean varieties, and the impact of spray droplet size was tested on two pinto, two kidney, two navy, and two black bean varieties. The adjuvant studies were conducted with seven to eight replicates, and the droplet size studies were conducted with nine or eleven replicates. A large number of replicates was utilized because white mold disease pressure is often uneven within fields, with areas of high disease pressure and areas of low disease pressure occurring over short distances. As the number of experimental replicates increases, the probability that each treatment is tested approximately the same number of times in areas of high versus low disease pressure increases.

Conversely, with just four experimental replicates, the standard for most agronomic research, it is likely that, by random chance, some treatments will end up on areas of high disease pressure three or even four times (75 or 100% of the time) while others end up on areas of low disease pressure three to four times, which would severely bias the results. Within each experimental replicate, each fungicide treatment was applied to a block of all dry bean market classes and varieties planted back-to-back, resulting in all varieties being sprayed concurrently with the exact same fungicide

Continued on Page 12

Table 1. Impact of spray droplet size on white mold control and dry bean yield; Wilger nozzles, Carrington, ND (2019). Fungicide application details, including the nozzles and pressures utilized, driving speed, spray volume, application timing and fungicides utilized, are provided at the bottom of the table. Within-column means followed by different letters are significantly different (P<0.05).

MARKET CLASS Variety, Year	DARK-RED KIDNEY 'Dynasty' (2019)		LIGHT-RED KIDNEY 'Pink Panther' (2019)	
	White mold % of canopy	Yield lbs/ac	White mold % of canopy	Yield lbs/ac
Non-treated	67 b*	1286 b*	60 b*	1685 b*
fine droplets	59 ab	1624 a	47 a	2288 a
medium droplets	56 a	1653 a	40 a	2256 a
coarse droplets	56 a	1658 a	41 a	2391 a
very coarse droplets	60 ab	1569 ab	48 a	2165 a
F:	2.96	3.86	10.33	10.20
P>F:	0.0344	0.0113	< 0.0001	< 0.0001
CV:	13.1	15.3	15.4	12.0
MARKET CLASS **Variety, Year**	**NAVY** **'HMS Medalist' (2019)**		**NAVY** **'T9905' (2019)**	
Non-treated	65 b*	1761 a*	68 b*	1790 b*
fine droplets	65 b	1971 a	64 b	2184 ab
medium droplets	52 ab	2257 a	57 ab	2331 a
coarse droplets	50 a	2227 a	51 a	2459 a
very coarse droplets	57 ab	2282 a	62 ab	2308 a
F:	3.98	2.24	5.42	4.42
P>F:	0.0098	0.0864	0.0019	0.0059
CV:	18.0	21.6	14.4	16.5
MARKET CLASS **Variety, Year**	**BLACK** **'Eclipse' (2019)**		**BLACK** **'Black Tail' (2019)**	
Non-treated	78 b*	1212 b*	77 b*	987 b*
fine droplets	71 ab	1812 a	69 ab	1604 a
medium droplets	65 a	1921 a	62 a	1595 a
coarse droplets	66 a	1897 a	64 a	1604 a
very coarse droplets	69 ab	1868 a	69 ab	1458 a
F:	4.60	6.99	4.10	5.51
P>F:	0.0047	0.0004	0.0085	0.0017
CV:	10.2	19.5	12.1	23.5
MARKET CLASS **variety, year**	**PINTO** **'Palomino' (2019)**		**PINTO** **'Vibrant' (2019)**	
Non-treated	77 b*	1132 b*	88 c*	894 b*
fine droplets	67 a	1907 a	85 bc	1332 a
medium droplets	66 a	1886 a	81 a	1456 a
coarse droplets	69 a	1688 a	83 ab	1277 a
very coarse droplets	70 ab	1669 a	84 ab	1299 a
F:	5.30	11.18	8.07	6.56
P>F:	0.0022	< 0.0001	0.0001	0.0006
CV:	8.2	17.0	3.5	19.8

Fungicide application details: Application A, Topsin (40 fl oz/ac), July 15 / Application B: Endura (8 oz/ac), July 27. **Growth stage at first fungicide application (July 15):** KIDNEY BEANS, 84-87% of plants with an open blossom, with initial pin-shaped pods in 'Pink Panther'; NAVY BEANS, 52-54% of plants with an open blossom; BLACK BEANS, 41-56% of plants with an open blossom; PINTO BEANS, 57-70% of plants with an open blossom. **Spray volume:** 15 gal/ac. **Driving speed:** 8.9 mph. **Nozzles and application pressures:** ER110-04, 50 psi (fine); MR110-04, 50 psi (medium); SR110-04, 50 psi (coarse); DR110-04, 50 psi (very coarse)

mix and sprayer calibration. Individual varieties were planted in plots 63 inches wide (3 rows wide) by 22 feet long, resulting in a total sprayed length of 88 feet per plot (4 varieties) for the adjuvant study and 176 feet per plot (8 varieties) for the droplet size study.

Fungicides were applied to a 100-inch width centered on the treatment plots, and non-harvested plots were established adjacent to all treatment plots to capture overspray and spray drift. The sprayer was turned on or off in a non-harvested 22-foot filler plot established before, between, and after treatment blocks. Boom height was set in accordance with the nozzle manufacturer's recommendations, 19 in. above the canopy for 110° Wilger nozzles and 20 in. above the canopy for 110°TeeJet nozzles, with average height across all varieties across the footprint of the study utilized to set boom height. Every plant in each plot was individually assessed for white mold shortly before maturity, clipped at the base to simulate knifing, and wind rowed. Yields are reported at 13.5% moisture.

CONCLUSIONS

Impact of spray droplet size: White mold management in kidney beans was optimized when fungicides were applied with medium to coarse droplets (Wilger nozzles; Table 1) and droplets on the coarse end of the medium spectrum to coarse droplets

Table 2. Impact of spray droplet size on white mold control and dry bean yield; TeeJet nozzles, Carrington, ND (2018 and 2019). Fungicide application details, including the nozzles and pressures utilized, driving speed, spray volume, application timing and fungicides utilized, are provided at the bottom of the table. Within-column means followed by different letters are significantly different (P<0.05).

market class	Dark-red kidney		Dark-red kidney		Light-red kidney	
variety, year	'Rosie' (2018)		'Dynasty' (2019)		'Pink Panther' (2019)	
	White mold	Yield	White mold	Yield	White mold	Yield
	% of canopy	lbs/ac	% of canopy	lbs/ac	% of canopy	lbs/ac
Non-treated	51 b*	2192 a*	47 b*	2369 b*	6 a*	3425 a*
fine droplets	40 ab	2510 a	32 a	2686 ab	4 a	3385 a
medium-fine droplets	44 ab	2468 a	32 a	2768 a	3 a	3427 a
medium droplets	41 ab	2526 a	29 a	2827 a	3 a	3364 a
medium-coarse droplets	37 a	2672 a	28 a	2803 a	4 a	3301 a
coarse droplets	38 a	2534 a	28 a	2686 ab	2 a	3451 a
F:	2.92	1.68	5.21	3.47	3.47	0.52
P>F:	0.0265	0.1655	0.0006	0.0091	0.0091	0.7572
CV:	19.6	14.0	31.6	11.1	11.1	7.7

market class	Navy		Navy		Navy	
variety, year	'Avalanche' (2018)		'HMS Medalist' (2019)		'T9905' (2019)	
Non-treated	48 b*	2097 b*	44 b*	3011 c*	46 b*	3115 b*
fine droplets	39 ab	2304 ab	24 a	3457 b	23 a	3703 a
medium-fine droplets	35 a	2520 a	24 a	3629 ab	22 a	3790 a
medium droplets	31 a	2619 a	21 a	3526 ab	21 a	3867 a
medium-coarse droplets	33 a	2616 a	22 a	3652 ab	26 a	3818 a
coarse droplets	38 ab	2460 ab	23 a	3832 a	21 a	3764 a
F:	5.35	4.89	12.35	10.73	18.65	7.52
P>F:	0.0009	0.0017	< 0.0001	< 0.0001	< 0.0001	< 0.0001
CV:	19.3	10.7	31.2	8.1	28.0	9.2

(TeeJet nozzles; Table 2). Applying fungicides with medium-coarse to coarse droplets rather than fine droplets was associated with modest gains in white mold management in kidney beans, reducing the percent of the canopy diseased by an average of 3 to 5 percentage points and increasing yield by an average 53 lbs/ac.

White mold management in navy beans was optimized when fungicides were applied with medium to coarse droplets with Wilger nozzles (Table 1) and medium droplets with TeeJet nozzles (Table 2). The use of medium droplets rather than fine droplets reduced the percent of the canopy diseased in navy beans by an average of 4 to 9 percentage points (TeeJet and Wilger, respectively) and increased navy bean yield by an average of 182 to 216 lbs/ac (TeeJet, Wilger). The use of coarse droplets or droplets on the coarse end of the medium spectrum rather than fine droplets reduced the percent of the canopy diseased in navy beans by an average of 2 to 14 percentage points (TeeJet, Wilger) and increased navy bean yield by an average of 202 to 265 lbs/ac (TeeJet, Wilger).

White mold management in black beans was optimized when fungicides were applied with medium droplets (Wilger and TeeJet nozzles; Tables 1 and 2). The droplet size studies conducted with TeeJet nozzles on black beans in 2019 were not

Continued on Next Page

market class	Black		Black		Black	
variety, year	'Eclipse' (2018)		'Eclipse' (2019)		'Black Tail' (2019)	
	White mold	Yield	White mold	Yield	White mold	Yield
	% of canopy	lbs/ac	% of canopy	lbs/ac	% of canopy	lbs/ac
Non-treated	44 b*	2051 b*	35 b*	2699 b*	45 b*	3096 b*
fine droplets	32 a	2541 a	17 a	3291 a	25 a	3793 a
medium-fine droplets			17 a	3522 a	19 a	3743 a
medium droplets	27 a	2641 a	16 a	3426 a	25 a	3617 a
medium-coarse droplets			17 a	3561 a	21 a	3802 a
coarse droplets	29 a	2570 a	18 a	3291 a	23 a	3709 a
F:	11.63	5.79	9.62	6.21	12.27	8.85
P>F:	0.0007	0.0110	< 0.0001	0.0002	< 0.0001	< 0.0001
CV:	15.4	10.2	39.3	12.7	30.2	8.3
market class	Pinto		Pinto		Pinto	
variety, year	'Palomino' (2018)		'Palomino' (2019)		'Vibrant' (2019)	
Non-treated	43 c*	2851 a*	59 b*	2888 b*	61 c*	2483 b*
fine droplets	26 a	3158 a	28 a	3933 a	43 b	3646 a
medium-fine droplets	36 bc	3063 a	29 a	4098 a	35 ab	3888 a
medium droplets	22 a	3014 a	29 a	3959 a	40 ab	3608 a
medium-coarse droplets	24 a	3349 a	28 a	3995 a	36 ab	3772 a
coarse droplets	28 ab	3562 a	31 a	4038 a	33 a	3866 a
F:	11.08	2.35	27.97	16.94	30.24	11.92
P>F:	< 0.0001	0.0615	< 0.0001	< 0.0001	< 0.0001	< 0.0001
CV:	23.4	14.8	22.3	9.7	15.1	14.2

Fungicide applications conducted in 2018: **PINTO BEANS:** Topsin (40 fl oz/ac), July 5 (bloom initiation) / Endura (8 oz/ac), July 19
BLACK, NAVY and KIDNEY BEANS: Endura (8 oz/ac), July 19 (full bloom, early pod) / Topsin (40 fl oz/ac), Aug. 1
Spray volume: 15 gal/ac Driving speed: 6.7 mph Nozzles and application pressures: XR8003, 50 psi (fine); XR8004, 40 psi (medium-fine); XR8006, 40 psi (medium); XR8008, 35 psi (medium-coarse); XR8010, 30 psi (coarse)
Fungicide applications conducted in 2019: Application A, Topsin (40 fl oz/ac), July 15 / Application B: Endura (8 oz/ac), July 27
Growth stage at first fungicide application (July 15): KIDNEY BEANS, 70-80% of plants with an open blossom, with initial pin-shaped pods in 'Pink Panther'; **NAVY BEANS**, 65-67% of plants with an open blossom; **BLACK BEANS**, 20-40% of plants with an open blossom; **PINTO BEANS**, 93-97% of plants with an open blossom, initial pin-shaped pods
Spray volume: 15 gal/ac **Driving speed:** 8.9 mph **Nozzles and application pressures:** XR11004, 50 psi (fine); XR11005, 40 psi (medium-fine); XR11006, 35 psi (medium); XR11008, 40 psi (medium-coarse); XR11010, 30 psi (coarse)

informative due to unusually high spatial variability in white mold disease pressure; plot-to-lot differences in disease pressure were greater than differences in disease control conferred by fungicide spray droplet size, precluding differentiation of treatments. Across the studies conducted with TeeJet nozzles in 2018 and with Wilger nozzles in 2019, applying fungicides with medium rather than fine droplets reduced the percent of the canopy diseased by an average of 6 percentage points and increased yield by an average of 67 lbs/ac.

Studies evaluating the impact of fungicide spray droplet size on white mold management in pinto beans were inconclusive. Applying fungicides with medium droplets optimized white mold management with Wilger nozzles (Table 1), but results from the studies conducted with TeeJet nozzles were variable across pinto bean varieties and study years (Table 2). To facilitate the development of rigorous fungicide spray droplet

Table 3. Impact of adjuvants on the efficacy of the fungicide thiophanate-methyl (Topsin) against white mold in pinto and black beans; Carrington, ND (2018 and 2019). Fungicide application details, including the nozzles and pressures utilized, driving speed, spray volume and application timing, are provided at the bottom of the table. 'Silkin' (Winfield United; River Falls, WI) is an organosilicone-based surfactant, 'Preference' (Winfield United) is a non-ionic surfactant and antifoaming agent. Within-column means followed by different letters are significantly different (P<0.05).

			PINTO BEANS			BLACK BEANS	
			'PALOMINO'		'VIBERANT'	'ECLIPSE'	'BLACKTAIL'
			Carrington	Carrington	Carrington	Carrington	Carrington
			2018	2019	2019	2019	2019
	Fungicide	**Adjuvant**	**WHITE MOLD SEVERITY: Percent of the canopy diseased**				
1	**Non-treated** control		49 c*	49 c*	64 b*	55 b*	50 b*
2	**Topsin 4.5FL** 30 fl oz/ac	No adjuvant	33 b	21 b	31 a	17 a	20 a
3	**Topsin 4.5FL** 30 fl oz/ac	**Preference** 0.25% v/v	20 a	11 a	31 a	23 a	18 a
4	**Topsin 4.5FL** 30 fl oz/ac	**Silkin** 0.25% v/v	17 a	14 ab	23 a	19 a	18 a
		CV:	17.7	21.0	27.6	30.4	28.7
	Fungicide	**Adjuvant**	**DRY BEAN YIELD: pounds/acre**				
1	**Non-treated** control		2950 b*	3251 b*	2865 b*	2749 b*	2485 b*
2	**Topsin 4.5FL** 30 fl oz/ac	No adjuvant	3670 a	4090 a	3967 a	4000 a	3207 a
3	**Topsin 4.5FL** 30 fl oz/ac	**Preference** 0.25% v/v	4008 a	4206 a	4134 a	3960 a	3308 a
4	**Topsin 4.5FL** 30 fl oz/ac	**Silkin** 0.25% v/v	4018 a	4329 a	4066 a	3839 a	3230 a
		CV:	6.3	8.0	11.5	10.0	10.3

Fungicide applications conducted in 2019:
Fungicides were applied twice: July 15, July 27. **Growth stage at first fungicide application (July 15):** BLACK BEANS, 20-40% of plants with an open blossom; PINTO BEANS, 93-97% of plants with an open blossom, initial pin-shaped pods
Spray volume: 15 gal/ac **Driving speed:** 8.9 mph **Nozzles, application pressure:** TeeJet XR11006 flat-fan nozzles at 35 psi (medium droplets)
Fungicide applications conducted in 2018:
Fungicides were applied twice: July 5, July 19. **Growth stage at first fungicide application (July 5):** 100% of plants with an open blossom, initial pods up to 2 to 3 inches long.
Spray volume: 15 gal/ac **Driving speed:** 4.4 mph **Nozzles, application pressure:** TeeJet XR11004 flat-fan nozzles at 35 psi (medium droplets)

size recommendations for pinto beans, testing conducted with pinto beans in the 2020 field season will be expanded to a third pinto variety and will be conducted with a larger number of experimental replicates.

Impact of adjuvants on efficacy of the fungicide thiophanate-methyl (Topsin and generics): The addition of the adjuvant Preference (Winfield United; River Falls, WI) at 0.25% v/v improved white mold control conferred by Topsin (30 fl oz/ac) on 'Palomino' pinto beans but not 'Vibrant' pinto beans or 'Eclipse' or 'Black Tail' black beans (Table 3). The results closely parallel testing conducted on 'Palomino' pintos in 2018 (Table 3). In field trials conducted on soybeans in 2019, a differential response to the use of adjuvants with Topsin was also seen across soybean varieties. The results suggest that the response to the use of adjuvants with Topsin might be variety-specific.

Lessons Learned: Applying fungicides with medium droplets (black beans) or medium to coarse droplets (navy and kidney beans) optimized white mold management. Fine droplets, which optimize fungicide performance against foliar diseases that develop in the upper crop canopy, lack the velocity to penetrate dense canopies and conferred sub-optimal control of white mold. Applying fungicides with excessively coarse droplets, which have the velocity to penetrate the crop canopy but result in poor fungicide coverage, was also associated with reduced white mold control and dry bean yield.

Testing was conducted with two sequential fungicide applications, and the crop canopy was much denser at the second fungicide application than the first application. For kidney and navy beans, where fungicide performance was optimized with medium to coarse spray droplets, the use of medium droplets is likely to optimize fungicide performance at early bloom and the use of coarse droplets is advised if a second application is made 7 to 14 days later and the canopy has fully closed.

Funding: This research was made possible through grants from the Northarvest Bean Growers Association and the North Dakota Crop Protection Product Harmonization Board and Registration Board.

Research Staff: NDSU CREC staff members Jesse Hafner, Billy Kraft, Eric Allmaras, Kaitlyn Thompson, Suanne Kallis and Thomas Miorini played critical roles in the execution of this research.

2019 Dry Edible Bean Disease Research Report

Principle investigators: Julie Pasche, dry bean pathologist, North Dakota State University and Sam Markell, plant pathologist, NDSU Extension

Background: As dry bean growers in the Northarvest region, you are faced with numerous challenges on a yearly basis. The pathology group at North Dakota State University (NDSU) aims to aid in combating the challenges posed by the many diseases that face the region including root rot, rust, bacterial blights and rust, among others.

The main objectives of NDSU dry bean pathology are to:

1. Monitor dry bean fields for diseases increasing in prevalence and severity
2. Evaluate pathogens for changes in virulence on the host or fungicide sensitivity
3. Work with the NDSU breeding program to identify sources of resistance to economically important diseases
4. Evaluate chemicals and other products for disease management

We believe these four objectives are critical to the immediate and long-term success of dry bean growers in the region.

Table 1. Incidence of diseases observed in North Dakota and Minnesota dry bean fields surveyed in 2019.

County	Number of fields	White Mold	Bacterial Blight (All)	CBB	BS	HB	Rust	Anthracnose
Benson	1	0	1	1	0	0	0	0
Eddy	1	1	1	1	0	0	0	0
Grand Forks	6	6	6	6	0	0	0	0
Griggs	1	1	1	1	1	0	0	0
Pembina	4	0	4	4	0	0	0	0
Steele	1	0	1	1	1	0	0	0
Traill	4	2	2	2	2	0	0	0
Walsh	4	0	4	4	0	0	0	0
Wells	7	2	7	7	3	1	0	0
Becker	1	0	1	1	1	0	0	0
Hubbard	3	3	3	3	3	0	0	0
Ottertail	3	0	3	3	0	0	0	0
Total	34	14	32	32	11	1	0	0

Survey conducted from August 21 to 29.

Monitor Fields for Diseases: Once again, the dry bean pathology group conducted a foliar disease survey across the Northarvest growing region. From August 21 to 29, 36 fields across nine North Dakota counties (Benson, Eddy, Grand Forks, Griggs, Pembina, Steele, Traill, Walsh and Wells) and three Minnesota counties (Becker, Hubbard and Ottertail) were visually evaluated for foliar disease and samples were returned to the lab for further evaluation (Table 1).

Fields included pinto (20), navy (4), black (5) and kidney (8). As is typical of our region, common bacterial blight (CBB) was observed in nearly 95% of fields evaluated. However, CBB incidence was low, not exceeding 20% in any field. As a comparison, in 2018 average CBB incidence was 57%, with the lowest incidence in a single field of 22%. In 2019, brown spot was observed in just over 30% of fields and halo blight in 3%, very similar to what was observed in 2018. This is not surprising as brown spot and halo blight are more prevalent earlier in the growing season when temperatures are cooler. White mold was observed in just over 40% of fields. Incidence did not exceed 15% across all fields where white mold was observed. No rust or anthracnose were observed in the 36 fields surveyed.

The low disease observed in 2019 is very much associated with the weather. Adverse weather conditions limited crop development and rows did not close in many areas. This allows airflow through the canopy, resulting in limited leaf wetness periods which are

required for the development of foliar diseases. It is important for growers to note that certified seed may be limited this year. While disease was low in 2019, growers need to remain vigilant about planting quality seed as even low levels of infected seed can result in disease epidemics if favorable weather conditions exist during the growing season.

Table 2. In-furrow and seed treatment fungicides applied in root rot trials conducted at Fargo and Perham in 2019.

Treatment	In-furrow fungicide	Rate	In-furrow fertilizer	Seed treatment	Rate
1	Non-treated	-	-	Cruiser Maxx	3.0 fl oz/100 lb
2	Non-treated	-	10-34-0	Cruiser Maxx	3.0 fl oz/100 lb
3	Headline	9.0 fl oz/A	-	Apron XL	0.32 fl oz/100 lb
4	Headline	9.0 fl oz/A	10-34-0	Apron XL	0.32 fl oz/100 lb
5	Proline	5.7 fl oz/A	-	Apron XL	0.32 fl oz/100 lb
6	Proline	5.7 fl oz/A	10-34-0	Apron XL	0.32 fl oz/100 lb
7	Vertisan	20.0 fl oz/A	-	Apron XL	0.32 fl oz/100 lb
8	Vertisan	20.0 fl oz/A	10-34-0	Apron XL	0.32 fl oz/100 lb

Pathogen Evaluation: In 2019, isolates of the bacterial pathogens that cause common bacterial blight, brown spot, and halo blight were collected in 14 of the 34 dry bean fields sampled in North Dakota and Minnesota, respectively, from July 11 to 24.

Two races of the halo blight pathogen have been identified. These races are both highly aggressive on most dry bean cultivars. Evaluations of the bacterium that causes CBB are ongoing. The dry bean pathology group has on ongoing effort to identify races of the pathogens that cause rust and anthracnose. These diseases were not observed during our annual disease survey; therefore, no information is available on pathogen races.

Fungicide Evaluation: Root rot is a major threat to the dry edible bean in the United States, especially in the Northarvest region. The severity of root rot caused by *Pythium, Fusarium* and *Rhizoctonia* can vary each year based on the host susceptibility,

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pathogen aggressiveness, but most importantly environmental conditions.

Field trials were conducted in 2019 in Fargo, ND (navy) and Perham, MN (dark red kidney) with locations planted on May 30 and June 3, respectively. The treatments consisted of a combination of seed treatment fungicides (Cruiser Maxx or Apron XL) along with in-furrow fertilizer (10-34-0) and in-furrow fungicides Headline (FRAC 11), Proline (FRAC 3) or Vertisan (FRAC 7) (Table 2).

This combination was evaluated to address grower questions concerning the utility of tank mixing fertilizer with fungicide. The trial located in Fargo was inoculated with *Fusarium* and *Rhizoctonia*. The trial in Perham was not inoculated as it was planted in a commercial production field with a long history of beans and root rot.

The plant population, general vigor and visible phytotoxicity were evaluated at two and four weeks after planting. Root rot disease severity of each treatment was determined by visually evaluating 10 plants per treatment. The Perham location was harvested on September 27 and the Fargo location was harvested on October 9.

We did not observe any significant differences in plant population or yield among the eight treatments at either location. Root rot disease pressure was very low in the Fargo site. The Perham trial was planted into a low-lying area, resulting in extremely high root rot pressure and drowning-out of 4 of 6 replicates by harvest time.

However, observations were made during the mixing and in-furrow application process. All fungicides exhibited flocculation when combined with the 10-34-0, indicating that the tested fungicides may be incompatible with liquid fertilizer (Fig. 1). Based on this, we strongly recommend that growers conduct a jar test prior to this sort of application. Fungicides, such as AZteroid FC (azoxystrobin), are available that have been formulated for mixing with liquid fertilizers. These may be more appropriate choices for this application.

In 2019, fungicides were tested as seed treatments, in-furrow and foliar applications for the management of many diseases on dry beans; including root rots, rust, white mold and others. We also collaborate with industry partners to test efficacy of fungicides currently available and fungicides that could potentially be available in the future. We look forward to making and improving recommendations as new products become available.

Identifying Sources of Resistance: The dry bean pathology group continues to provide support to the NDSU breeding project by working with Juan Osorno and his team to evaluate material for resistance to common bacterial blight, root rot, anthracnose and rust, along with addressing any other pertinent needs that may arise. Pathogens are selected based on our field collections and evaluations to ensure that we are targeting the specific pathogens most common or most aggressive in the region. Breeding for resistance is an integral part of disease management and our focus remains on working as a team to move forward in this area.

Figure 1. Flocculation resulting from the mixture of 10-34-0 fertilizer with fungicides evaluated in the in-furrow field trials.

Thank You: As in the past, we thank our grower partners, the Northarvest Bean Growers Association, the North Dakota Department of Agriculture and our private industry partners for support of our research. We also thank research specialists Patrick Beauzay, Dimitri Fonseka, Shalu Jain, Robin Lamppa, Scott Meyer, and Jessica Halvorson; graduate students Katie Nelson, Claire Poore, Bryan Hansen, and LeAnn Lux; and the many undergraduate students on our teams for their work on these projects. Thank you also to our collaborators including Juan Osorno, dry bean breeder, and his team Kristin Simons, Albert (Jody) Vander Wal and John Posch. We would also thank our cooperator in Perham, Mark Dombeck, for providing land for our off-station research trials.

Precision Planting of Dry Edible Beans

Principle investigator: Eric Eriksmoen, Research Agronomist, NDSU North Central Research Extension Center, Minot, ND.

Introduction: Seeding equipment utilizing seed singulation technologies is very expensive but has been proven to enhance corn production by eliminating yield limiting skips and doubles. In other crops like canola, seed singulation technologies have lowered seeding rates by as much as 50%, while maintaining yields. For crops with high seed costs, this savings can be substantial. We now also recognize plant sensory systems as they relate to a plants tolerance to its neighbors and a plant's need for its own growing space. Row spacing and plant population are directly related to this interaction.

Dry beans are known to have some ability to branch and fill their growing space, and therefore may be an ideal crop for precision planting. A key question to precision seeding technology in dry bean is whether there is a true economic advantage over conventional seeding equipment. This study was initiated during the 2018 growing season and included pinto, navy, black and dark red kidney bean market classes. The 2018 trial sustained severe drought which adversely affected growing conditions and resulted in relatively poor yields. The 2019 trial used the same experimental design but reduced the market classes to just pinto and dark red kidney types.

Approach: The main objective of this replicated small plot research trial was to compare precision seeding vs. conventional seeding equipment. The 2018 trial consisted of "ND Palomino" pinto, "Avalanche" navy, "Eclipse" black and "Montcalm" dark red kidney bean, and the 2019 trial consisted of "ND Palomino" pinto and "Montcalm" dark red kidney beans. Beans were planted into 15 inch and 30 inch row spacing

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and these row spacing were planted in combination with three seeding rates: 50,000, 70,000 and 90,000 pure live seeds per acre for pinto and kidney beans, and 90,000, 110,000 and 120,000 pure live seeds per acre for navy and black beans, respectively.

The trials were planted at the NDSU North Central Research Extension Center at Minot, North Dakota using a split block experimental design with three replications. Precision planted plots were planted with a 4 row SRES Classic Air Flex small plot planter using a Monosem seed singulation metering system and Great Plains double disc openers. The conventional planted plots were planted with a custom-built small plot cone seeder using John Deere MaxEmerge row units. The trials were planted on June 4, 2018 and June 5, 2019 into a minimally tilled Williams loam soil that was spring wheat the previous year. Soil fertility levels were adequate for a 3000-pound crop.

All seed was treated with the appropriate strain of Rhizobia inoculant. Weeds were controlled with a preplant application of sulfentrazone & carfentrazone (Spartan Charge) + glyphosate and a post-emergence application of bentazon & imazamox (Varisto) in 2018 and imazamox (Raptor) in 2019. The trials were treated with a pre-harvest application of paraquat + flumioxazin (Valor). Fungicides were not applied. Individual plots were 5 feet wide by 25 feet long and trimmed to 19 feet long for harvest. Plots were direct harvested on September 18, 2018 and September 25, 2019 with a Kincaid small plot combine.

Results and Discussion: Detecting positive and negative outcomes, understanding those outcomes and making realistic management decisions is the ultimate goal of this project. The 2018 trial sustained a severe season long drought, with total growing season precipitation of 5.57 inches. This drought obviously affected overall plant growth and seed production and therefore results from each year are shown separately.

Data was tabulated on days to seedling emergence, established plant stand, maturity date, plant height at harvest, lodging, 100 seed weight, test weight and seed yield. Days to seedling emergence was seven days after planting for all plots in 2018 (data not shown) and there was no observed lodging in either year (data not shown). Tables 1 and 2 compare overall means for planter type. Subsequent tables are broken down by market class and year.

The only statistically significant difference between planters in the 2018 trial was for 100 seed weight in which the conventional planted beans producing slightly heavier seed. This was not observed in the 2019 trial. The only statistically significant difference between planters in the 2019 trial was for a one-day difference in seedling emergence and a one-inch difference in plant height. This may be due to slight differences in planting depth, but in general these differences have little overall effect on the practical outcome of the trial.

PINTO BEAN (2018 AND 2019)

Statistical differences between planters was observed for maturity and seed weight in the 2018 trial (Table 3), with the conventional planted beans maturing a couple

Table 1. Overall combined mean comparisons between planters, 2018.

Planter	Plant Stand plants/A	Maturity Date	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
Conventional	68,190	24	12	23.7	60.0	540
Precision	72,761	24	12	22.3	59.7	460
LSD 0.05	NS	NS	NS	*	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 2. Combined mean comparisons between planters, 2019.

Planter	Days to Emerge days	Plant Stand plants/A	Maturity Date Sept	Plant Height inches	100 Seed Wt. grams	Test Wt. lbs/bu	Yield lbs/A
Conventional	13	62,113	18	12	42	58.8	1239
Precision	12	62,597	19	11	42	58.9	1147
LSD 0.05	*	NS	NS	*	NS	NS	NS

NS = no statistical difference between planters. *Statistically different

of days later and producing heavier seed than pinto beans planted with the precision planter. Crop maturity and seed weight typically have an inverse relationship with plant stand. When plant populations decrease, maturity and seed weight tend to increase. The 2019 trial (Table 4) did not show any statistical differences between planters except for a one-day difference for seedling emergence.

Tables 5 and 6 show combined means for row spacing from the 2018 and 2019 trials, respectively. Results from both trials were similar with narrow rows producing more established plants and lower test weights. These are common observations where wider rows produce more plant-to-plant competition within the row which tends to reduce the overall established plant stand and seed size. Smaller seeds tend to produce a heavier test weight.

Tables 7 and 8 show combined means for seeding rates from the 2018 and 2019 trials, respectively. Results from both trials showed no statistical differences for seeding rates in agronomic, seed quality or seed yields. For every incremental increase in seeding rate, there was an incremental decrease in the number of plants that survived and contributed to yield.

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Table 3. Combined mean comparisons between planters for pinto beans, 2018.

Planter	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
Conventional	50,551	24	13	28.3	58.3	540
Precision	58,295	22	12	26.8	58.3	450
LSD 0.05	NS	*	NS	*	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 4. Combined mean comparisons between planters for pinto beans, 2019.

Planter	Days to Emerge days	Plant Stand plants/A	Maturity Date Sept	Plant Height inches	100 Seed Wt. grams	Test Wt. lbs/bu	Yield lbs/A
Conventional	12	54,853	18	12	36.4	59.6	1394
Precision	11	62,275	18	11	36.8	59.5	1264
LSD 0.05	*	NS	NS	NS	NS	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 5. Combined means for pinto bean row spacing, 2018.

Row Spacing	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
15″	60,446	24	12	27.6	57.9	527
30″	48,400	23	13	27.5	58.7	462
LSD 0.05	*	NS	NS	NS	*	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 6. Combined means for pinto bean row spacing, 2019.

Row Spacing	Days to Emerge days	Plant Stand plants/A	Maturity Date Sept	Plant Height inches	100 Seed Wt. grams	Test Wt. lbs/bu	Yield lbs/A
15″	17	61,307	16	12	36.9	59.2	1369
30″	17	55,821	15	11	36.3	59.9	1288
LSD 0.05	NS	NS	NS	NS	NS	*	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 7. Combined means for pinto bean seeding rates, 2018.

Row Spacing	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
50,000	48,400	24	12	28.0	58.3	458
70,000	52,595	23	13	27.2	58.3	482
90,000	62,275	24	13	27.5	58.2	545
LSD 0.05	7,734	NS	NS	NS	NS	NS

NS = no statistical difference between seeding rates.

DARK RED KIDNEY BEAN (2018 AND 2019)

Statistical differences between planters were observed for maturity, seed weight and yield with the 2018 trial (Table 9). Although statistical differences between planters were detected for maturity, it appears that row spacing probably had a greater influence on this agronomic characteristic. Differences between planters for seed weight were similar to those for pinto bean. Yield differences were not a result of planter, row spacing or seeding rate interactions, but may be attributed to harvest losses during combining. There were no statistical differences for seed quality or seed yield in the 2019 trial (table 10). There were small but statistically significant differences between planters for seedling emergence and maturity. Differences for seedling emergence may be attributed to slight differences in planting depth between planters. Differences between maturities is typically related to plant populations, with thinner stands having longer maturities.

2018 and 2019 trial results of kidney bean row spacing are shown in tables 11 and 12, respectively. Plant maturities were indirectly influenced by row spacing in 2018 but not in the 2019 trial. Plant population tends to influence plant maturity to a higher degree which explains this agronomic difference. Similar to the 2019 pinto beans, 2019 kidney bean test weights were also influenced by row spacing.

Table 13 shows the 2018 seeding rate results for kidney beans. Differences were observed for yield with the 70,000-seeding rate yielding statistically more than the 50,000 rate, however, all yields were pathetically low. 2019 seeding rate results are shown in table 14. Even though established plant stands were

Table 8. Combined means for pinto bean seeding rates, 2019.

Seeding Rate	Days to Emerge days	Plant Stand plants/A	Maturity Date Sept	Plant Height inches	100 Seed Wt. grams	Test Wt. lbs/bu	Yield lbs/A
50,000	17	49,852	16	12	37.1	59.6	1242
70,000	17	60,500	16	12	36.6	59.7	1341
90,000	17	65,340	15	11	36.0	59.3	1352
LSD 0.05	NS	12,597	NS	NS	NS	NS	NS

NS = no statistical difference between seeding rates.

Table 9. Combined mean comparisons between planters for dark red kidney beans, 2018.

Planter	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
Conventional	51,949	26	12	38.4	55.7	446
Precision	55,606	28	12	35.5	55.5	297
LSD 0.05	NS	*	NS	*	NS	*

NS = no statistical difference between planters. *Statistically different.

Table 10. Combined mean comparisons between planters for dark red kidney beans, 2019.

Planter	Days to Emerge days	Plant Stand plants/A	Maturity Date Sept	Plant Height inches	100 Seed Wt. grams	Test Wt. lbs/bu	Yield lbs/A
Conventional	13	69,373	21	12	48	58.0	1084
Precision	12	62,920	22	11	48	58.2	1031
LSD 0.05	*	NS	*	NS	NS	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 11. Combined means for kidney bean row spacing, 2018.

Row Spacing	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
15"	64,103	28	12	37.4	55.3	365
30"	43,352	26	12	36.6	55.9	377
LSD 0.05	*	*	NS	NS	NS	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 12. Combined means for kidney bean row spacing, 2019.

Row Spacing	Days to Emerge days	Plant Stand plants/A	Maturity Date Sept	Plant Height inches	100 Seed Wt. grams	Test Wt. lbs/bu	Yield lbs/A
15"	12	60,661	21	11	47.9	57.8	1071
30"	12	58,080	21	11	48.1	58.5	1044
LSD 0.05	NS	NS	NS	NS	NS	*	NS

NS = no statistical difference between row spacing. *Statistically different.

significantly higher for the 90,000-seeding rate, this did not translate into higher yields. Agronomic, seed quality and seed yields were all statistically similar to each other, regardless of seeding rate.

NAVY BEAN (2018)

Small but statistically significant differences between planters were observed for seed weight and test weight (Table 15) with the conventional planter producing heavier seed and heavier test weight. Statistical analysis indicated that this difference was produced by an interaction between planter and row spacing (data not shown). Interactions between planter, row spacing and seeding rates did not account for the differences between planters for test weight.

Table 16 shows results of row spacing. The magnitude of established plants between row spacing was quite remarkable with 15-inch rows producing 41% more established plants than 30" rows. This difference, however, did not significantly affect agronomic characteristics, seed quality or yield.

Table 17 shows results of seeding rates. Statistically significant differences were detected for yield. The 120,000-seeding rate produced a higher yield than the 110,000 rate, but had a similar yield to the 90,000 rate. This is probably related to adverse growing conditions and/or losses during harvest.

BLACK BEAN (2018)

Like pinto and kidney bean, the precision planter produced more established black bean plants than the conventional planter (Table 18), however, more plants did not translate into higher yields in this low yielding environment.

Table 19 shows results of row spacing. Like the oth-

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Table 13. Combined means for kidney bean seeding rates, 2018.

Seeding Rate	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
50,000	42,592	28	12	37.3	55.9	321
70,000	59,048	26	12	37.1	55.3	401
90,000	59,693	26	12	36.5	55.5	393
LSD 0.05	6,874	NS	NS	NS	NS	76

NS = no statistical difference between seeding rates.

Table 14. Combined means for kidney bean seeding rates, 2019.

Seeding Rate	Days to Emerge days	Plant Stand plants/A	Maturity Date Sept	Plant Height inches	100 Seed Wt. grams	Test Wt. lbs/bu	Yield lbs/A
50,000	12	52,756	21	11	48.2	58.0	985
70,000	12	54,692	22	11	48.2	58.0	1086
90,000	12	70,664	21	12	47.6	58.3	1101
LSD 0.05	NS	14,880	NS	NS	NS	NS	NS

NS = no statistical difference between seeding rates.

Table 15. Combined mean comparisons between planters for navy beans, 2018.

Planter	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
Conventional	79,268	25	12	14.1	63.9	598
Precision	76,580	23	12	13.3	63.3	532
LSD 0.05	NS	NS	NS	*	*	NS

NS = no statistical difference between planters. *Statistically different.

Table 16. Combined means for navy bean row spacing, 2018.

Row Spacing	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
15"	91,207	24	12	13.6	63.7	599
30"	64,641	23	12	13.9	63.4	531
LSD 0.05	*	NS	NS	NS	NS	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 17. Combined means for navy bean seeding rates, 2018.

Seeding Rate	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
90,000	72,116	25	12	13.8	63.5	594
110,000	80,344	23	12	13.5	63.4	479
120,000	81,312	24	12	13.9	63.8	622
LSD 0.05	7,888	NS	NS	NS	NS	106

NS = no statistical difference between seeding rates.

er market classes, 15-inch row spacing significantly increased plant establishment, however, as stated above, more plants did not translate into significantly higher yields.

As would be expected, there was a trend for increasing plant stands with increasing seeding rates (Table 20). This positive trend, however, did not enhance agronomic characteristics, seed quality or yield.

Conclusions: As previously stated, concrete management decisions based on results derived from adverse growing conditions should be avoided. General observations from this study indicate:

1. The precision planter typically produced a more uniform and higher established plant stand but this did not translate into higher yields or better seed quality.
2. Narrow rows tended to produce more established plants than wider rows, but again, these increased plant populations did not significantly enhance seed production, and
3. Higher seeding rates tended to produce higher plant stands, but these increased stands also did not significantly enhance seed production.

A benefit of higher seeding rates and narrow rows is enhanced crop competition with weeds. This is especially important in no-till or reduced tillage systems. In conventional tillage systems, wider rows allow for in-season cultivation for weed control and lower seeding rates reduces seed costs. From these trials and observations, it would be difficult to justify the additional cost of precision equipment for the sole purpose of dry bean production. A well maintained and properly calibrated conventional planter should provide the same production performance to precision planting equipment.

Acknowledgements: A huge thank you to Northarvest Bean Growers Association for their direction and financial support of this project.

Table 18. Combined mean comparisons between planters for black beans, 2018.

Planter	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
Conventional	90,992	22	10	14.1	62.1	575
Precision	100,564	22	10	13.5	61.7	561
LSD 0.05	*	NS	NS	NS	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 19. Combined means for black bean row spacing, 2018.

Row Spacing	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
15"	114,869	23	10	13.8	62.2	606
30"	76,687	21	10	13.7	61.7	531
LSD 0.05	*	NS	NS	NS	NS	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 20. Combined means for black bean seeding rates, 2018.

Seeding Rate	Plant Stand plants/A	Maturity Date Aug	Plant Height inches	100 Seed Weight grams	Test Weight lbs/bu	Yield lbs/A
90,000	87,443	22	10	13.8	61.8	502
110,000	99,059	22	11	13.8	62.2	626
120,000	100,833	22	10	13.7	61.8	577
LSD 0.05	8,578	NS	NS	NS	NS	NS

[a]DAP=Days after Planting NS = no statistical difference between seeding rates.

What's Happening at the SHARE Farm -- Logan Center

Principle investigator: Abbey Wick, soil health specialist and associate professor, NDSU Extension

The Soil Health and Agriculture Research Extension (SHARE) Farm concept has proven to be a successful approach for conducting field-scale, on-farm, farmer-driven, long-term research and is unique to North Dakota. We now have two SHARE Farms, one in Mooreton, ND (est. 2013) and a second location in Logan Center (est. 2019). Funding from Northarvest Dry Bean Association along with ND Wheat Commission, ND Corn Council and ND Soybean Council combined with a cooperating farmer, Sam Landman, make this type of project possible and successful.

The objectives of the SHARE Farm – Logan Center are to develop and evaluate soil health building management approaches (reduced tillage, cover crops, salinity management) in a pinto bean-corn-soybean-wheat rotation, alongside an effective Extension program to share information across the region. Research conducted on-site is related to:

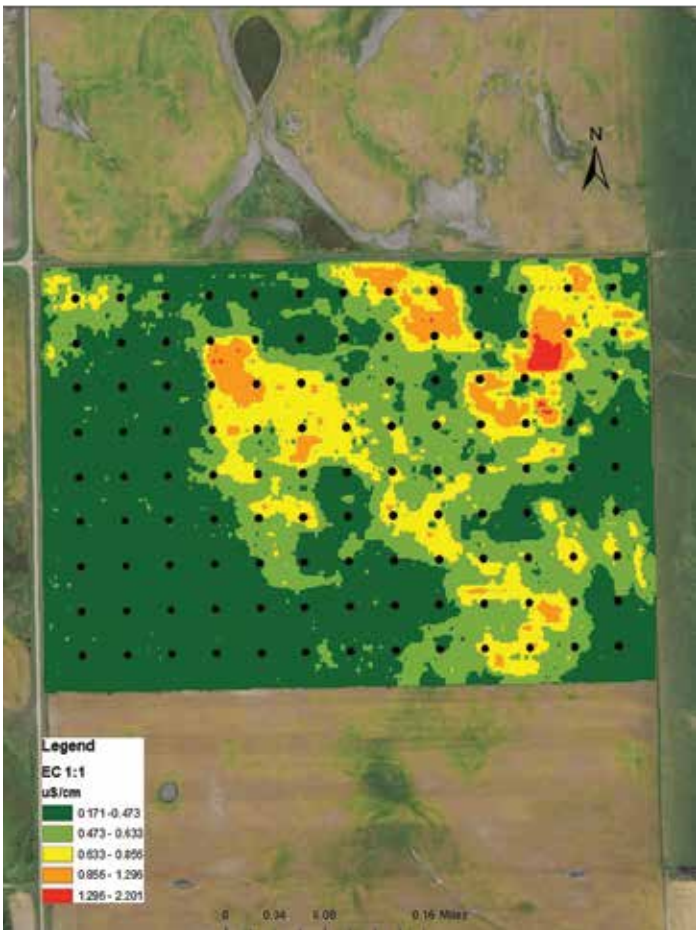

Figure 1. Veris map to indicate soil salinity and soil sampling points (black circles) across the SHARE Farm.

1. Soil moisture and temperature in reduced till systems
2. Soil health assessment and enhancement
3. Cover crop establishment and impact on soil health in all phases of the rotation
4. Crop health and performance
5. Stacking of multiple tools for salinity management.

Extension program development includes field days, Café Talks, DIRT Workshop and the Soil Sense podcast – pretty much whatever avenues farmers want for getting information. Here's what we accomplished in the first year:

Research: The field was planted to pinto beans on wheat stubble in 2019. Three tillage strips were installed across the field with a high-speed disk in the spring of 2019 prior to planting. In the future, the high-speed disk strips will be managed with a fall chisel plow and spring field cultivator passes to be more representative of management in the area.

Site Setup: A soil series map was created in the spring with NRCS MLRA Leader, Keith Anderson. This helped us identify different topsoil depths across the field, presence of salts etc. A North Dakota Agricultural Weather Network (NDAWN) station was installed in the northwest corner and was linked to the NDAWN network for weather data to accompany research data by Daryl Ritchison, director, and crew. A Veris map for salinity and baseline soils were collected across the field (Figure 1) and analyzed for salts and fertility.

Tillage Practice Evaluation: In the spring of 2020, soil moisture and temperature sensors will be installed to measure conditions throughout the growing season by Aaron Daigh, North Dakota State University (NDSU) Assistant Professor of Soil Physics. Hundreds of thousands of data points will be collected by these sensors and used to mod-

Continued on Page 28

Figure 2. Direct seeding pinto beans into wheat stubble with a radish biostrip-till in 2019.

el soil conditions relative to crop establishment under both the tillage and no-till/cover crop treatments.

Baseline sampling and analysis for soil health parameters in the tillage treatment strips and no-till/cover crop locations was completed by Caley Gasch, NDSU Assistant Professor of Soil Health. With the samples being baseline, there's not much to really look at with them yet. Once we get a couple years under our belt with this site, we'll sample again and look for changes in soil properties like aggregation and available organic matter.

Earthworm assessment was completed on-site with grab samples and species identification by Rod Utter, NDSU research technician. He found *Aporrectodea tuberculata, Aporrectodea caliginosa* and *Octolasion sp.* species throughout the field. *Aporrectodea* are one of the most common earthworms found in North Dakota – they move laterally in the top two feet of soil.

Dave Franzen, NDSU Extension soil specialist and professor, also used this location for his free-living nitrogen fixing bacteria study (funded by ND Corn Council 2019-2021). He's sampling for this because there are indications they may be more prevalent in no-till soils and could help with nitrogen availability for crop use. He sampled throughout the growing season of several fields recently converted to no-till including both SHARE Farm sites, along with fields in Lakota and New Rockford, ND.

Agronomic: Pinto beans were directly seeded into wheat stubble and into the high-speed disk strips on June May 29, 2019. Pinto bean stand density, plant development and yield were measured as well by Greg Endres, NDSU agronomist and Marisol Berti, NDSU Professor for Forage and Cover Crops (Table 1). Cover Crops (70 lbs/ac oats) were flown on into pinto beans before leaf drop. Establishment and biomass were recorded by Wick. Due to a late harvest and early winter, there was negligible establishment of the cover crop. Weed type, establishment and biomass were also recorded along with disease pressures.

Extension: Extension programming was led by Wick, Naeem Kalwar (NDSU Langdon REC), Mike Ostlie, Greg Endres, Mary Keena (NDSU Carrington REC) in partnership with numerous county Extension agents.

Video: We posted a video from the SHARE Farm – Logan Center on the NDSU Soil Health website (ndsu.edu/soilhealth). This provides a nice summary of the project and some aerial photos of the field.

DIRT Workshop: Wick hosted the first annual Dakota Innovation Research and Technol-

DAKOTA INNOVATION, RESEARCH AND TECHNOLOGY WORKSHOP

DIRT

Figure 3. DIRT Workshop crowd in Fargo, ND

Table 1. SHARE Farm - Logan Center Pinto Bean population, plant height, residue, canopy closure and seed in 2019 (statistical differences not shown).

Tillage	Plant Population plants/A			Plant Height inches	Plant residue (% Ground Cover)	Canopy closure (%)		Yield	Seed Moist	TW
	13-Jun	23-Jun	23-Jul	23-Jul	23-Jun	Visual 26-Jul	Canopeo 26-Jul	lb/A	%	lb/bu
HS Disk	43,670	57,240	52,220	19.1	33	58	64	2903	8.4	61.2
Direct Seed	53,990	75,830	71,700	17.8	97	62	66	2786	8.5	61.4

ogy (DIRT) Workshop in December 2019. With around 250 people in attendance, this was a primary method for sharing information from projects. One format used during the DIRT Workshop were Café Talk style discussion groups. Attendees spread out into groups of 15-20 people to attend 15 different topics offered in small discussions at any given time. The 2020 dates are set for December 7-9 in Fargo (DIRTworkshopND.com).

Café Talk Program: 23 Café Talks in total (in past, the number of Café Talks averaged 12 per year) was developed for 2020. Most

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Figure 4. Farmer evaluation respondent adoption of cover crop management practices.

Farmers 2019

Cover Crops Practices Farmers

Farmer respondents show much more progress in cover crops practices. This likely reflects the amount of effort the Café Talks and other NDSU Extension programs have put into this topic in recent years. The **greatest impacts** among respondents include **using cereal rye as a cover crop (26% adoption)** and **establishing a cover crop after harvest of a cash crop (20% adoption)**. The greatest potential for future adoption include establishing a cover crop in standing soybean and using a multi-species cover crop mix (51% considering adoption).

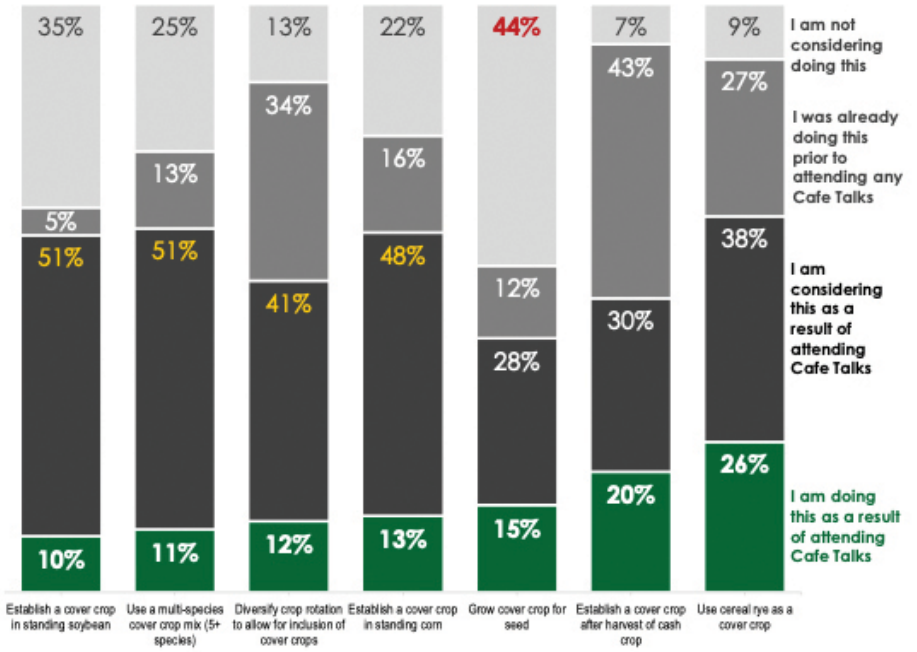
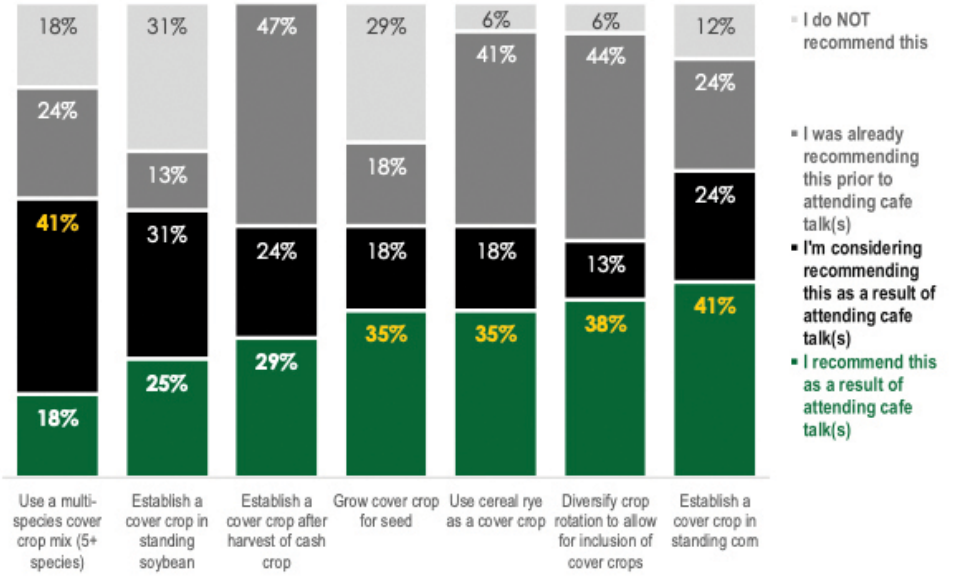


Figure 5. Consultant evaluation respondent adoption of cover crop management practices.

Consultants 2019

Cover Crops Practices Consultants

Like with tillage practices, we see higher numbers of consultant recommendations as a result of attending Café Talks. The highest recommendation adoption rate is for **establishing a cover crop in standing corn (41%)**. Using a multi-species cover crop mix holds the greatest promise for adoption in the future.



of these Café Talks were held in the northeast corner of the state. An evaluation after six years of Café Talks was completed in 2019 to guide the approaches used and topics that may be discussed.

Adoption and recommendation of cover crops practices from the evaluation of Café Talk attendees from 2013 to 2019 are below in Figures 4 and 5. Results are separated by "farmer respondents" and "consultant respondents", as indicated in the top right hand corner of each figure. This is important because consultant respondents advise on more than double the acres as farmer respondents (327,000 vs. 157,298 acres) and only represent 13% of the total respondents – meaning less people influencing management of more acres. Seeing interest in both groups is necessary for moving soil health efforts forward.

WHAT TO WATCH FOR IN 2020

We don't know what 2020-2021 will bring, but we hope to host a field tour on-site where we talk about interseeding cover crops into corn, cover crop seeding timing and selection and salinity management. We have an additional partner on board now, the North Dakota Barley Council, that will be funding research on fertility and cover crops in the neighboring field.

Figure 6. Locations of Soil Sense podcast plays for the United States.

The Café Talk program will continue to be hosted through the NDSU REC's and County Extension Agents – with a new lineup determined in November 2020. We will also host the DIRT Workshop December 7-9 in Fargo and will include information from the SHARE Farm projects on the program.

In addition, we have had great success with the Soil Sense Podcast. The first series was released August 1, 2019 and we are recording our second series to be released March 2, 2020. Episodes are available at NDsoilsense.com – including an episode with Sam Landman (episode 5). With over 13,000 plays, we feel this is a valuable way to share information. Locations of plays for US are shown in Figure 6. The podcast has been well received and played across the world.

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

Principal Investigators: Greg Endres, cropping systems specialist, and Mike Ostlie, agronomist, NDSU Carrington Research Extension Center

Background: Field studies were continued with pinto bean by North Dakota State University (NDSU) in 2019 to examine response to selected fertilizer treatments; winter rye as a cover crop; and response to row spacing and plant populations.

Fertilizer Treatments

The Carrington Research Extension Center (CREC) has been conducting research since 2009 to examine pinto bean performance primarily with starter phosphorus fertilizer and application methods. Results have been published in the NDSU Extension circular A1883 'Pinto bean response to phosphorus starter fertilizer in east-central ND'.

The 2019 trial was conducted at the CREC to examine pinto bean response with selected zinc (Zn), sulfur (S) and specialty starter, and post-applied fertilizer treatments. The dryland trial was established on a conventional-tilled loam soil with 3.8% organic matter, 7.3 pH, 7 ppm (low) P, and 0.20 ppm (low) Zn. 'ND Palomino' was planted in 22-inch rows on May 31. Starter fertilizer was in-furrow (IF) applied at planting. Foliar fertilizer treatments were applied on July 22 at the R3-5 bean growth stages.

Fertilizer treatments included:

- IF 10-34-0 and chelated Zn; preplant incorporated granular Zn plus S followed by IF 10-34-0 (fertilizer checks)
- IF 10-34-0 plus Zn
- IF 10-34-0 followed by foliar Zn and S
- Specialty fertilizer products: IF RizeR plus Accomplish LM (Loveland) and Redline (West Central); and foliar MAXIN Ultra ZMB + Ascend (Winfield).

Trial reports are available at the website: www.ag.ndsu.edu/CarringtonREC/agronomy/crop-index/dry-bean/fertility. Multi-year results are showing limited yield response to Zn, S and specialty fertilizers. The research will continue in 2020 to build substantial databases of these fertilizer treatments for reference by farmers and crop advisers.

Winter Rye as a Cover/Companion Crop: A study was initiated at the CREC during fall 2016 with winter (cereal) rye establishment for dry bean production in 2017, and continues to explore the performance of pinto bean with winter (cereal) rye. Expected advantages with winter rye, established ahead of pinto bean and timely termination, include reduction in soil erosion, supplement for managing weeds, manage excess soil moisture, and efficiency with direct harvest of bean seed.

Seeding pinto bean plants in terminated rye.

To establish the 2019 trial, 'ND Dylan' rye was direct-seeded into barley residue at 60 lb/A in 7-inch rows on September 18, 2018. Rye was terminated by tillage on October 1 followed by preplant (PP) glyphosate on May 2 and pre-emergence (PRE) glyphosate plus Spartan Elite on June 5 to establish a conventional check (treatment 1). Rye was terminated by PP glyphosate on May 2 (trt 2); May 14 (trt 4); or May 29 (trt 5). Rye also was terminated by PP glyphosate on May 2 followed by PRE glyphosate plus Spartan Elite on June 5 (trt 3). Rye also was terminated by PRE glyphosate on June 10 (trt 6). 'ND Palomino' pinto bean was direct planted into rye residue (except tilled plots) or living rye in 21-inch rows on June 3, 2019. Selected post-emergence herbicides were

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applied across the trial for general weed control.

Delaying rye termination until near or after pinto bean planting (trts 5 and 6) extended bean plant development (emergence, flowering, and maturity) 8-14 days compared to the conventional production check and earlier rye termination treatments. Plant stand was similar among treatments though there was a trend for the conventional check having the highest plant density. Plant stand across treatments averaged 62,300 plants/acre, which was 67% of the 93,300 pure live seeds/A planting rate. Bean canopy closure also was reduced with the delay in rye termination until near or after bean planting. Bean yield was similar among treatments (2805-3385 lb/A), though there was a trend for reduced yield with delayed rye termination near or after bean planting.

In summary, lack of adequate spring rainfall and stored soil moisture during pinto bean plant establishment and delay in rye termination until near or after bean planting negatively impacted bean plant development and canopy closure but statistically not seed yield. The delay in rye termination provided the benefits of additional ground cover and a substitute for PRE herbicide for weed control.

The study continues in 2020.

Row Spacing and Planting Rate: A multi-year study with black and navy beans was conducted by NDSU during 2014-2018 to explore if higher plant populations (greater than current recommendation of 90,000 plants/A) plus narrow row spacing will increase seed yield. Results have been published in the NDSU Extension circular A1921 'Black and navy bean response to row spacing and plant population in eastern ND'.

- Black bean seed yield was similar among three row spacings (14-, 21- and 28-inches). The high plant population (slightly more than 140,000 plants per acre) increased yield 3% compared to the low population (slightly less than 100,000 plants per acre).
- Narrow (14-inch) rows with navy bean plant populations of greater than 115,000 plants per acre increased yield 24% to 28% compared to wide rows with slightly more than 90,000 plants per acre.

In 2018 at the CREC, a study was initiated to examine pinto bean response among 21- vs. 28-inch rows and targeted stands of 50,000, 70,000, and 90,000 plants/A. Averaged over two years (2018-19), seed yield with 'ND Palomino' increased with narrow (2460 lb/A) vs. wide (2100 lb/A) rows. Two-year plant stand averages were 51,600, 71,300 and 86,500 plants/A and yield was 2300, 2395 and 2465 lb/A, respectively.

The study will continue in 2020 at the Carrington and Langdon Research Extension Centers.

Dry Bean Improvements for the Northern Plains

Principal Investigators: Juan M. Osorno, Dry Bean Breeder, North Dakota State University. Research Specialists: A. Jody Vander Wal John Posch; research assistant Kristin Simons; and graduate students Edgar Escobar and Eddy Ixcotoyac

Objectives: The objective of the dry bean breeding program at North Dakota State University (NDSU) is to develop high yielding, high quality dry bean cultivars adapted to the Northern Plains. This involves many characteristics of dry beans and different disciplines of research (e.g. genetics/breeding, pathology, physiology, soils, nutrition, etc.).

The main priority is to improve pinto, navy, black, and kidney market classes, along with Great Northern, red and pink beans. 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/tolerance to both biotic and abiotic stresses such as: white mold, rust, root rots, anthracnose, virus, bacterial blights, flooding, and nutrient deficiencies.

2019 Growing Season: Across all eight locations, the beginning of the growing season started with normal conditions during the months of May and June. Herbicide injury at a nursery near Johnstown, ND caused the loss of 70% of the trials. During flowering and pod filling stages, the most common disease observed common bacterial blight and white mold, while rust was detected at Hatton, ND at the end of the growing season.

Root rot pressure at our nurseries in Minnesota allowed the identification of superior kidney genotypes, especially in the case of resistance to *Fusarium solani*. Heavy rainfall and even snowfall during harvest made difficult to timely collect the seed yield data and seed samples from our field trials. Therefore, during the 2019 harvest season, 50% of the field trials and nurseries could not be harvested because of weather issues.

Except for kidney beans in Minnesota, no selections were made for any of the remaining market classes and therefore, the same breeding material grown in 2019 will be repeated in 2020. Consequently, this will set back the program 1-2 years.

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North Dakota Dry Edible Bean Variety Trials

The Northarvest Bean Growers Association funds dry edible bean variety trials at the NDSU Research Extension Centers in Minot, Williston, Langdon, Carrington, Oakes and Hettinger.

This work provides unbiased, science-based variety comparisons for pinto, navy, black and miscellaneous bean classes. Each trial consists of approximately 20 varieties, including experimental lines selected by NDSU dry bean breeder Juan Osorno. The trials utilize conventional tillage at Langdon and Carrington, no-till at Minot and Hettinger and irrigated conventional tillage at Oakes and Williston.

The North Dakota Dry Edible Bean Variety Trial information is available online at www.ag.ndsu.edu/varietytrials/dry-bean.

On average, it is normal for the breeding program to lose either part or an entire location each year, but this is the biggest loss in the history of the program since its beginning in 1980.

2019 Research Activities: The Dry Bean Variety Trials eight locations in North Dakota (including several Research Extension Centers) and two in Minnesota include 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. On average, every year the NDSU dry bean breeding program grows field trials and nurseries accounting for ~9,000 plots across all eight locations that when combined are equivalent to ~40 acres. Consequently, this is the largest public dry bean breeding program in the USA.

Variety testing is made in collaboration with the NDSU Research and Extension Centers across the state. Results of these variety trials can be found in the NDSU Extension publication A-654. In addition, the aid of winter nurseries that were made at Puerto Rico (~1800 rows each year) and New Zealand (~300 rows plus breeder seed increases) help to speed up the breeding process, especially at the early generations.

Breeding activities mainly involved crosses in the greenhouse, selection at early generations, yield testing of preliminary and advanced breeding lines, marker-assisted selection for specific disease-resistance genes, and some genetic/agronomic studies. Breeding targets include high seed yield and quality, disease resistance, early maturity, upright plant architecture for efficient mechanical harvest, and canning quality.

Greenhouse activities complement the field work by doing disease screening (bean rust, common bacterial blight, BCMV, anthracnose, and white mold), crossings, and seed increases. Inoculum for disease screening is provided by Dr. Julie Pasche in the plant pathology department. Each year, the crossing block in the greenhouse facilities

involves approximately 250 new parental combinations.

The results and new findings are 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.

Additional research conducted by graduate students and postdoctoral scientists focuses on seed coat slow darkening, upright plant architecture, nutritional traits, multiple disease resistance (common bacterial blight, anthracnose, rust, white mold, and bean common mosaic virus), as well as genetic resistance to root rots in large-seeded types (for kidney).

New potential sources of resistance have been identified for waterlogging tolerance, slow darkening, 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. Berlin Nelson) on genetic resistance to soybean cyst nematode. In collaboration with Dr. Phil McClean, studies are focused on the use/application 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.

2019 MILESTONES

- Three new varieties were released in early 2019 from the NDSU dry bean breeding program that combine superior agronomic performance and disease/pest resistance in some cases: ND Falcon pinto, ND Pegasus great northern, and ND Whitetail white kidney. In addition to either competitive or superior seed yields, these varieties also offer interesting disease resistance packages such as rust (ND Falcon), white mold (ND Pegasus and ND Whitetail), soybean cyst nematode (ND Falcon), bacterial blights (ND Whitetail), and root rots (ND Whitetail). These are all important traits included in the current list of "areas of interest" developed by Northarvest Bean Growers Association.
- The future markets for slow-darkening pintos is still not 100% clear. However, the feedback about ND-Palomino obtained from growers and industry has been very positive regarding the agronomic performance and seed quality. Results from breeding and variety trials across more than 50 locations continue showing that seed yield of ND-Palomino is competitive with current regular darkening pintos. Now the growers as well as the rest of the food chain will have a product of superior quality, which may reduce the amount of economic losses due to poor seed quality. We are seeing a renewed interest in slow darkening pintos for the 2020 growing season because of the difficult harvest conditions experienced during the 2019 harvest. This is reflected in new seed orders of Foundation seed of ND-Palomino.
- New research has shown that slow darkening pintos offer four times more iron absorption compared with regular pintos in spite of having similar iron seed content. It is one of the highest levels of iron bioavailability

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found in beans, only comparable to yellow beans. The absence of specific polyphenolic compounds in slow darkening pintos that inhibit iron absorption may be the reason for these drastic differences. This would potentially open new marketing opportunities (added value) for slow darkening pintos, especially in developing countries where mineral malnutrition is an issue.

- Talon dark red kidney and Rosie light red kidney continue to show either competitive or 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 2018 field trials keep confirming the superior performance of these two kidney varieties that are having significant economic impact in the region.
- With approximately 92% of the total acreage planted with black beans, Eclipse is the most important cultivar used in the region for black bean production. However, Eclipse was released in 2005 and therefore, intensive efforts were underway to find a good replacement for Eclipse. This task has been quite challenging given Eclipse's excellent agronomic performance and seed quality. Nonetheless, a new black bean variety named ND Twilight was released in early 2020.
- The most important meeting for bean scientists, Bean Improvement Cooperative, was held in Fargo in November and allowed us to showcase the NDSU dry bean breeding program to the world. Approximately 140 attendants from 15 countries attended this event.
- New potential sources of resistance/tolerance to both biotic and abiotic stress are identified each year by intensive evaluation and phenotyping/genotyping of germplasm from different bean production areas around the world. Target traits include seed yield and quality, fungal and bacterial diseases, waterlogging/flooding tolerance, upright plant architecture, and nutritional quality. As mentioned before, these are all important traits included in the current list of "areas of interest" developed by Northarvest Bean Growers Association.
- The NDSU dry bean breeding project is also educating/training the next generation of plant breeders that will continue making North Dakota's agriculture highly competitive. Each year, at least one individual on average complete their graduate studies (either M.S. or Ph.D.) doing genetic and agronomic research relevant to dry bean production.

The long-term economic support from the dry bean commodity groups, such as the Northarvest Bean Growers Association has been of key importance for the success of this breeding program.

Acknowledgements: The support from Northarvest Bean Growers Association, NDSU, and the North Dakota Dry Edible Bean Seed Growers Association has been fundamental for the long-term success of the dry bean breeding program at NDSU and the growers of the Northarvest region. Other funding agencies include USDA-ARS, USDA-NIFA, USDA-AMS, North Dakota Department of Agriculture, and USAID.

Last but not least, thank you to the following growers for allowing research trials on their farms: Dennis and Eileen Bolton of Park Rapids, MN), Mark Dombeck Perham, MN, Jim and Dylan Karley of Johnstown, ND, Brian Shanilec of Forest River, ND, Tim Skjoiton of Hatton, ND, and Mark and Jim Sleeten of Hatton, ND.

2020 NORTHARVEST BEAN GROWERS SCHOLARSHIP

APPLICATION

The Northarvest Bean Growers Association is offering two - $1,000 scholarships to the children and grandchildren of members in 2020. The association is comprised of dry bean growers from North Dakota and Minnesota.

Applicants must meet the following requirements:

1. A parent or grandparent must be a current participating grower-member of the Northarvest Bean Growers Association.
2. Applicant must be planning to enroll or be enrolled in their first year of college or technical college.
3. Applicant must have at least a 3.0 grade point average from high school.

If the above criteria is met, the applicant must complete an application when applying for the scholarship. Applications must be received no later than June 1, 2020.

The association looks forward to helping students with their educational goals.

DATE: _____

NAME: _____

ADDRESS _____

CITY: _____ STATE: _____ ZIP: _____

TELEPHONE: _____ DATE OF BIRTH: _____

EMAIL ADDRESS: _____

NAME AND ADDRESS OF PARENTS/GRANDPARENTS:

_____

_____

_____

NAME AND ADDRESS OF COLLEGE/UNIVERSITY PLANNING ON OR CURRENTLY ATTENDING:

_____

_____

_____

COURSE OF STUDY: _____

_____

Please type/print responses to the following questions on a separate sheet(s) of paper and attach to this page along with your reference letters. Please keep each response to 200 words or less.

1. Please list your scholastic achievements (GPA, Academic awards, Scholarships, etc.) Include current grades or transcript.
2. Demonstrated Leadership (Offices held in school, projects directed, athletic involvement, band, choir, FFA, student council, boys/girls state, etc.)
3. Service to Community (Volunteer work, theater groups, coaching and any other activities which have contributed to the betterment of your community)
4. Describe the benefit(s) of being involved with dry bean production for you and your family.
5. Career Plans?
6. At least two references *must be attached*

**Northarvest scholarship winners are asked to attend "Bean Day" January 2021

☐ Check if are willing to attend

**Enclose a recent wallet size photo that can be used with an announcement story if you are selected.

** Mail application to Northarvest Bean Growers Association, 50072 East Lake Seven Road, Frazee, MN 56544, or email nhbean@loretel.net, no later than June 1, 2020.

SIGNATURE: _____


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