

Project Title: Reducing Canola Input Costs through Singulation and Row Spacing
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Organization Name: Minnesota Canola Council

Supplemental Final Report

Previously, there was limited agronomic data comparing air seeding of canola to singulation, however, seeding rates, and thus costs, may be significantly reduced with singulation planting. Singulation is a planter performance characteristic ensuring that only a single seed is picked up and fed to the planter, enabling precise delivery of seeds to the soil. The ultimate goal is to reduce seed costs, while providing the benefits of reducing inter-plant competition and disease, thus helping achieve the plant's optimum yield. Singulation holds the potential for producers to cut their seed costs by as much as half, while still maintaining or improving yield. Research has shown the benefits of singulation in corn, but there is little information on the yield effects of singulation in canola

The research objective was to compare a systems approach of integrated planter technologies with singulation versus a standard air seeder/drill investigating stand establishment and yield comparisons. We originally proposed to conduct the trials from 2017 – 2019 at two on-farm sites near Roseau and Hallock, MN with farmer cooperators. However, issues with the commercial singulation planting company and one grower collaborator declining to conduct the research trial resulted in adjustments being made to the originally proposed research.

Background and Rationale:

In early 1990's canola was a new oil seed crop in Minnesota. Research showed that seeding canola with a grain drill in 6-inch rows at a 5 lb/A seeding rate was optimal for canola establishment. In the early 2,000's air seeders were an advancement in planting technology and a row spacing of 7.5-inches with a 5 lb/A seeding rate provided a consistent stand over a wide range of conditions. However, new advancements in precision technology may allow canola farmers to reduce seeding rates by precision seed placement reducing seed costs.

Previous research by North Dakota State University demonstrated seeding with conventional drills in 6 to 9-inch rows produced optimum yields (Hanson et al., 2008). Recent row spacing research in Oklahoma showed hybrid varieties responded better to wide rows compared to open pollinated varieties and a 0-10% yield reduction was observed in canola seeded in 30" compared to 15" rows (Godsey, 2012). Canadian row spacing research conducted in the early 2000's showed an 11% yield reduction when going from 9" to 24".

New planting equipment technology and improved genetics have caused a renewed interest in canola row spacing and seeding rate research in Minnesota. Precision planting will allow farmers to be more efficient with seed costs. Canola crop budgets have seed accounting for over 25% of direct costs. (NDSU 2016 Crop Budgets for NE ND). Precision planting (singulation technology) will adapt to existing plate planters making true precision planting in canola a reality. Minnesota canola farmers could save up to 40-60% of seed costs with this new technology. With the decline in commodity prices, profit margins have shrunk causing farmers to focus on increasing yields and/or decreasing costs.

Materials and Methods

The objective of this research was to compare canola growth, development and yield from two methods of canola establishment using on-farm sites and to investigate seeder technology, row spacing and seeding rates utilizing plot research experiments in collaboration with Rice Farms and Northern Resources Cooperative – West Plant located near Roseau, MN.

In 2017 and 2018, a trial was established on a grower's field comparing the seeder technology of conventional air seeding versus singulation. In both years, the trial was conducted as a randomized complete block design with 4 replications. In 2017, the treatments were conventional seeding with an air seeder at 7.5 inch row spacing and a seeding rate of 5 lb/A and precision planting at 22 inch row spacing and a seeding rate of 2.7 lb/A. The trial was seeded on May 5, 2017 on the Tony Brateng Farm located two miles south of Roseau, MN. Individual plot widths was adapted to the farmers planting and harvesting equipment. Plot length was the length of the field for the conventional planting and 1,000 feet for the singulation, precision planting. Trial management was the grower's standard practices for fertility and pest control. Both treatments were direct harvested using the farmer cooperator's combine with a 35 foot header. The harvested plot area was 0.49 acres. Each plot was weighed separately using a grain cart and a seed sample taken for quality analysis.

In 2018, the trial was conducted on the McGlynn Farms located west of Stephen, MN. Due to issues with being unable to use the same custom singulation planter from North Dakota to plant our trials, the treatments were conventional seeding with a Flex Hoe drill air seeder at 7.5 inch row spacing and a seeding rate of 4.5 lb/A and precision planting using a converted sugar beet singulation planter at 22 inch row spacing and a seeding rate of 2.5 lb/A. Trial management was the grower's standard practices for fertility and pest control. Both treatments were direct harvested using the farmer cooperator's equipment with the harvested plot area being 1.78 acres. Each plot was weighed separately using a grain cart and a seed sample taken for quality analysis.

In 2017 – 2019, a second, larger plot trial was established on the Magnusson Research Farm, Rice Farms or Northern Resources Cooperative – West Plant comparing seeder technology (singulation verses conventional), row spacing and seeding rate. The trials were conducted as a randomized complete block design with 4 replications in all three years. Plot size was 6 feet by 27 feet for conventional seeding using a Hege small plot seeder with 6 inch, 12 inch or 24 inch row spacings. Plot size was 10 feet by 27 feet for singulation treatments in 2017 with 10 inch and 20 inch row spacings and 11 feet by 27 feet in 2018 and 2019 with 22-inch row spacings using field-scale equipment. The seeding rates with the precision planter were 3 or 6 plants per square foot and the seeding rates with the conventional planter were 3, 6, 9 or 12 plants per square foot. The trials were seeded on May 19, 2017, May 23, 2018 and May 29, 2019. The canola variety seeded was L140P in 2017 and 2018 and L234P in 2019. Prior to seeding, soil samples were taken for analysis of background fertility levels and plots were subsequently fertilized with a broadcast application of 140 – 40 – 40 – 20S prior to seeding. After seeding, weeds, insects and diseases were managed according to best management practices. Data collected included: plant counts per square foot; early season vigor rating; percent groundcover; seed yield; test weight; protein and oil content; and bloom.

Results and Discussion:

On-farm Large Plot Trials: In 2017, the average yield of the precision planting was significantly higher (2610 lb/A versus 2309 lb/A) than the conventional planting (Table 1). In this field, an extra 301 lb/A yield was harvested with the precision planting. Using seed cost of \$13 per pound, almost \$30 per acre was saved using the precision seeder. With a selling price of \$ 0.18/lb, an extra \$54 per acre would have been harvested. This translated to a higher profit of \$84 per acre potentially being realized by the producer. In addition, the protein and oil levels were higher in the precision planted plots which may provide the grower with an additional profit. However, in 2018 there was no difference in seed yield between the conventional versus precision seedings. Using seed costs of \$13 per pound, there would be savings of \$26 per acre in seed costs with the precision planter which suggests these newer precision seeding technologies could potentially be advantageous for growers by increasing their profits through reduced seed costs.

Research Plot Planting Trials (2017 – 2019): Precision planting versus conventional planting at various seeding rates and row spacings was investigated for three years (Tables 3 – 5). In 2017, plant emergence on precision planted plots was excellent and emergence was very good on conventional plantings. Early season vigor on June 7 was very good to excellent on all plots but vigor increased as seeding rate increased at all row spacing and seeding methods. Plant counts per square foot both done on June 7 and after harvest on September 29 would also indicate a high rate of seedling emergence.

In 2017, yield of all plots was high with a trial mean of 3129 lb/A. Precision planted plots generally were slightly higher than conventional plantings at equivalent seeding rates but the overall mean yield of singulation versus conventional seeding averaged over seeding rates was also not significantly different (3018 lb/A versus 3168 lb/A). With the singulation planter, the narrower 10" rows yielded better than 20" rows. The conventional plantings in 24" rows were lowest yielding at all seeding rates. The highest yields were obtained with conventional plantings in 6" or 12" row spacing and high seeding rates of 3.8 – 5.2 lb/A which is consistent with previous research results.

In 2018, due to planter issues, the precision seeded plots were only seeded at the 22 inch row spacing at two seeding rates, 1.5 or 3.0 lb/A (Table 4). Unfortunately, the custom seeding company that agreed to establish our research plots for three years withdrew from the grant after one year. Due to the late notice by the company in late spring, 2018 about their unwillingness to seed our research plots, we were fortunate to be able to find an alternative seeder but at an additional cost to the grant.

In 2018, we again observed no differences in canola emergence from the precision or conventional planted canola. Early season vigor and ground cover generally was better with narrow rows and with higher seeding rates. The average canola yield was 2,787 lb/A which was 350 lb/A lower than the yield in 2017. In contrast to 2017, in 2018 the conventional seeded canola had higher yields than the precision planted canola. The precision planted canola in 22 inch rows were the lowest yielding treatments at both seeding rates. In 2018, conventional planted canola yields were higher and averaged 112, 105 and 109% of mean from 6 inch row spacing at 3.0 lb/A seeding rate, 12 inch row spacing at 4.5 lb/A seeding rate and 24 inch row spacing at 4.5 lb/A seeding rate, respectively. Few differences in other traits were observed, however, the widest 24-inch row spacing did have the highest protein levels when compared to the narrower row spacings with conventional seeding equipment.

In the 2019 canola row space seeding rate trial, the mean canola yield was 2,654 lb/A which was lower than the two previous trial years (Table 5). Canola seeded in 22 inch rows using a singulation precision planter had yields range from 2,435 to 2993 lb/A and demonstrated that the low seeding rate of 1.5 lb/A in 22 inch rows even with a precision planter is risky and too low a seeding rate for canola. No difference in seed yield was detected from the 3.0 or 4.5 lb/A seed rate when using a precision planter. When canola was planted using a conventional seeder in 6 inch rows, yields ranged from 2,485 to 2,876 lb/A. When canola was seeded in 6-inch rows only the highest seeding rate of 6 lb/A produced yields over 100% of the trial mean. In the 12-inch row spacing, yields were variable with only the 4.5 lb/A seeding rate producing canola yields over 100% of trial mean. However, when seeded in 24 inch rows only the low seeding rate of 1.5 lbs/A produced canola yields less than 100% of trial mean demonstrating that wider row spacings of 24 inches with the conventional planter and 22 inches with the precision planter with intermediate to high seeding rates of 3.0 – 6.0 lbs/A produced the highest seed yields.

The 2017 – 2019 data suggests that canola is a crop that will respond to a wide range of row widths, seeding rates, and planter types. However, the lower seeding rates, especially the 1.5 lb/A seeding rate, do not provide consistent yields or sufficient stands at any row spacing or seeder technology. Multiple years of data from this study as well a five year study investigating row spacing and seeding rates demonstrates that the highest canola yields were observed primarily when the higher seeding rates of 4.5 – 6.0 lb/A were used with 6 – 12 inch row spacing resulting in 7 – 9 plants per square foot.

Outreach

The education and outreach effort for this grant was coordinated between the Minnesota Canola Council and the University of Minnesota. The information derived from this research was made widely available through local and regional events, reports, and the University of Minnesota and the Minnesota Canola Council websites. Research was showcased and discussed annually with growers at the Canola Summer Field Day held each year in early July and the grower education meeting held annually in December, both organized by the Minnesota Canola Council and the University of Minnesota. The Minnesota Canola Council has distributed this information via Council newsletters sent to all growers in the state and on the Councils' website where annual and final reports of the canola research activities can be accessed by growers at any time (www.mncanola.org). In addition, each year, a joint Minnesota/North Dakota annual research conference is at the North Dakota State University in November at which the principal investigator will present results to members of both the Northern Canola Growers Association and the Minnesota Canola Council.

References

Godsey, C. 2012-13. Evaluation of winter canola grown in 30-inch rows. Production Technology Report 2012-13. Oklahoma State University Agriculture.

Hanson, B., B. Johnson, R. Henson, and N. Riveland. 2008. Seeding rate, seeding depth, and cultivar influence on spring canola performance in the northern Great Plains. *Agron. J.* 100: 1339-1346. doi.org/10.2134/agronj2007.0034

Table 1. 2017 Conventional Compared to Precision Planting of Canola.

Planting Method	Yield ³	Protein	Oil	Plants/foot of row		Plants/foot ²	
	lb/A	%	%	6-13-17	Harvest	6-13-17	Harvest
Conventional ¹	2309	17.7	42.4	10.5	6.6	16.7	12.1
Precision ²	2610	20.2	44.2	15.4	5.6	9.7	3.5
LSD @5%	111	2.4	1.3	1.6	0.9	6.3	4.5
CV(%)	2	6	1	5	4	6	7

Tony Brateng Farm located 2 miles south of Roseau, MN.

Planting date: May 5, 2017

¹Conventional: planted in 7.5 inch rows at 5 lb/A seeding rate

²Precision: planted in 22inch rows at 2.7 lb/A seeding rate

³Yield in pounds per acre adjusted to 8.5% moisture

Table 2. 2018 Conventional Compared to Precision Planting of Canola.

Seeding method	Yield (lb/A) ³	Plants per foot	Plants per acre
Flex Hoe Drill ¹	2,839	4.7	204,000
Precision Planter ²	2,869	3.0	131,000
LSD at 5%	NS	NS	NS
CV (%)	2.4	23	23

McGlynn Farm, west of Stephen, MN.

¹Precision Planter: 22" precision plant rows at 2.5 lb/A seeding rate with a converted sugar beet planter

²Flex Hoe Drill: 7.5 inch row spacing at 4.5 lb/A seeding rate

³Yield in pounds per acre adjusted to 8.5% moisture

Table 3: 2017 Canola Conventional versus Precision Planting

Seeding Method ¹	Row Spacing	Seeding rate		Yield lb/A	Net return per acre	Seed cost per acre	Plants/ft ²		Plants/A (X1000)		Seed (% on DM basis)		ESV ³ rating	% ground cover ⁴	Test WT lb/bu	Height in.	Flowering # of days
		PLS/ft ²	lb/A				7-Jun	29-Sep	7-Jun	29-Sep	Protein	Oil					
Singulation	10"	3	1.3	3174	\$227.03	\$17.29	3.1	2.8	138	123	18.8	44.8	7.3	63	50.5	51	18
Singulation	20"	3	1.3	2899	\$177.53	\$17.29	2.4	2.4	103	103	18.8	44.7	7.3	43	50.6	53	19
Singulation	10"	6	2.6	3237	\$219.75	\$34.58	4.6	4.9	202	212	18.5	45.1	7.5	73	50.5	53	17
Singulation	20"	6	2.6	3013	\$179.43	\$34.58	4.2	3.6	183	157	18.9	45	8	50	50.4	51	17
Conventional	6"	3	1.3	2886	\$175.19	\$17.29	3.9	3.9	172	172	19.1	44.2	6.3	25	51.0	50	20
Conventional	6"	6	2.6	3524	\$272.74	\$34.58	5.6	6.4	245	278	18.9	44.4	7.3	60	50.8	53	20
Conventional	6"	9	3.8	3312	\$218.62	\$50.54	7.5	8.3	327	359	18.6	45.2	7.5	70	50.8	50	18
Conventional	6"	12	5.2	3454	\$226.89	\$69.16	9.4	10.5	408	457	18.4	45.4	8	80	50.8	50	17
Conventional	12"	3	1.3	2971	\$190.49	\$17.29	2.3	2.4	98	106	19	44.3	6.5	40	50.8	51	20
Conventional	12"	6	2.6	3071	\$191.20	\$34.58	4.0	4.2	175	184	18.3	45.1	7.8	53	50.8	50	18
Conventional	12"	9	3.8	3688	\$286.30	\$50.54	5.1	5.7	221	249	19	44.7	8	63	50.7	52	19
Conventional	12"	12	5.2	3591	\$251.55	\$69.16	6.6	7.1	286	310	19	44.6	7.5	63	50.8	50	17
Conventional	24"	3	1.3	2502	\$106.07	\$17.29	1.7	2.3	76	100	19	44.1	7.3	28	50.6	55	18
Conventional	24"	6	2.6	2778	\$138.46	\$34.58	3.8	3.5	163	151	19.3	44.4	8.5	38	50.7	54	20
Conventional	24"	9	3.8	2916	\$147.34	\$50.54	4.3	4.7	185	206	18.8	44.7	8.3	33	50.6	51	18
Conventional	24"	12	5.2	3043	\$152.91	\$69.16	5.4	5.8	234	253	19.4	44.3	8.8	40	50.7	53	18
LSD 5%				389			1	1.2	33.2	38.2	0.7	0.8	0.8	12	NS	3	0.6
CV (%)				8.7			15.5	16.7	15.5	16.7	2.5	1.2	7.2	16.5	1	4.2	4.5

Northern Resources Cooperative - West Plant, Roseau, MN.

Canola variety- L140P

Mean trial yield: 3129 lb/A

¹Conventional planter done with a Hege small plot cone seeder with double disk openers

Singulation planting done with 10' Plains Grain precision planter by Travis Messer of Plains Grain

²Two plant counts per plot (plants/ft²)

³ESV: (early season vigor) rating from 1 to 10 with 10 being most vigorous on 6-7-2017

⁴% Ground cover rated on 6-12-2017

Calculations used for economic returns-

Seed cost = \$13.30/lb

Canola price= \$ 0.18/lb

All other fixed and variable production costs= \$327 per acre

Table 4: 2018 Canola Conventional versus Precision Planting

Seeding Method ¹	Row Spacing	Seeding rate		Yield		Stand at harvest ²			Seed (% on DM basis)		ESV ³ rating	% Ground cover ⁴	Test weight ^T lb/bu	Height in.	Flowering # of days
		Plants/ft ²	lb/A	lb/A	% of mean	Plants/ft row	Plants/ft ²	Lodging	Protein	Oil					
Singulation	22"	3	1.5	2553	92	5.1	2.8	1.0	16.9	48.7	6.5	55	50.5	57	18
Singulation	22"	6	3.0	2484	89	8.5	4.6	1.0	16.2	48.9	7.5	65	50.5	52	17
Conventional	6"	3	1.5	2815	101	2.5	5.0	1.0	16.3	47.6	6.0	30	50.5	56	18
Conventional	6"	6	3.0	3113	112	5.6	11.2	1.0	16.6	47.6	7.0	64	50.4	54	17
Conventional	6"	9	4.5	2793	100	6.0	12.0	1.0	16.3	48.1	8.0	73	50.4	51	17
Conventional	6"	12	6.0	2774	100	8.3	16.6	1.0	16.3	47.9	8.5	80	50.3	49	17
Conventional	12"	3	1.5	2733	98	3.5	3.5	1.0	16.6	47.7	6.0	45	50.6	54	18
Conventional	12"	6	3.0	2889	104	6.3	6.3	1.0	16.6	47.8	7.5	63	50.4	53	17
Conventional	12"	9	4.5	2920	105	9.1	9.1	1.0	16.6	47.8	8.5	75	50.4	50	18
Conventional	12"	12	6.0	2563	92	12.5	12.5	2.5	16.3	47.8	8.5	65	50.3	50	17
Conventional	24"	3	1.5	2904	104	5.5	2.8	1.0	16.8	47.2	5.5	25	50.5	56	18
Conventional	24"	6	3.0	2727	98	10.3	5.2	1.0	16.8	47.4	6.5	35	50.4	53	18
Conventional	24"	9	4.5	3024	109	12.3	6.2	1.0	16.8	47.4	7.5	33	50.4	51	18
Conventional	24"	12	6.0	2726	98	14.6	7.3	5.0	17.0	47.1	7.5	45	50.5	51	17
LSD 5%				279	10	2	4	0.7	0.4	0.4	1.8	12	0.1	3	4
CV (%)				7	7	18	18	35	2	0.5	17	16	0.2	5	18

Rice Farms, Roseau, MN

¹Conventional planter done with a Hege small plot cone seeder with double disk openers
Singulation planting done with an field-scale RDK planter

²Two plant counts per plot (plants/ft²)

³ESV: early season vigor rating from 1 to 10 with 10 being most vigorous on 6-14-2018

⁴Lodging: rated on a scale of 1 to 10 with 1 being no lodging and 10 being flat.

⁴% Ground cover rated on 6-14-2018

Table 5: 2019 Canola Conventional versus Precision Planting

Seeding Method ¹	Row Spacing	Seeding rate		Yield		Stand ²		Seed (% on DM basis)		ESV ³ rating	% Ground cover ⁴	Test weight lb/bu	Height in.	Flowering # of days
		Plants/ft ²	lb/A	lb/A	% of mean	13-Jun	Harvest	Protein	Oil					
Singulation	22"	3	1.5	2435	92	3	2	19.6	45.3	5.5	6	49.7	50	17
Singulation	22"	6	3.0	2993	113	5	4	18.9	45.8	8.0	10	49.3	52	17
Singulation	22"	9	4.5	2871	109	6	6	19.6	45.5	7.5	10	49.3	51	16
Conventional	6"	3	1.5	2485	93	4	3	19.0	45.6	4.0	10	49.1	48	16
Conventional	6"	6	3.0	2517	95	6	5	19.0	45.4	3.5	8	49.5	50	18
Conventional	6"	9	4.5	2581	97	9	8	18.9	45.7	4.0	10	49.4	51	17
Conventional	6"	12	6.0	2876	108	12	11	20.1	45.0	5.5	26	49.2	52	17
Conventional	12"	3	1.5	2616	98	3	2	19.4	45.3	2.5	7	49.7	50	18
Conventional	12"	6	3.0	2271	86	8	6	19.3	45.6	3.0	5	49.4	49	18
Conventional	12"	9	4.5	2708	102	8	6	19.4	45.4	3.0	9	49.4	51	17
Conventional	12"	12	6.0	2583	97	10	9	19.2	45.5	5.5	12	49.4	51	17
Conventional	24"	3	1.5	2448	92	2	2	20.1	44.8	1.5	4	50.0	48	19
Conventional	24"	6	3.0	2796	105	4	3	20.9	44.0	3.5	6	49.8	51	19
Conventional	24"	9	4.5	2899	109	6	5	20.0	44.8	4.5	9	49.7	48	18
Conventional	24"	12	6.0	2728	103	7	5	19.8	44.9	4.3	9	49.5	49	18
LSD 5%				352	13	2	2	0.7	0.7	2.2	11	0.4	3	2
CV (%)				9	9	23	25	3.0	1.0	35	84	1	4	4

Northern Resources Cooperative - West Plant, Roseau, MN.

¹Conventional planter done with a Hege small plot cone seeder with double disk openers
Singulation planting done with an farm-scale RDK planter

²Stand: plants/ft²

³ESV: early season vigor rating from 1 to 10 with 10 being most vigorous on 6-13-2019

⁴Lodging: rated on a scale of 1 to 10 with 1 being no lodging and 10 being flat.

⁴% Ground cover rated on 6-14-2018