

NATIONAL SUNFLOWER ASSOCIATION
OF CANADA



2018-19 Development of Long-Type Confection Sunflower Hybrids



FUNDING APPROVALS

The NSAC applied for continued funding towards the confection sunflower variety development program for an additional five years through the Diverse Field Crops Cluster. The Diverse Fields Crops Cluster is an agri-science cluster that supports the research and development of high-potential emerging crops: flax, camelina, canaryseed, sunflower, hemp, quinoa and mustard. On January 15, 2019 Minister Lawrence MacAulay, Minister of Agriculture and Agri-Food Canada (AAFC) announced over \$13 million in funding from AAFC through the Canadian Agricultural Partnership's AgriScience Program. This investment, combined with industry contributions of nearly \$11 million, brings the value of the cluster to over \$24 million. The NSAC was approved for matching funding over the five years at a total of \$2.467 million dollars towards our variety development project. Manitoba Agriculture through the CAP—Research & Innovation project will provide \$235,125 over three years (must re-apply in 2021) and \$320,650 from Western Grain Research Foundation.

YEAR 1: 2018-19

ACTIVITY 1: SUMMER AND WINTER NURSERY

The objective of the summer and winter breeding nurseries is to develop elite parent lines, possessing genes for tolerance to sulfonylurea herbicides, rust and downy mildew that will, when crossed, produce herbicide tolerant experimental hybrids highly adapted to Canada, with a high level of resistance to downy mildew and rust, and possess improved seed types for Canadian processors and producers. For simplicity, the breeding of male parent lines and female parent lines in our program generally follows the same process.

The 2018 summer nursery was planted near Fargo, North Dakota with a total of 3,520 rows on 8 acres.

Activity 1 met its 2018-19 objectives to develop elite parent lines, possessing genes for tolerance to sulfonylurea herbicide (SU-7: non-transgenic), rust (R12) and downy mildew (PLARG) to provide a competitive production advantage to existing hybrids. The following quantities of finished, and unfinished parent lines were grown. The quantities of lines contained in the program are as follows:

- Finished male restorer lines - no dominant disease resistance genes. Elite (12)
- Finished male restorer lines - no dominant disease resistance genes. Semi- Elite (30)
- Finished male restorer lines fixed for gene PLARG or PLARG and R12 Elite (0)
- Finished male restorer lines fixed for gene PLARG or fixed for both PLARG and R12. Semi-Elite (48)
- Finished female A x B lines with cytoplasmic male sterile conversion completed. Elite (15)
- Finished female A x B lines with cytoplasmic male sterile conversion completed. Semi-Elite (31)



Generation of new breeding populations

Development of Male Restorer Lines:

- (summer 2018) F₂ populations were bagged at R8. The bagged F₂ plants were rated for agronomics and seed type.
- (summer 2018) Tissue sampled top rated F₂ plants were tissue sampled and marker screened for dominant disease resistance genes.
- (winter 2019) F₃ plants were selected and bagged in the winter nursery (Chile) based primarily on earliness and plant type.
- (summer 2018) F₄ plants were bagged at R8. The bagged F₄ plants were rated for agronomics and seed type.
- (summer 2018) F₄ plants were bagged at R8. The bagged F₄ plants were rated for agronomics and seed type.
- (summer 2018) Tissue samples were taken from the top rated F₄ plants and marker screened for dominant disease resistance genes.
- (winter 2019) F₅ plants were selected and bagged in the winter nursery based primarily on earliness and plant type.

Development of Female A x B Lines:

- (summer 2018) F₂ plants were selected before bloom based on earliness and plant type and a first cross was made to cytoplasmic male sterility made.
- (summer 2018) The top rated F₂ plants were advanced to winter nursery based on agronomics and seed type.
- (winter 2019) F₃ plants were selected based on earliness and plant type and a first backcross was made to cytoplasmic male sterility.
- (summer 2018) F₄ plants were selected based on earliness and plant type with a third backcross made to cytoplasmic.
- (summer 2018) The top rated F₄ plants were advanced to winter nursery based on agronomics and seed type.
- (winter 2019) F₅ plants were selected based on earliness and plant type and a fourth backcross was made to cytoplasmic male sterility. If female conversion to sterility was complete, the new female A x B line was used to make experimental hybrids for testing in the 2019 summer nursery.



HERBICIDE TOLERANCE SCREENING

All parent lines in the program were developed with herbicide tolerance. The SU-7 gene is a single dominant gene from DuPont that conveys herbicide tolerance to tribenuron in sunflower. The trait is now 100% incorporated into parental lines after successful completion of the five-year funding under GF2 “Confection Sunflower Development Initiative”.

DOWNY MILDEW, RUST AND SCLEROTINIA SCREENING

Breeding activities in the male parent program include the incorporation of genes for disease resistance (downy mildew: PL_{ARG}, rust: R₁₂). Male restorer parent lines that contain the resistant genes were screened to confirm that the resistance genes were present. Plants that contain the resistance genes were selected for further advancement into the 2018-19 winter nursery

NSAC collected tissue samples in the summer of 2018 to confirm the prevalent races found in Manitoba.

YEAR 1 RESULTS

180 new herbicide tolerant male restorer lines (F₅) that are fixed for genes for downy mildew resistance were identified in 2018-19. 10 of these lines were used in the South American winter breeding nursery to make experimental hybrids for testing in 2019 and were thus advanced to activity 2. SNP marker information confirmed that 50 of the new male restorer lines were also fixed for genes for rust resistance.

Based on agronomics, seed type and SNP marker information obtained from individual plants, approximately 51 new F₃ female lines were identified that contain genes for downy mildew and/or rust resistance. Conversion to cytoplasmic male sterility (CMS) of the 51 new female lines was initiated in the 2018-19 winter nursery.

DELIVERABLES

Currently in the program, there are approximately 107 finished parent lines that have been utilized to make all experimental hybrids for testing in Canada (68 males, 39 females) since the program started in 2014. All 107 lines are herbicide tolerant and have been advanced through the program based on solid agronomics, seed type and adaptability to Canadian growing conditions. Approximately 35 of the male lines also contain genes for resistance to downy mildew and/or rust.

DISCUSSION

Based on comparative yields and seed types obtained from experimental hybrids tested in Manitoba in 2018, it appears that the program currently has the potential to produce a high number of experimental hybrids that can yield competitively and can produce improved seed types to commercial confection hybrids currently being grown in Canada. High yield performance and improved seed types in combination with herbicide tolerance and genetic disease resistance will provide attractive hybrid option for Canadian producers.



ACTIVITY 2: CANADIAN TESTING PROGRAM

The overall objective of the Canadian Testing Program is to isolate commercially viable experimental hybrids for advanced testing and eventual commercialization. While seed type and marketability are of extreme importance, the hybrids must also be early maturing, high yielding and have a strong agronomic package. Testing activities will include four levels of testing.



Preliminary Hybrid Screening

Planting Date: May 14 (Miami) and May 15 (Holland)

The NSAC transports our planting equipment from Fargo, ND in order to plant our nursery. This process has eliminated planting errors and ensures that the trials are planted at the desired time.

132 new preliminary hybrids were tested in two locations in Manitoba, replicated twice using the RBCD design. Each trial location includes two performance checks (6946 DMR, Panther DMR) and one herbicide tolerant check for resistance to SU-7 (P63ME80) to ensure the trait is present.

The trial was sprayed and tilled by a contract services company in both locations and plot maintenance including thinning was performed by NSAC's Research

Agronomist. Data points were collected from all hybrids including standard agronomic ratings (emergence, herbicide tolerance, days to bloom, height, lodging, days to maturity, yield, test weight and seed sizing.

The NSAC crew hand clipped the sunflower heads from the selected lines on October 4th. The sunflower heads had to be dried, due to snow, in order to thresh the seed. The heads were threshed on October 18th with quality testing conducted in the week following.

Based on agronomic and seed type traits, 12 new hybrids were selected to be advanced to additional testing for the 2019 season. Selections were reviewed with the sunflower processing industry and our producer directors.



Variety Performance Trials (VPT)

Objective: Advanced hybrids that were selected from the 2018 preliminary screening nurseries were entered in the VPT for additional regional adaptation. The VPT test the advanced hybrids against other commercially available sunflower hybrids for agronomic competitiveness and merit.

Three new hybrids were tested at 4 locations within Manitoba. Each trial included 3 replicates using a RCBD (Randomized Complete Block Design) for analysis. Disease screening was conducted by PSI (Pest Surveillance Initiative) located in Oak Bluff, MB in a controlled environment and under field conditions for Downy Mildew, Rust, Verticillium Wilt and Sclerotinia.

The VPT had a total of 6 hybrids tested including 3 new hybrids which were tested at 4 locations in Manitoba. Data for only 2 locations were reported. The other 2 locations were lost due to dry planting conditions that resulted in variable and thin seedling emergence within the plots. The trials were harvested, and the results were communicated through the NSAC website and Seed Manitoba in December 2018.

TABLE 1 : 2018 VARIETY PERFORMANCE TRIAL RESULTS

Variety Descriptions						
Company	Hybrid	Genetic Traits 1	Site Years	Yield % Check	Maturity (days to R9)	Height (inches)
NuSeed America	6946 DMR	DM	23	100	0	0
NuSeed America	Panther DMR	DM	31	99	1	-3
Experimental lines being tested/proposed for registration in Canada						
NuSeed America	NSKM53777	CL	6	92	6	-3
NSAC	EX 27441	ExSun	2	99	5	0
NSAC	EX 37444	ExSun	2	79	2	2
NSAC	EX 64588	ExSun	2	86	-1	4
CHECK CHARACTERISTICS						
	6946 DMR		23	3177	120	69
			site years	lb/ac	days	inches

1 Genetic traits include CL = Clearfield tolerance; ExSun = Express tolerance; DM = Downy Mildew Resistance

Pre-Commercial Strip Trial Testing

Objective: Advanced successful experimental hybrid(s) to the next level of testing, pre-commercial strip trial testing.

One hybrid from the 2018 variety performance trial (Confection Sunflower Variety Development Initiative) was advanced and tested at 3 locations within Manitoba in a head to head, field scale comparison to the commercial hybrid 6946 DMR. Each strip trial hybrid was treated the same as the commercial hybrid. Agronomic data was collected on both hybrids in the strip trial throughout the season. The trial was managed by the producer throughout the whole growing season. The hybrids were harvested and a weigh wagon captured the yield data. Seed samples were collected for seed quality (test weight, seed sizing, visual acceptance).

The experimental hybrid performed equal to the commercial hybrid. It trended to be slightly taller in height with a higher yield, however had a lower test weight than the commercial hybrid. The seed type of the new hybrid was longer than that of the commercial check hybrid. Based on final assessment and upcoming hybrids, the NSAC committee and breeder agreed to drop the hybrid for further advancement.



TABLE 2: PRE-COMMERCIAL STRIP TRIAL RESULTS

Wawanesa:		Harvested - Sept 29/18										
Variety/Strip	Harv. Area	Harv. Wgt	Harv. Mst	Yield	Yield	Bus. Wgt	Head Size	Sizing				Dockage
	(acres)	(lbs)	(%)	(lbs/ac)	% of 6946	(lbs/bus)	(inches)	> 18/64	>20/64	>22/64	> 24/64	
6946	2.55	4690	12.6	1787		23.3	--	30	25	11	3	3.5
64588	1.7	3460	12.7	1976	110	22.2	--	18	25	28	17	2.5
Dundonald:		Harvested - Oct. 19/18										
Variety/Strip	Harv. Area	Harv. Wgt	Harv. Mst	Yield	Yield	Bus. Wgt	Head Size	Sizing				Dockage
	(acres)	(lbs)	(%)	(lbs/ac)	% of 6946	(lbs/bus)	(inches)	> 18/64	>20/64	>22/64	> 24/64	
6946	1.67	4811	13.2	2883		26.3	7	48	33	3	0	1.5
64588	1.67	4828	13.6	2900	101	23.4	6	5	14	50	31	1.5
Horndean:		Harvested - Oct. 22/18										
Variety/Strip	Harv. Area	Harv. Wgt	Harv. Mst	Yield	Yield	Bus. Wgt	Head Size	Sizing				Dockage
	(acres)	(lbs)	(%)	(lbs/ac)	% of 6946	(lbs/bus)	(inches)	> 18/64	>20/64	>22/64	> 24/64	
6946	2.12	3800	13	1792		26.0	7	45	22	6	2	17
64588	1.41	2840	13	1985	110	23.4	6.5	12	31	46	10	25

KNOWLEDGE TRANSFER EVENTS:

As the National producer organization for Canadian sunflower growers, knowledge transfer to our members is extremely important, as the NSAC must demonstrate producer's check-off dollars at work. For this project, there are two specific target audiences: producers and sunflower processors/buyers.

During the 2018-19 program year, the NSAC held three knowledge transfer events with our target audience.

- September 12, 2018 - Nursery Tour with interested sunflower breeding company
- September 17, 2018 - Nursery Tour with Manitoba sunflower industry representatives
- February 13, 2019—NSAC Annual General Meeting with sunflower members



FUNDING ACKNOWLEDGMENTS:

The National Sunflower Association of Canada gratefully acknowledges the funding support from the Diverse Field Crops Cluster with funding from Agriculture and Agri-Food Canada's Canadian Agricultural Partnership program, Government of Manitoba & Government of Canada through the CAP-Ag Action Manitoba program and Western Grains Research Foundation.