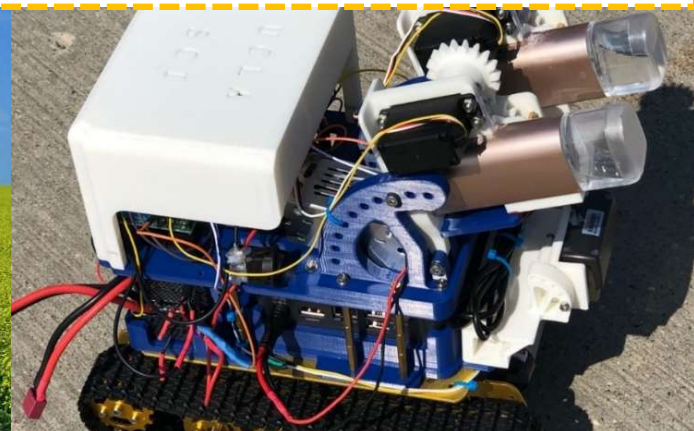


NCGA 15th Annual Canola Research Conference



NDSU Canola Breeding Program



Mukhlesur Rahman
November 04, 2021



NDSU Canola Breeding Program

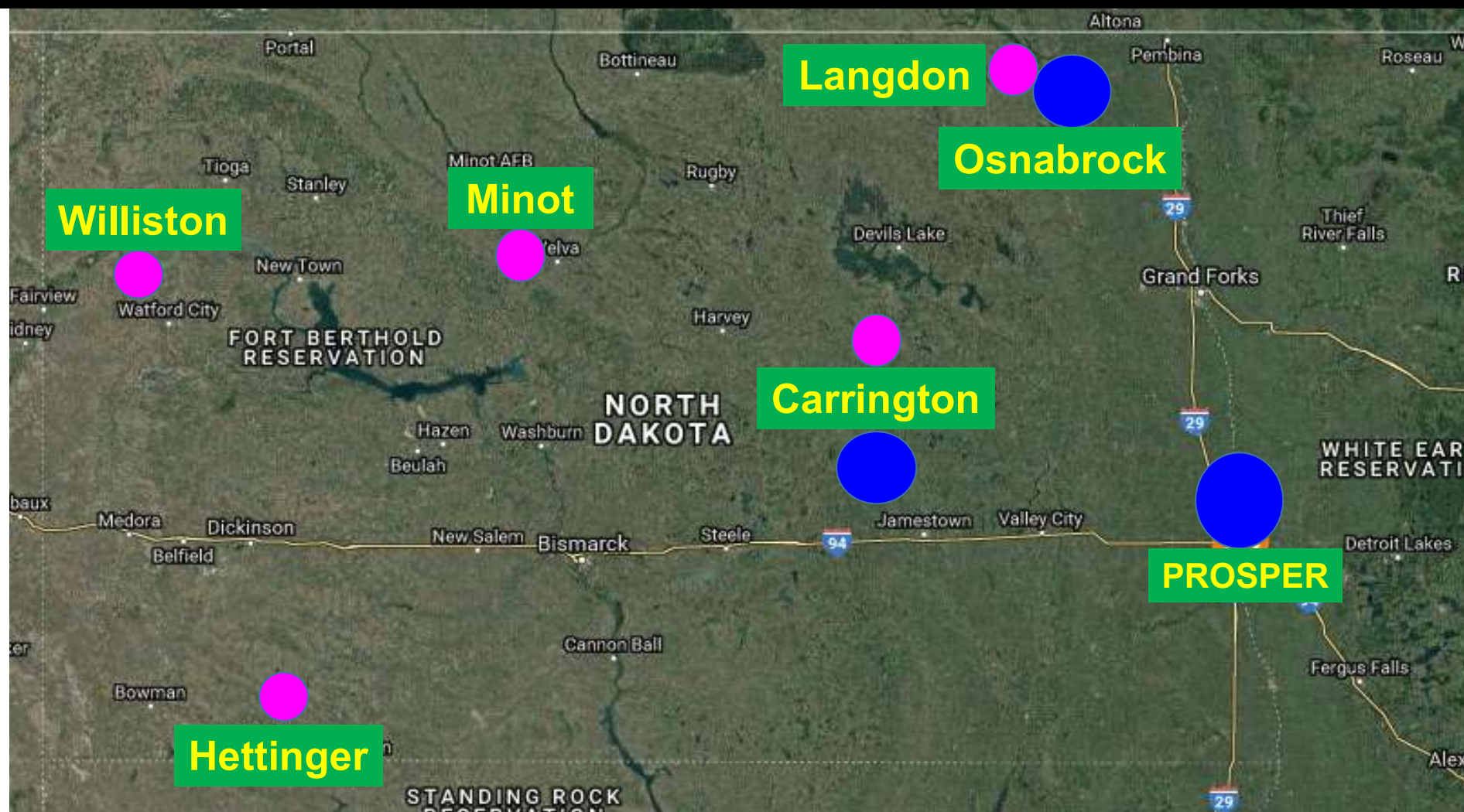
Line development

1. Conventional **OP** line development (Inbred)
2. Conv. **Ogura-CMS** and **RESTORER** lines development
3. Hybrid / joint-hybrid

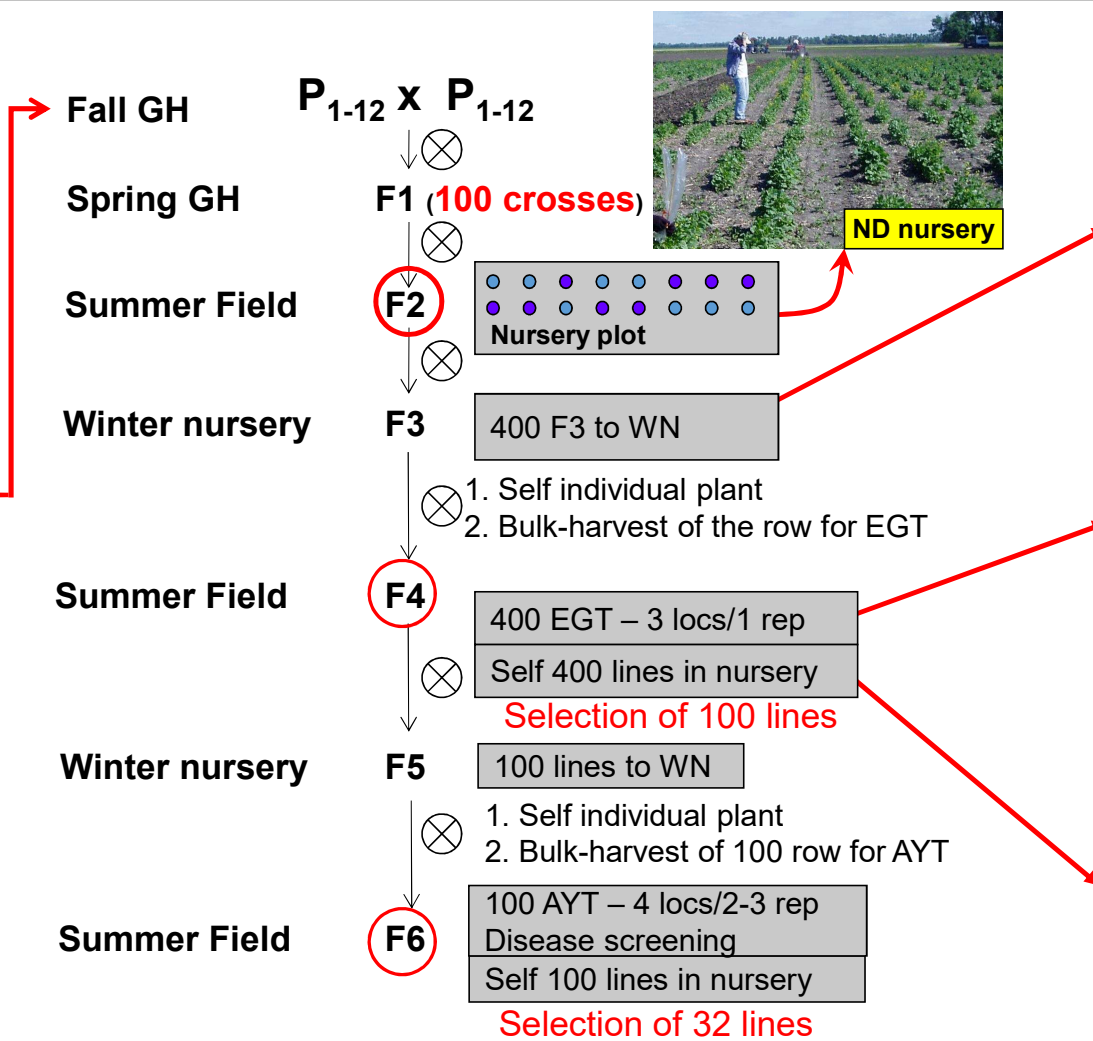
Breeding Objectives (Canola)

1. High seed yield
 2. High oil content
 3. Disease resistance:
 - Sclerotinia stem rot
 - Blackleg disease
 4. Shattering tolerance
 5. Good root system
- High oil/acre**

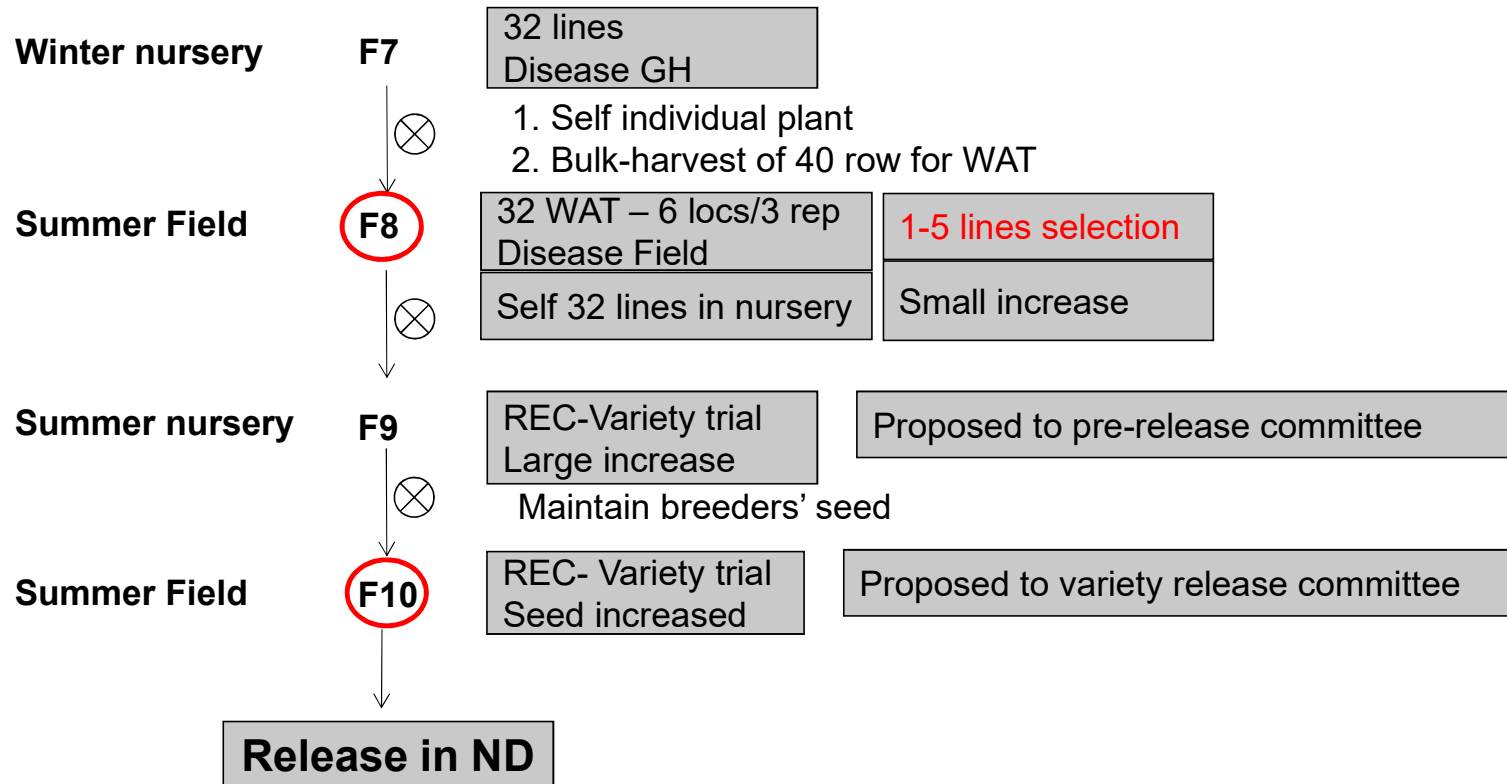
NDSU Canola breeding (Experiment - Sites)



Line Development program (OP)



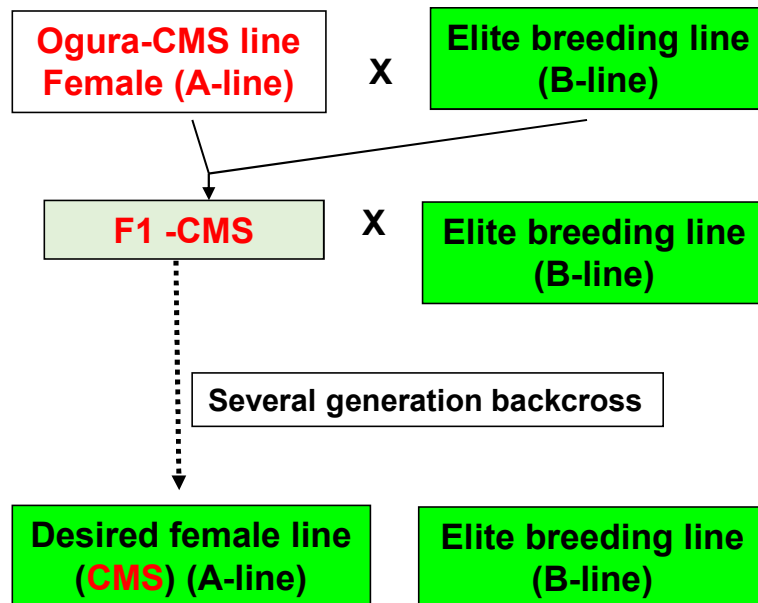
Line Development program (OP)



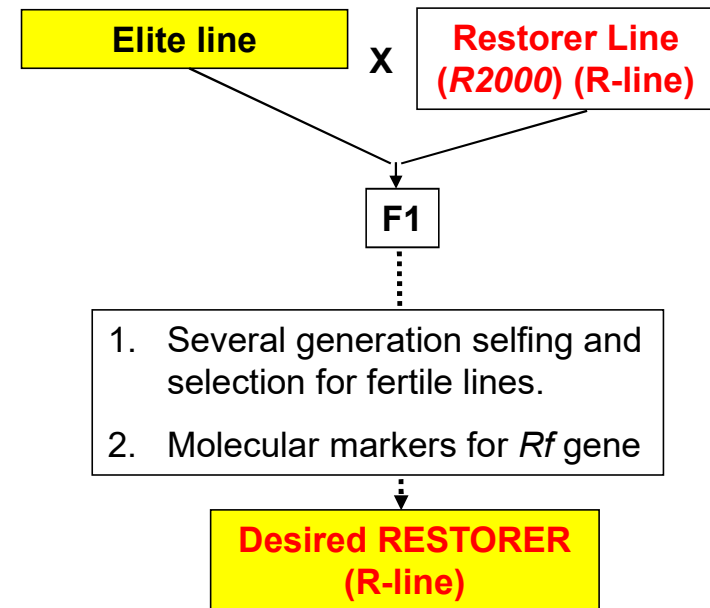
Line Development Program (Hybrid)

- CMS and Restorer lines
- Hybrids

Ogura-CMS (Female line) development



R2000-restorer (Male line) development

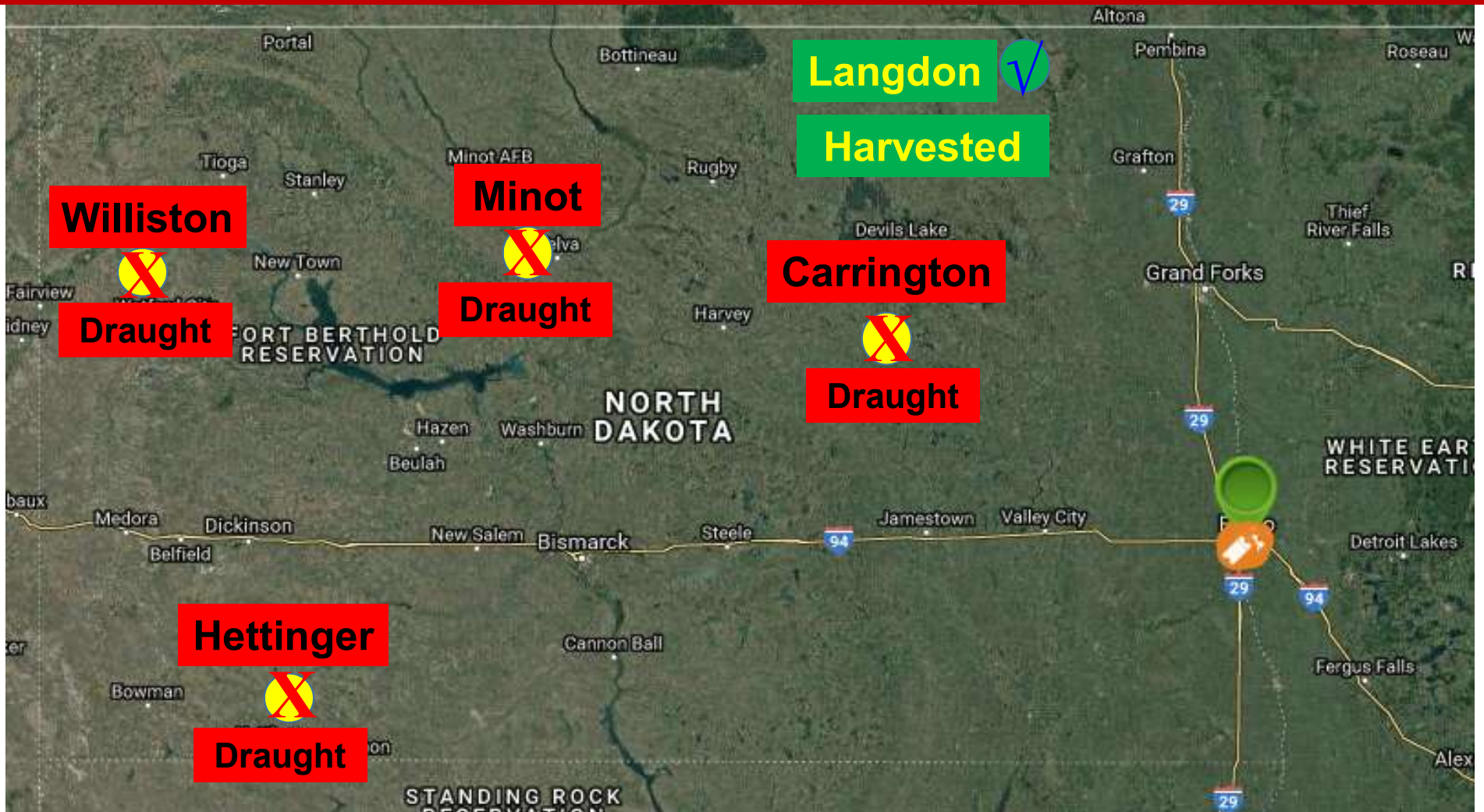


2021 Field Experiments

Expt ID	Genotypes	Plot	Loc
2101-WAT-Conv	36	648	6
2102-AYT-Conv	64	768	4
2103-EGT-Conv	326	978	3
2104-Hybrid-Conv	36	54	1
2105- Fargo (Single row F2)	100	50	1
2106 Shattering (Single row)	160	720	3
2107-Single Row -Breeding lines	1000	500	1
Total	1722	3718	

2021 Experiments and Results

ND Canola Variety Trial (Harvest)



2021 ND Canola Variety Trial (Conventional) - Langdon

			Yield	Oil
Open-Pollinated	NDSU	NDC-E16169	1261	41.1
	NDSU	NDC-E16257	1205	40.1
	NDSU	NDC-E16294	1107	40.4
	NDSU	NDC-E12079	1104	40.2
	NDSU	NDC-E16189	1063	40.3
	NDSU	NDC-E16198	1059	38.5
	NDSU	NDC-E17075	846	40.5
	NDSU	NDC-E12121	817	40.2
Hybrids	Meridian	CS2700 CL	1618	42.7
	BASF	L343PC	1582	43.7
	BASF	EXP #2	1457	42.9
	Dyna-Gro	DG 200CL	1433	41.1
	Croplan	CP7144LL	1419	43.4
	BASF	LR344PC	1387	43.1
	BASF	L233P	1386	42.2
	BASF	L345PC	1382	42.4
	BASF	L234PC	1307	42.6
	BASF	L340PC	1232	41.5
	Croplan	CP7130LL	1220	43.7
	Pioneer	P505MSL	1172	42.2
	BASF	L255PC	1106	43.5
	Meridian	CS4000 LL	1000	42.5
	Pioneer	P506ML	990	44.3
	Dekalb	H19W94354	936	43.9
	Dekalb	DKTFLL21SC	917	43.3
	Dekalb	DKLL82SC	715	43.4
Trial Mean			1182	42.1
C.V. %			21.4	1.1

2019-2021 ND Canola Variety Trial (Conventional)

Seed Yield – Langdon only

Name	2019	2020	2021	3 ys Avg.
NDSU-NDC-E16169	3708	2576	1261	2515
NDSU-NDC-E16198	3744	2605	1059	2469
NDSU-NDC-E12121	3755	2821	817	2464
Dyna-Gro-DG 200CL	3216	2644	1433	2431
BASF-L233P	3528	3565	1386	2826
BASF-L234PC	3394	3195	1307	2632
BASF-L255PC	3937	2961	1106	2668
Trial Mean	3432	2881	1182	2498
C.V. %	8.2	8.2	21.4	
LSD 5%	396	331	222	

NDC-E16198, NDC-E16169

ND Canola Variety Trial: 2019-2021

Seed Yield – 3 years

Name	2019					2020			2021	Mean	Over Trial mean (%)
	Lan	Min	Car	Will	Hett	Lan	Car	Will	Lan	(9 Env)	
NDC-E16198	3744	1392	2947	1230	1128	2605	1342	790	2469	1961	4.7
NDC-E16169	3708	1272	2586	1046	875	2576	1371	743	2515	1855	-0.9
Trial mean	3432	1253	2813	996	925	2881	1207	842	2498	1872	

NDC-E16198, NDC-E16169

NDSU Canola Breeding Trial: 2017-2021

Seed Yield – NDSU 5 years

Year	2017	2018	2019	2020	2021	Average	Over hybrid checks (%)
Entries	4-Loc	4-Loc	4-Loc	3-Loc	2-Loc	17-Env	
NDC-E16198	2420	1660	1426	1486	1395	1677	9.5
NDC-E16169	2287	1664	1157	1385	1400	1579	3.1
Trial mean	2275	1688	1234	1467	993	1531	

2021 NDSU canola breeding trial – WAT – 2 loc

NAME	YIELD (2L)	Over hybrids (%)	Score (4L)	EV (2L)
NDC-E18161	1416	42.6	8.0	8.4
NDC-E16169	1400	41.0	7.6	8.4
NDC-E16198	1395	40.5	8.0	8.8
NDC-E16175	1337	34.7	8.0	8.3
NDC-E17353	1273	28.2	7.3	8.4
NDC-E19019	1251	26.0	7.4	8.7
NDC-E18143	1178	18.6	7.7	7.8
NDC-E15031	1163	17.1	7.4	8.4
NDC-E18003	1152	16.0	7.2	8.1
NDC-E18022	1145	15.3	8.0	8.2
NDC-E18270	1138	14.6	8.3	8.3
NDC-E18125	1124	13.2	7.6	8.0
NDC-E18093	1109	11.6	7.8	8.3
NDC-E19012	1078	8.5	7.9	8.6
NDC-E18260	1077	8.5	7.9	8.3
DKL38-48	818	-17.7	8.9	8.2
DKL70-07	1374	38.4	8.5	7.9
PIONEER45H29	1126	13.4	8.7	8.2
PIONEER45H33	654	-34.1	6.6	5.5
Mean hybrids	993		8.2	7.4
CV (%)	26.7		14.6	6.6
LSD (5%)	311.1		0.9	0.6

Total entries= 36

Replications= 3

Loc= 6 (Pros, Car, Lan,
Min, Hett, Will)

Abundant:

Car – hail

Min+Wil+Het - Drought

2021 NDSU breeding trial – AYT (Pros + OSN)

Name	Yield (2L)	Over Cks (%)	Score (3L)	DF (2L)	EV (2L)
NDC-E20123	1294	20	7.8	43.0	7.9
NDC-E17279	1277	19	7.2	45.8	7.8
NDC-E20125	1276	19	8.0	43.3	7.8
NDC-E20205	1275	19	6.5	44.5	7.3
NDC-E18149	1261	17	8.3	44.7	7.7
NDC-E19007	1208	12	7.3	42.3	7.3
NDC-E20141	1198	11	7.9	43.0	8.2
NDC-E18025	1164	8	8.1	42.8	8.2
NDC-E17090	1132	5	8.5	43.5	7.3
NDC-E20127	1084	1	8.0	46.0	8.0
DKL71-14BL	1107	3	8.7	39.8	7.8
DKL70-50CR	1118	4	8.4	44.3	7.3
PIONEER45S56	1004	-7	8.4	45.5	7.6
Mean cks	1076		8.5	43.2	7.5
CV (%)	31.0		16.7	4.7	10.8
LSD (5%)	365.0		1.2	2.3	0.9

Total entries= 64

Replications= 3

Locations= 4 (OSN, Carr,
Pros, Minot)

Abundant:

Carrington – hail

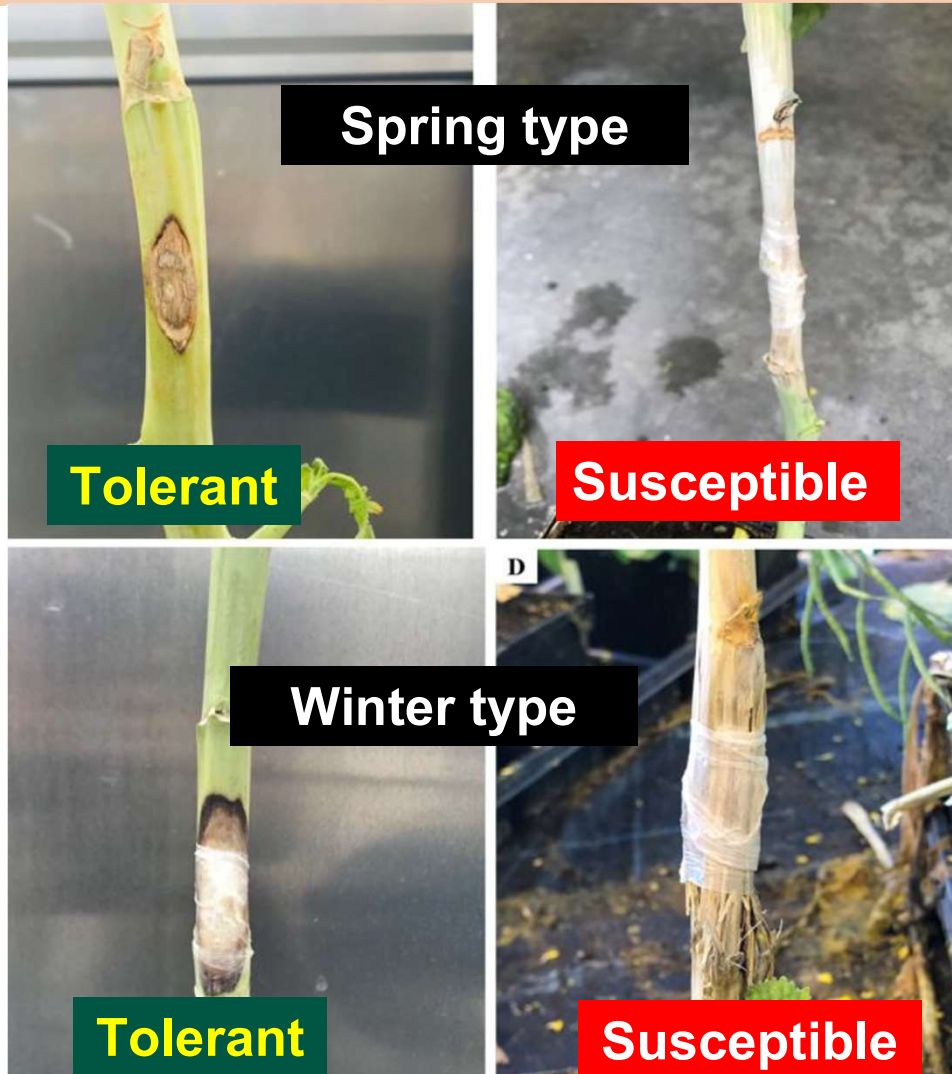
Minot - drought

2021 NDSU canola breeding trial – EGT – 2 (Pros + Osn)

Total entries= 324, with replicated checks (hybrid)

Name	Yield	Score	Note	Name	Yield	Score	Note
NDC-E21078	2296	9.0	NOL	NDC-E21090	1669	9.5	LTL
NDC-E21197	2249	8.0	CIRCLED SHORT	NDC-E21089	1663	9.5	VT,LOD, CIRCLED
NDC-E20185	2188	9.0	VT,LTL	NDC-E21131	1658	9.0	LTL
NDC-E21003	2184	9.5	VT,LTL	NDC-E21093	1643	8.0	CIRCLED SHORT
NDC-E20145	2162	9.5	NOL	NDC-E21235	1637	7.0	VT,LTL
NDC-E21027	2132	9.5	LTL	NDC-E20058	1594	8.0	VT,LTL
NDC-E21089	1988	8.0	VT,LOD, CIRCLED	NDC-E21134	1493	8.5	CIRCLED SHORT
NDC-E21171	1966	9.0	LTL	NDC-E21053	1493	8.5	TALL
NDC-E21196	1932	8.5	CIRCLED SHORT	NDC-E20140	1442	9.0	big pot
NDC-E20234	1809	9.0	CIRCLED SHORT	NDC-E21048	1361	8.0	VT,LTL
NDC-E21235	1744	9.0	LTL	NDC-E21131	1355	9.0	LTL
NDC-E21005	1709	7.0	LOD,LATE	NDC-E21076	1295	8.5	CIRCLED SHORT
NDC-E21048	1696	7.0	VT,LTL	NDC-E21172	1253	7.0	LTL
NDC-E21017	1696	9.0	VT,LTL	NDC-E20151	1214	8.0	LTL
NDC-E20110	1689	8.5	NOL	NDC-E21113	1201	8.0	LTL

Sclerotinia stem rot disease screening



Germplasm screened

Field= 189 (96 data/line) – 4 Env
GH = 337 (30 data/line) – 2 times

Tolerant germplasm:

NDSU-N147, NDSU-N384
NDSU-N332, NDSU-N017

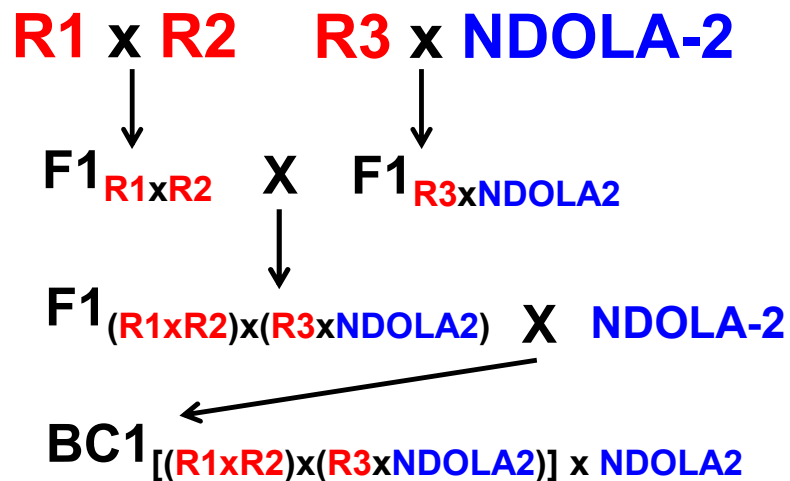
Sclerotinia stem rot disease screening

Resistant lines

Name	Adult Stage		Seedling Stage
	Field (Stem)	Greenhouse (Stem)	Greenhouse (PIT)
NDSU-N147	Resistant (1 st)	Resistant (1 st)	Resistant (2 nd – 3 rd)
NDSU-N384	Resistant (9 th)	Resistant (2 nd)	Resistant (2 nd – 3 rd)
NDSU-N332	Resistant (5 th)	Moderate resistant (17 th)	Moderate resistant (7 th)
NDSU-N017	Resistant (2 nd)	Moderate resistant (10 th)	Susceptible (62 nd)

Breeding methods – SSR resistance

Gene introgression (backcross)



BC1 seeds have been planted in the greenhouse

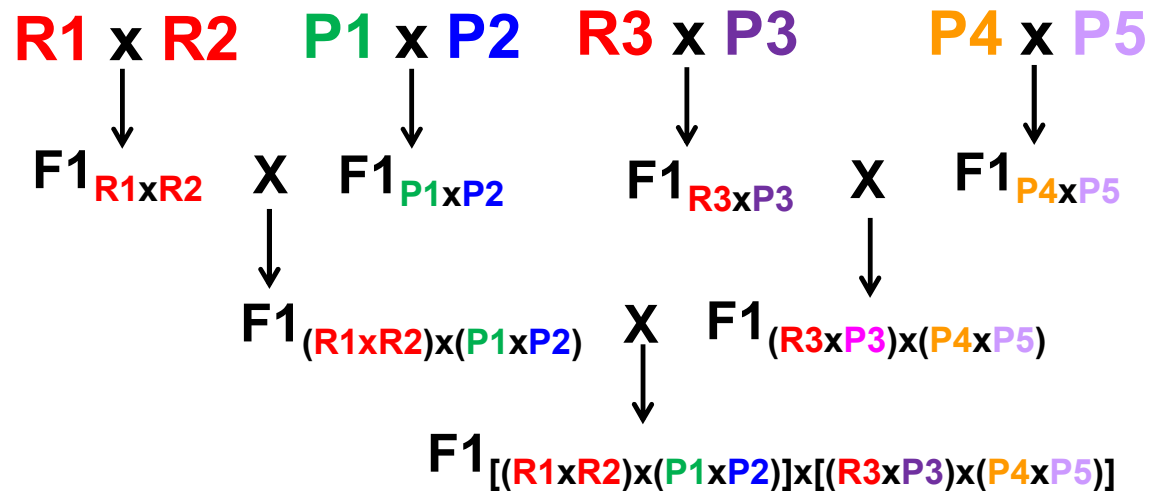
Screening & selection

BC5

Selfing, screening & selection

**Advanced Breeding lines with
SSR resistant genes**

Magic population with Resistant sources



F5 generation has been planted in the greenhouse

**New diversified population
with SSR RESISTANT GENES**
 (Multiparent advanced generation intercross population)

New research: Shattering study

Device developed by:
Dr. David Horvath, USDA

Tolerant lines (2020)

1. NDSU151000
2. NDC-E16015
3. NDC-E16152
4. Galaxy
5. Comet

325 rpm for 20 sec
Random impact method (Bruce et al. 2002)

Field Experiments:

Germplasm: 150

Samples/Rep = 20

Replication = 3

Locations: Fargo, Carrington, Osnabrock

Year = 2020, 2021

Date point/Entry = $20 \times 3 \times 3 \times 2 = 360$ pods

Greenhouse Experiment

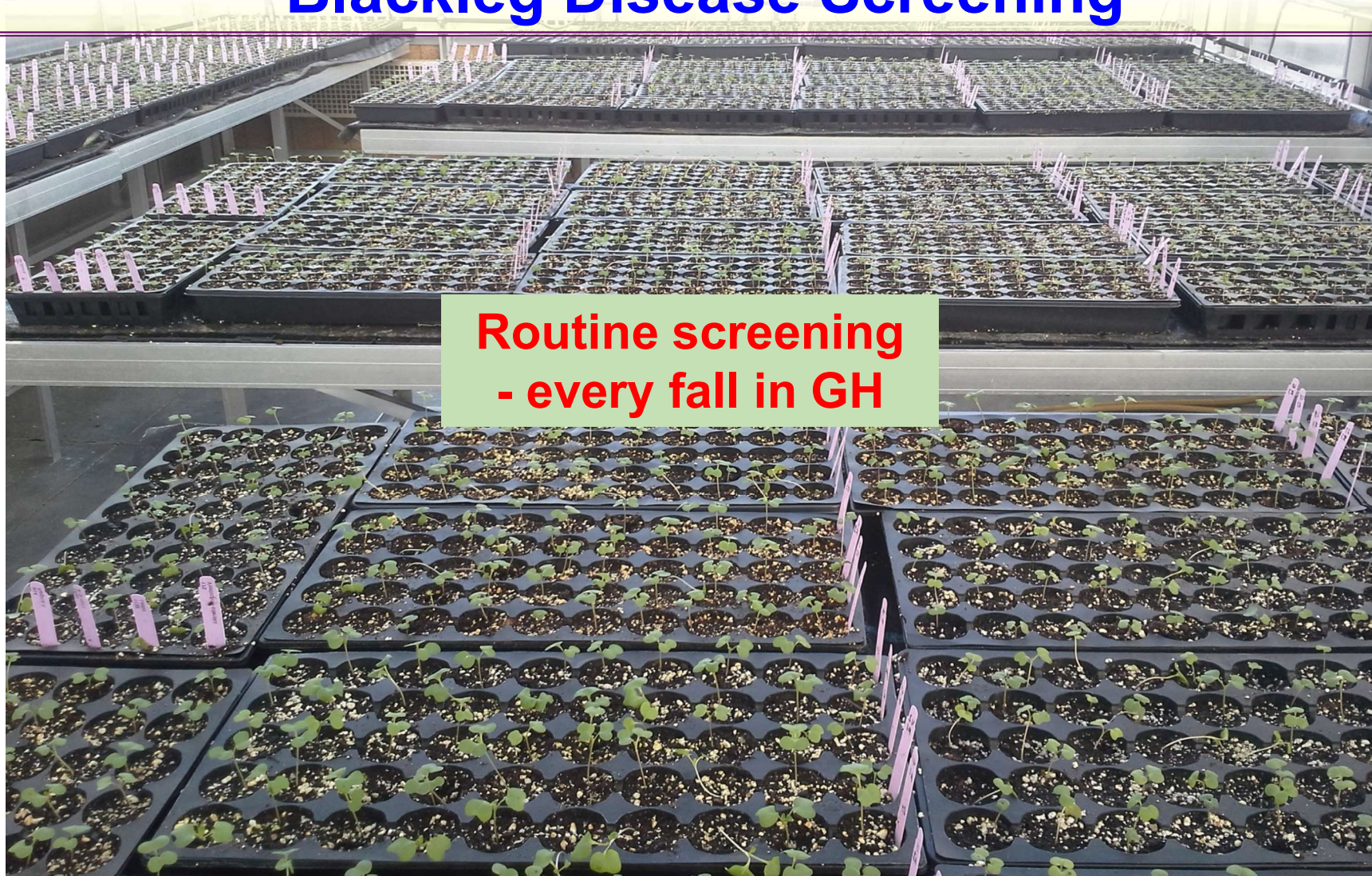
Germplasm: 150

Samples/Rep = 20

Replication = 3

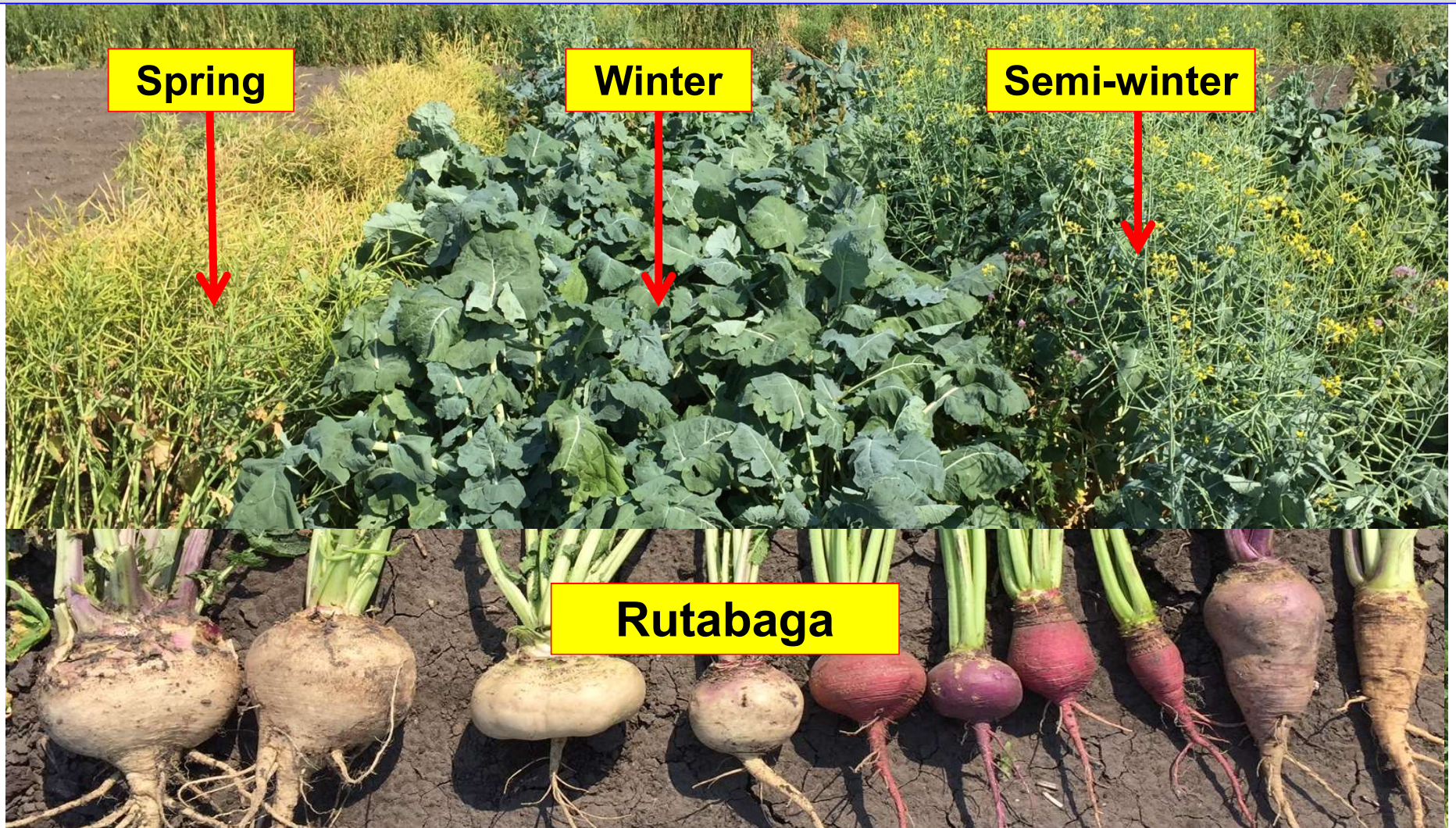
Year = 2020-2021

Blackleg Disease Screening

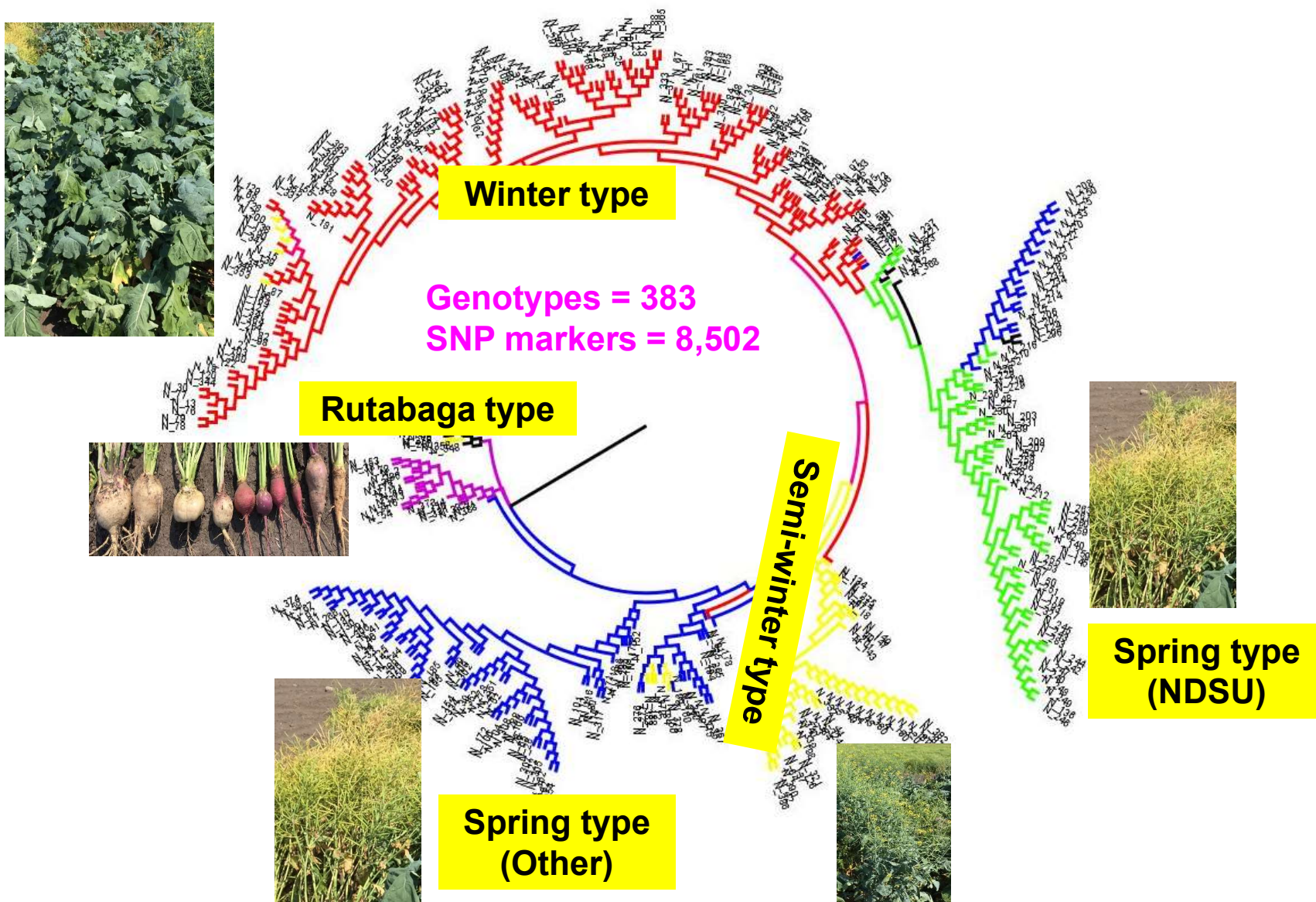


**Routine screening
- every fall in GH**

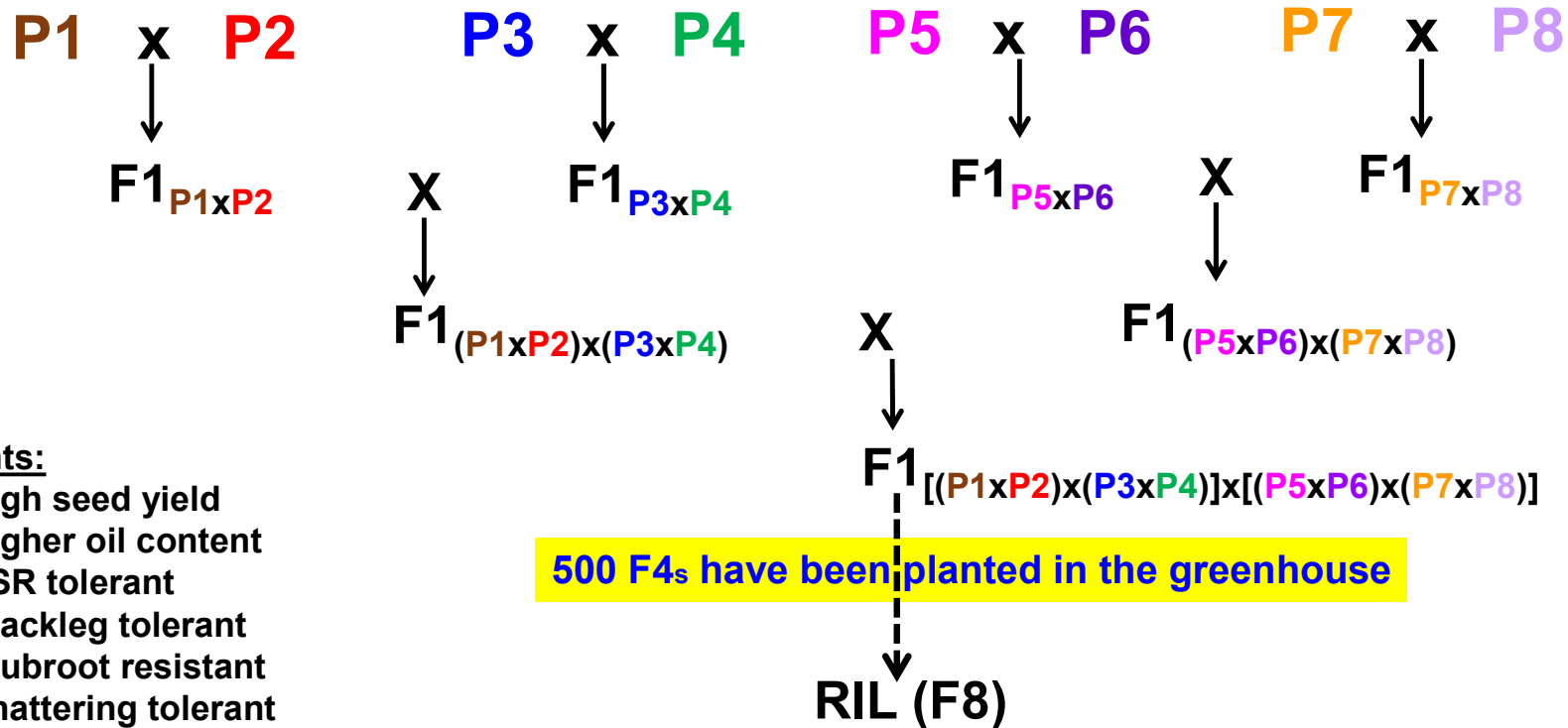
Increasing genetic diversity in spring canola (*B. napus*)



Crossing Parent Selection



Magic (Multiparent advanced generation intercross) population – 8 parents

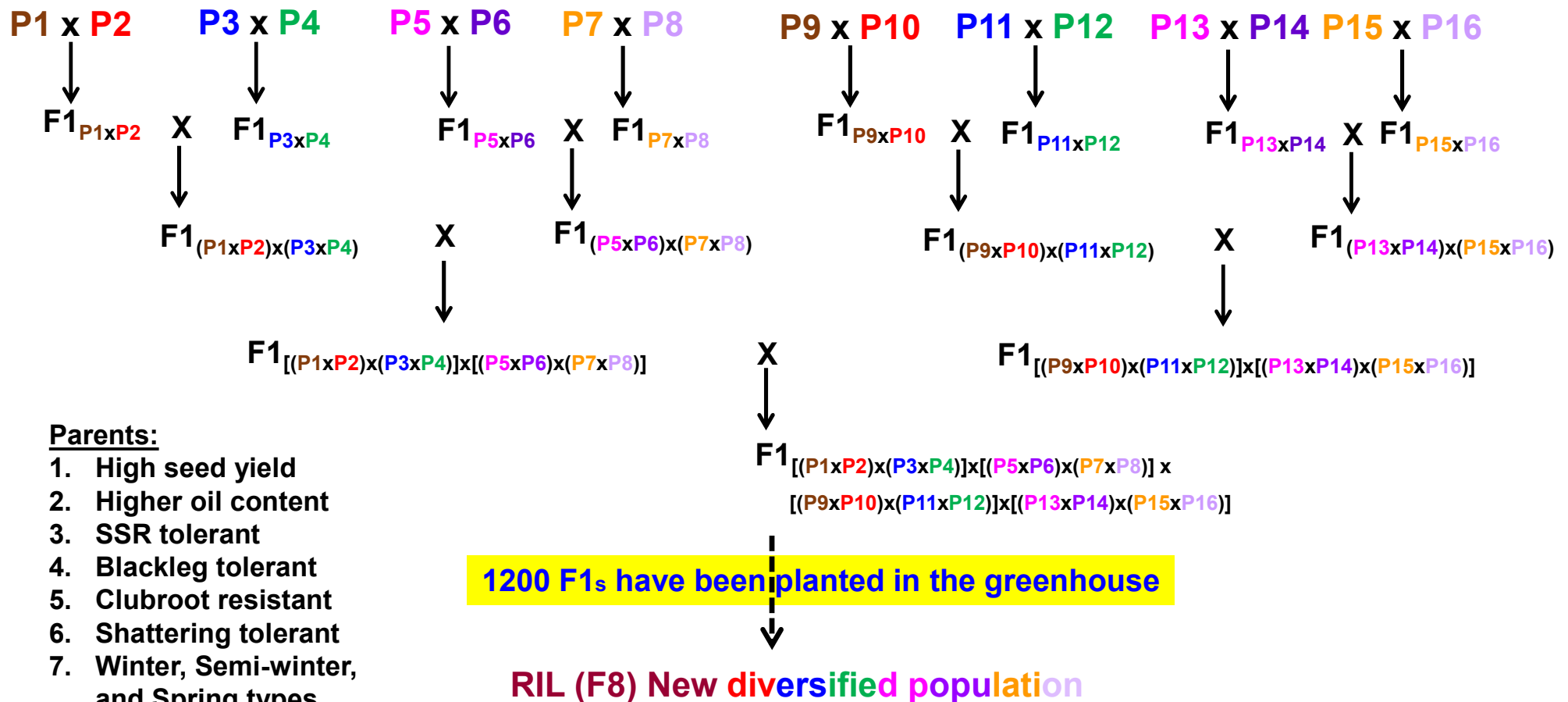


Parents:

1. High seed yield
2. Higher oil content
3. SSR tolerant
4. Blackleg tolerant
5. Clubroot resistant
6. Shattering tolerant
7. Winter, Semi-winter, and Spring types
8. Vigorous roots

- Genotyping 500 RILs
- Genomic selection
- Field evaluation

Magic (Multiparent advanced generation intercross) population – 16 parents



Breeding facilities: Winter nursery (in Chile)



Breeding facilities: Seed quality lab



**Nuclear magnetic resonance (NMR) spectroscopy
for OIL + PROTEIN**

Breeding facilities: Seed quality lab at NCI

Oil, Protein and fatty acids compositions

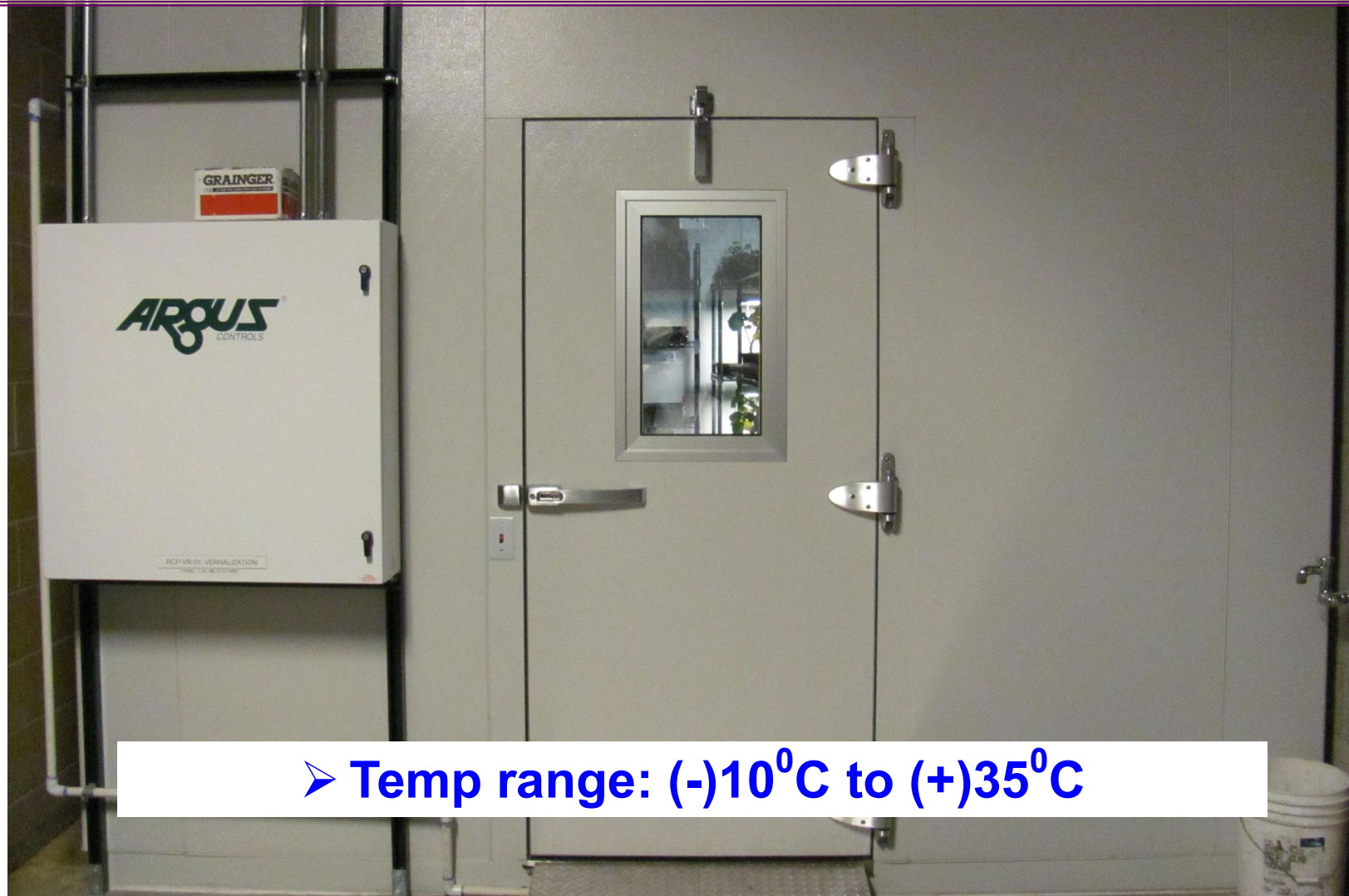
**Near Infrared Spectroscopy
(DA7250 Analyzer, Perten Instruments Inc.)**



Greenhouse facilities (6 rooms)



Plant Growth Chamber



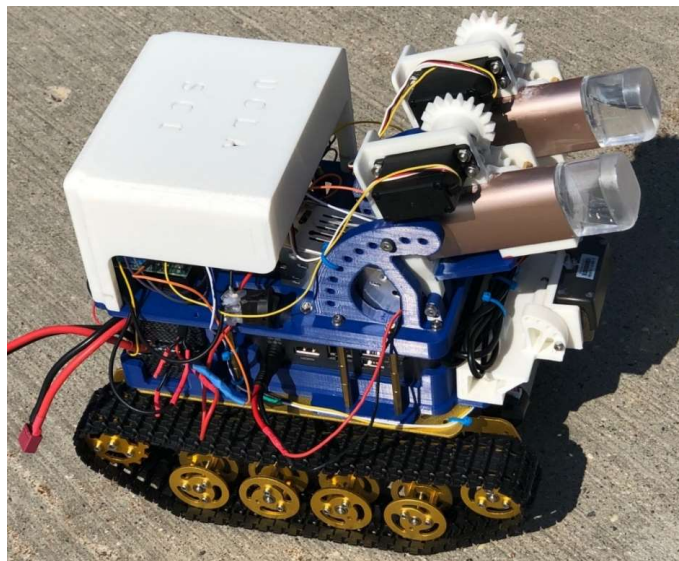
➤ Temp range: $(-)10^{\circ}\text{C}$ to $(+)35^{\circ}\text{C}$

Phenotyping

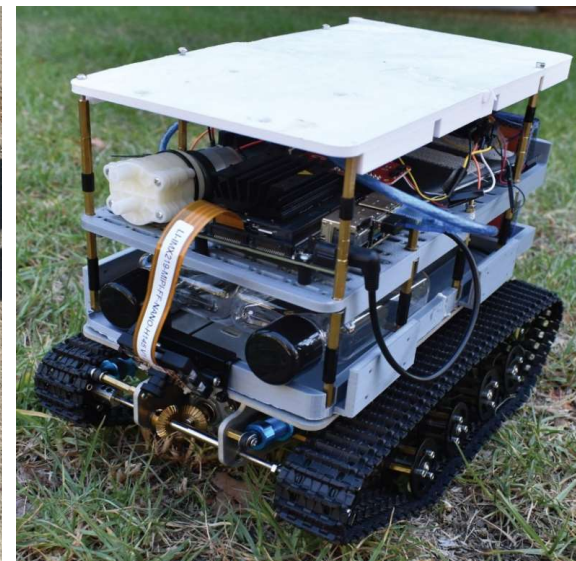
Research: ROBOT and DRONE in Breeding Program



Drone – DJI M200 V2 with MicaSense Multispectral (RedEdge) camera



Small autonomous Robot

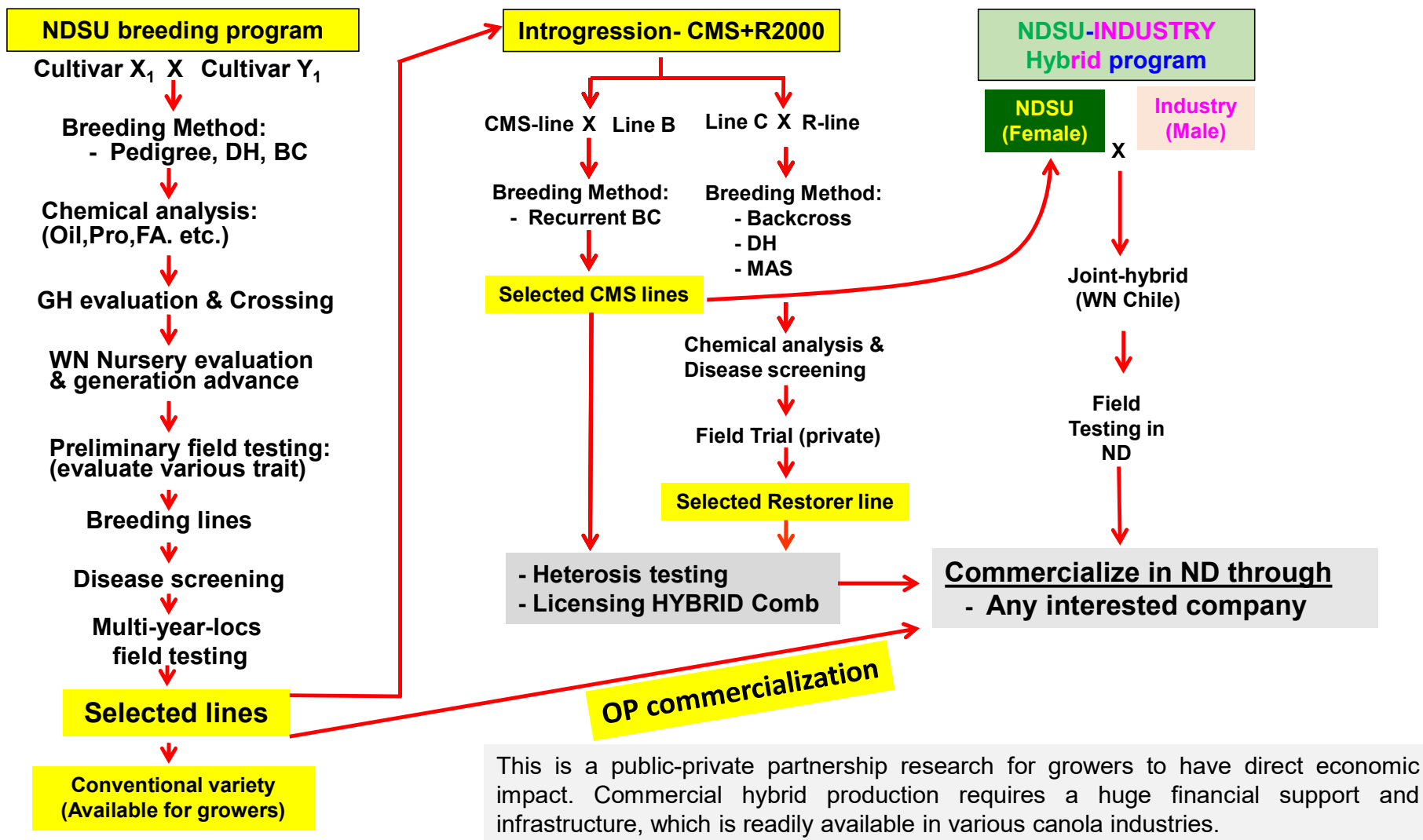


Small autonomous Robot

Collaborators:

Dr. Paulo Flores	:	Ag. Bio. System Engineering, NDSU
Dr. Khalid Jawed	:	University of California, Los Angeles

NDSU-Private Joint-Research: Overview



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- **Northern Canola Growers' Association**
- **National Institute of Food and Agriculture (NIFA)**
- **State Board of Ag. Res. and Education's (SBARE)**
- **National Sclerotinia Initiative (NSI) USDA-ARS**

NDSU-Collaboration with Public Researchers

Dr. Phil McClean	:	Professor (Genomics), NDSU
Dr. Luis Del Rio	:	Professor (Plant Pathology), NDSU
Dr. Janes Anderson	:	USDA, Fargo
Dr. David Horvath	:	USDA, Fargo
Dr. Khalid Jawed	:	UC Los Angels, CA
Dr. Janet Knodel	:	Professor (Entomology), NDSU
Dr. Mohi Quadir	:	Asstt. Prof., Coatings & Polymeric Mat., NDSU
Dr. Venkat Chapara	:	Assistant Research Professor, NDSU
Dr. Natsuki Fujiwara	:	Northern Crop Institute, Fargo
Dr. Mike Ostlie	:	Carrington Research Extension Center
Blaine Schatz	:	Carrington Research Extension Center
Bryan Hanson	:	Langdon Research Extension Center
Eric Eriksmoen	:	North Central Research Extension Center, Minot
John Rickertsen	:	Hettinger Research Extension Center
Cameron Wahlstrom	:	Williston Research Extension Center
Brian Otteson	:	Agronomy Seed Farm, Casselton
Barry Coleman	:	Northern Canola Growers' Association

Acknowledgements (Breeding team)



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Research Specialists (Canola)



Kreg Kercher
Research Specialists (Flax)

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Ahasanul Hoque
(Ph.D. from 2017)



TM Shaikh
(Ph.D. from 2019)



Afrina Rahman
(Ph.D. from 2021)



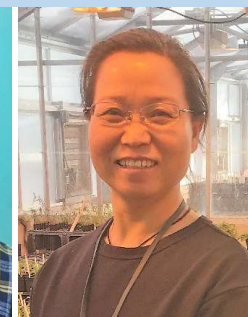
Zahangir Alam
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Shakil Hosain
(M.S. from 2019)



Ashok Mandal
(M.S. From 2019)



Puying Zheng
(M.S. from 2016)