Nexera® Canola Performance in North Dakota and Minnesota

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Dow AgroSciences™

Abstract

Dow AgroSciences and Mycogen Seeds have focused on the development of canola cultivars which produce heart healthy oils having increased stability for foodservice and consumer packaged-goods applications. Such oils reduce the need for hydrogenation and provide nutritional advantages to soy, palm and many other oils used by the food industry. Open-pollinated spring varieties and hybrids with Clearfield or Roundup Ready herbicide tolerant traits have been developed and tested in the Prairie Provinces of Canada and in northern ND and northwest MN. The objectives of this presentation are to document the agronomic performance and characterize certain quality aspects of Omega-9 canola oil. In addition to the functional and dietary advantages of the oil, contract production of specialty canola affords farmers additional cropping options.

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Presentation Outline

- History of Product Development
- Breeding Capabilities
- Agronomic Performance
- Oil Quality Parameters
- Crop Production
- Oil Utilization
- Future Developments

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Agrigenetics / Lubrizol

- Agrigenetics was part of the Lubrizol Corporation in the late 1980's
- Lubrizol's Specialty Vegetable Oil (SVO) Division was looking for naturally stable vegetable oils to use as base oils for their lubricants business and also was developing food applications for these oils
- Several programs were funded towards development of high stability canola oil:
  - Sungene Technologies (microspore research)
  - University of Idaho (mutagenesis research)
  - Agrigenetics (oil applications research)

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Agrigenetics / Mycogen / Dow Elanco

- The breeding program at Agrigenetics in the early 1990's was conducted in the Madison WI greenhouses using contract field testing in Canada
- RFLP markers were used to map the loci controlling the high oleic / low linolenic trait
- In the 1990's, ownership of the Agrigenetics canola program went from Lubrizol to Mycogen Corporation
- In the late 1990's, Dow Elanco Canada began testing and scale up of the Agrigenetics high oleic / low linolenic canola lines

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Dow AgroSciences / Mycogen Seeds

- In 1998, Dow AgroSciences (DAS) fully acquired Mycogen and the high oleic / low linolenic canola breeding program was moved from Madison WI to Saskatoon SK
- DAS launched the Nexera® brand for it's high oleic / low canola varieties

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Herbicide Tolerance: Clearfield

- **Dow AgroSciences' customers in Japan, wanted certification that the grain they were purchasing was from a non-GM source. This request prompted DAS to begin development of Clearfield® (CL) OP varieties.**
- **DAS licensed PM1/PM2 sources, QA protocols from BASF and introduced the CL trait into proprietary Nexera® germplasm producing a series of commercial OP varieties.**

® Clearfield is a registered trademark of BASF

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Herbicide Tolerance: Roundup Ready

- **To align with the glyphosate management programs of many canola growers, DAS also began developing Roundup Ready® (RR) varieties.**
- **DAS licensed RT73, markers and QA protocols from Monsanto and introduced the RR trait into proprietary Nexera® germplasm producing a series of commercial OP varieties.**
- **This broadening of the product offering allowed DAS/Mycogen Seeds access to many more potential acres, especially in areas were ALS-resistant kochia is present.**

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Transition to Hybrids

- To further enhance the yield and agronomic performance of Nexera® varieties, DAS is in the process of transitioning from OP varieties to hybrids.
- DAS has chosen the Ogura cms/Rfo system for our hybrid development and licensed the R2000 Rf source from INRA.
- DAS is developing cms and Rfo parent lines for hybrid development. Stable parent lines have been developed and subsequent hybrids have been verified to be of Nexera® seed quality.
- Dow AgroSciences' first Nexera® hybrids are in Canadian registration trials.

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Modern Breeding Capabilities

- DAS is now employing state of the art technology to support our Nexera® breeding program
- Di-haploid production via microspore culture
- High throughput analysis for seed quality including non-destructive FTNIR single seed analysis
- Marker assisted selection:
  - SSR / SNP based marker systems – Indianapolis and Saskatoon
  - Proprietary set of markers for key oil quality
  - Key set of markers for genetic distance establishment
  - Key set of markers established for Quality Control / Quality Assurance of commercial and pre-commercial seed lots
  - Markers for disease resistance
  - ExZact™ Technology for precision gene insertion

™ ExZact is a trademark of Dow AgroSciences LLC

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Nexera Development Summary

- Invention of Nexera® trait
- Ongoing breeding improvements for yield, agronomic traits, disease resistance and maturity while maintaining Omega-9 quality oil.
- Modern Breeding Capabilities
  - Di-haploids
  - FTNIR
  - Marker assisted selection
  - ExZact™ Technology
- Herbicide Tolerance
  - Clearfield
  - Roundup Ready
- Hybrids
- Future traits

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ND 2010 Canola Acreage

County	Acres	% of Total
Cavalier	272,458	21.5%
Towner	99,799	7.8%
Ward	92,422	7.3%
Bottineau	88,016	6.9%
Renville	81,525	6.4%
McLean	67,615	5.3%
Rolette	67,095	5.2%
Hettinger	61,537	4.8%
Mountrail	56,837	4.4%
Ramsey	49,799	3.9%
Burke	47,421	3.7%
McHenry	41,822	3.3%
Total	1,026,346	81.0%
All counties	1,266,861	

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Canola MEGA Plot Testing

- Testing is contracted at 6 locations in northern ND and northwest MN.
- Clearfield and Roundup Nexera® Open-pollinated varieties and hybrids are tested in a RCBD design.
- Plots are 15 feet wide X 50 feet long with 3 replications. Plot design minimizes inter-plot competition between OP's and hybrids.
- Contractors collect agronomic & yield data.
- Data and seed samples returned to Mycogen.
- Oil analysis conducted by DAS
- Cross location data analysis compiled by DAS

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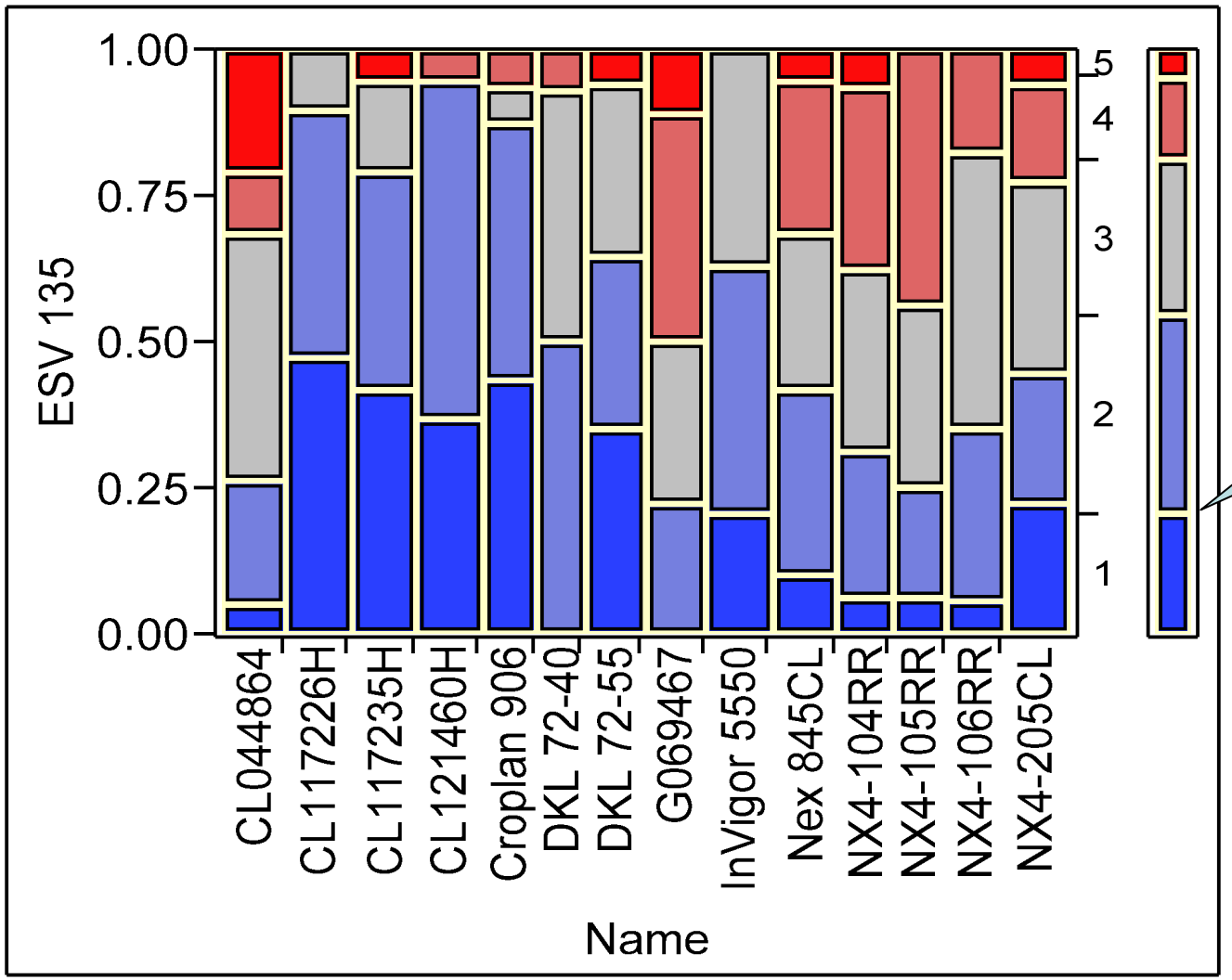
Early Season Vigor (1 to 5 Rating)



A high proportions of dark blue (1) and blue (2) are preferred, i.e. more vigorous

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Days To Flower (DTF)

LSMeans Differences Tukey HSD
α =0.050

Entry							Least Sq Mean
G069467	A						47.161957
CL044864	A						47.079066
NX4-106RR	A	B					46.719714
CL121460H	A	B					46.627174
NX4-205CL	A	B					46.388989
NX4-105RR	A	B	C				46.273932
NX4-104RR		B	C	D			45.487230
CL117235H			C	D	E		45.077829
Croplan 906			C	D	E		45.013966
CL117226H				D	E		44.755049
InVigor 5550				D	E	F	44.625937
Nex 845CL					E	F	G	44.174045
DKL 72-40						F	G	43.402330
DKL 72-55							G	43.082221

Levels not connected by same letter are significantly

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Days To Maturity (DTM)

LSMeans Differences Tukey HSD
α =0.050

Entry		Least Sq Mean
Croplan 906	A	87.588501
CL044864	A	87.572602
CL121460H	A	87.559684
NX4-105RR	A	87.551969
DKL 72-55	A	87.547316
NX4-106RR	A	87.525864
InVigor 5550	A	87.520932
G069467	A	87.459035
NX4-104RR	A	87.452265
DKL 72-40	A	87.442468
CL117226H	A	87.404674
Nex 845CL	A	87.404674
CL117235H	A	87.391757
NX4-205CL	A	87.156654

Levels not connected by same letter are significantly

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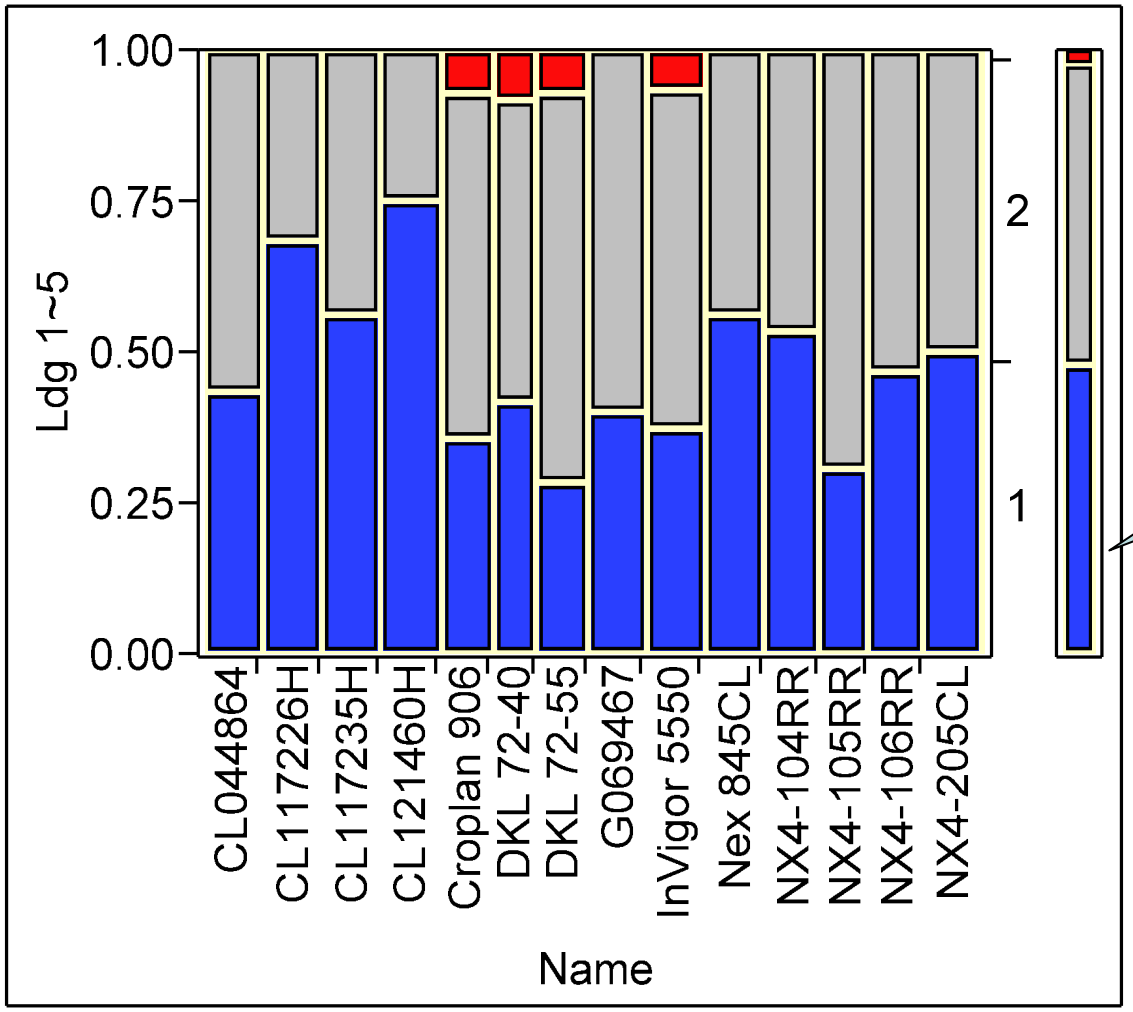
Root Lodging (1 to 5 Rating)



A high proportion of dark blue (1) is preferred, but grey (2) is still very acceptable.

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Plant Height (Inches)

LSMeans Differences Tukey HSD
α =0.050

Entry		Least Sq Mean
CL121460H	A	48.060632
InVigor 5550	A	47.860066
NX4-106RR	A	47.546960
CL117226H	A	46.671293
NX4-205CL	A	46.474573
G069467	A	46.088025
CL117235H	A	45.747531
Croplan 906	A	45.743999
NX4-104RR	A	45.397015
DKL 72-40	A	45.198563
CL044864	A	45.184457
DKL 72-55	A	44.749677
Nex 845CL	A	44.616807
NX4-105RR	A	44.542833

Levels not connected by same letter are significantly different.

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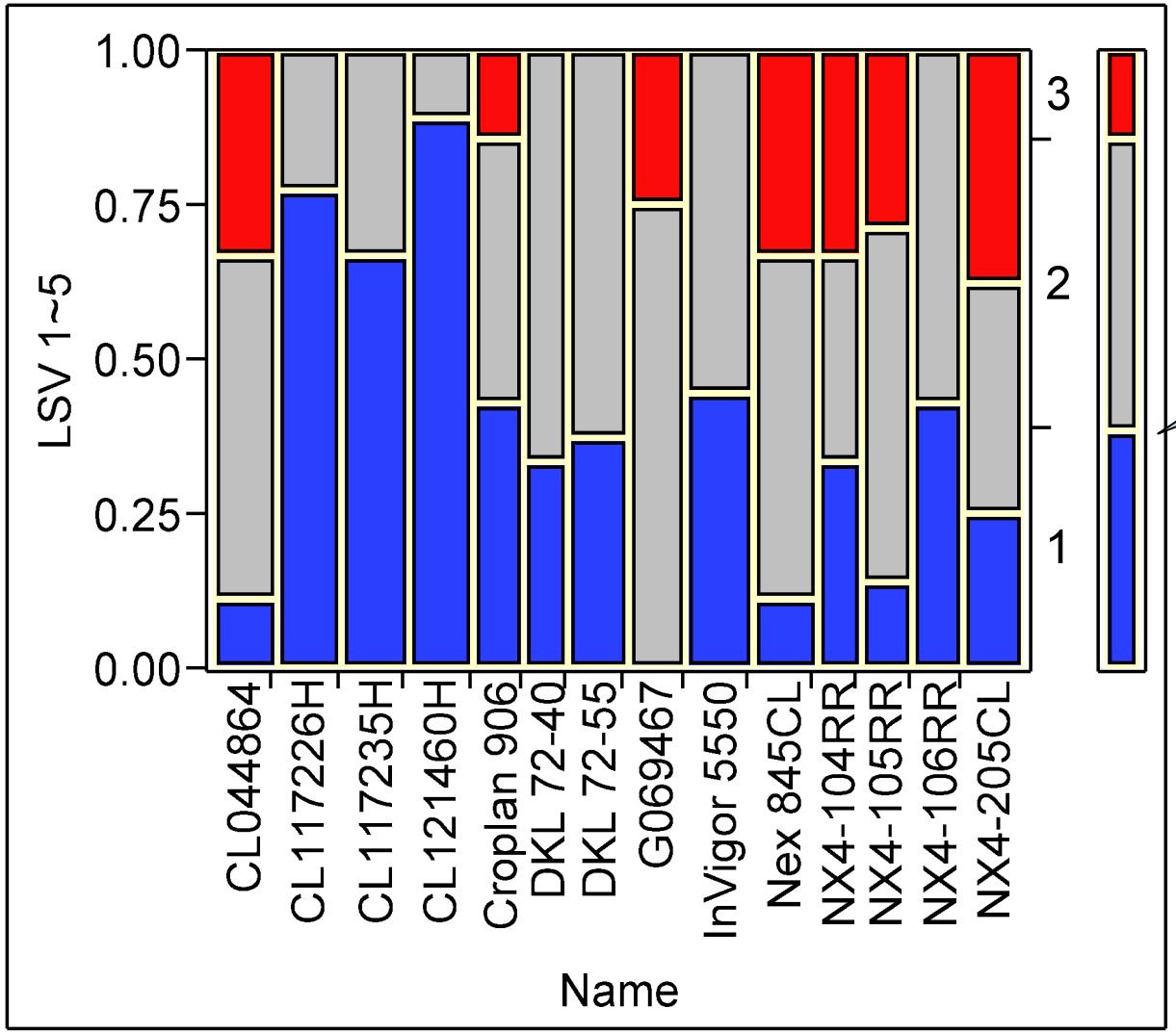
Late Season Vigor (1 to 5 Rating)



A high proportion of dark blue (1) is preferred, but grey (2) is still very acceptable.

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Yield (Lbs/Ac @ 8.5% Seed Moisture)

Name LSMeans Differences Tukey HSD
α =0.050

Entry					Least Sq Mean
DKL 72-55	A				2706.7910
CL117226H	A	B			2658.3324
InVigor 5550	A	B			2616.0954
CL117235H	A	B	C		2598.6137
DKL 72-40	A	B	C	D	2583.9658
Croplan 906	A	B	C	D	2552.9378
CL121460H	A	B	C	D	2528.3539
Nex 845CL	A	B	C	D	2467.7994
NX4-106RR	A	B	C	D	2417.1001
NX4-104RR	A	B	C	D	2397.7299
CL044864		B	C	D	2330.1408
G069467			C	D	2267.8545
NX4-105RR			C	D	2257.8533
NX4-205CL				D	2247.6375

Levels not connected by same letter are significantly different.

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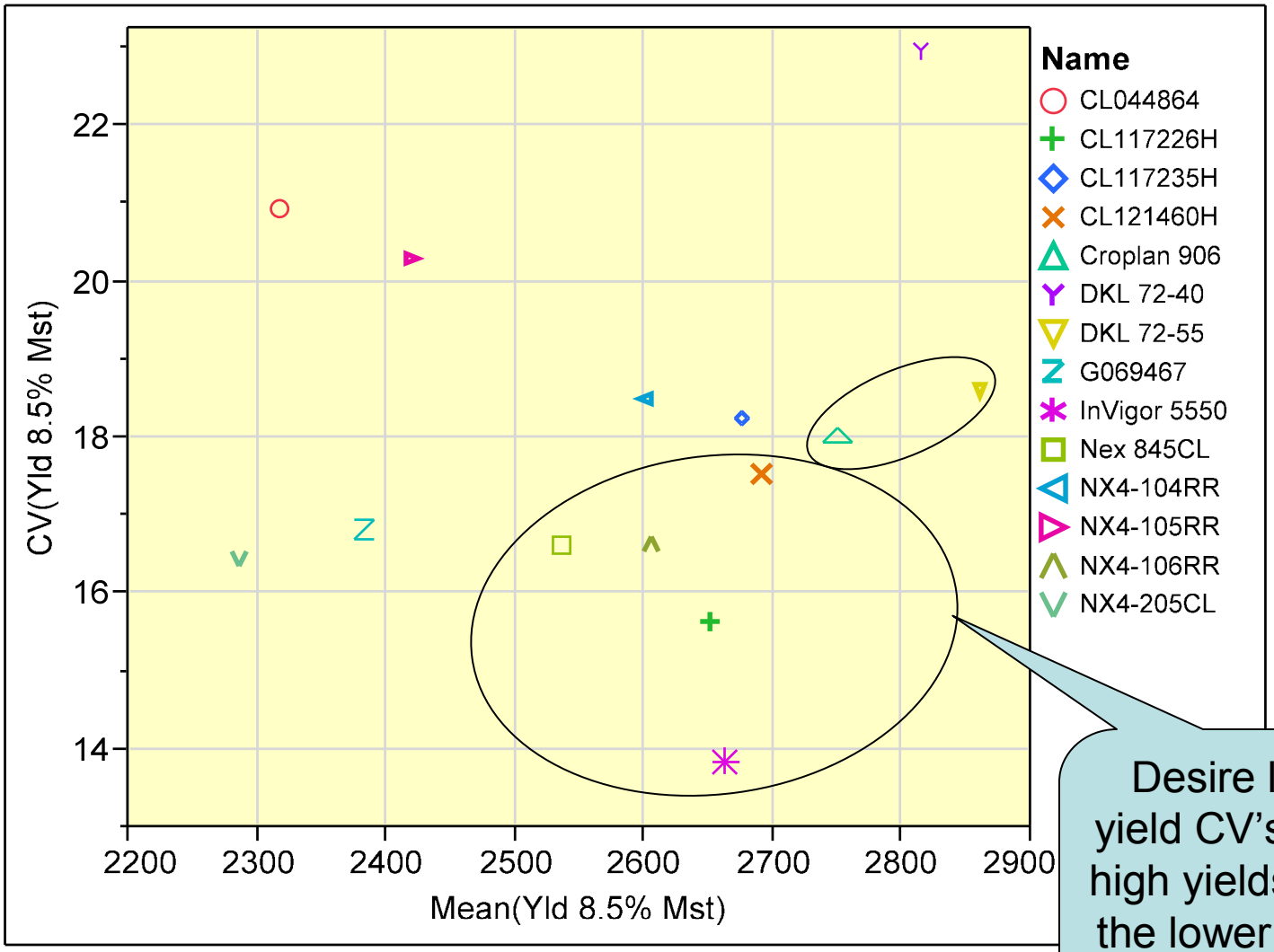
Yield Stability (Yield CV by Mean Yield)



Desire low yield CV's and high yields, i.e. the lower right quadrant.

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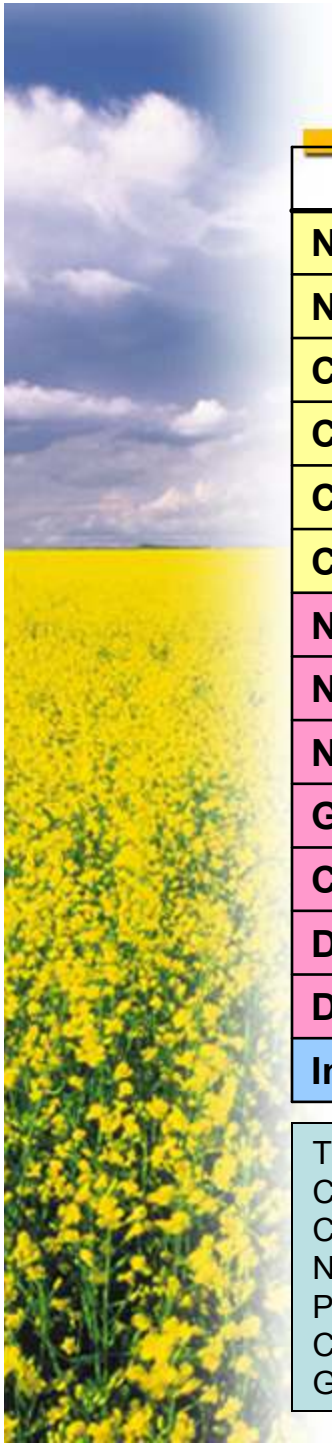

Analytical Assays (4 locs in 2010)

Name	T.Sats	C18:1	C18:3	Oil	Pro NIR	Chl NIR	Gluc NIR
Nex 845CL	6.78	76.25	2.07	48.55	22.87	3.27	9.62
NX4-205CL	6.63	76.98	1.38	47.69	23.57	5.80	10.72
CL044864	6.79	74.98	1.60	45.41	26.23	5.41	12.99
CL117226H	6.91	75.86	1.61	47.33	23.75	6.56	10.78
CL117235H	6.94	75.69	1.56	46.17	24.35	4.70	11.54
CL121460H	6.74	75.83	1.59	48.45	23.49	5.78	10.74
NX4-104RR	7.01	76.76	1.72	46.91	22.28	6.54	11.38
NX4-105RR	6.94	75.52	1.70	48.16	21.58	5.33	10.58
NX4-106RR	7.21	75.76	1.69	46.68	21.85	5.88	10.22
G069467	7.26	75.16	1.68	45.34	23.81	4.59	12.34
Croplan 906	7.30	63.12	7.65	46.18	23.17	4.76	11.00
DKL 72-40	7.13	64.49	7.64	48.08	23.96	5.94	12.50
DKL 72-55	7.10	65.43	7.25	47.77	23.80	6.55	11.00
InVigor 5550	6.60	61.28	9.95	45.84	25.31	6.54	13.77

T. Sats = Total Saturates
C18:1 = Oleic Acid % (FAME Analysis)
C18:3 = Linoleic Acid % (FAME Analysis)
NMR = Oil % at Dry Wt Basis
Pro NIR = % Protein by NIR Analysis
Chl NIR = Chlorogenic Acid by NIR Analysis
Gluc NIR = Glucosinolates by NIR Analysis

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Omega-9 Canola Oil Properties

Great Taste, Superior Performance, & Outstanding Health

Oil	OSI	Oleic C18:1	Linoleic C18:2	Linolenic C18:3	Total Sats	Total Trans	Trans + Sats
Omega-9 Canola Oil	OSI 17	73%	15%	<3%	<7%	1%	<8%
Omega-9 Sunflower Oil	OSI 20	87%	5%	0%	9%	<1%	<10%
PH Canola	OSI 10	79	8	<1	11	19	30
Canola	OSI 7	62	20	9	7	2	9
Low Linolenic Canola	OSI 12	64	24	4	7	1	8
PH Soybean	OSI 10	50	31	2	16	20	36
Soybean	OSI 6	23	54	8	15	2	17
Low Linolenic Soybean	OSI 8	26	55	3	16	2	18
Extra Virgin Olive Oil	OSI 12	60	15	1	20	<1	<21

PH = Partially Hydrogenated

- High stability (OSI)
- High Omega-9 (oleic acid) content
- Low linolenic acid content
- Low in saturates and trans fat

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Nexera® Production

- In the US, planting seed of Nexera® canola sold through Mycogen Seeds.
- Seed is only sold to growers having a total crop production contract from an oilseed processor, e.g. Bunge, ADM.

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DAS Works with 80% of NA Canola Processors

ADM

BUNGE

LDM FOODS

LouisDreyfus Commodities

RICHARDSON

VITERRA™
Essential ingredients. Global success.

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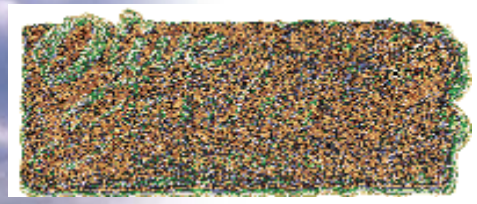
Over 100 North America Users of Dow AgroSciences' Omega-9 Canola Oil



Red Lobster

Jack in the box

abc COUNTRY RESTAURANT

POP Weaver MICROWAVE POPCORN

BURGERVILLE

Trail's End America's Best Popcorn

Church's CHICKEN SINCE 1952

TACO BELL

Biscuitville FRESH BISCUITS. FRIENDLY FOLKS.

Sodexho

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CHEESEBURGER in Paradise BAR AND GRILL

Bashas' Groceries on the Go

RoyalCaribbean INTERNATIONAL

BON APPÉTIT MANAGEMENT COMPANY food services for a sustainable future®

ina's breakfast · lunch · dinner

RUSH UNIVERSITY MEDICAL CENTER

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Future Traits

- DAS is working on developing new traits in our Nexera® canola varieties:
  - DHA (Docosahexaenoic acid) Omega-3 fatty acid
    - DHA has been shown to provide cognitive/brain function benefits as well as cardiovascular benefits and thus stands apart from other Omega-3 fatty acids
    - DAS is collaborating with Martek, manufacturer of DHA via algal fermentation, to produce DHA in canola oil by transforming Martek's proprietary gene set into *Brassica napus*
    - Goal is to reduced the cost of production thereby allowing incorporation of DHA into a greater range of consumer products
  - Reduced saturated fatty acids
    - Nutritional guidelines continue to promote the importance of reducing the amount of saturated fat in our diets
    - Canola oil is already an excellent oil in this aspect being low in saturated fat
    - DAS is pursuing approaches to further reduce the level of saturated fat in our Omega-9 canola oil

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