Canola Diseases in North Dakota - Research update

Venkat Chapara, PhD
Langdon REC/NDSU

Major Canola Diseases and their Management

- Blackleg

- White Mold

Clubroot

Symptoms of Blackleg on Canola

http://www.ag.ndsu.edu/pubs/plantsci/crops/pp1367-2.jpg

http://www.ag.ndsu.edu/archive/entomology/ndsucpr/Years/2005/may/26/blackleg_stem.jpg

Blackleg

- Yearly survey done by Dr. Del Rio, NDSU, Fargo

Blackleg	2016	2017	2018	2019
Fields Scouted	82	83	70	84
Fields with Blackleg	73	41	14	44
Mean Blackleg Severity (%)	14	10	2	4

Del Rio (Personal Communication, 2019 NCGA)

Research in Langdon for Blackleg Management

- Germplasm screening
- Seed treatments
- Foliar fungicides

Seed treatment evaluation to manage blackleg on Canola

Seed Treatment	Blackleg DSI (0-5)	Blackleg Incidence (%)	Yield (lbs/a)	Test Weight (lbs/bu)
Product A	1.35	61	2409	51.25
Product A + C	1.38	62	2956	51.48
Product B	1.37	67	2541	51.5
Product B + C	1.94	76	2729	51.5
Product B1+ D	1.57	68	2488	51.43
Product B2+ D	1.4	69	2481	51.43
Product E+ F	1.36	62	2611	51.3
Mean Blackleg	1.48	66.43	2602	51.4
CV %	37	23.9	19.9	0.54
LSD	NS	NS	NS	NS
P-Value (α=0.05)	NS	NS	NS	NS

Fungicidal Trial to Manage Blackleg on Canola

Table 1: Efficacy of commercially available fungicides in managing blackleg and their influence on yield and test weight.

			Blackleg			
Treatments	**Dosage (oz/A)**	**Application Timing**	**Incidence (%)**	**DSI (0-5)**	**Yield (lbs/a)**	**Test Weight (lbs/bu)**
NON-TREATED CHECK	NA	NA	59	1.44	2736	51.76
EXPERIMENTAL 1	8.22	2-4 leaf stage	22	0.30	3034	52.01
EXPERIMENTAL 2	12.33	2-4 leaf stage	35	0.51	2815	52.17
EXPERIMENTAL 3	16.44	2-4 leaf stage	46	0.73	2797	52.08
EXPERIMENTAL 4	13.70	2-4 leaf stage	39	0.57	2816	52.12
EXPERIMENTAL 5	13.70	2-4 leaf stage	37	0.59	2857	52.04
EXPERIMENTAL 6	5.48	2-4 leaf stage	34	0.43	2826	52.12
EXPERIMENTAL 7	3.43	2-4 leaf stage	40	0.60	2861	52.24
EXPERIMENTAL 8	5.48	2-4 leaf stage	33	0.46	2744	52.07
HEADLINE	5.48	2-4 leaf stage	42	0.89	2848	51.96
Mean			**39**	**0.65**	**2833**	**52.05**
C.V. %			**29**	**63**	**8.2**	**0.41**
LSD 5%			**16**	**0.59**	**NS**	**NS**
p-Value (α at 0.05%)			**0.01**	**0.03**	**NS**	**NS**

Surfactant @ 6.4 fl. oz/A was added in treatments Exp 7, Exp 8 and Headline.

White Mold

- Yearly survey done by Dr. Del Rio, NDSU, Fargo

White Mold	2016	2017	2018	2019
Fields Scouted	82	83	70	84
Fields with White Mold	49	5	6	12
Mean White Mold Severity (%)	7	<1	<1	<1

Del Rio (Personal Communication, 2019 NCGA)

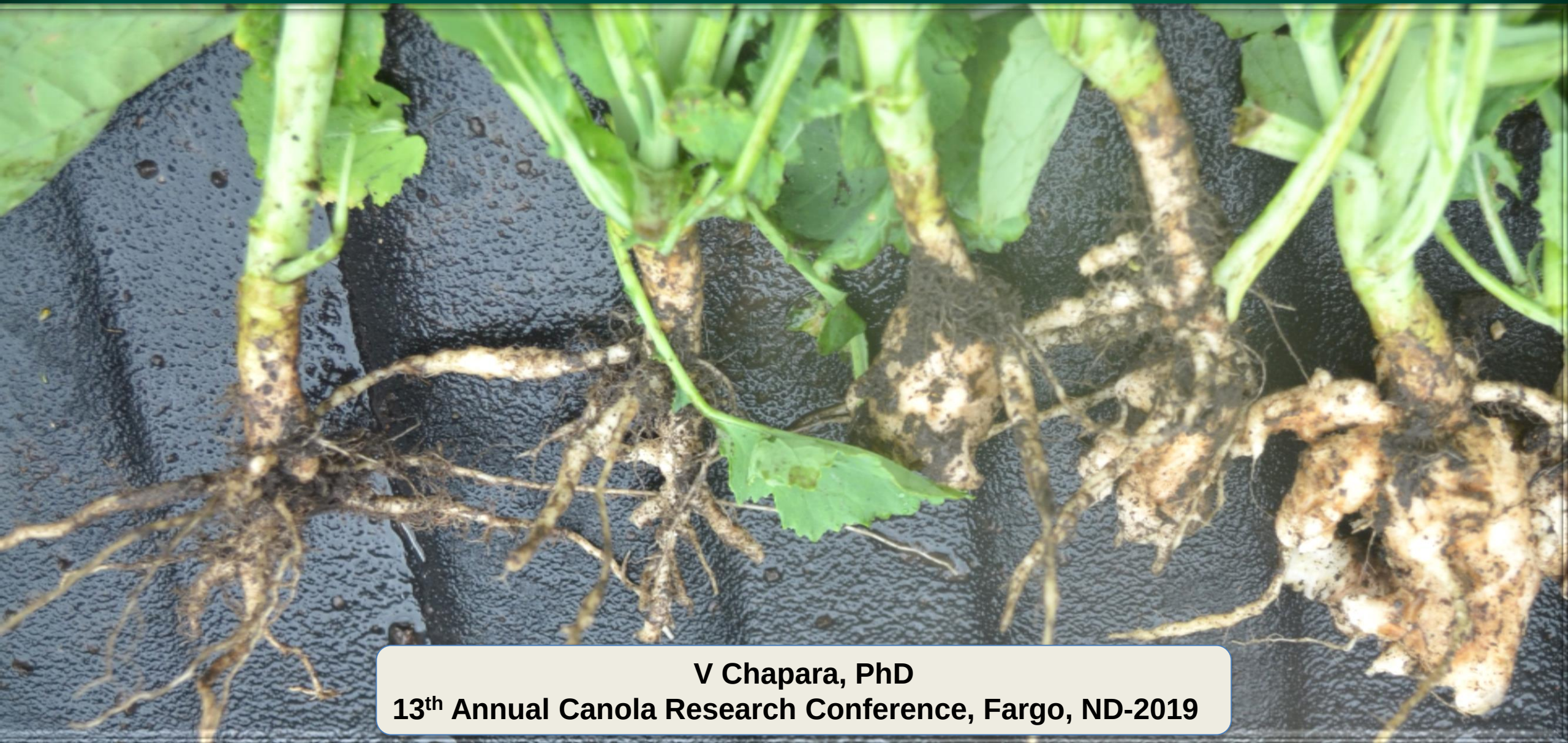
White Mold on Canola-Fungicide Research

Table 1: Efficacy of commercially available fungicides in managing white mold and their influence on yield and test weight.

		WHITE MOLD ON CANOLA			
Treatments	**Dosage/A**	**Incidence (%)**	**DSI (0-5)**	**Yield (lbs/A)**	**Test Weight (lbs/bu)**
Non-treated Check	CHK	27.5	1.16	3248	50.6
EXPERIMENTAL	13.7 oz + .125 v/v	9.0	0.42	3566	50.9
PROLINE+NIS	5 oz + .125 v/v	16.5	0.79	3529	50.7
PRIAXOR+NIS	4 oz + .125 v/v	21.5	1.05	3716	50.8
QUASH+NIS	3 oz + .125 v/v	20.0	0.81	3571	50.7
TOPSIN	1.0 lb	17.0	0.76	3556	50.8
QUASH+TOPSIN	3 oz + ½ lb	18.0	0.83	3828	50.5
MEAN		**18.5**	**0.83**	**3574**	**50.7**
C.V. %		**43.2**	**49.5**	**11.4**	**0.58**
LSD 5%		**NS**	**NS**	**NS**	**NS**
p-Value (α at 0.05%)		**NS**	**NS**	**NS**	**NS**

Treatments were applied at 20% bloom and 12 days after first spray.

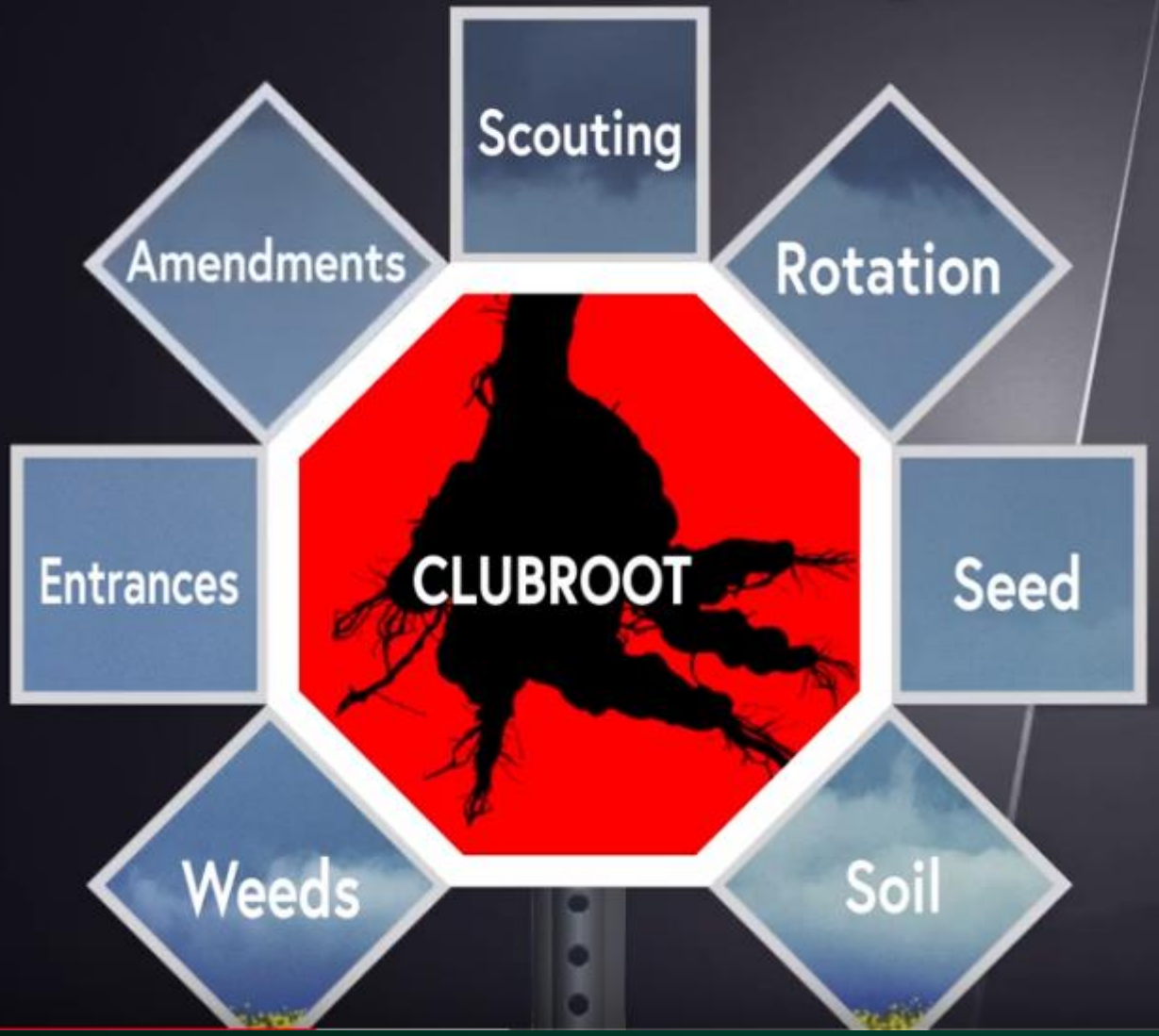
2019-Research Updates of Clubroot on Canola



V Chapara, PhD

13th Annual Canola Research Conference, Fargo, ND-2019

Best Management Practices



Soil amendments, such as lime

Source: Canola Council of Canada

2019- Clubroot on Canola Survey In North Dakota

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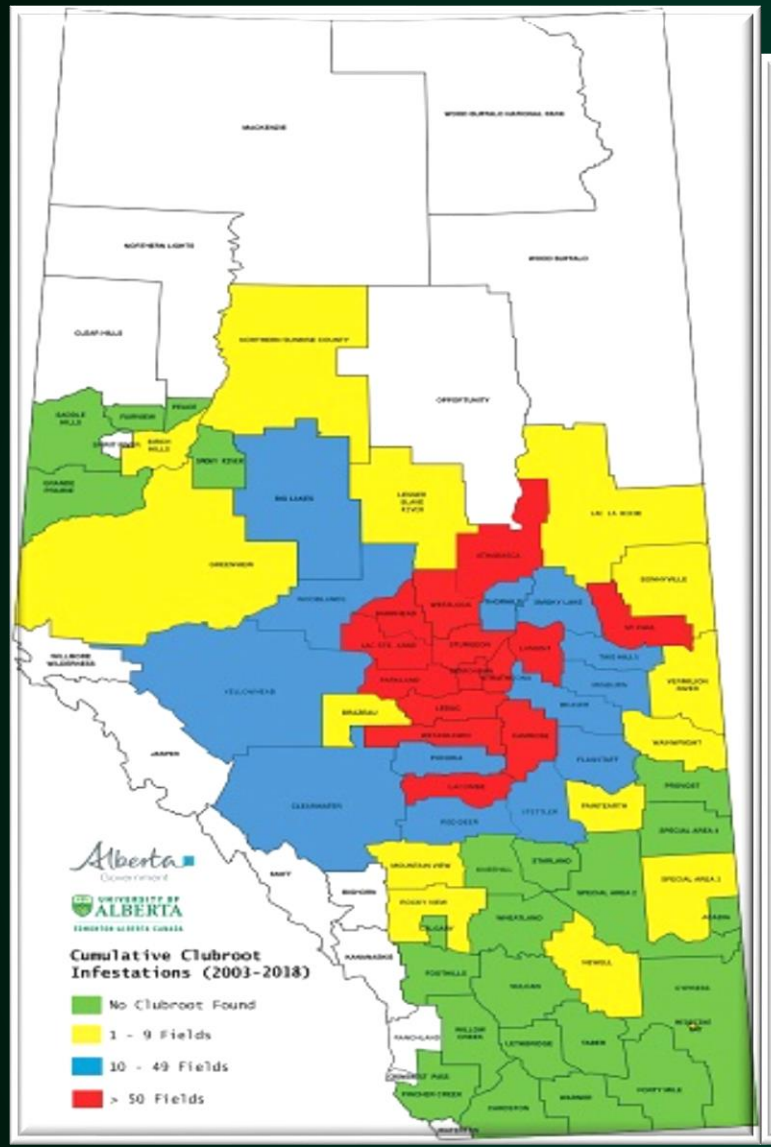

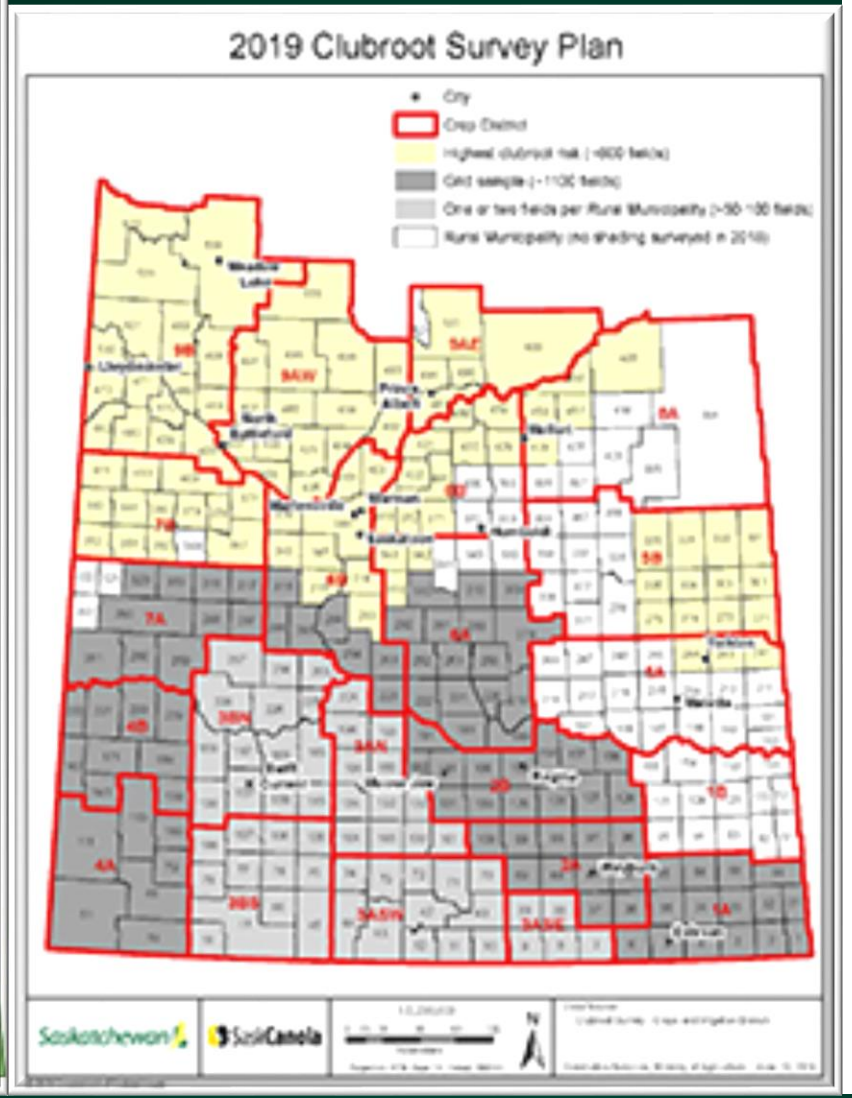

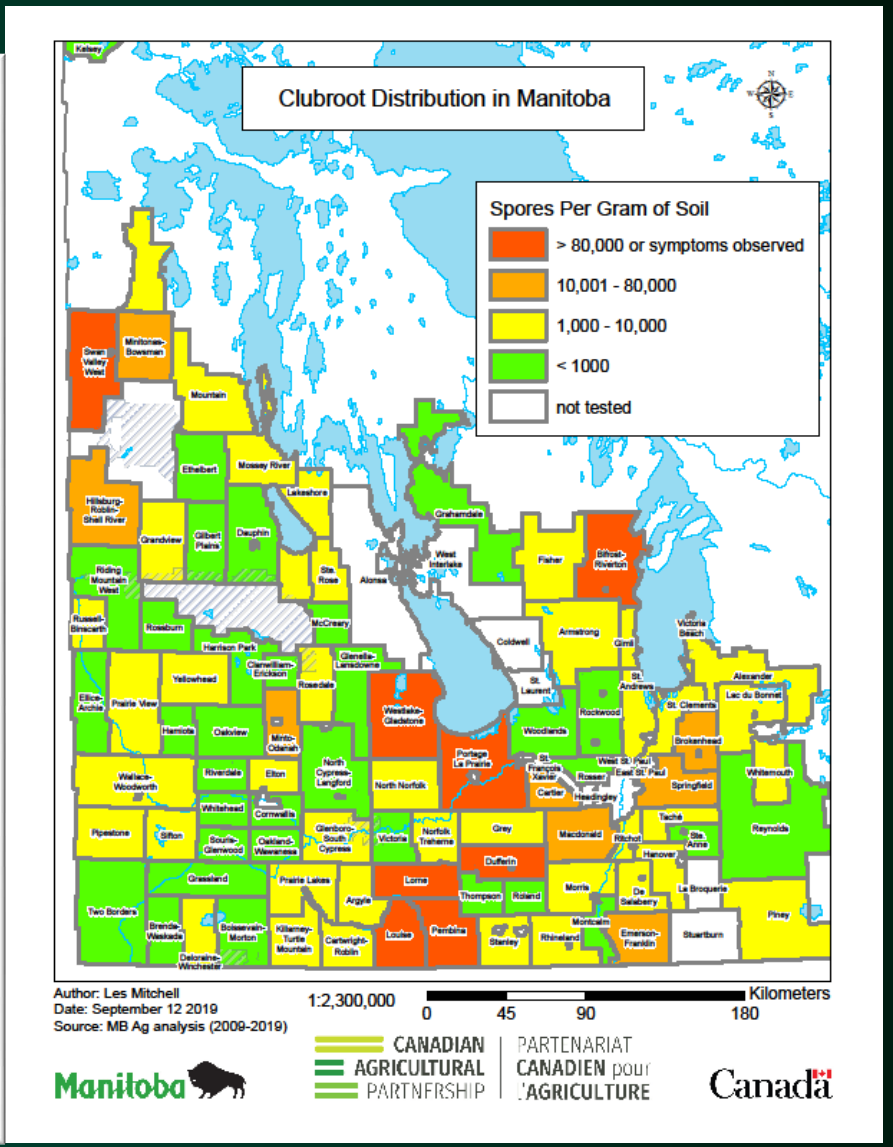

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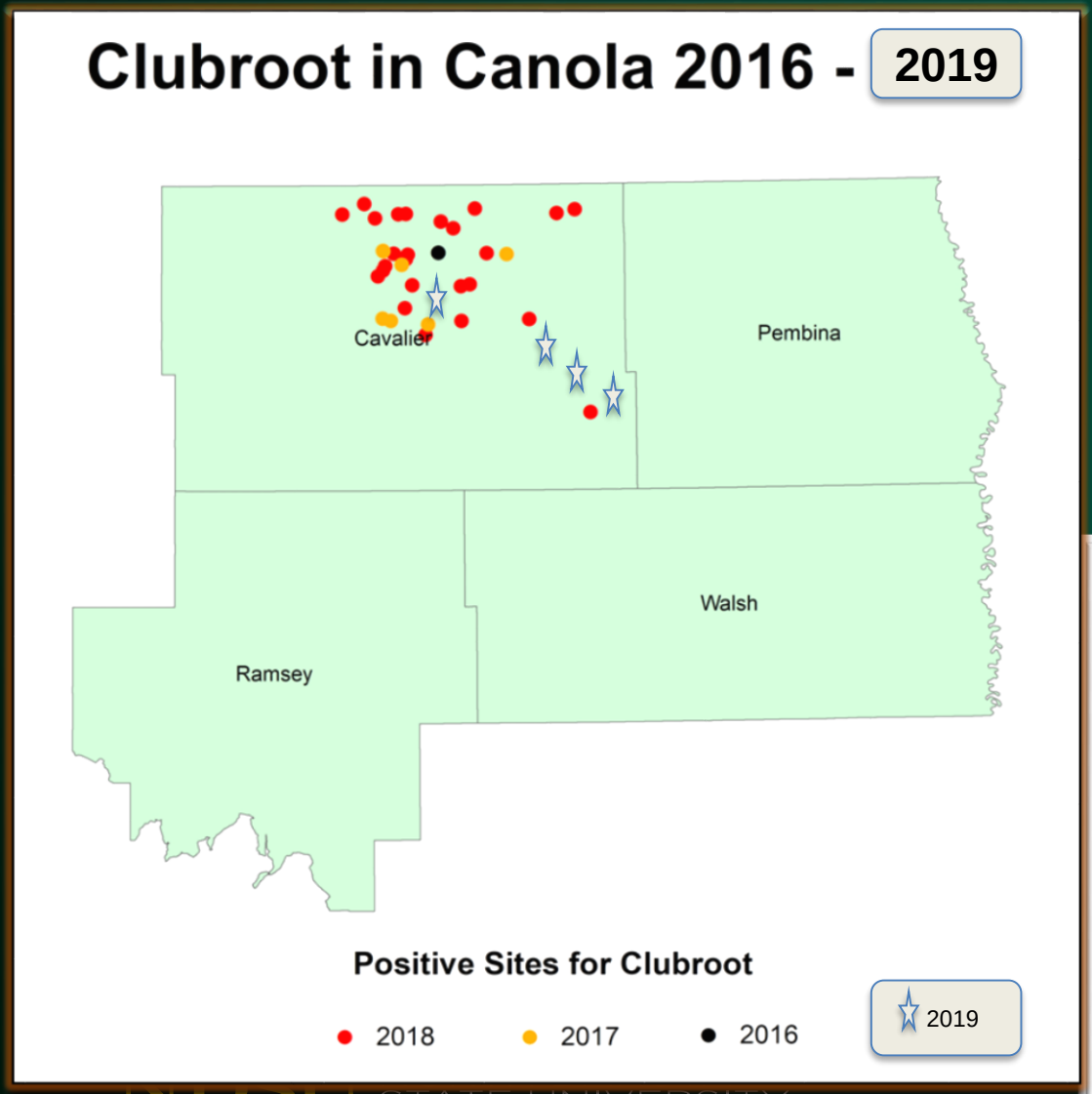
Eye on our Neighbors

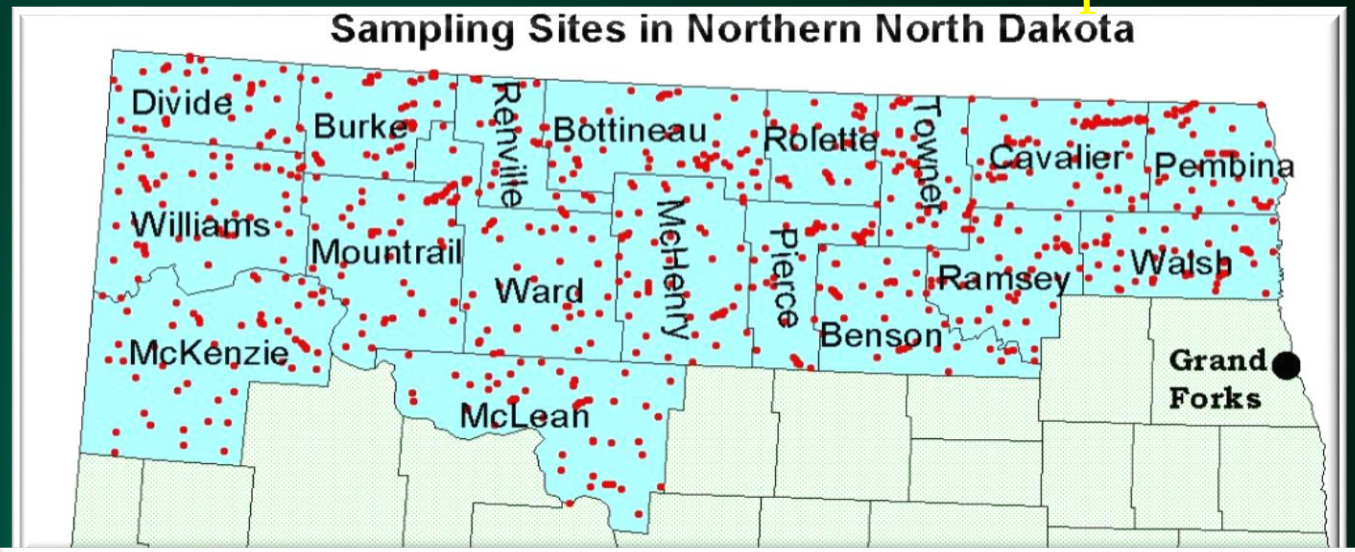
Pathotype 3x found in RM of Pembina valley in Manitoba, Canada

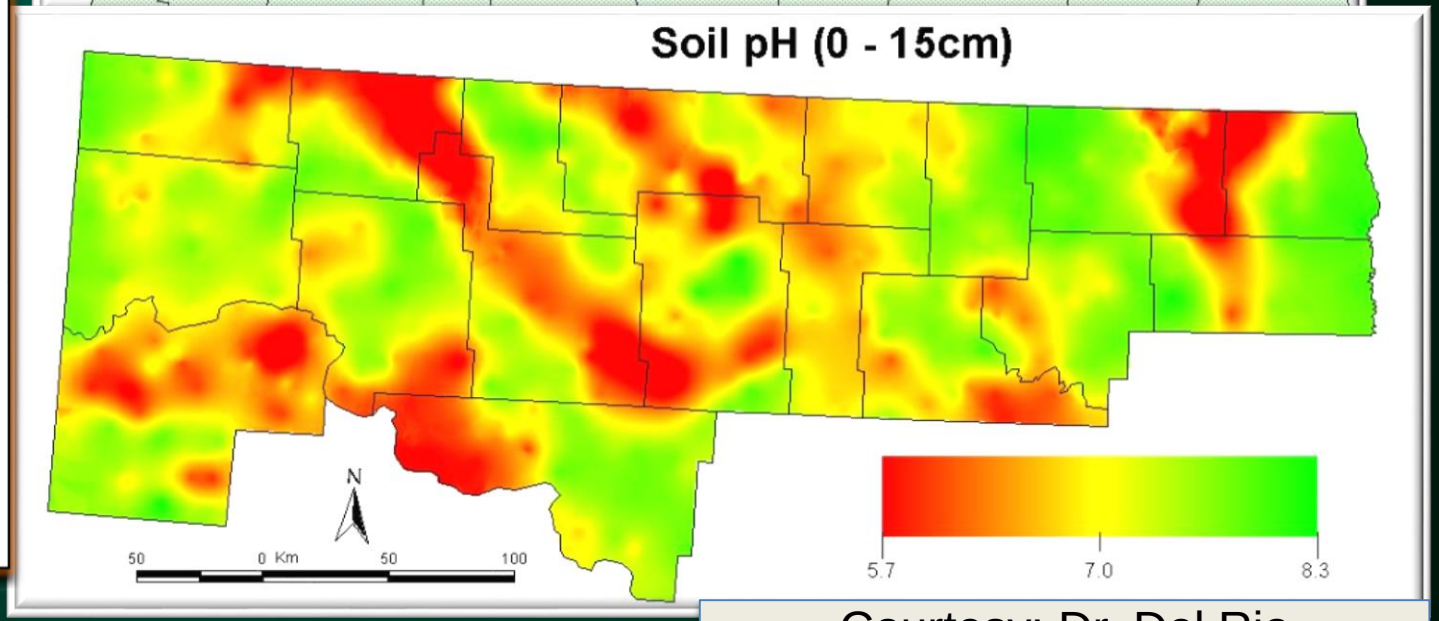
Potential areas needs scouting in North Dakota for clubroot

Norvell et al.,
Soil pH



Drs. Jan Knodel and Bu Hongang





Courtesy: Dr. Del Rio

2019-Clubroot on canola survey

- Aim: To survey canola fields from bordering counties of Canada
  - Collaborators: Dr. Travis Prochaska, NCREC, Minot, ND
  - Dr. Audrey Kalil, WREC, ND
  - Dr. Kishore Chittem, Department of Plant Pathology, Fargo, ND
  - Dr. Del Rio Mendoza, Department of Plant Pathology, Fargo, ND
  - Canola Growers through Minnesota Canola Growers Association

Methods of Survey

- Visual survey during flowering and swathing
  - Collection of soil samples (Venkat, Travis,& Audrey in ND and growers in MN)
  - Collected over 100 soil samples for pH and quantification
  - Received samples from 7 canola growers of MN

- Molecular Procedure:
  - Molecular determination of clubroot spores and their quantification per gram of soil (Dr. Chittem will present)

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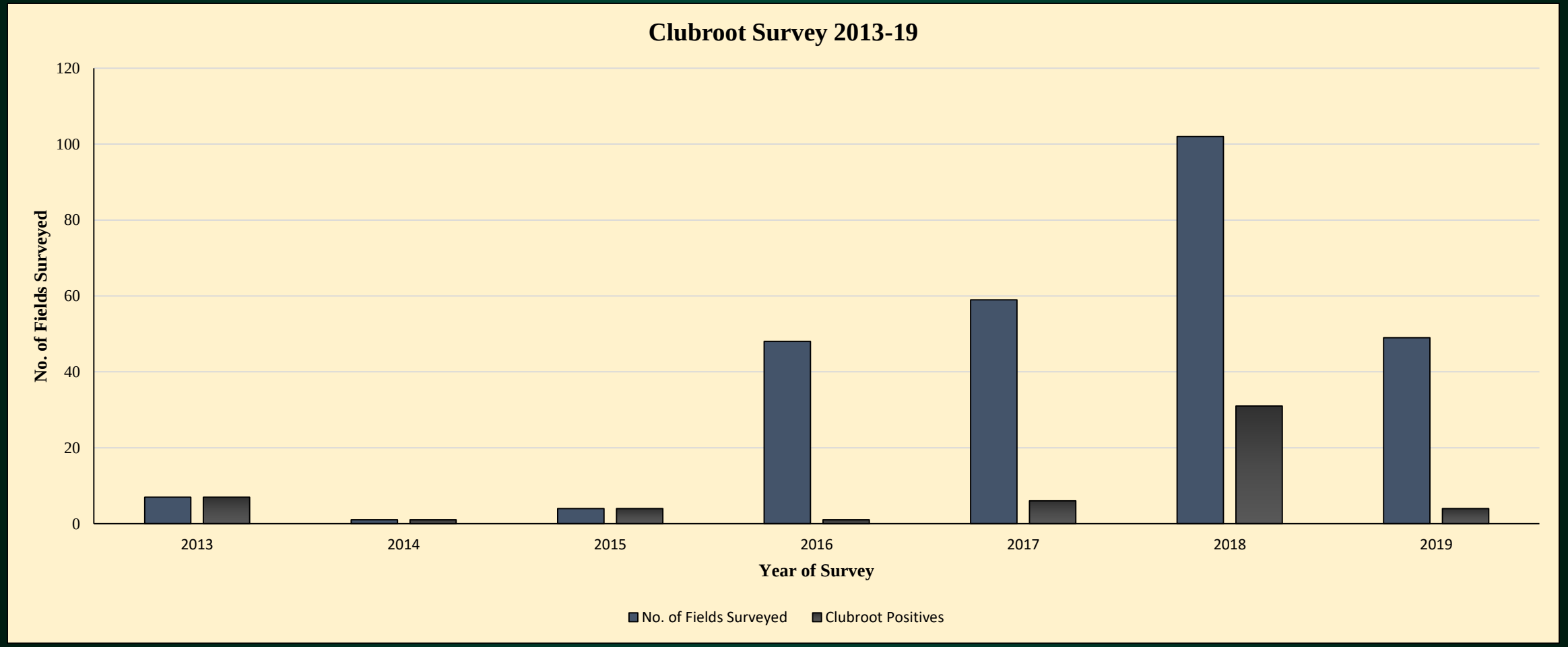
Survey Results from 2013-2019 in Cavalier County



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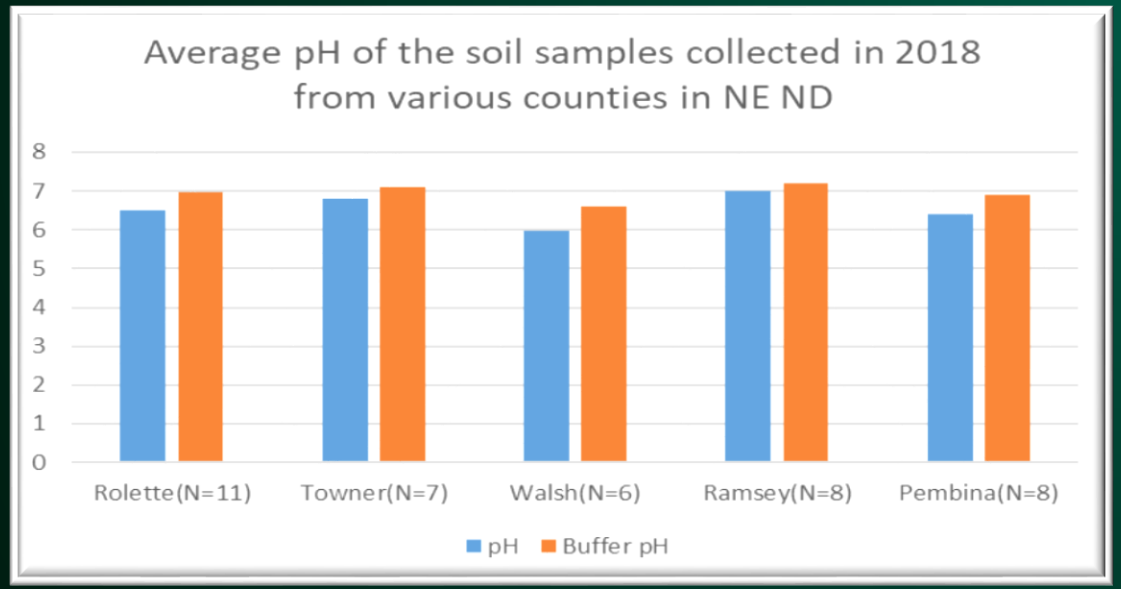
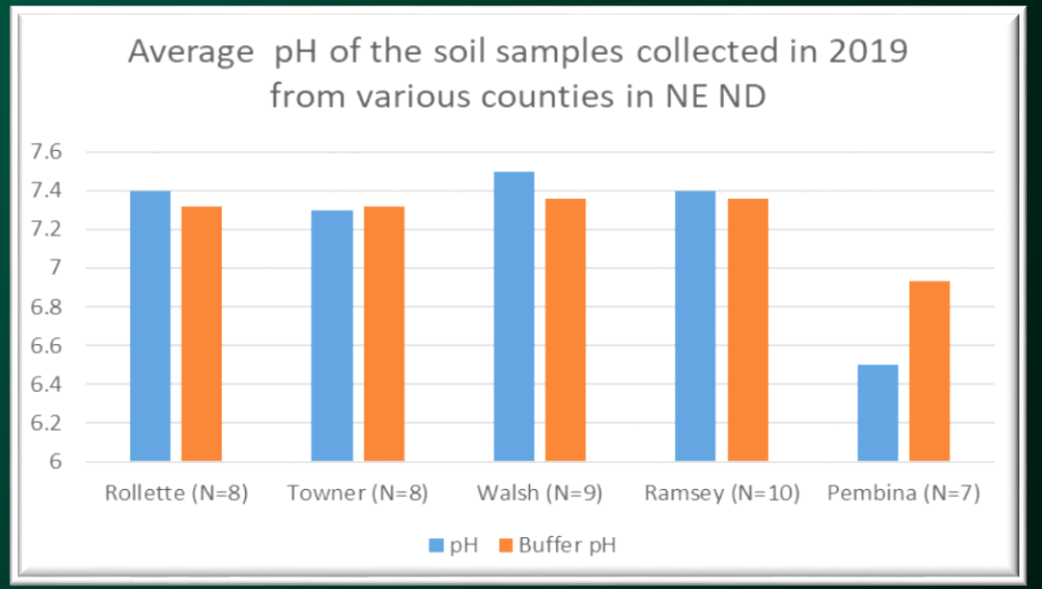
Soil pH from two year Survey Counties Surrounding Cavalier County

2018 County	Average pH	Average Buffer pH	Depth of soil sampling (3") Range	Range
Rolette(N=11)	6.52	6.97	5.2-7.1	6.27-7.25
Towner(N=7)	6.8	7.1	6.3-7.1	6.83-7.24
Walsh(N=6)	5.97	6.6	5.0-7.1	6.19-6.84
Ramsey(N=8)	7	7.2	5.2-7.1	6.27-7.25
Pembina(N=8)	6.4	6.9	5.4-7.3	6.3-7.28

2019 County	Average pH	Average Buffer pH	Depth of soil sampling (3") Range	Range
Rolette (N=8)	7.4	7.32	6.8-7.7	7.11-7.46
Towner (N=8)	7.3	7.32	6.7-7.8	7.07-7.5
Walsh (N=9)	7.5	7.36	6.9-7.8	7.18-7.58
Ramsey (N=10)	7.4	7.36	6.5-7.7	7.0-7.51
Pembina (N=7)	6.5	6.93	5.4-7.5	6.29-7.5





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Results of North Central and western Counties are due, likewise MN samples too

Soil Samples of Cavalier County

Year	# of samples	Average pH	Range	Average Buffer pH	Range
2018	101	6.4	4.8-7.4	6.79	5.1-7.35
2019	49	6.5	4.7-7.8	7.19	6.06-7.8

- 8% of fields were infected with clubroot in 2019 survey (Visual Observations)
- 33% of fields in 2018

pH range of Clubroot infected fields
2018: 4.5-6.4
2019: 4.7-6.7

Clubroot positives identified through Molecular assays

Positive fields of clubroot detected through molecular assays				
Sample ID	**Depth (Inches)**	**pH**	**Buffer pH**	**Spore population/gm of soil**
Cavalier County				
CCtc-38	0-3	5.3	6.73	13280
CCtc-11	0-3	7.6	7.64	184
Rollette County				
RLTC-3	0-3	7.6	7.42	27
Towner County				
TWC-3	0-3	7.3	7.32	17.15
TWC-7	0-3	7.0	7.22	16.56
Pembina County				
PBC-1	0-3	6.5	6.95	25.32
PBC-3	0-3	6.3	6.87	13.98
PBC-5	0-3	7.0	7.10	29.42
PBC-6	0-3	7.5	7.50	29

Chittem, Del Rio and Chapara 2019

Prevention of Clubroot spread at grass root level Lacombe, Alberta, Canada

Agronomist: Mr. Dan Orchard

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Hosts of Clubroot

All Brassicas

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Brassica Hosts of Clubroot

Chapara 2019

Common Brassica Weeds

Pennycress

Shepherds Purse

Wild Mustard

Shepherds Purse

Wild Mustard

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Camelina

Aim: Is Camelina a host of clubroot?

Variety: Joelle

Seed Courtesy Dr. Marisol Berti

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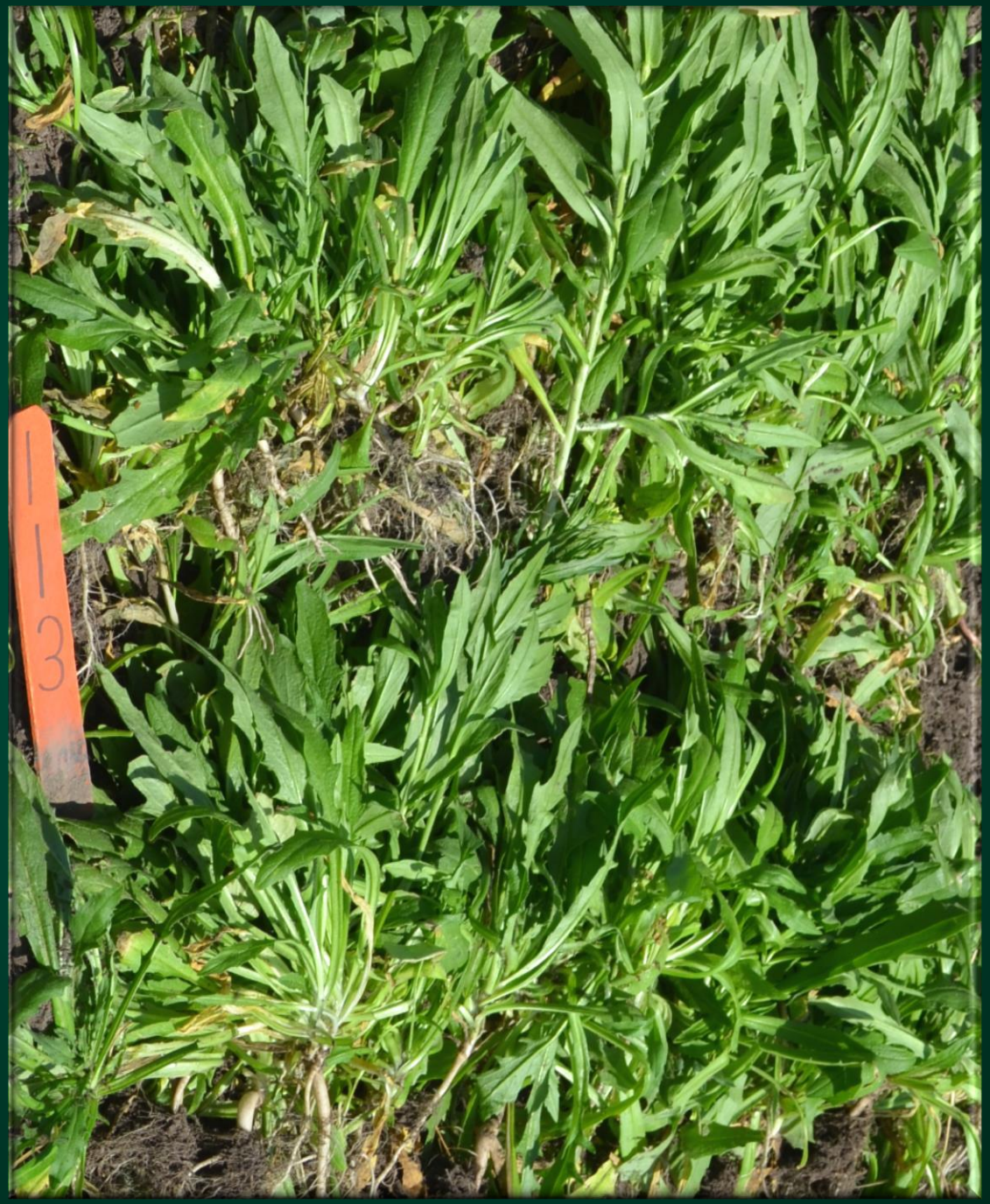
Camelina



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Camelina

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27% of Clubroot Disease Severity Index recorded on “Camelina” in the replicated trial

Cultivar resistance to Clubroot

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Evaluation of Cultivar Resistance to Clubroot-2019

11 varieties, Replicated 4 times

Scale:
DSI <30% Resistant
DSI 30-69% Intermediate
DSI > 70 Susceptible

Validity of Trial >60% DSI in susceptible check

Cultivar	Source	Description
6076CR	RENE MABON	Bret Young Seeds
4187RR	RENE MABON	Bret Young Seeds
INVIGORL255P	JORDAN	BASF
INVIGORL234P	JORDAN	BASF
CP9919RR	CAMEROON ACKER	Crop Plan Genetics
DKL30-42	CARGIL	Cargil
45CS40	NOWATZKI	Pioneer
45H33	NOWATZKI	Pioneer
CP955RR	CAMEROON ACKER	Crop Plan Genetics
CP9978TF	CAMEROON ACKER	Crop Plan Genetics
CP9982RR	CAMEROON ACKER	Crop Plan Genetics

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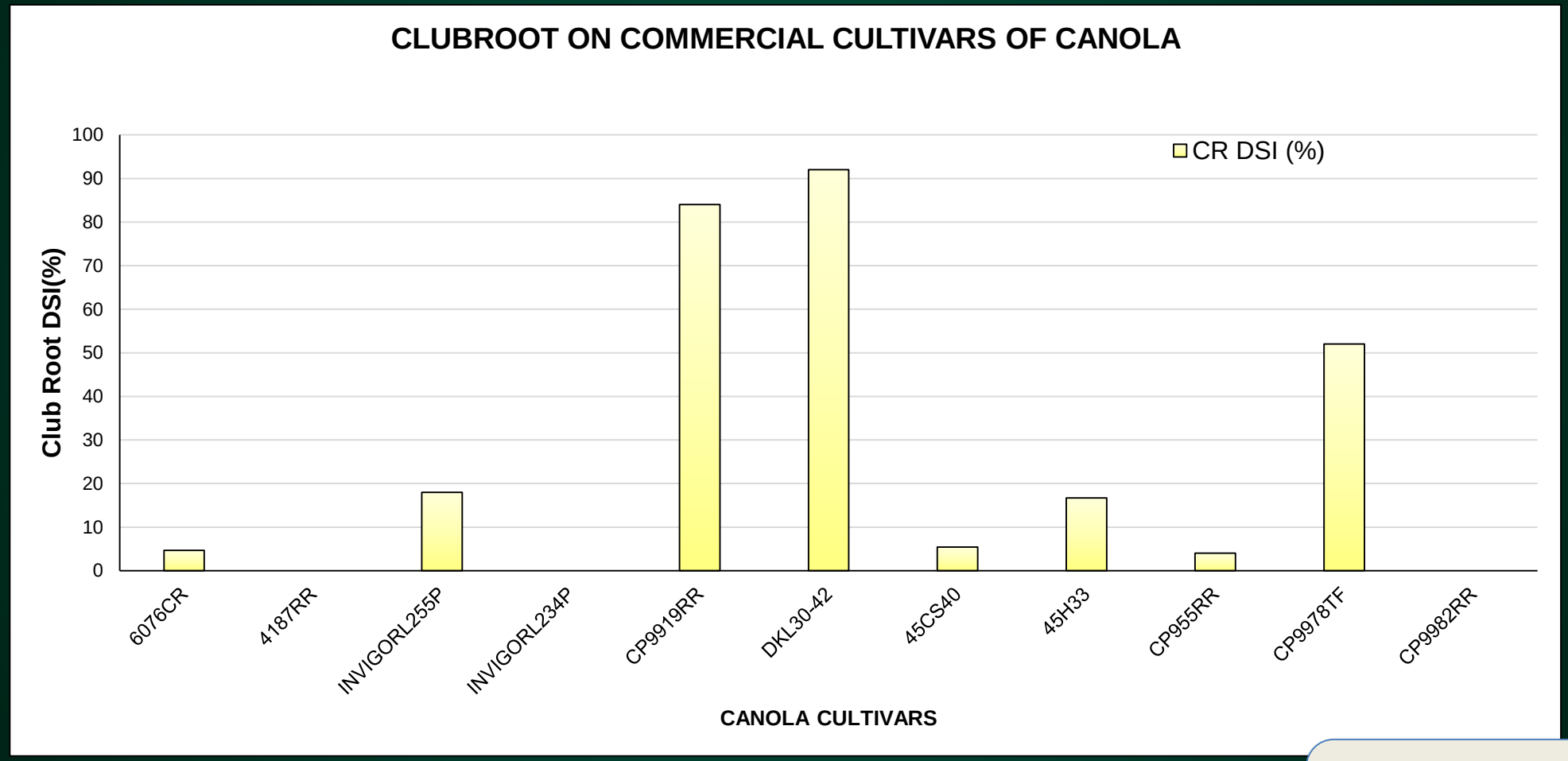
Evaluation of Cultivar Resistance to Clubroot-2019



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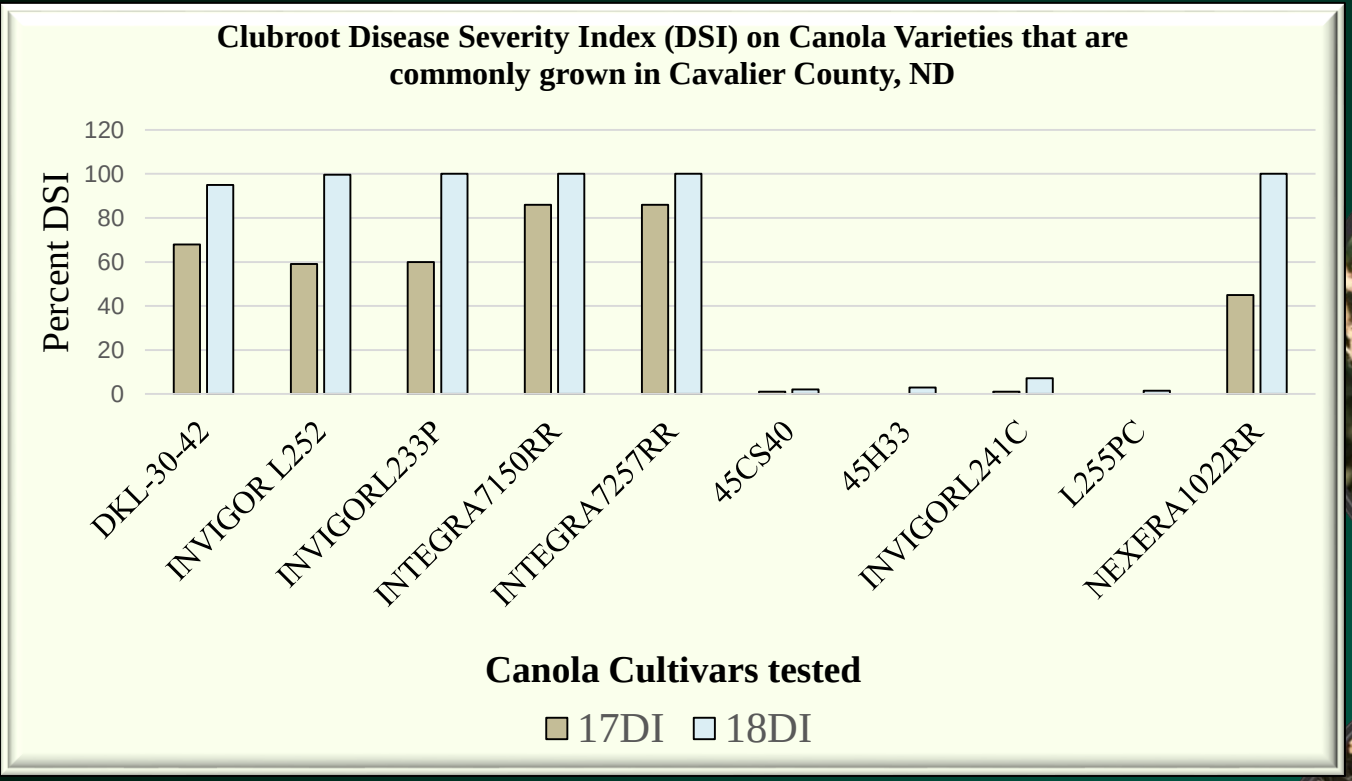
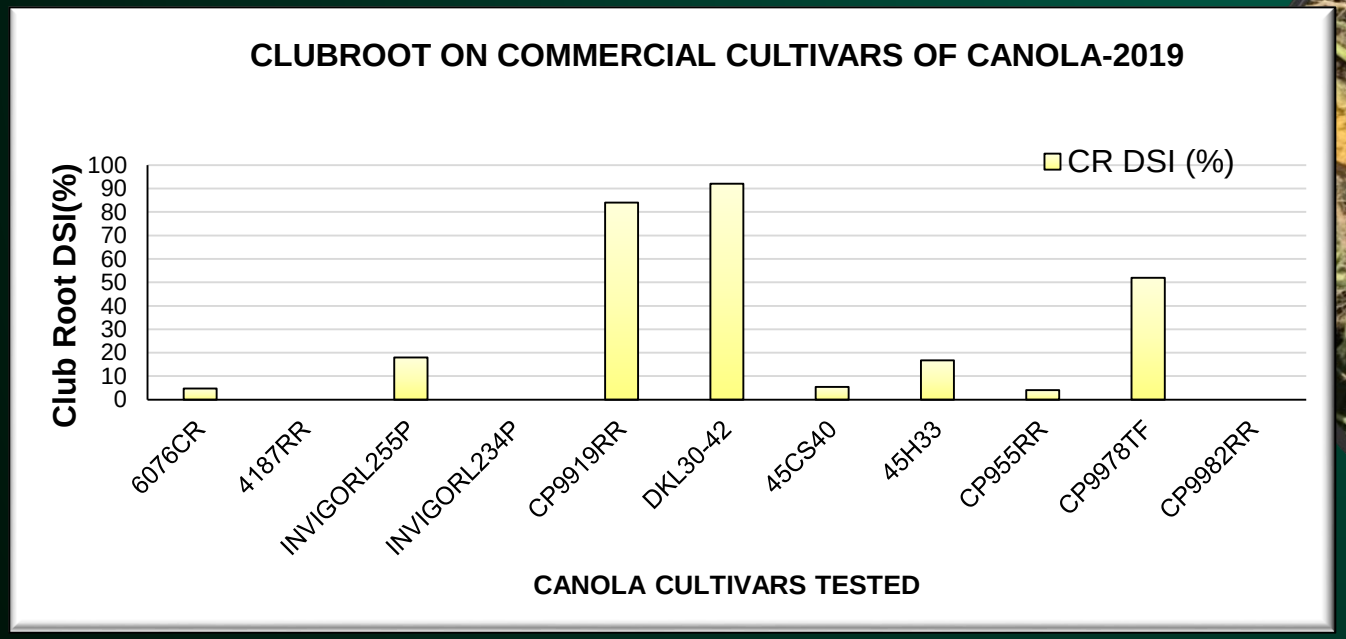
Mean: 27.8
LSD: 29.2
P-Value: 0.00001


Clubroot Disease Severity Index (DSI) on Canola Varieties that are commonly grown in Cavalier County, ND
Percent DSI
120
100
80
60
40
20
0
DKL-30-42
INVIGOR L252
INVIGORL233P
INTEGRA7150RR
INTEGRA7257RR
45CS40
45H33
INVIGORL241C
L255PC
NEXERA1022RR
Canola Cultivars tested
17DI
18DI


CLUBROOT ON COMMERCIAL CULTIVARS OF CANOLA-2019
Club Root DSI(%)
100
90
80
70
60
50
40
30
20
10
0
CR DSI (%)
6076CR
4187RR
INVIGORL255P
INVIGORL234P
CP9919RR
DKL30-42
45CS40
45H33
CP955RR
CP9978TF
CP9982RR
CANOLA CULTIVARS TESTED


Susceptible cultivar


Resistant Cultivar

United States Clubroot Resistant Canola Varieties

In Vigor
L255PC
L234PC*
L258HPC
L135C
L241C

Nexera
1026 RR
1028 RR
2028 CL

BrettYoung
6076CR*
4187RR

Pioneer
45H33
45H29
45H37
45CM36
45CS40
45CM39

Canterra*
CS 2000
CS2600TR

DeKalb*
75-42 CR

Croplan Genetics
CP955RR
CP9982RR

Canola Varieties in Purple font are available in ND

* Indicates Varieties with multiple genes of resistance (2nd generation) to various pathotypes of *P. brassicae* (clubroot causal agent)

Clubroot resistant varieties listed here were made after consulting several Industry representatives a year ago. Some varieties in the list may be outdated, and may not be available to growers. Check with your seed dealers.

Soil Amendments Evaluation

Two trials:

1. Different Rates of Beet lime, Pellet lime and Wood ash were tested
2. A surfactant was tested alone and in combination with the best treatments over the years

Evaluation of different rates of three soil amendments to manage Clubroot on Canola

Treatments	Rates (tons/ha)
WOODASH	0
WOODASH	2.5
WOODASH	5
WOODASH	7.5
PELLETLIME	0
PELLETLIME	2.5
PELLETLIME	4.5
PELLETLIME	7.5
BEETLIME	0
BEETLIME	5
BEETLIME	10
BEETLIME	15

Factorial RCB Design
Replicated 4 times

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Had great help this year from these two

Plots in Mid-Season

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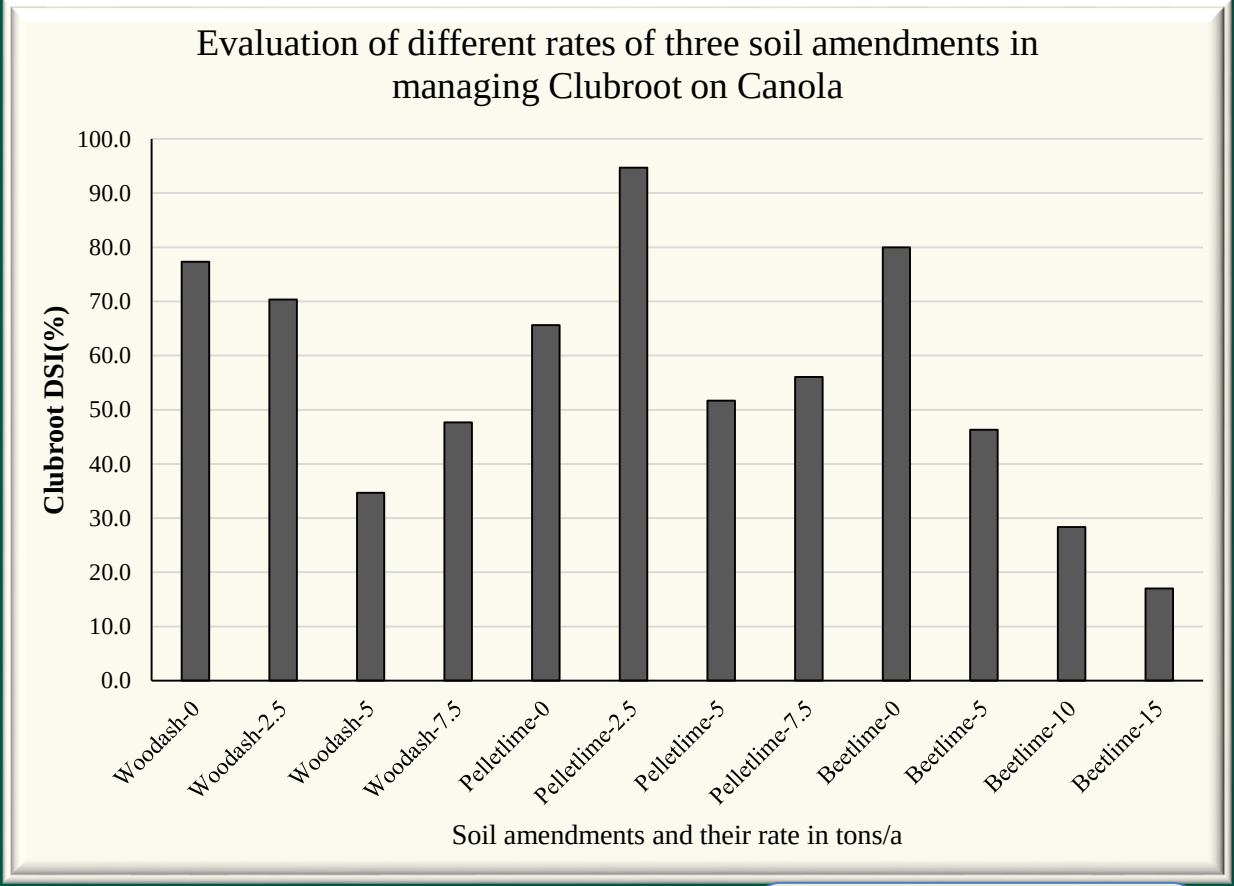
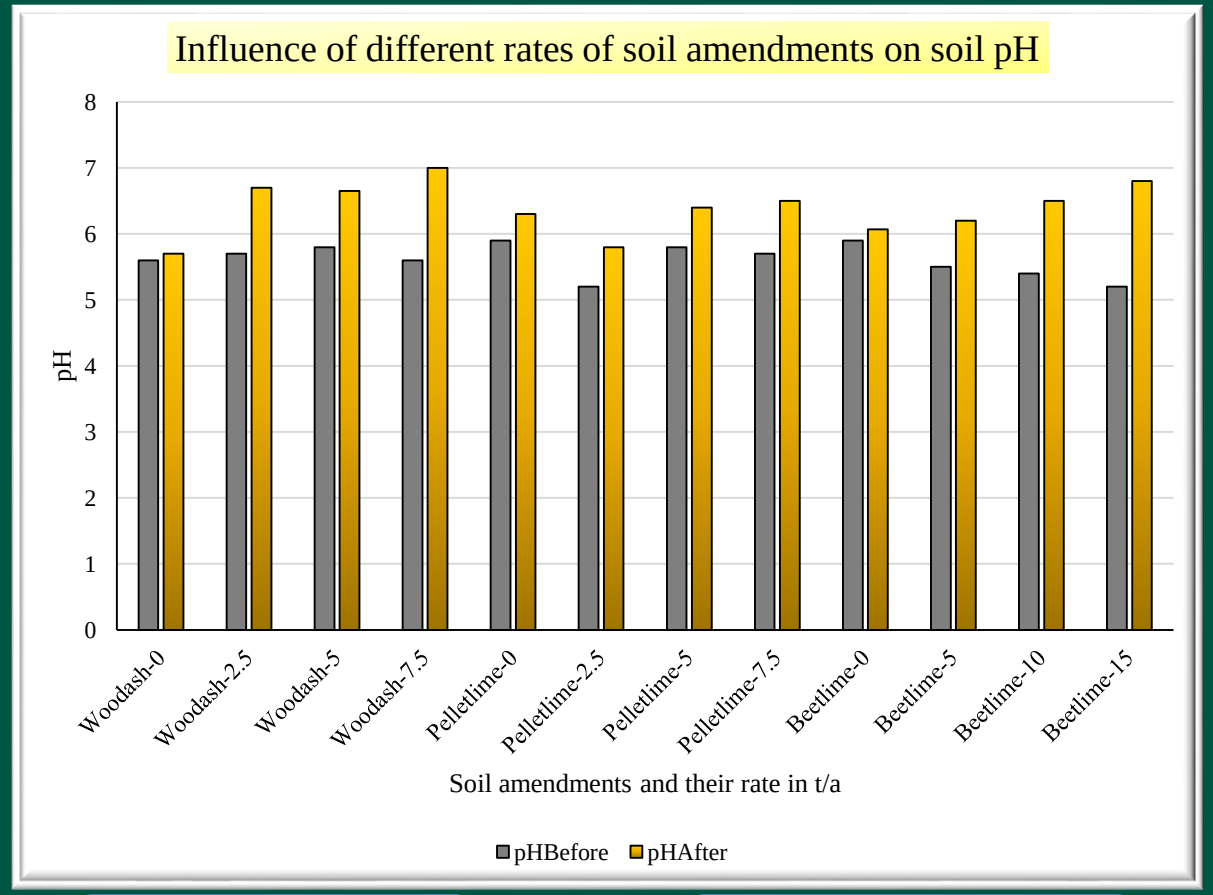
Evaluation of different rates of three soil amendments to manage Clubroot on Canola





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Mean: 55.9
LSD: 29.2
P-Value (0.05): 0.0238*

pH Before application
Mean: 5.6
LSD: 0.44
P-Value (0.05): 0.41NS

pH After application
Mean: 6.4
LSD: 0.7
P-Value (0.05): 0.0049*

Evaluation of ORZ to Manage Clubroot Under Field Condition

entry	Treatment	Rate
1	ORO-RZ	2pt/a
2	TRICHODERMA	10.5oz/a
3	AQUAGRO+ORO	10g/meter of row
4	RANMAN+ORO	7.5l/ha
5	ALLEGRO+ORO	1.75l/ha
6	BEETLIME+ORO	7.5t/ha
7	NANOCAL	4pt/a
8	LIME+ORO	7.5t/ha
9	BEETLIME	7.5t/ha
10	LIME	7.5t/ha
11	CHECK	CHK

Design: RCB
Replicated 4 times

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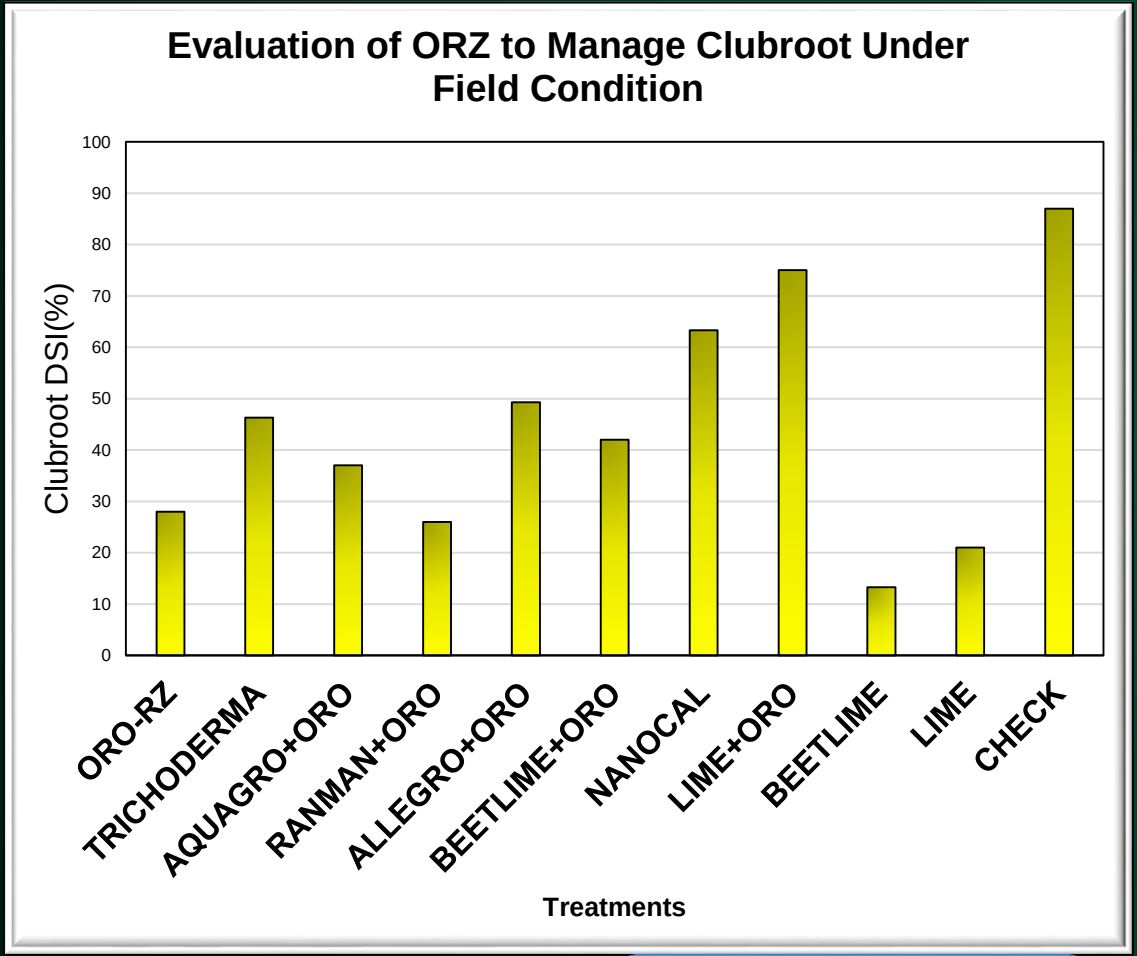
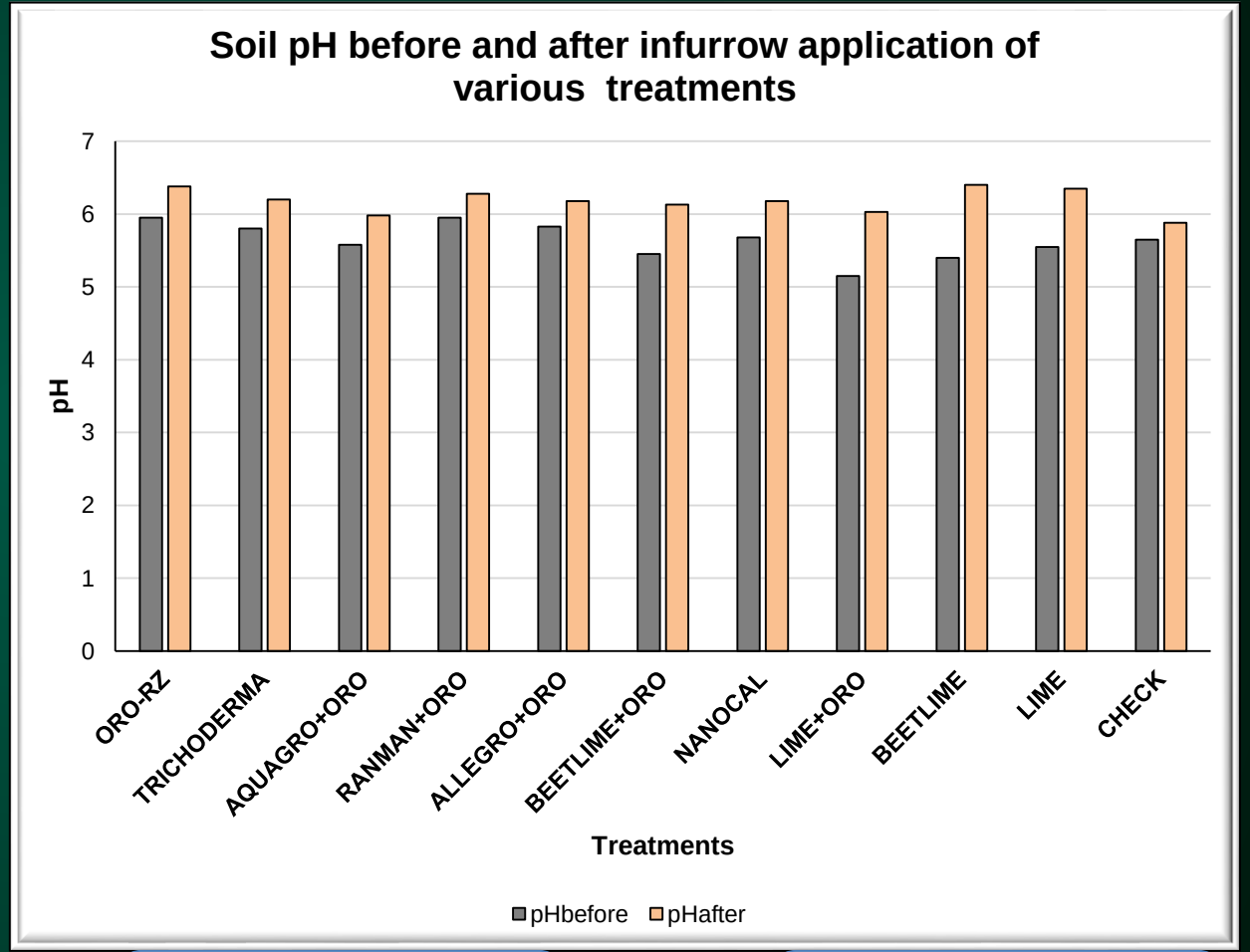
Courtesy: Korey Sundby

Evaluation of ORZ to Manage Clubroot Under Field Condition





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Clubroot DSI in Treatments
Mean: 44
LSD: 44
P-Value (0.05): 0.0417*

pH Before application
Mean: 5.6
LSD: 0.56
P-Value (0.05): 0.163NS

pH After application
Mean: 6.2
LSD: 0.61
P-Value (0.05): 0.8895NS

Desirable disease management strategies

- Breeding of cultivars for resistance to clubroot
  - should be based on screening of pathotypes
  - knowledge of their distribution
  - to obtain varieties resistant to the prevalent pathotypes

Plasmodiophora brassicae pathotype determination in North Dakota

- Galls collected from 33 clubroot infected canola fields in 2018
- Representative samples were screened By Dr. Strelkov research group in Alberta, Canada

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Clubroot on Canola- Pathotype designations of *Plasmodiphora brassicae* from North Dakota

Common Clubroot Pathotypes: 2,3,5,6 and 8 (Williams et al. 1966) - 4 differentials can separate 16 pathotypes (P3A is Variant of P3)

Some et al. 1996: P1, P2, P3,P4 and P5 (3 differentials, 5 pathotypes)

17 Pathotypes were Identified in Canada by 2018 as per Canadian Clubroot Differentials {CCD} set; Uses 13 brassica hosts.

Pathotypes are designated as:

3A,2B,5C,3D,8E,2F,5G,3H,5I,8J,5K,5L,6M ,8N,3O,8P and 5X

- Red font pathotypes are variants that resulted in resistance breakdown in canola CR Cultivars
- Right now there are more than 36 pathotypes

Strelkov et al. 2019

Sample	North Dakota clubroot Pathotype Designation		
	Some et al. (1996)	Williams (1966)	Canadian Clubroot Differential Set
FFCR	P3	8	Novel
MMCR	P3	2	Novel
PBCR-2	P2	8	N
RBCR-4	P3	8	Novel
RBCR-5	P3	8	AE
YCR-16	P3	8	Novel

Dr. Strelkov, Alberta

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Threshold >50%

European Clubroot Differential (ECD) – 15 Differentials can differentiate 35 pathotypes (16/15/15)

Strelkov & V. Chapara 2019

Pathotypes of *P. brassicae* present in ND

- Only two of the six matched existing pathotypes on the CCD system ("N" and "AE").
- None of the six overcame first generation CR resistance so far
- 4 of the 6 field isolates had novel virulence phenotypes
- New pathotype designations to be provided as per CCD

Future Research

- Pathotyping of more *P. brassicae* populations of ND
- Screening lines of canola using ND populations of *P. brassicae*
- Continuous survey for clubroot spread in ND and neighboring states
- Monitor clubroot in resistant varieties
  - **Volunteer canola seed**
  - **Off-types: no canola hybrid is 100% pure; (1 to 4%) of the seed that is susceptible**
  - **10% of seeded plants (do not count volunteers) are infected, indication of clubroot resistance**
- Evaluation of soil amendments to manage clubroot

Acknowledgements

- We appreciate the unconditional support of Canola growers of Cavalier County in survey and finding solutions in clubroot management

Northern Canola Growers Association

- Crop Protection Harmonization Board of North Dakota
- USDA/NIFA grant
- SBARE
- Mr. Barry Coleman for his constant updates and guidance
- Jacob Kram (NDSU Intern) and Ben Girodat (Student Hourly)
- Amanda, Travis, Lesley, Naeem, Anitha Chirumamilla and Ron Benada
- Mr. Todd Christianson (Simplot)
- ORZ supplier Mr. Sundby
- Clubroot seed suppliers and Mr. Varberg
- Drs. Prochaska, Kalil, DelRio and Chittem

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To all my colleagues and to MANY OTHERS

Thank You

QUESTIONS?

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