CLUBROOT OF CANOLA:
Prevalence and evaluation of chemicals, canola cultivars and brassica hosts to manage clubroot on Canola in field condition

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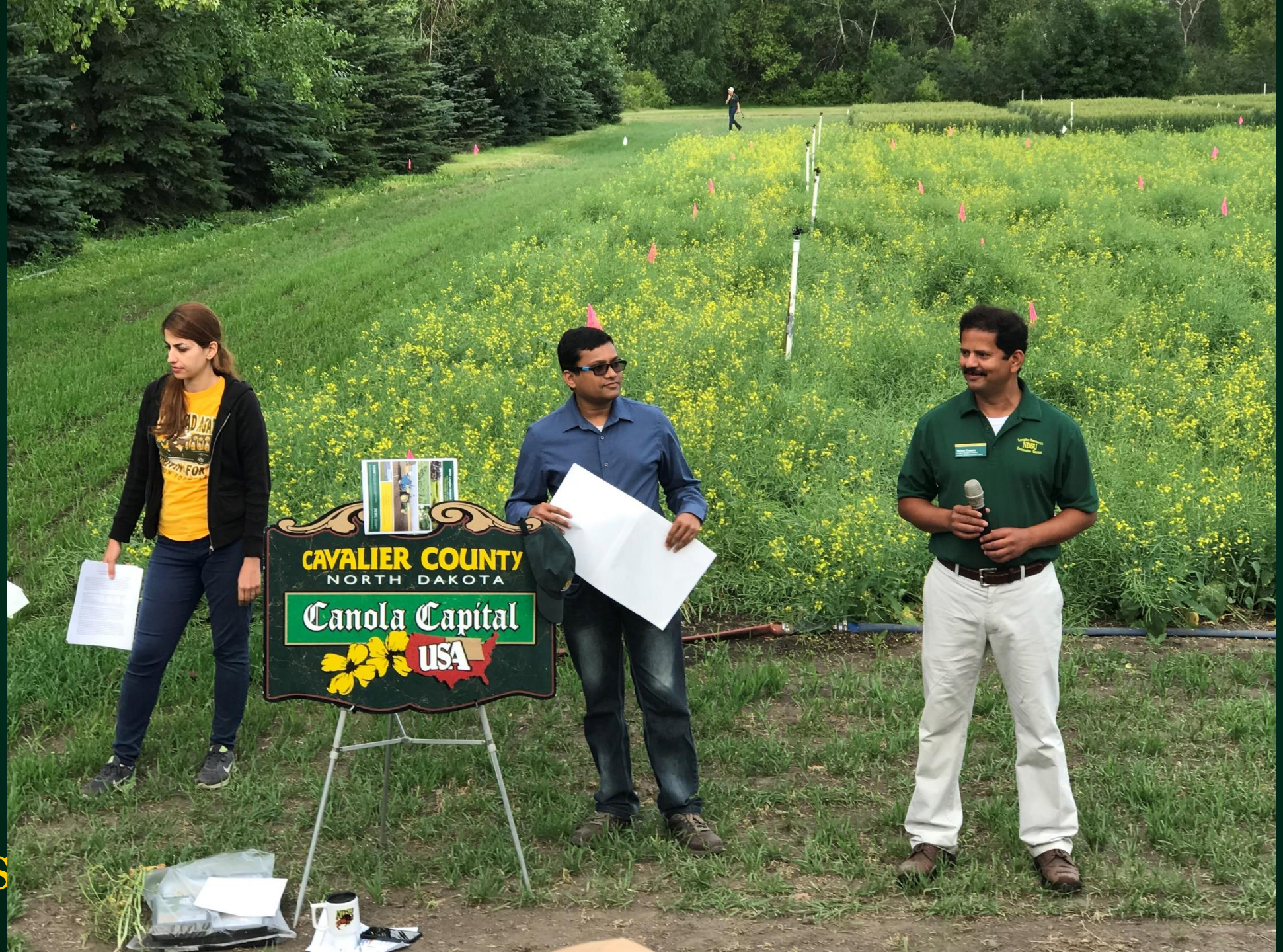

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Canola Acreage in North Dakota

Year	Area Planted (1000 acers) in ND
2016	1460
2017	1590
2018	1650

Clubroot

- Caused by a pathogen *Plasmodiophora brassicae* belong to lower group of living organisms called Protista
- Not a fungus/amoeba/slime mold but has some characters similar from each
- A serious yield robing disease of brassica crops
  - E.g. Canola, cauliflower, cabbage, rutabaga, radish, turnip, brussel sprouts, kale etc.
  - Susceptible brassica weeds: wild mustard, shepard's purse, penny cress, volunteer canola, stink weed
- Prefers acidic soils but found in the soils of pH up to 7.2
- Once in the soil can live as resting spores up to 20 years
- Pathogen infects roots; causes galls there by restricting the flow of water and nutrients to the plant
- If 100% of plants infected results in 50-80% reduction in yields (Europe and Sweden Research)

Clubroot - The challenge

- Clubroot has been a regular finding ever since identified in Cavalier County, ND in 2013
- Clubroot has appeared in 2016, in the field where it has been identified in 2014
- In 2017 started spreading to neighboring fields (found in new fields too)
- 2018 outbreak in low pH soils (Epidemic?)

Challenges:

  - Lack of understanding of pathogen biology
  - Lack of knowledge of Genetic resistance
  - No effective chemical control and
  - Lack of knowledge on rotations to be followed
  - No significant yield loses seen in clubroot infected fields yet in Cavalier County (2018 showed some clubroot impact on canola yields)

- A Clubroot survey group has been formed with one pathologist, two extension specialists and seven county agents to create awareness of clubroot and its management in 2016.
- Contribution of 7 positive CR fields from Ron Benada in 2018 survey are included too.

Early Survey (started in First week of July)

Wilting symptoms at Early flowering

Patches in the standing crop

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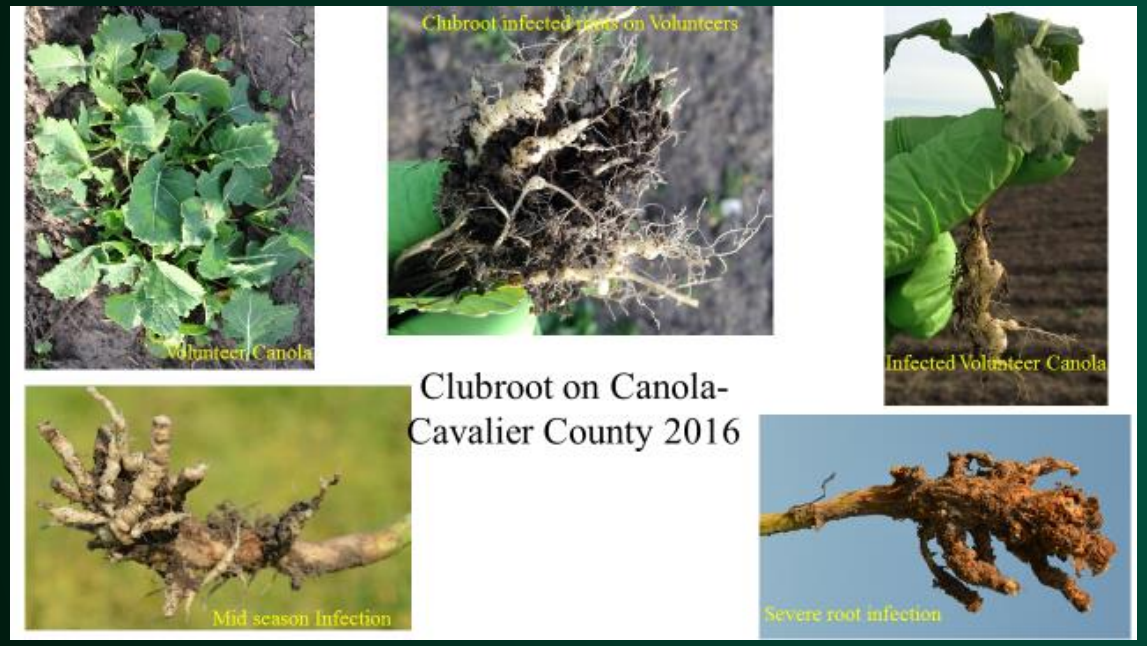
Clubroot symptoms can bee seen in field right after 45 days of planting



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Yield Losses?

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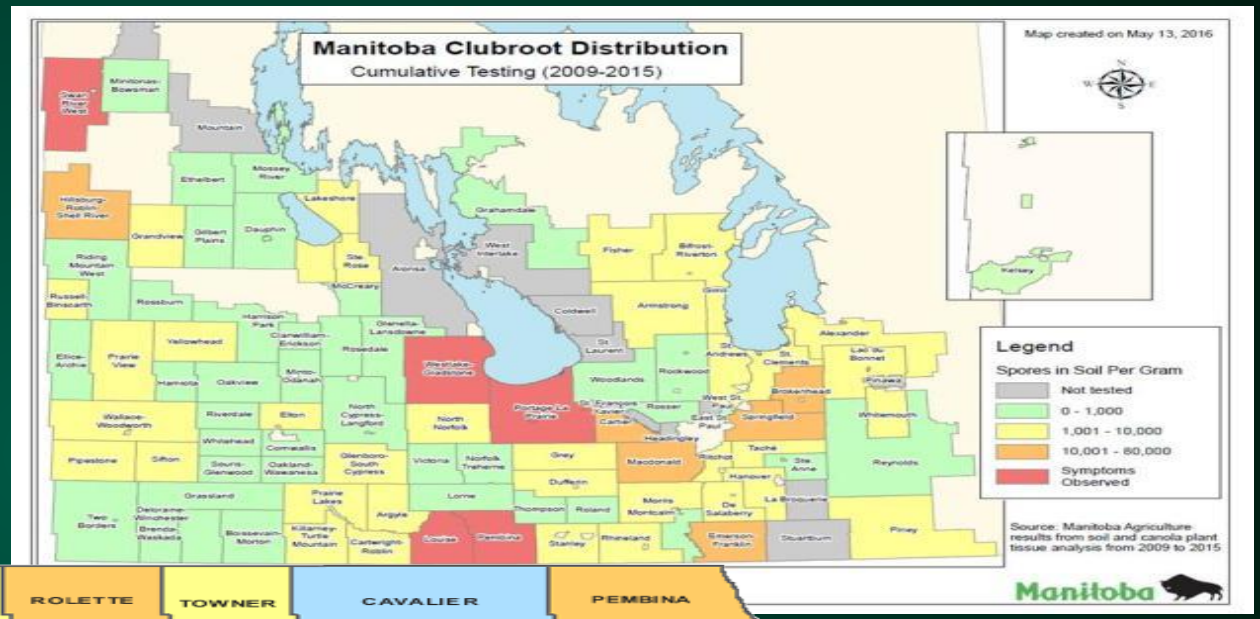
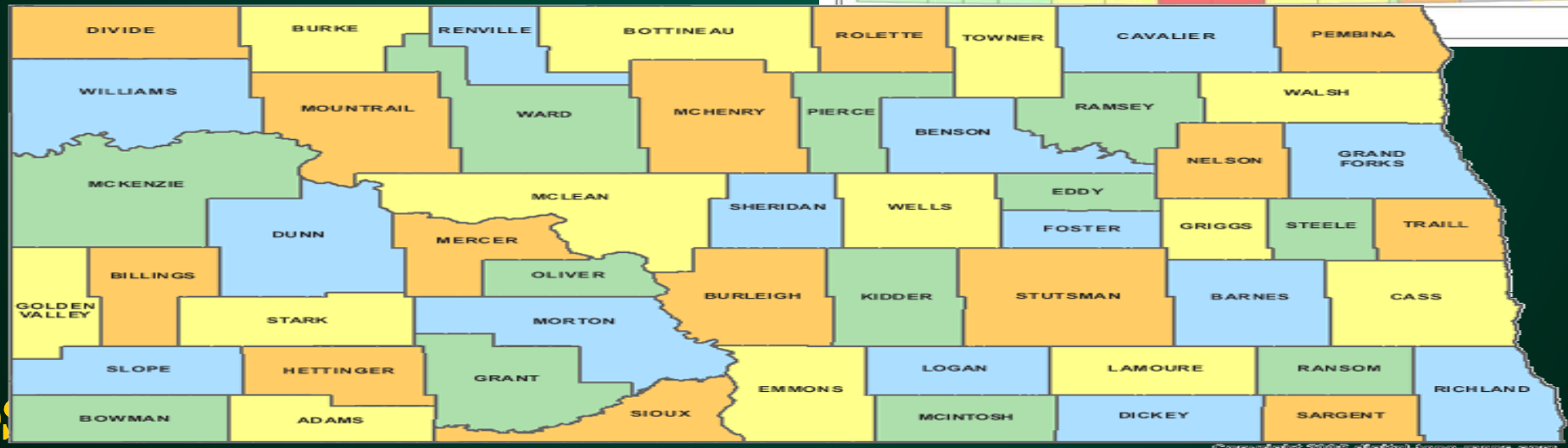
80 acres field infected with clubroot yielded 2000lbs/a this year where the average in the county was 2500lbs/a

Clubroot in ND and in Manitoba, Canada





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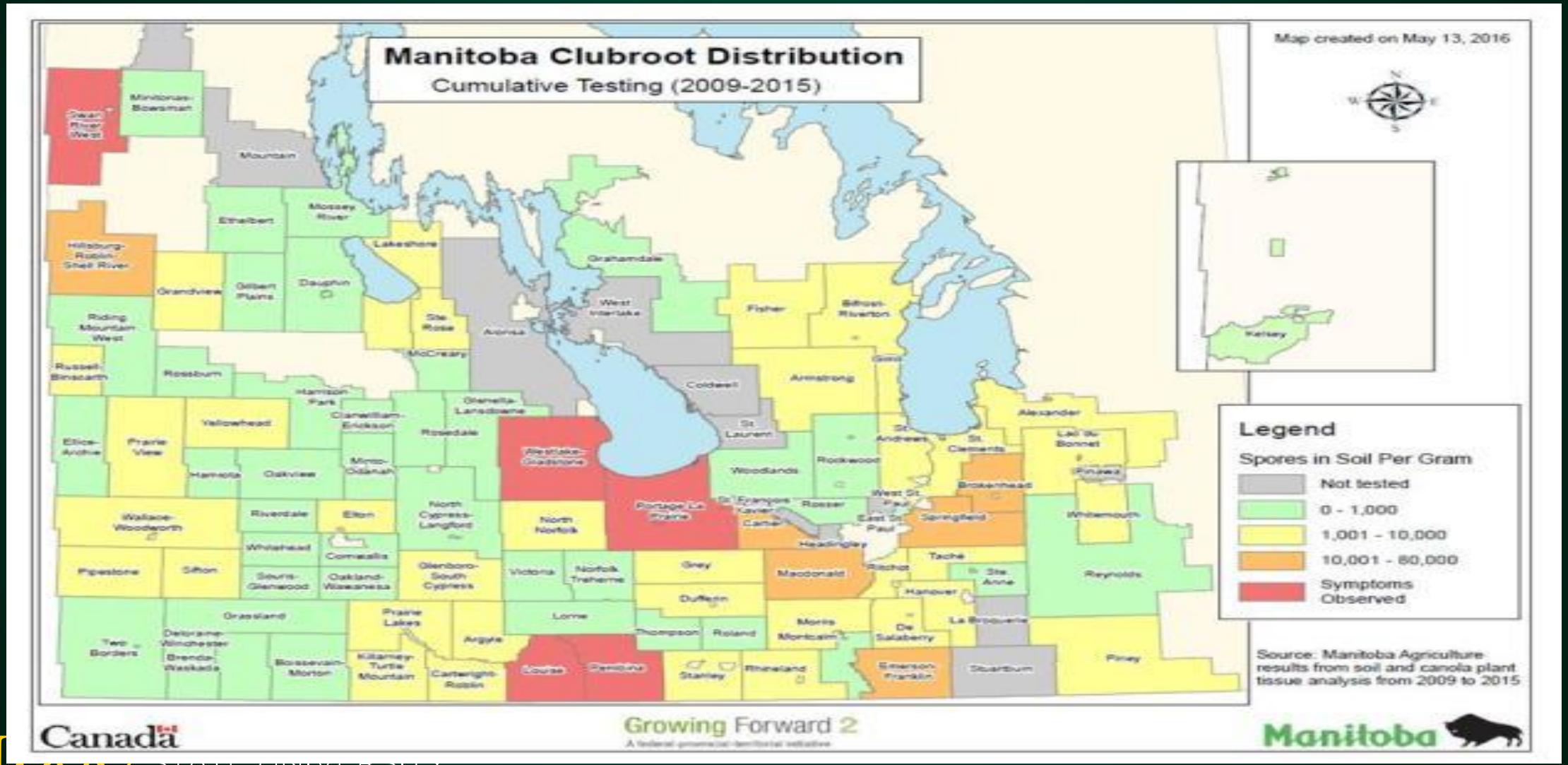
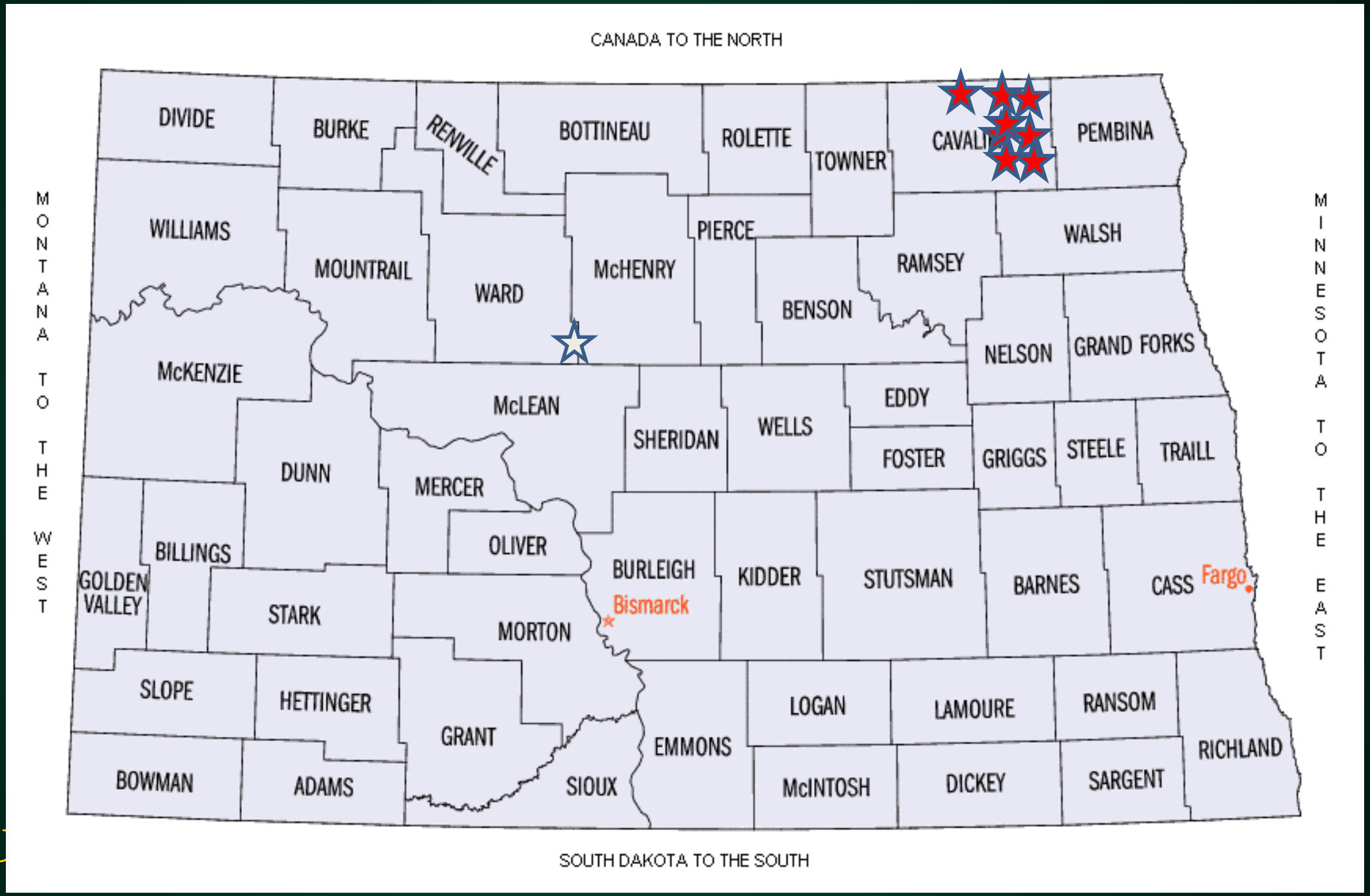
Spore population per gram of soil



Spore population per gram of soil

- On going project (Dr. Chittem will present in detail)
- Collected soil samples
- Quantification is in progress (in Drs. Del Rio and Chittem lab)
- Early detection of positive fields if they have low populations?
- Will give Accurate status of non-infected fields (low population? Or low pH?)


CANADA TO THE NORTH
DIVIDE
BURKE
RENVILLE
BOTTINEAU
ROLETTE
TOWNER
CAVALIER
PEMBINA
WILLIAMS
MOUNTRAIL
WARD
McHENRY
PIERCE
RAMSEY
WALSH
BENSON
NELSON
GRAND FORKS
McKENZIE
McLEAN
SHERIDAN
WELLS
EDDY
FOSTER
GRIGGS
STEELE
TRAILL
DUNN
MERCER
OLIVER
BILLINGS
GOLDEN VALLEY
STARK
BURLEIGH
Bismarck
KIDDER
STUTSMAN
BARNES
CASS
Fargo
MORTON
SLOPE
HETTINGER
GRANT
EMMONS
LOGAN
LAMOURE
RANSOM
RICHLAND
BOWMAN
ADAMS
SIOUX
McINTOSH
DICKEY
SARGENT
MONTANA TO THE WEST
MINNESOTA TO THE EAST
SOUTH DAKOTA TO THE SOUTH

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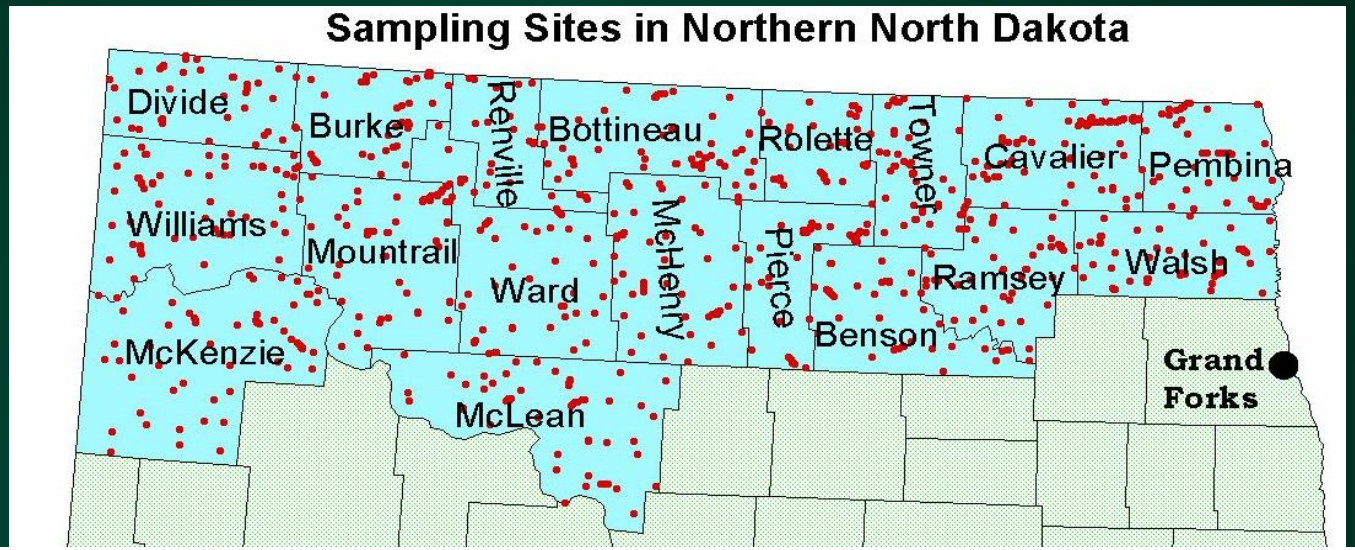
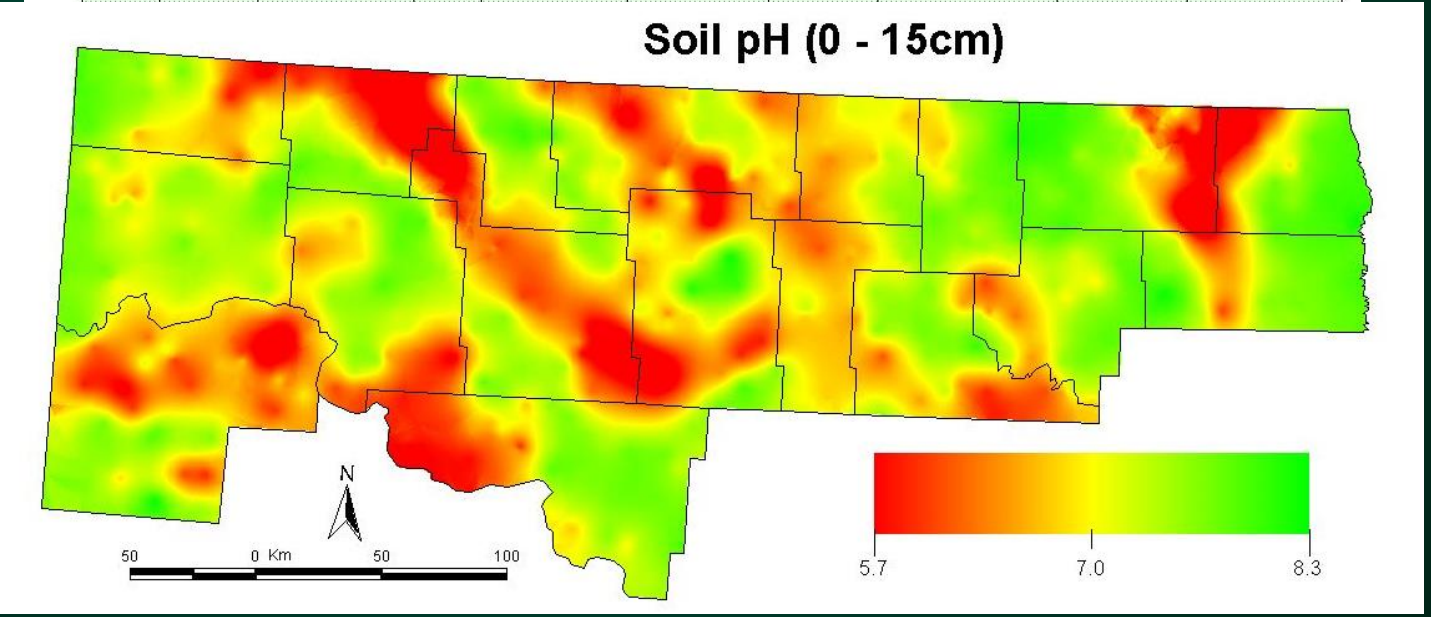
Soil pH

Norvell et al.,

Potential areas needs scouting in North Dakota for clubroot





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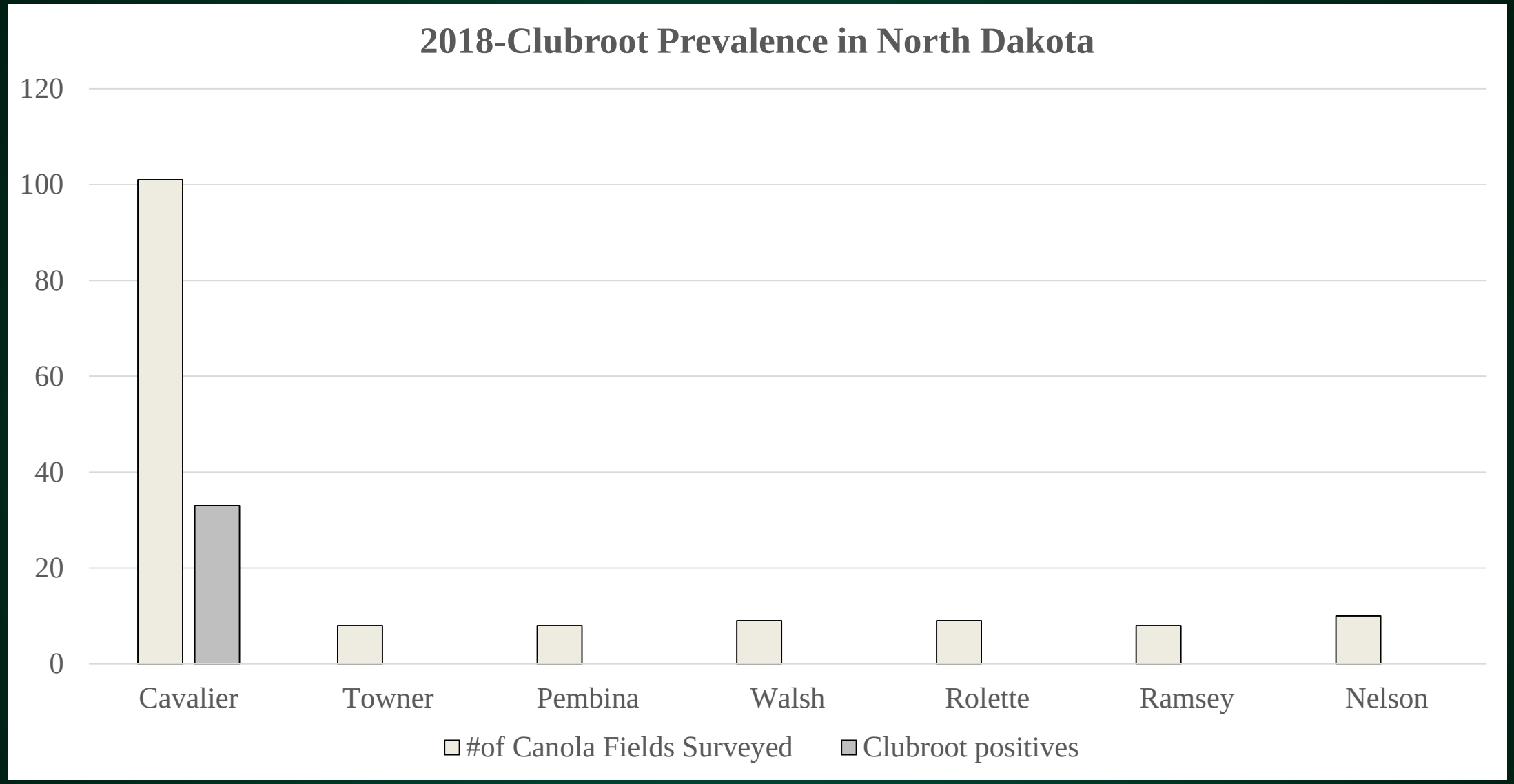
Courtesy: Dr. Del Rio



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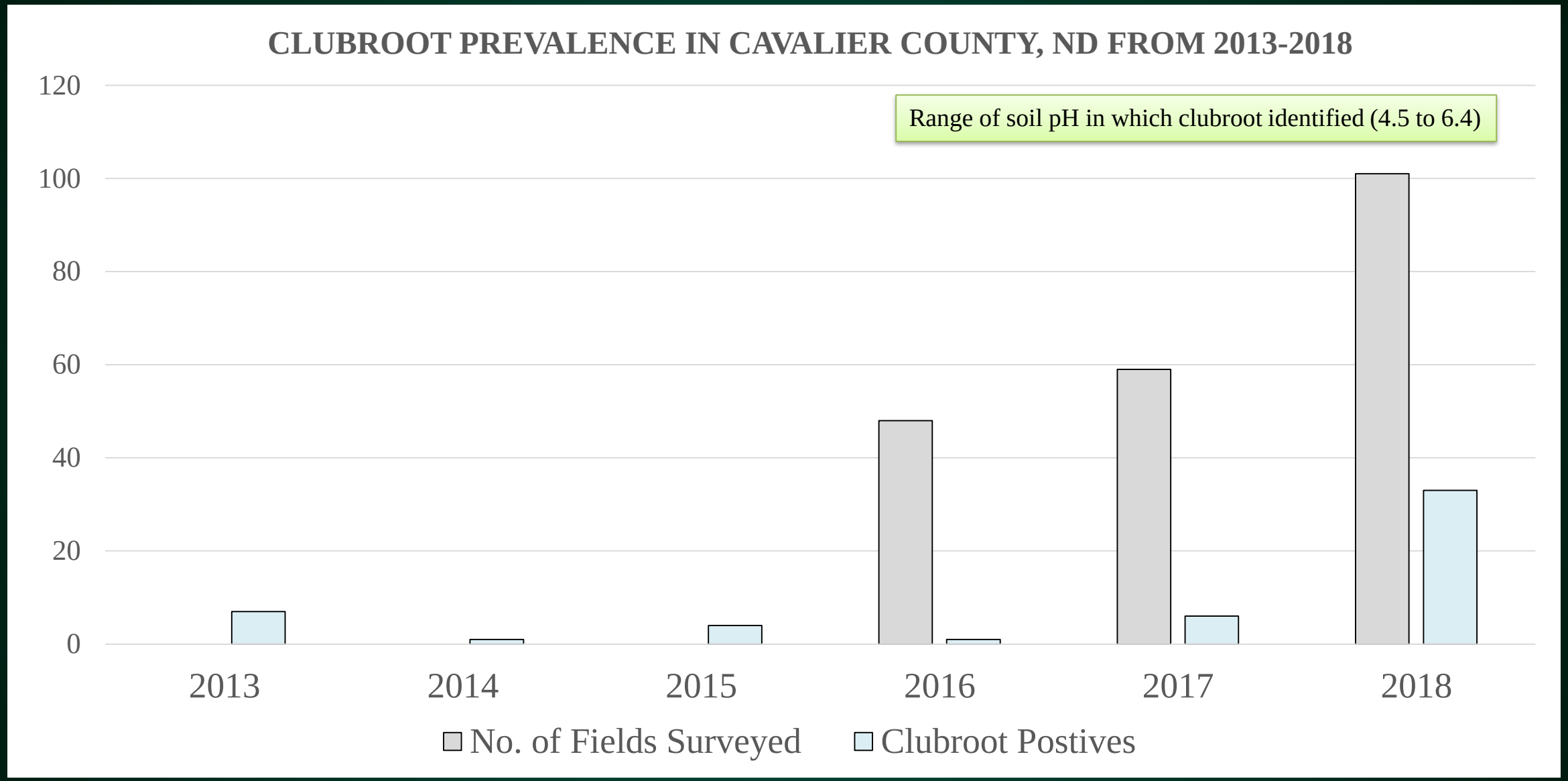

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Are we reaching Epidemic Status?

Objectives

Plot lay out of three objectives

1. Chemical efficacy
2. Host susceptibility
3. Response of Commercial cultivars

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Evaluation of chemicals, fungicides and soil ameliorating products

Treatment	Tradename	Dosage
Cyazofamid	Ranman	7.5 l/ha
Fluazinam	Allegro	2000 g/ha
PCNB	Blocker	67.5kg/ha
Wood ash	Fly Ash	7.5t/ha
Calcium Carbonate	Pellet Lime (Lime)	7.5t/ha
Beet lime	Versa Lime	15 t/ha
Gypsum	Gypsum	7.5 t/ha
Nano Particle	Zn	500mg/L of Zn
Non-Ionic surfactant	Aqua-Gro 2000	10g/m just before planting Incorporated into rows
Non-treated	CHK	

Two years Research

- Planted in: First Week of June
- Plot size:5ft Length

3ft. Width

9 products compared with non-treated check,

Replicated 4 times

Rated on: Last week of July

Cultivar used: DKL30-42

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Methodology

Evaluation of chemicals, fungicides and soil ameliorating products

Research Plots

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Clubroot rating scale

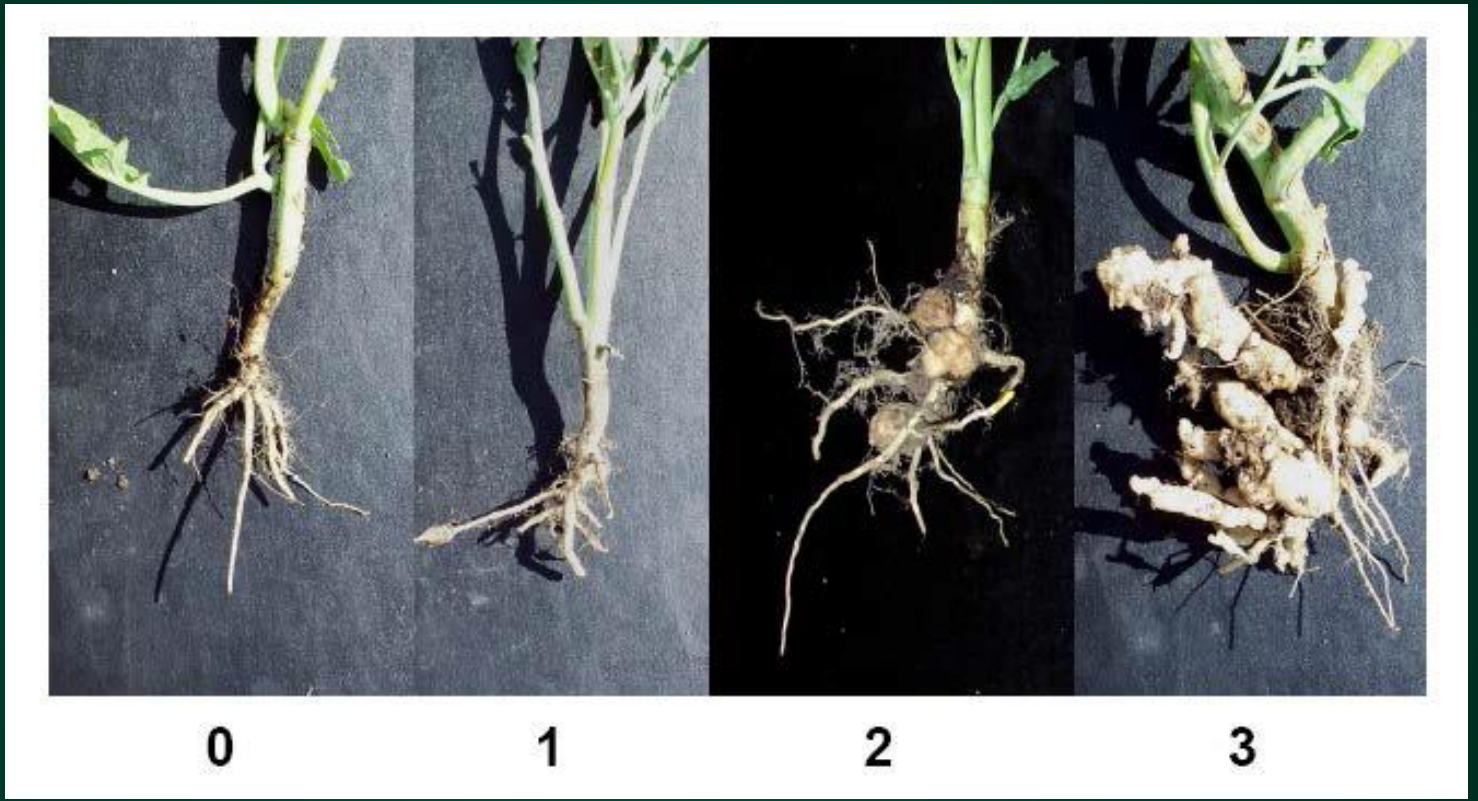

Fig. 1. Clubroot rating scale: 0 = no galling; 1 = a few small galls (small galls on less than 1/3 of roots), 2 = moderate galling (small to medium-sized galls on 1/3 to 2/3 of roots), 3 = severe galling (medium to large-sized galls on more than 2/3 of roots) (S.E. Strelkov)

RESULTS

Beet Lime

Non-treated Check

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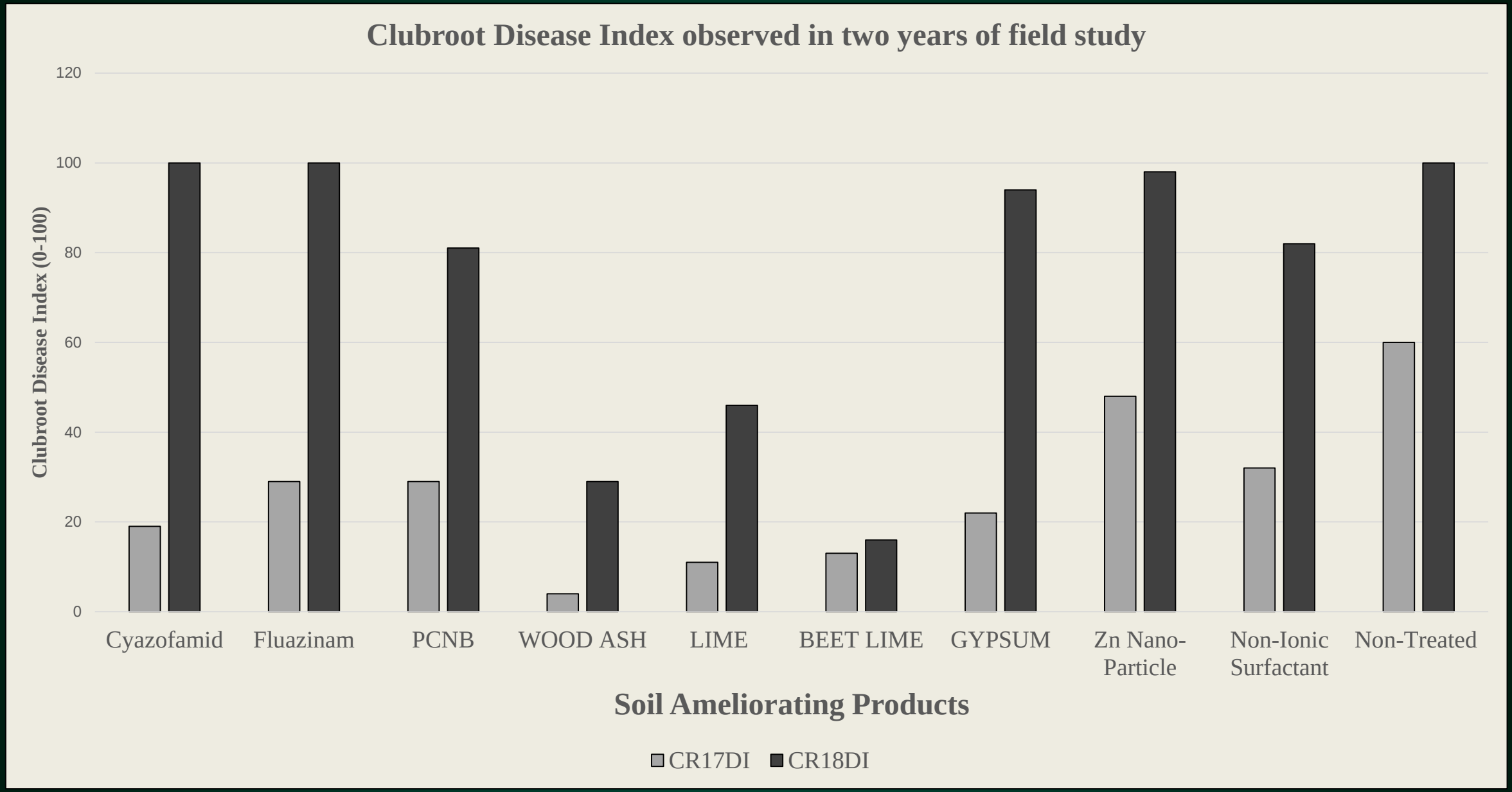
RESULTS

Wood Ash (Fly Ash)

Pellet Lime



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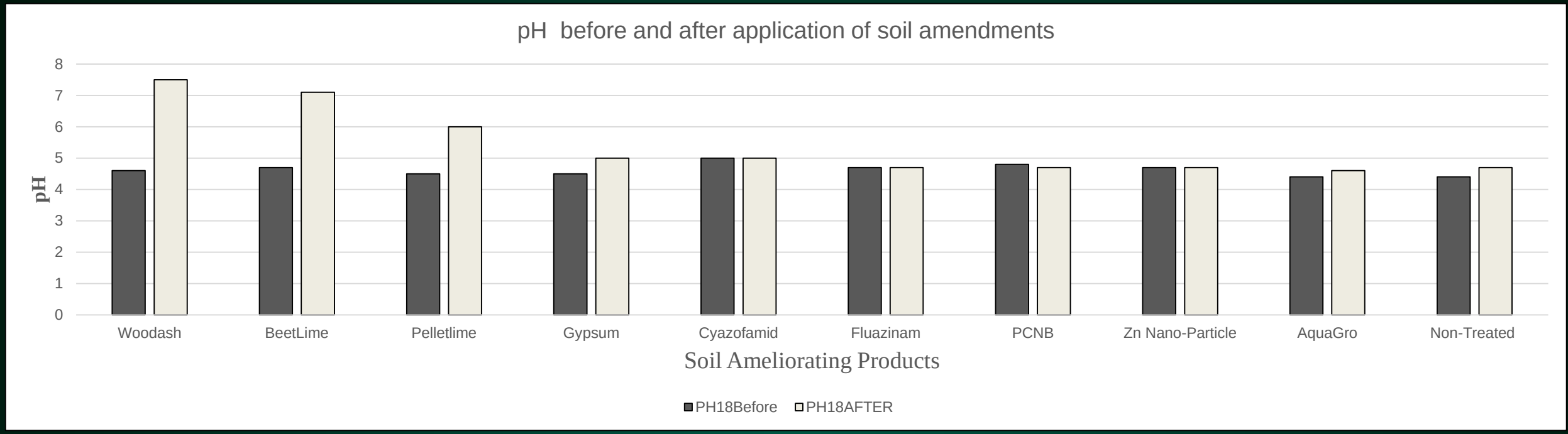
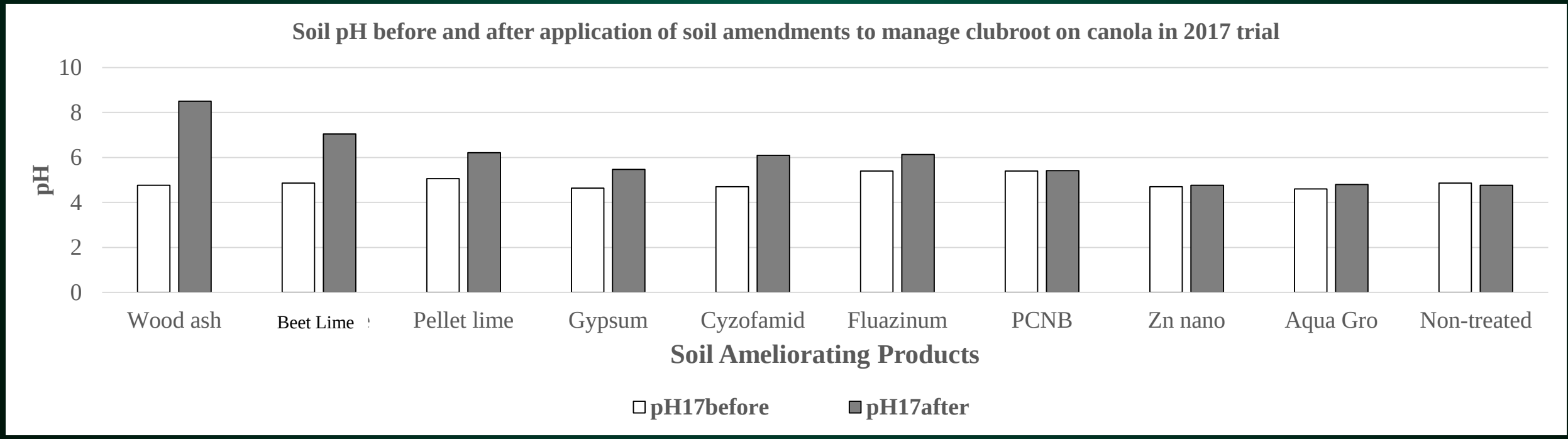

pH before and after application of soil amendments
pH
8
7
6
5
4
3
2
1
0
Woodash
BeetLime
Pelletlime
Gypsum
Cyazofamid
Fluazinam
PCNB
Zn Nano-Particle
AquaGro
Non-Treated
Soil Ameliorating Products
PH18Before
PH18AFTER


Soil pH before and after application of soil amendments to manage clubroot on canola in 2017 trial
pH
10
8
6
4
2
0
Wood ash
Beet Lime
Pellet lime
Gypsum
Cyzofamid
Fluazinum
PCNB
Zn nano
Aqua Gro
Non-treated
Soil Ameliorating Products
pH17before
pH17after

Varietal Susceptibility

Two years Research

- Planted in: First Week of June
- Plot size:5ft Length

3ft. Width

10 varieties tested, Replicated 4 times

Rated on: Last week of July

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Varietal Susceptibility

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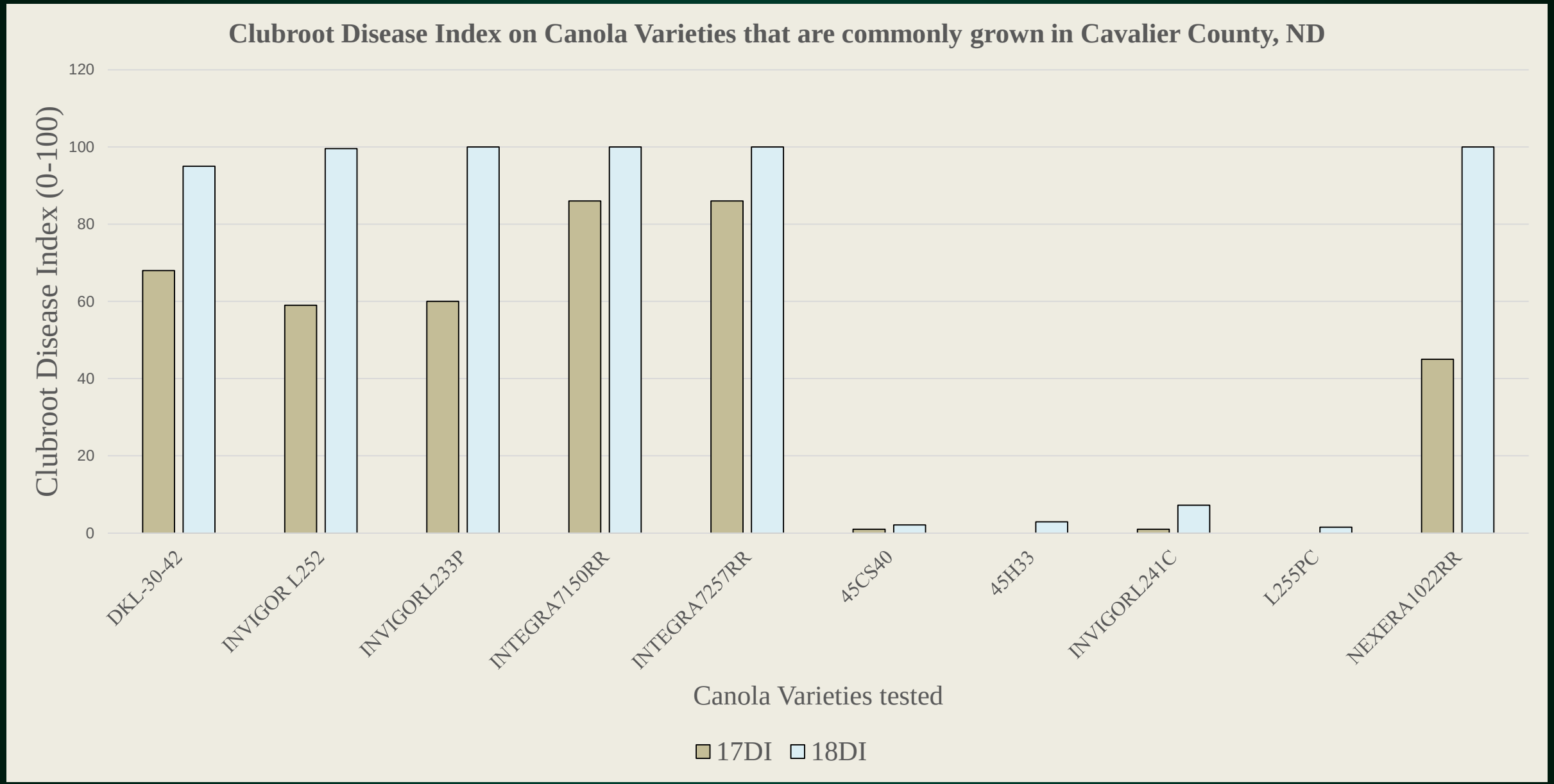
Intermediately Resistant Cultivar

Susceptible cultivar

Resistant Cultivar



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Canadian CR cultivars

CPS

Proven SEED

- ✓ PV 9558
- ✓ VR 9562
- ✓ PV 580
- ✓ PV 581
- ✓ PV 585

DUPONT/ PIONEER

PROTECTOR

- ✓ 45H29
- ✓ 45H33
- ✓ 45H37
- ✓ 45CS40
- ✓ 45CM36
- ✓ D3155C

DL Seeds

- ✓ 1960
- ✓ 1990
- ✓ CS2000

CANTERRA SEEDS

- ✓ 6056 CR
- ✓ 6076 CR
- ✓ 6086 CR
- ✓ 6090 RR

Cargill

VICTORY

- ✓ V12-3
- ✓ V14-1

MONSANTO

DEKALB

- ✓ 73-67
- ✓ 73-77
- ✓ 73-77
- ✓ 74-54
- ✓ 75-42

BAYER

InVigor

- ✓ L135C
- ✓ L241C
- ✓ L255PC

Syngenta

Genuity®

- ✓ SY4105
- ✓ SY4187

Dow AgroS

NEXERA

- ✓ 1020 RR
- ✓ 1024 RR
- ✓ 2020 CL

BRASSICA FAMILY (HOST) SUSCEPTIBILITY TO CLUBROOT

Two years Research

- Planted in: First Week of June
- Plot size: 5ft Length

3ft. Width

10 hosts tested, Replicated 4 times

Rated on: Last week of July

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Brassica family (Host) Susceptibility to Clubroot

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Host Susceptibility to Clubroot

Radish

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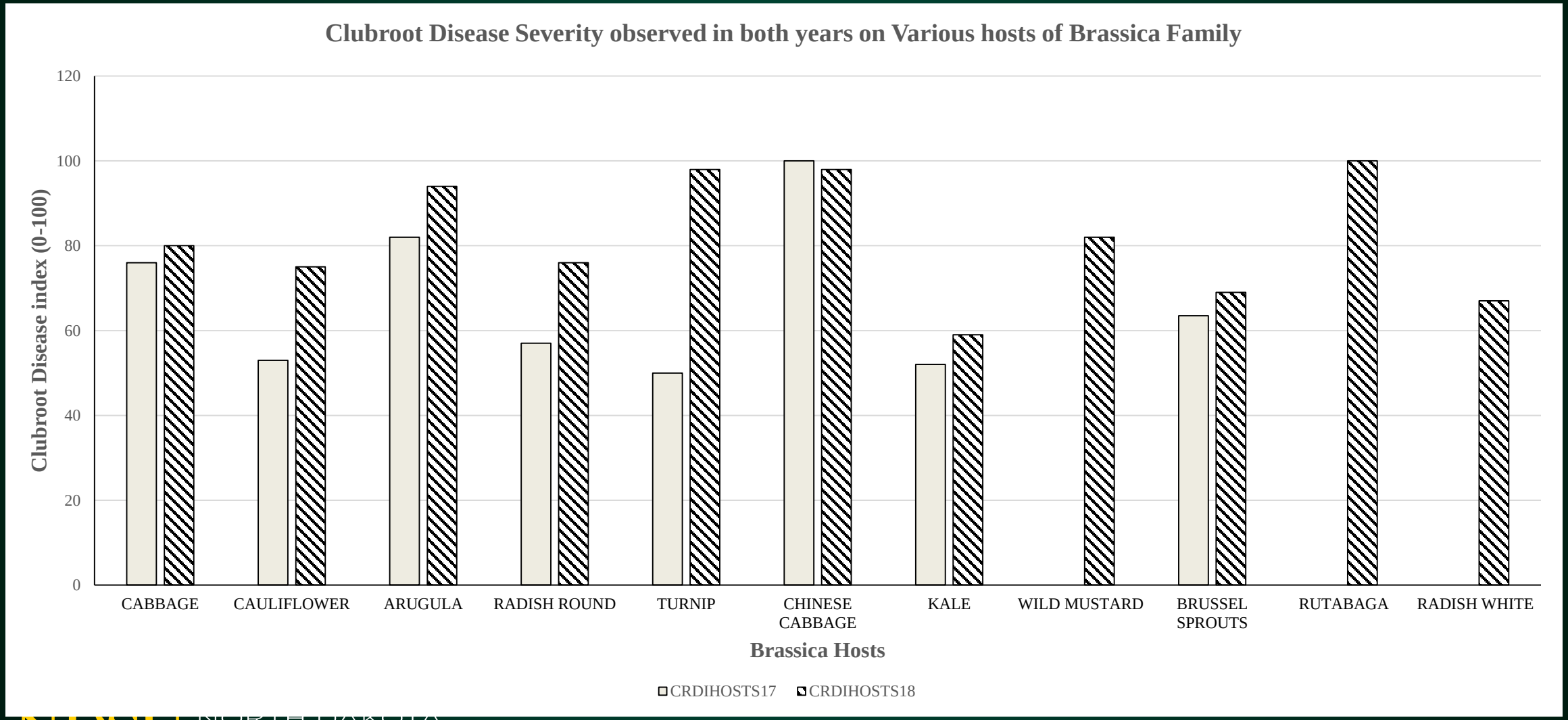
Host Susceptibility to Clubroot



Host Susceptibility

Kale

Arugula

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Host Susceptibility

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Wild Mustard

Host Susceptibility

Rutabaga

Chinese Cabbage

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Host Susceptibility

Host Susceptibility

Brussel Sprouts

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Host Susceptibility

Turnip

ND

Case Study: What happens on planting Canola varieties in a ground for the first time after five years after clubroot first report

Objective: To determine infection potential of clubroot resting spores after 5 years

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Case Study

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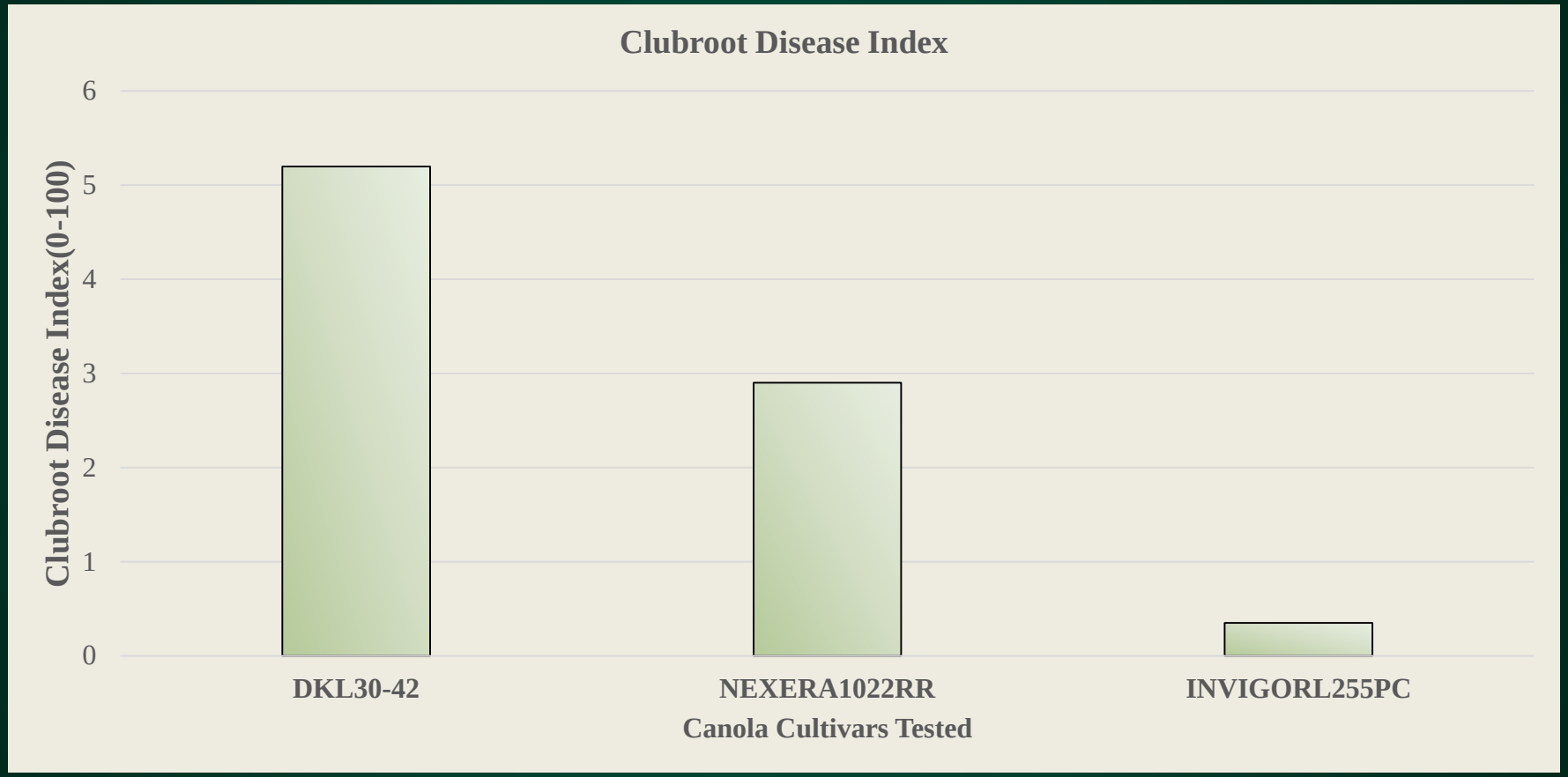
Case Study



Results indicate that spore population in soil reduced drastically varieties showed low incidence of clubroot, even the resistant variety has clubroot

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Summary

- Clubroot is now very common on Canola in Cavalier County of North Dakota especially in low pH (ranging from 4.5-6.4 (Acidic)) soils
- The actual numbers probably much higher (limited resources, time and trained personnel)
- Beet lime (Versa lime) showed promising results followed by Pellet Lime in both the years of research with low clubroot Disease Index
- Wood ash (Fly Ash) has efficacy potential, more research and dose determination needed
- Urgent need of more products to be tested under field condition
- Resistant Varieties can be used with recommended length of crop rotations

Future research

- Combination of a resistant variety and beet lime worth testing in high soil population to allow growers for a shorter rotations as their current practice
- Patho-type /race typing need to be done ASAP
- Spore population per gram of soil objective will be crucial in designing management options
- Urgent need of state wide survey of clubroot in North Dakota

Life after Clubroot

- A grower's view in Canada (Excerpts from online webpage) a bit of psychology in one's back pocket to deal with clubroot in a mature, intelligent way.

- **He compared discovering clubroot on one's farm to the seven steps in the grieving process**:
  - **1. Shock and denial** — for example, doubting the accuracy of tested samples.
  - **2. Pain and guilt**, perhaps over tight rotations.
  - **3. Anger, blame and bargaining**. Blaming custom applicators, oil crews, or others for bringing it into the field.
  - **4. Depression, reflection, loneliness**. Perhaps not wanting to go for to the coffee shop because of shame, or not wanting to talk about it.
  - **5. The upward turn**. Looking at resistant varieties, looking at other crops.
  - **6. Reconstruction and working through it.** Getting a plan together, adapting cultural practices.
  - **7. Acceptance and hope.**

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
- Clubroot International workshop organizers
- Student Hourly Jordyn Ullyott and Nester
- Survey group: Lesley Lubenow, Naeem Kalwar, Anitha Chirumamilla and Ron Benada
- Drs. DelRio and Chittem

To all my colleagues and to MANY OTHERS

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- Thank You
- Questions and Suggestions are welcome