Seeking the Freaks

Genetic Tools for Surveying Herbicide Resistance in Weeds

Zack Bateson, Ph.D.
Research Director

Where are we going?

- NAGC's place in the wild world of weeds

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- Statewide Genetic Survey – Results

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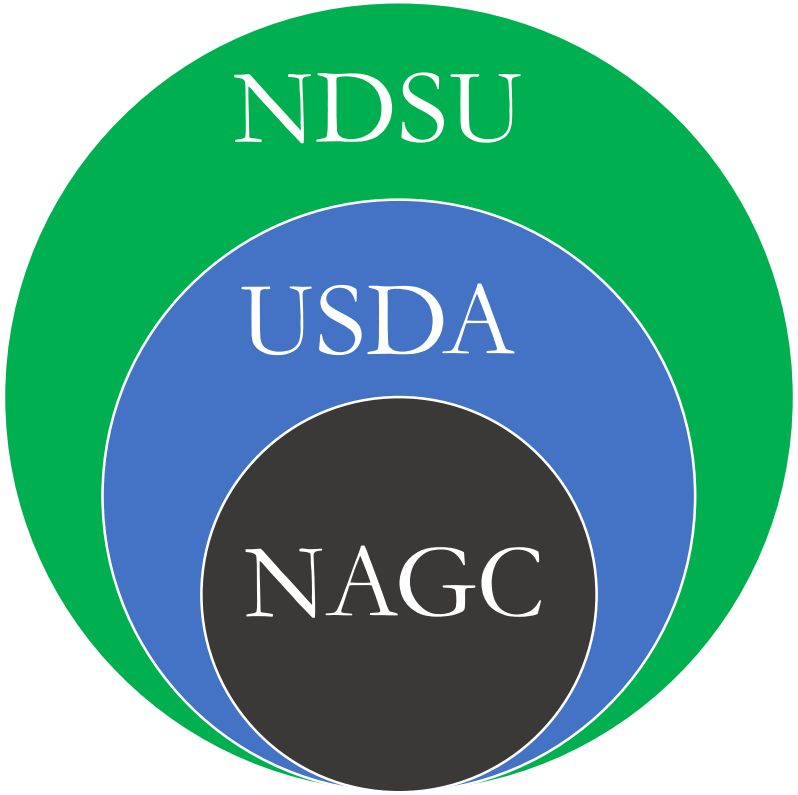
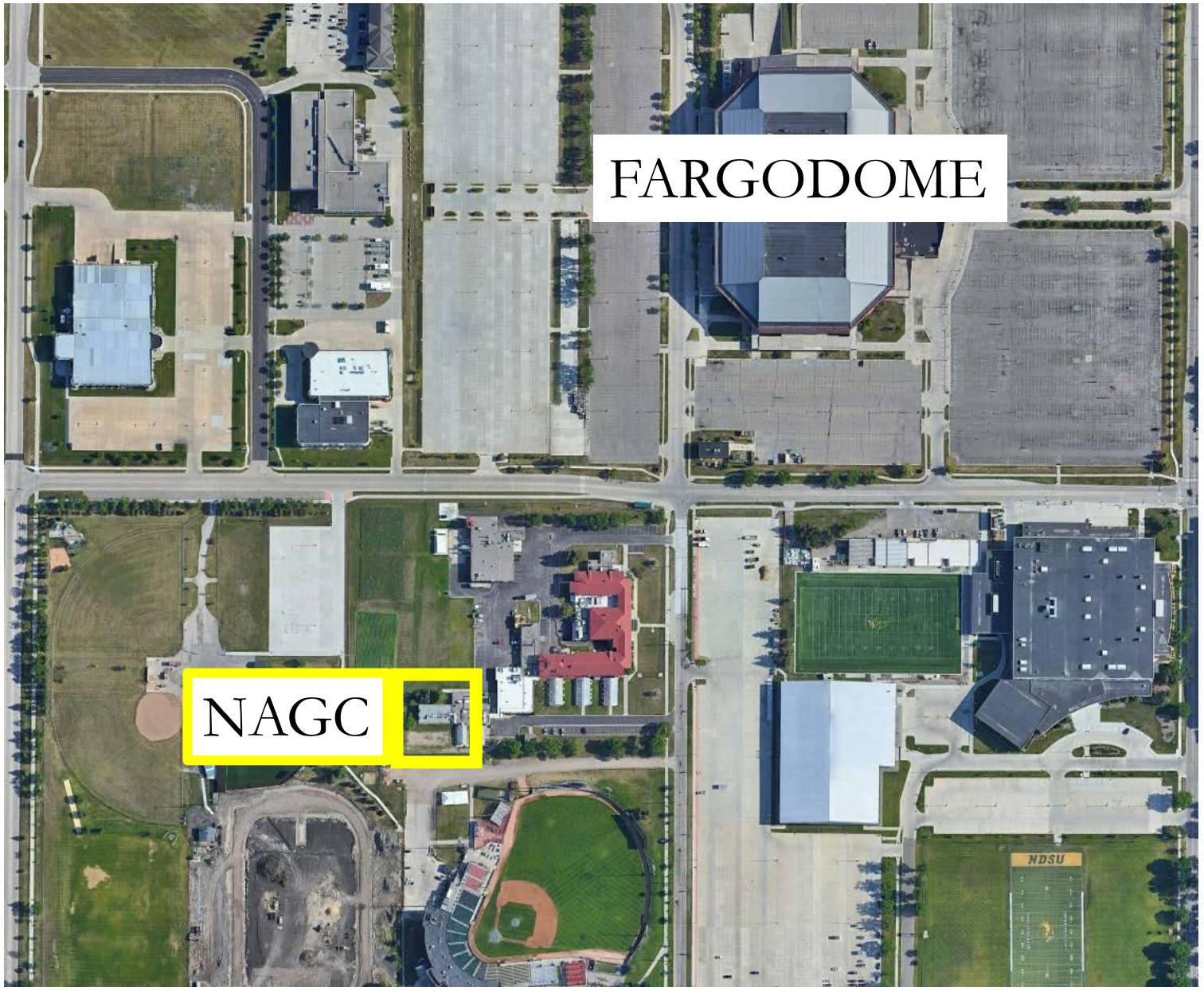
- NAGC's place in the wild world of weeds
- Statewide Genetic Survey – Results
- Upcoming Projects
- Begging

The Place





The People

ANAB
ACCREDITED
ISO/IEC 17025
TESTING LABORATORY

The Things

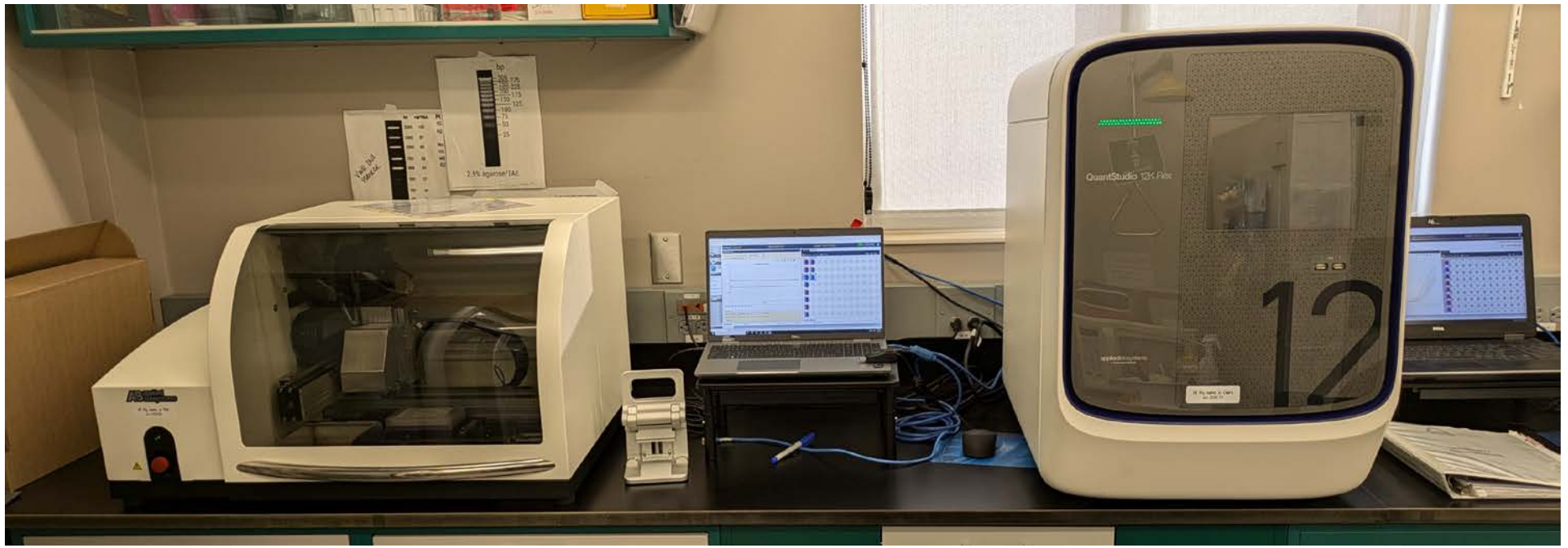
Harry & Lloyd

Dwight & Steve

Mary, Kate, & Ashley

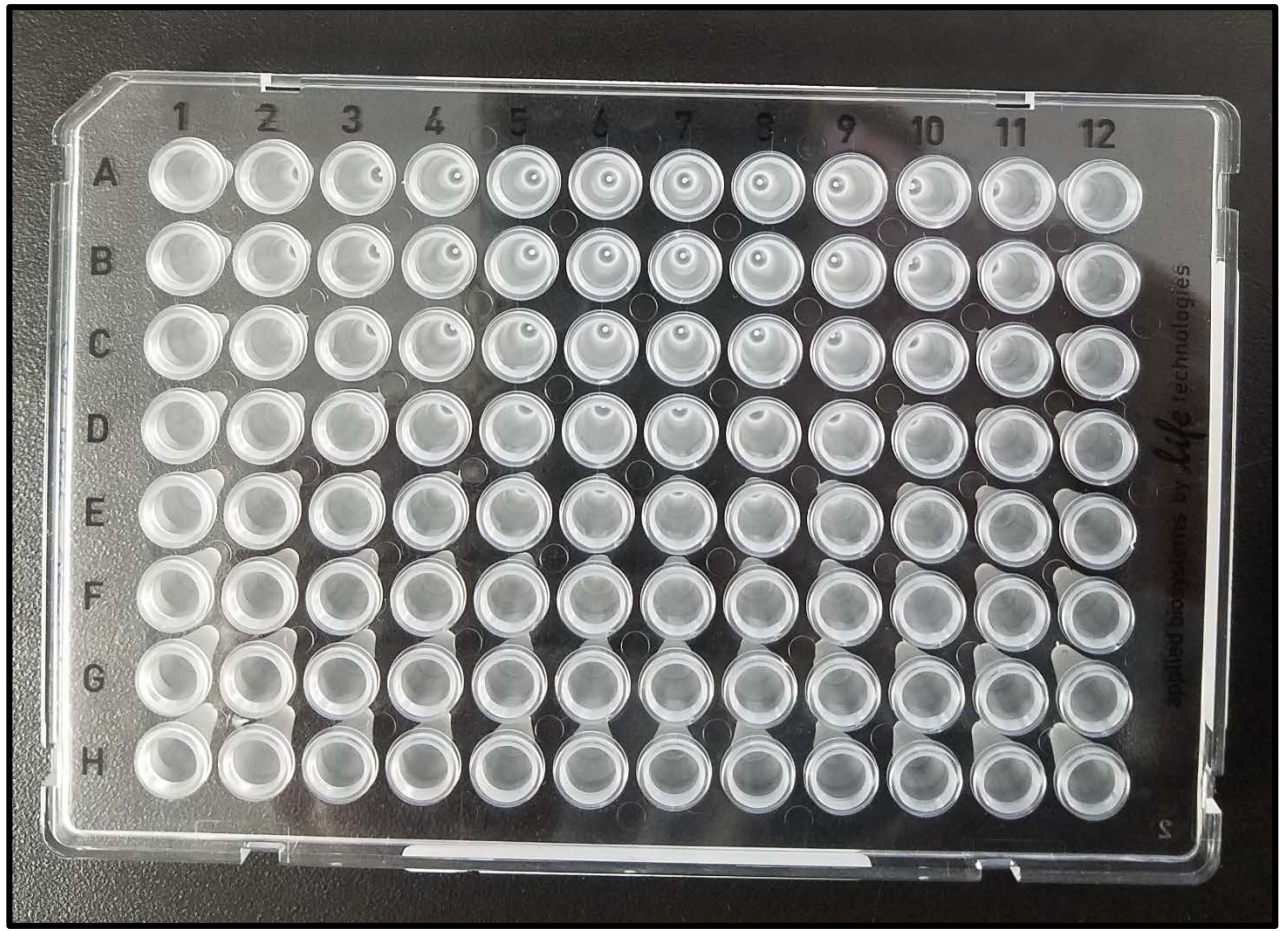
Tiffani & Veronica

The Things



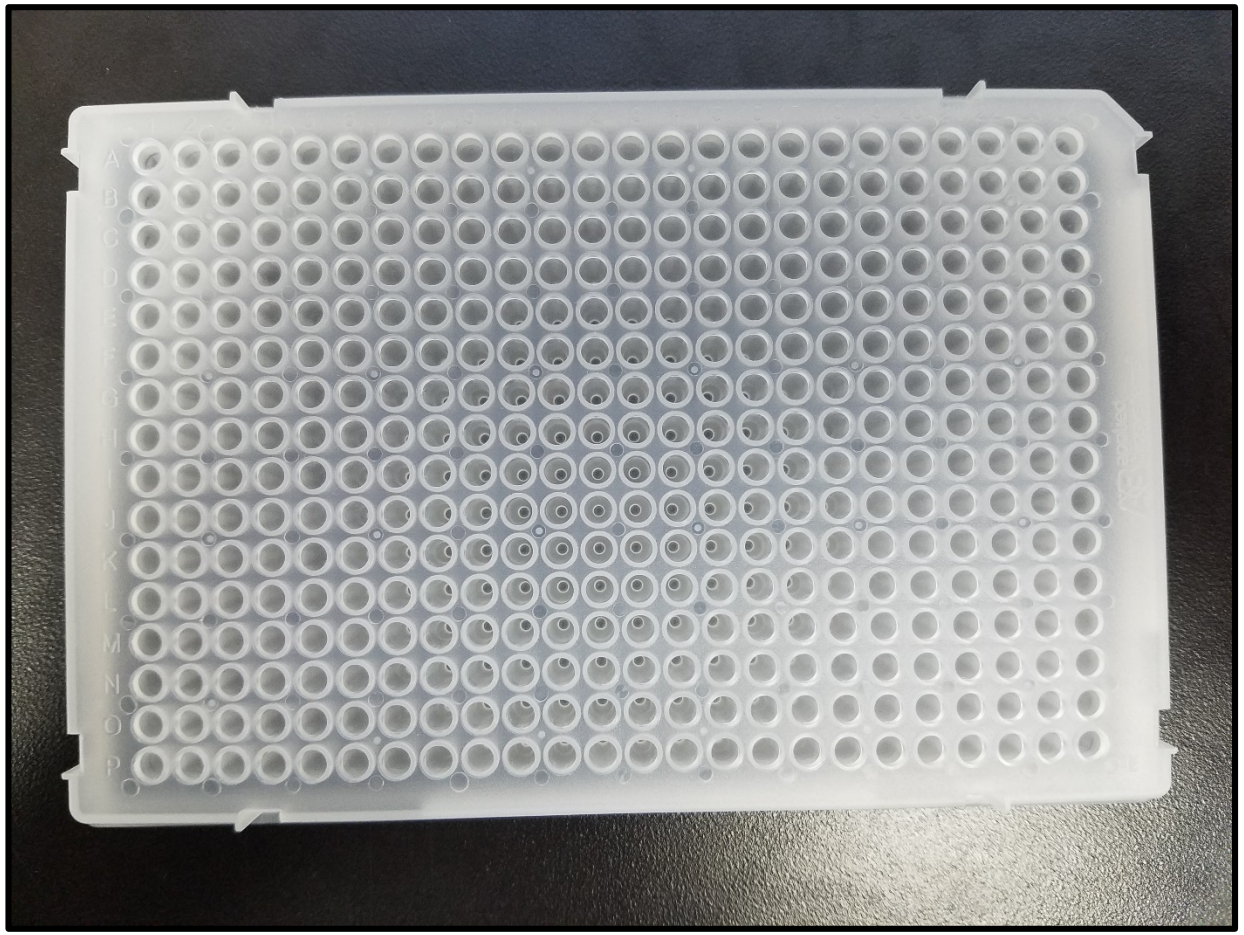
Phil

Claire



96-well Plate

384-well Plate



General approach

- Collaborate
- Complement, not compete
- Confidential reporting to clients

Our weed-focused approach

Collaborate

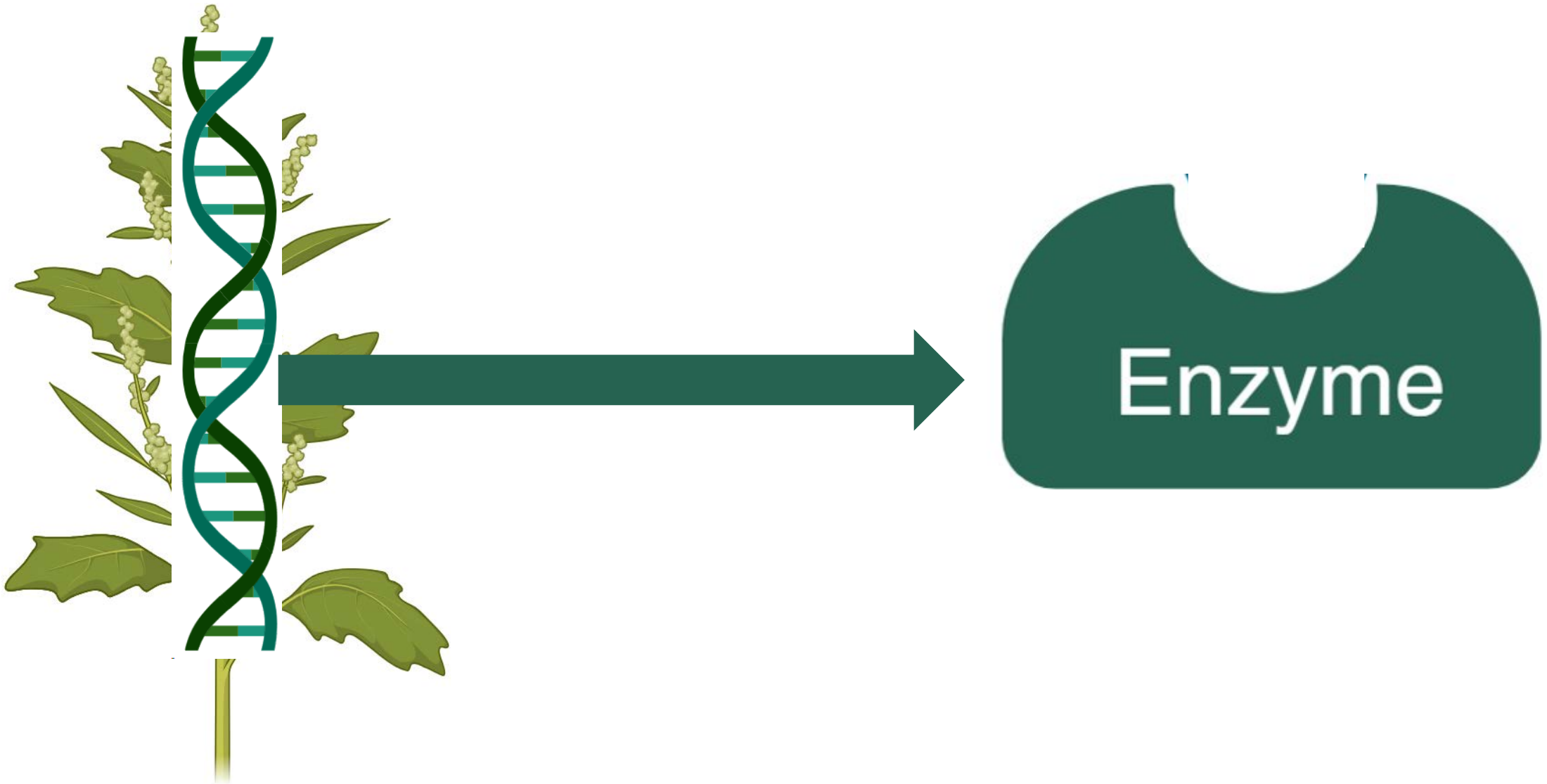
- Dr. Joseph Ikley, NDSU
- Dr. Brian Jenks, NDSU-NCREC
- Dr. Michael Christoffers, NDSU
- Dr. Kirk Howatt, NDSU
- Dr. Tom Peters, NDSU

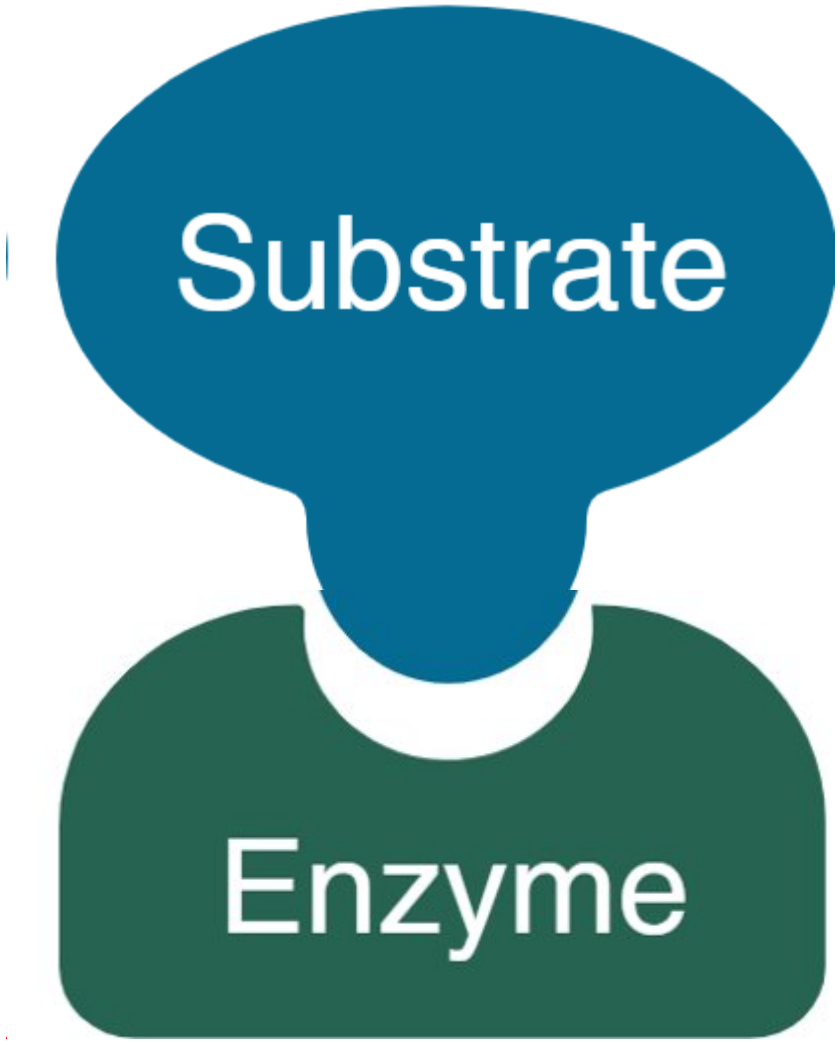
Increase access of DNA tech to all

Provide fast turnaround

What we test

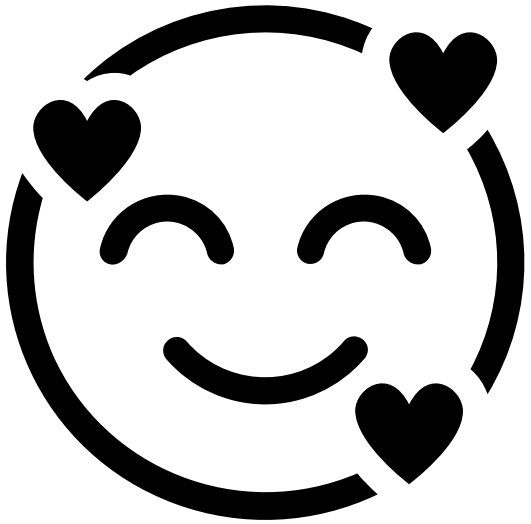
Target-site Mutations


Enzyme


Substrate
Enzyme

Products

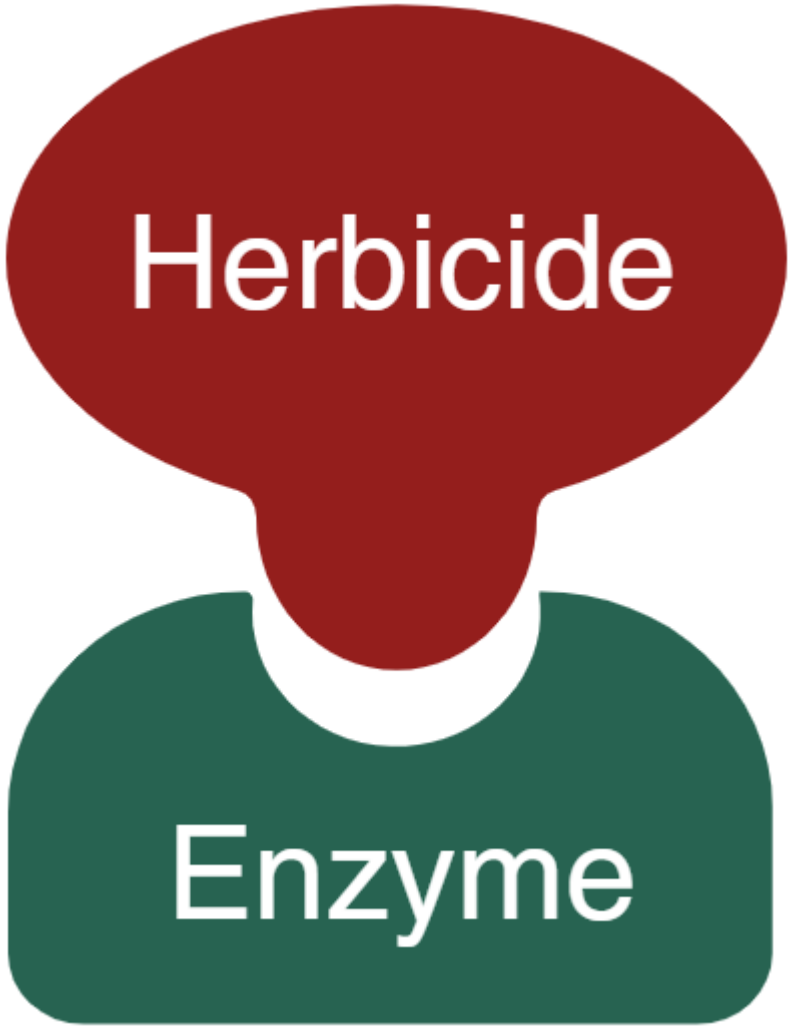
Enzyme



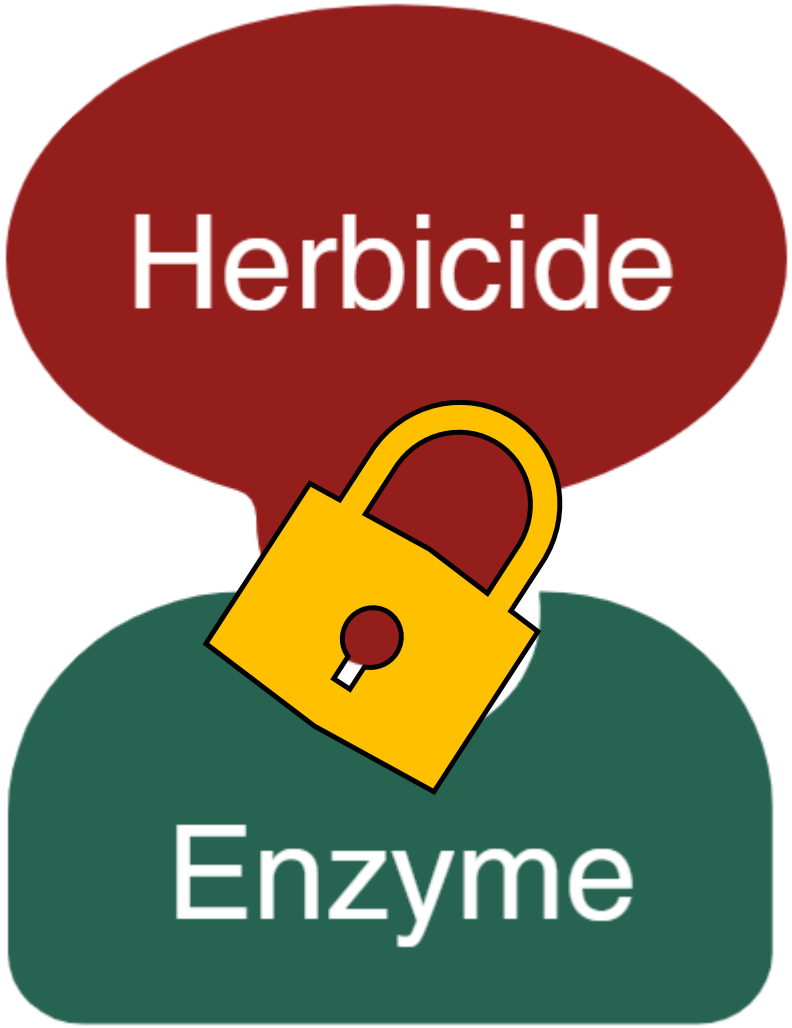
Enzyme

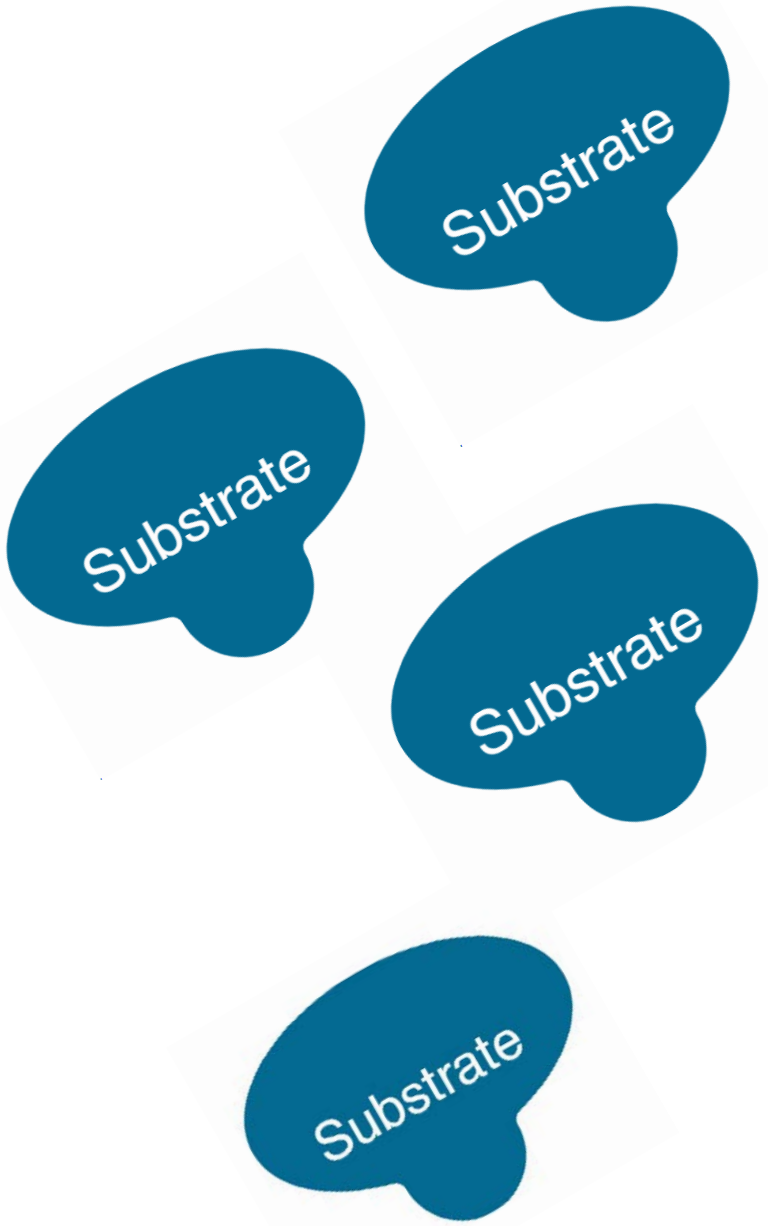
Products

Competitor

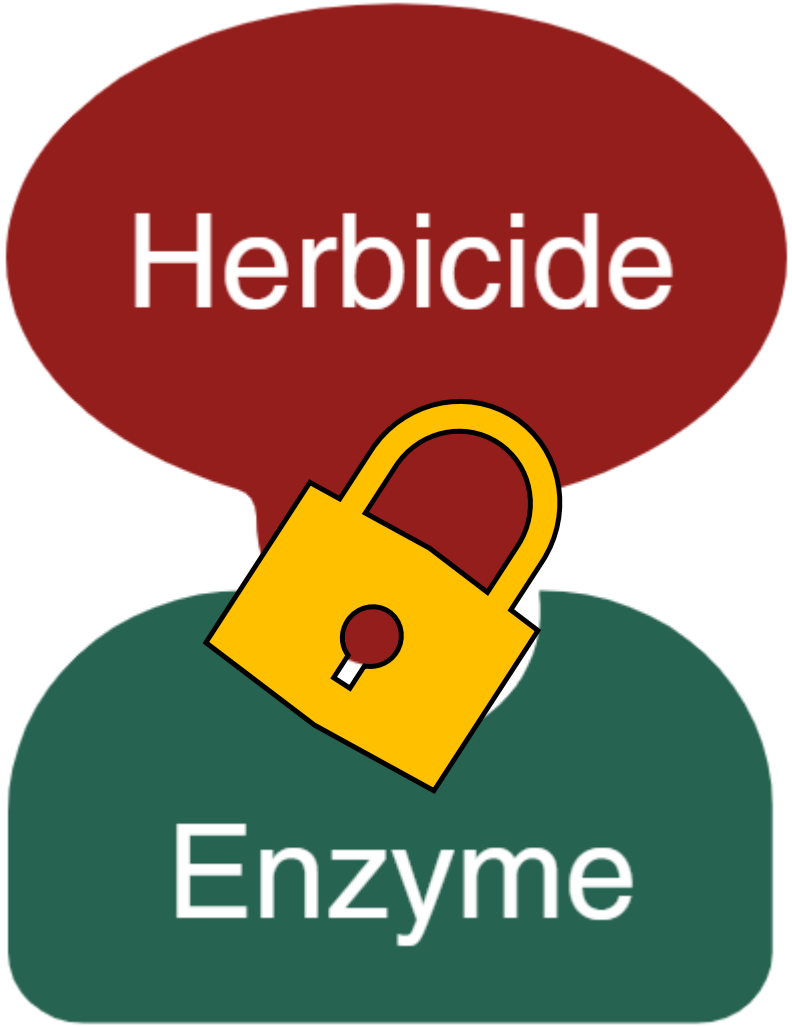


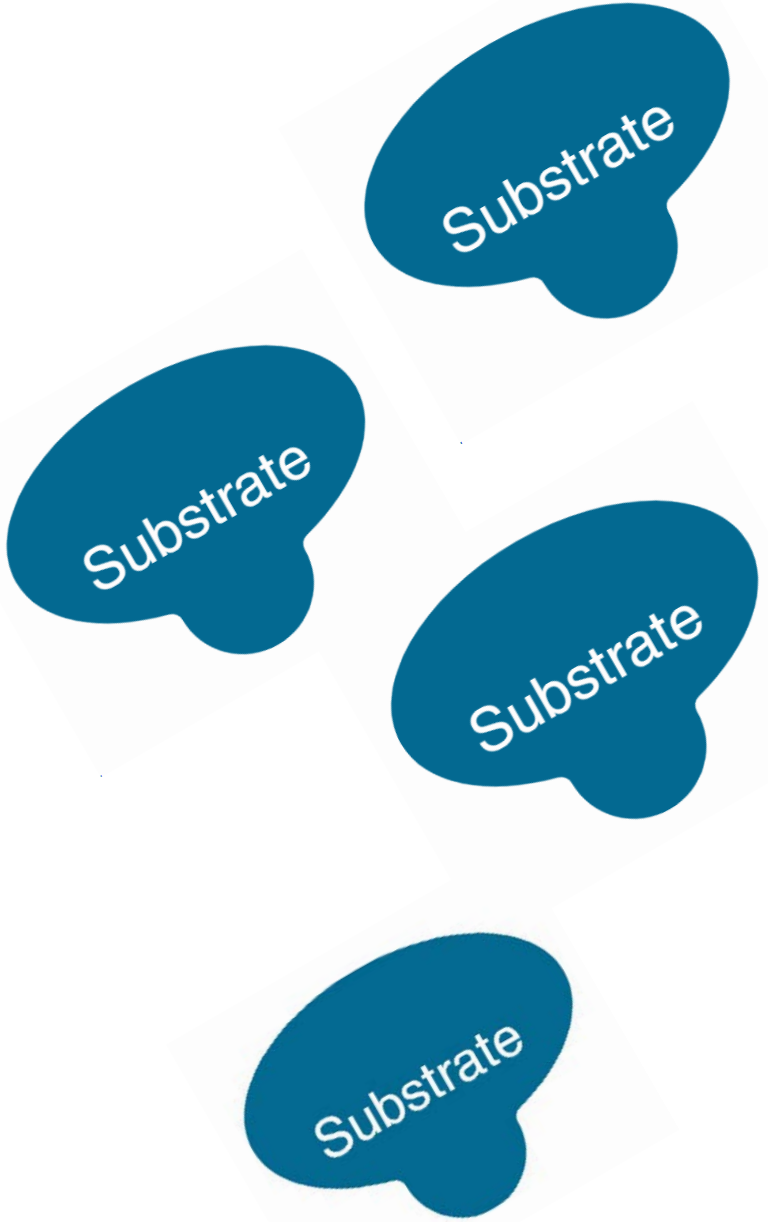
Competitor


Herbicide
Enzyme


Substrate
Substrate
Substrate
Substrate

Competitor


Herbicide
Enzyme


Substrate
Substrate
Substrate
Substrate

Enzyme changes shape

Herbicide

Herbicide

Substrate

Enzyme

Herbicide

Products

Herbicide

Herbicide

Enzyme

Herbicide

Products

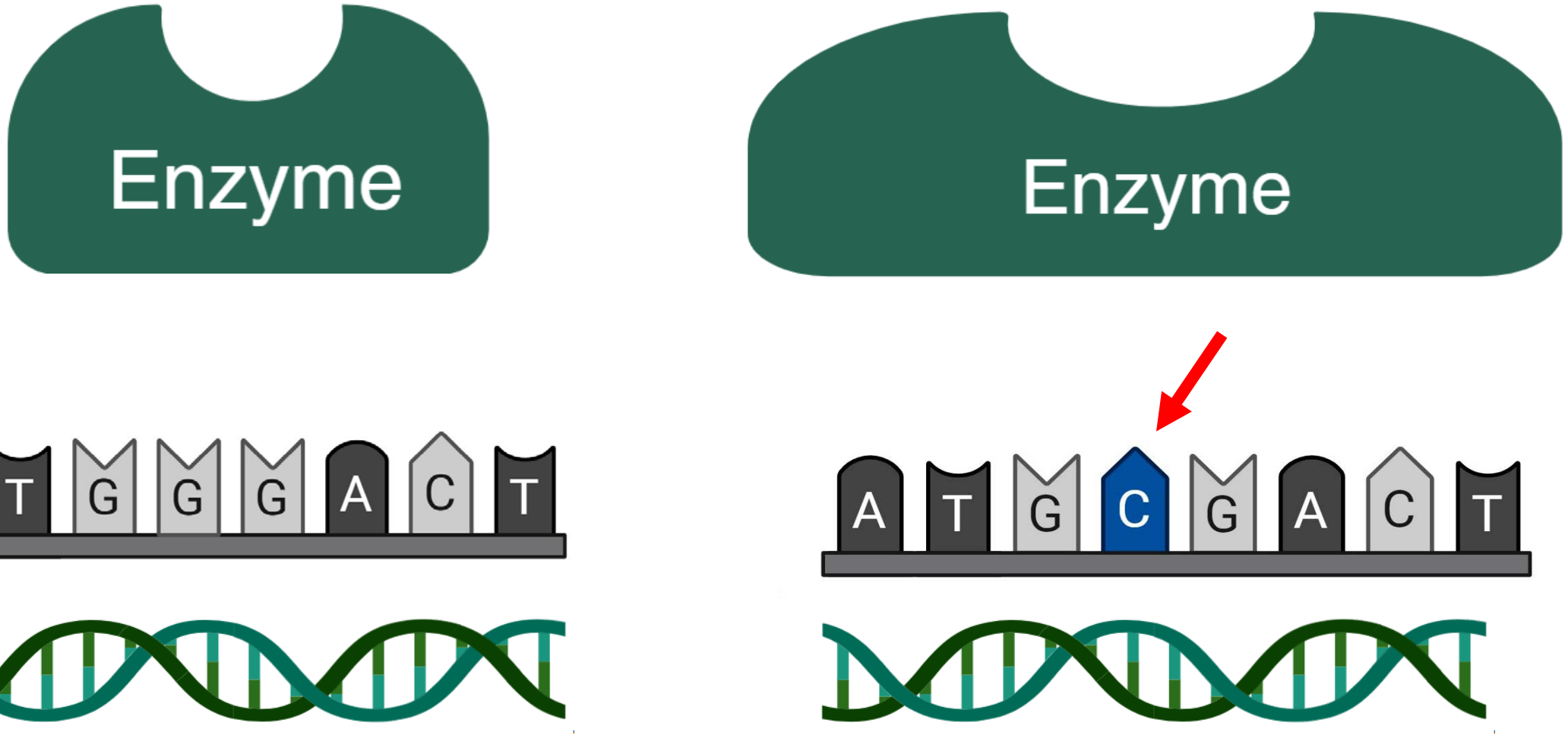
Herbicide

Herbicide

Enzyme

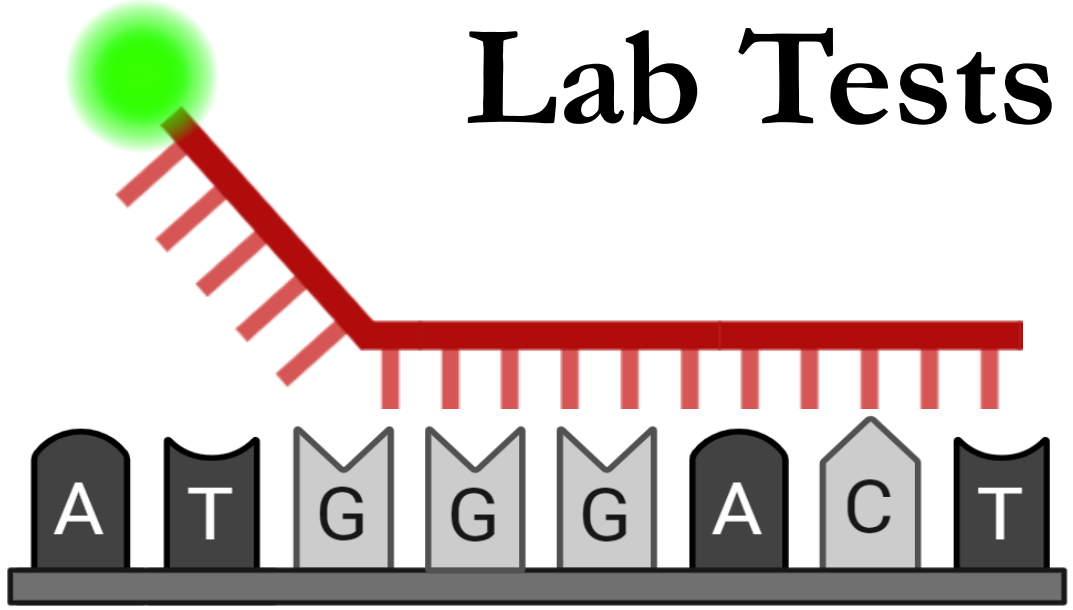
Herbicide

Enzyme changes shape due to a mutation

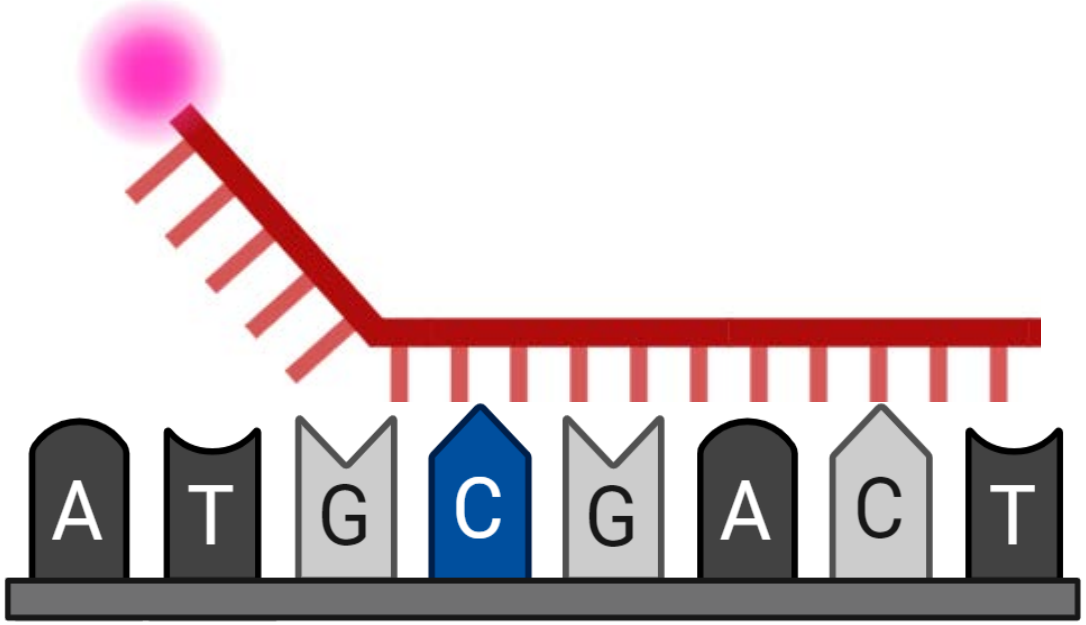


Susceptible
Genotype

Lab Tests



Resistant
Genotype



Goals of the Statewide Survey

1. Seek the freaks by genotyping
2. Easy collection & submission

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1. Seek the freaks by genotyping
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3. Fast reporting for early detection
4. County-level maps for regional trends

Survey limitations

- Known genetic markers linked to resistance

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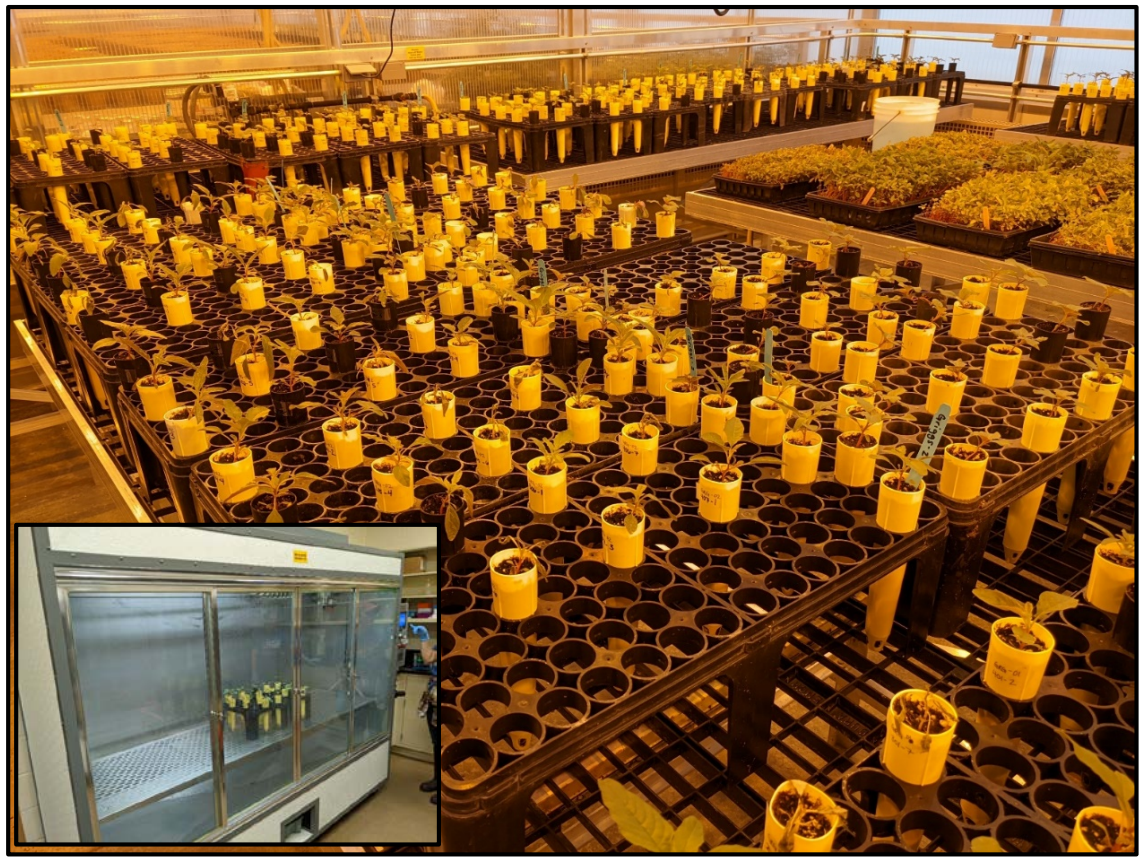
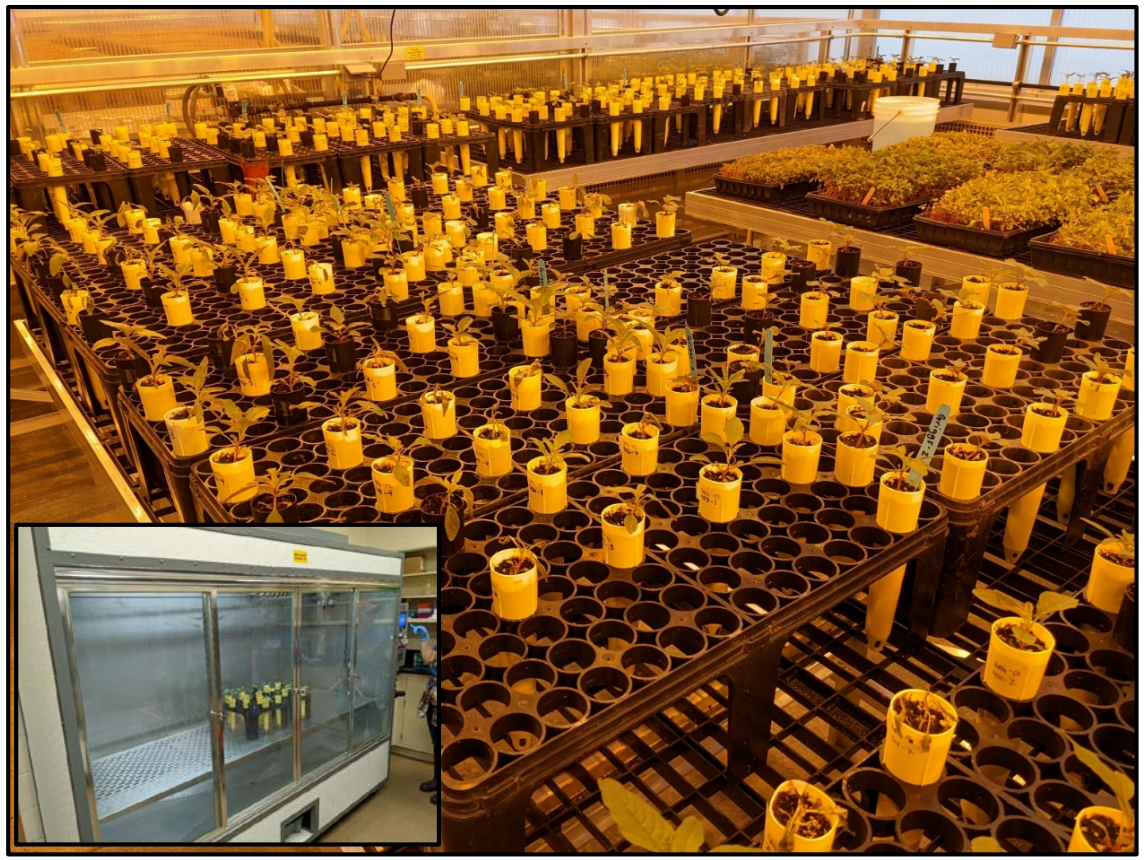
- Known genetic markers linked to resistance
- Cannot detect new mutations
- Cannot detect non-target site mechanisms

Partnership - weed diagnostic program



NDSU | EXTENSION

Partnership - weed diagnostic program



NDSU EXTENSION

NAGC NATIONAL AGRICULTURAL GENOTYPING CENTER

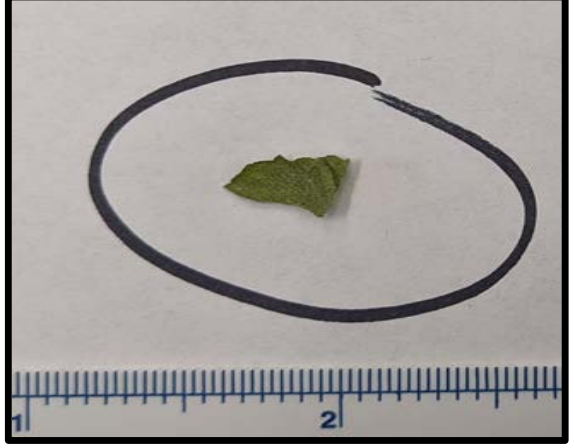
Survey started in August 2023

Focus on pigweeds & kochia

Current tests detect DNA markers **associated** with resistance

Group 2 – Raptor, Beyond
Group 9 – Roundup
Group 14 – Reflex, Sharpen

Easy Collection



Easy Submission

Submission Form

Submitter Information

Name: _____

Phone: _____

Email(s): _____

Collaborators

NAGC NATIONAL AGRICULTURAL GENOTYPING CENTER

NDSU EXTENSION

Envelope	Sample ID [Year-Month-County-Field Description] Example [24-06-Cass-SE4]	Kochia or Pigweed species	Herbicide(s) applied to weeds/field
1			
2			
3			
4			

Sponsors

ND SOYBEAN COUNCIL

NORTH DAKOTA CORN COUNCIL

Direct any sampling questions to NAGC
Email: research@genotypingcenter.com
Phone: 701-239-1451

Confidential Reports

National Agricultural Genotyping Center

1616 Albrecht Blvd N Fargo, ND 58102
TEL: (701) 239-1451
www.genotypingcenter.com

To: NAGC Proficiency Testing Committee
1616 Albrecht Boulevard N
Fargo, ND 58102

Attn: Doogie Howser

REPORT ON THE EXAMINATION OF PHYSICAL SAMPLES

Testing Request: Herbicide Resistance Genotyping (koPPO, koEPSPS-COPY, and koALS-W574L)

Laboratory Case #: 24-1299

Report Date:

Description of Submitted Samples:

Item	Description
1	One (1) microcentrifuge tube labeled 24-06-1-1 containing DNA extract
2	One (1) microcentrifuge tube labeled 24-06-1-2 containing DNA extract
3	One (1) microcentrifuge tube labeled 24-06-1-3 containing DNA extract
4	One (1) microcentrifuge tube labeled 24-06-1-4 containing DNA extract
5	One (1) microcentrifuge tube labeled 24-06-1-5 containing DNA extract

Results/Interpretations/Opinions:

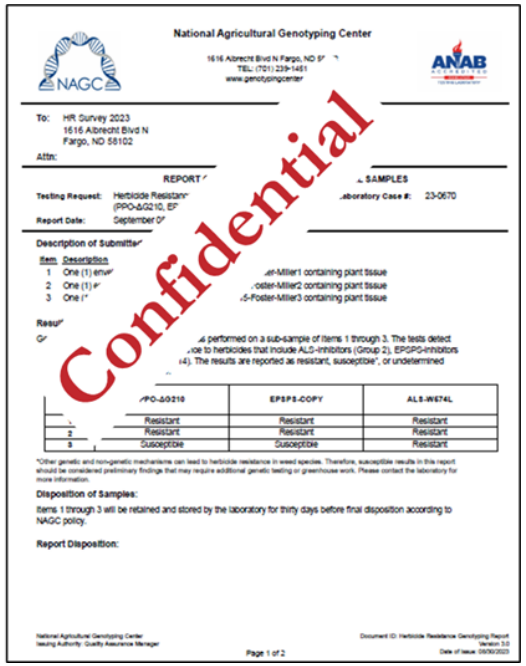
Genotyping for herbicide resistance traits was performed on the sample, as received, from Items 1 through 5. The tests detect genetic mutations associated with resistance to herbicides that include PPO-inhibitors (Group 14), EPSPS-inhibitors (Group 9), and ALS-inhibitors (Group 2). The results are reported as resistant, susceptible*, or undetermined and can be found in the table below.

Item	koPPO	koEPSPS-COPY	koALS-W574L
1	Susceptible	Resistant	Susceptible
2	Resistant	Resistant	Resistant
3	Resistant	Susceptible	Resistant
4	Resistant	Resistant	Resistant
5	Resistant	Resistant	Resistant

FREE year-round testing in North Dakota

Turnaround = 7-day (or less)

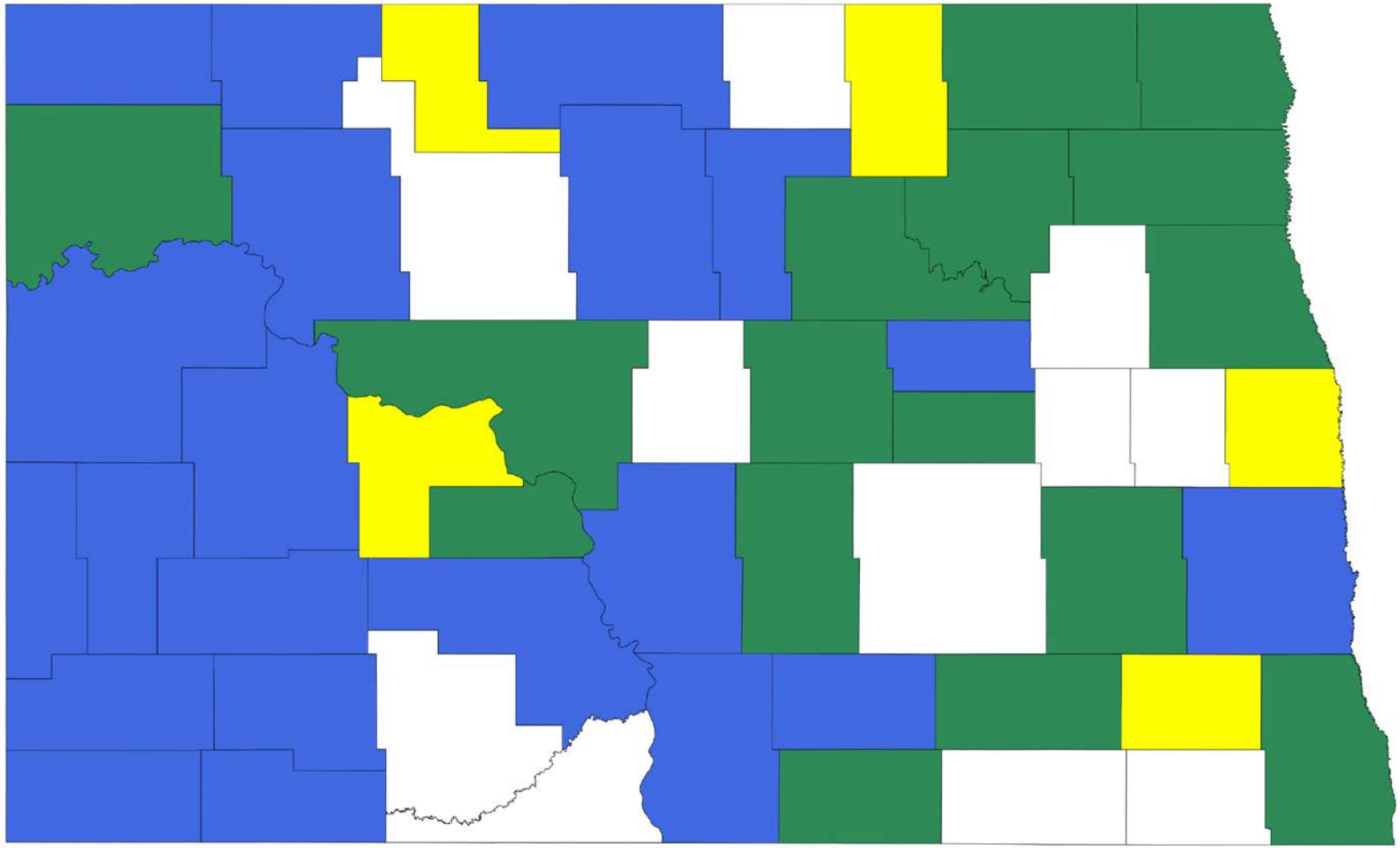
NAGC
NATIONAL AGRICULTURAL GENOTYPING CENTER



Results – Last 1.5 years

Genetic Results Only

520 samples since August 2023



80% counties

Kochia only = blue
Pigweed only = yellow
Both = green

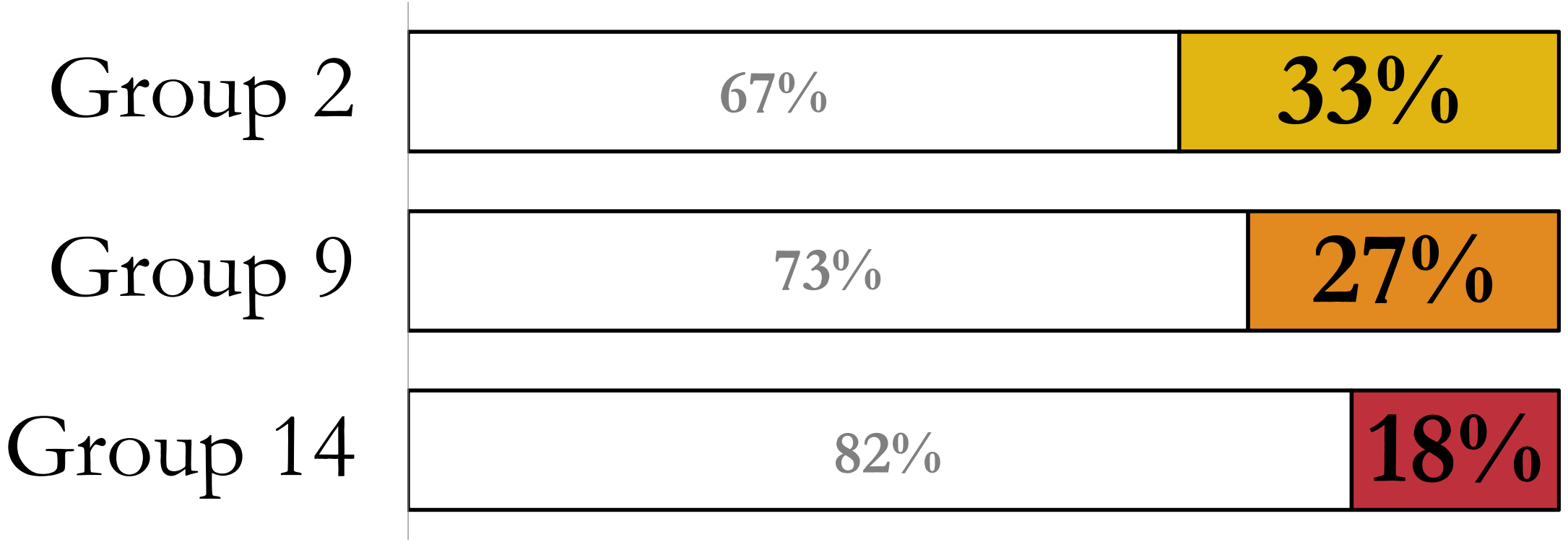
Pigweeds

21 Counties

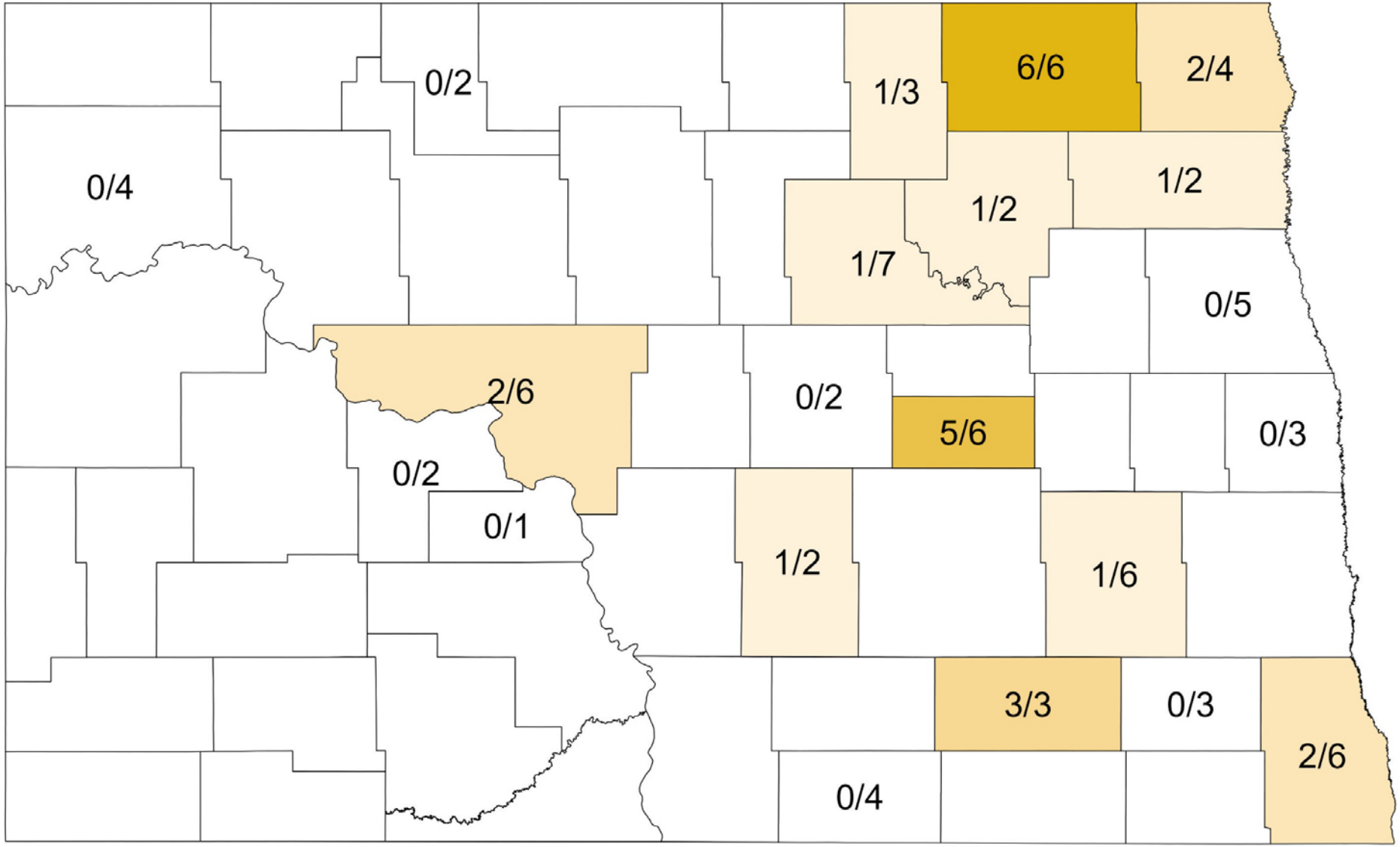
79 Plants

Pigweeds

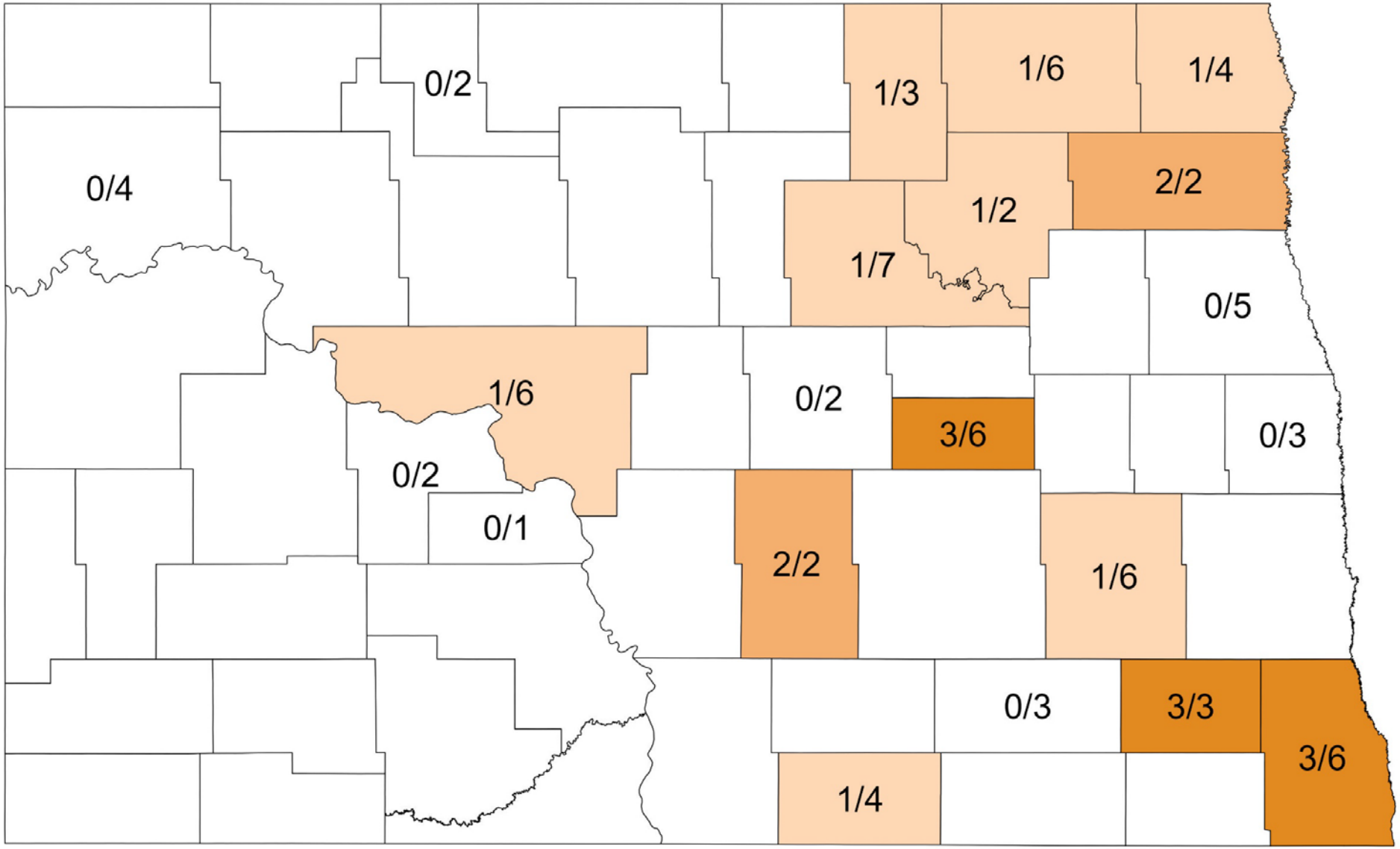
R plants by Herbicide Group



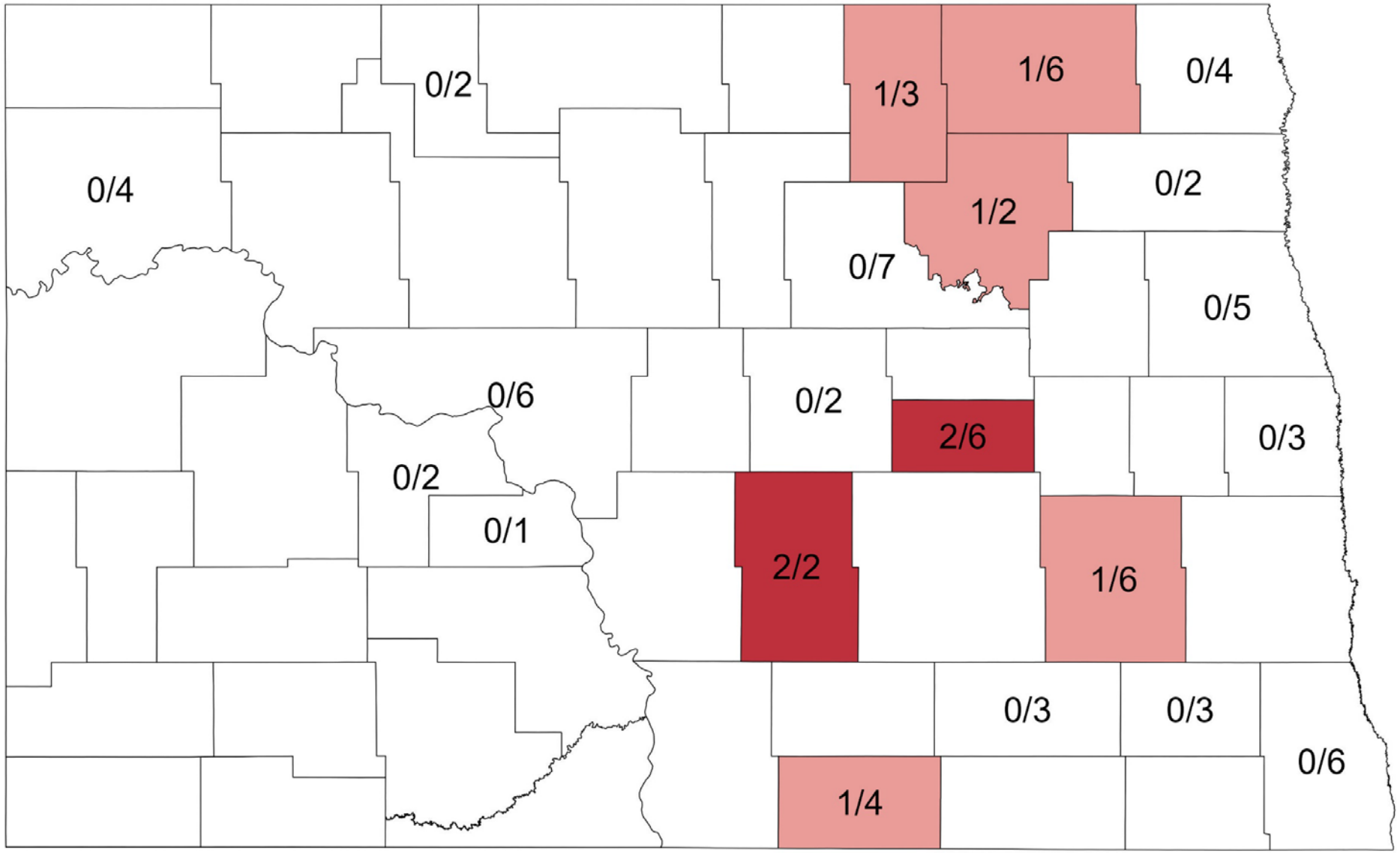
Pigweeds - Group 2 Resistance Marker



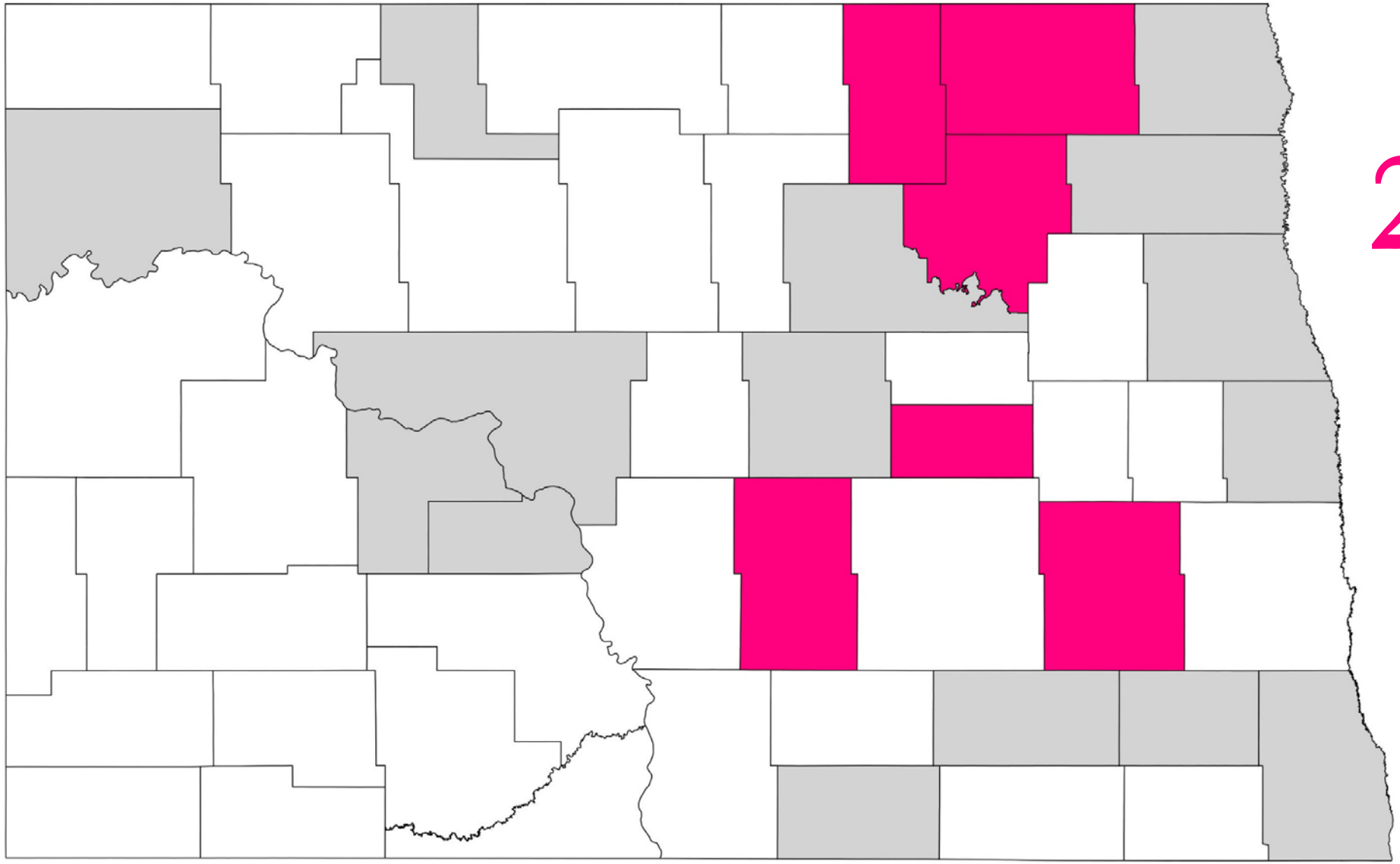
Pigweeds - Group 9 Resistance Marker



Pigweeds - Group 14 Resistance Marker



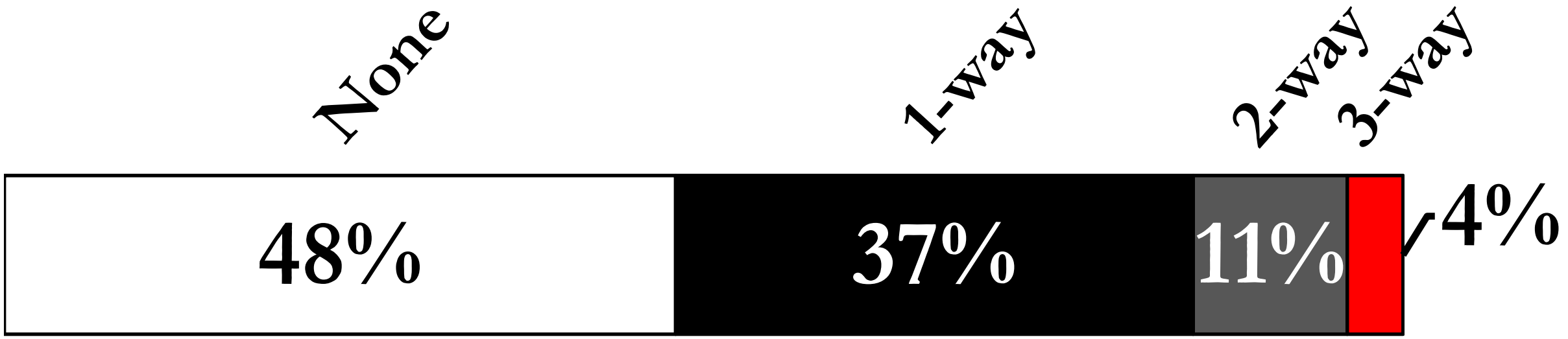
Pigweeds – Counties with all three R markers



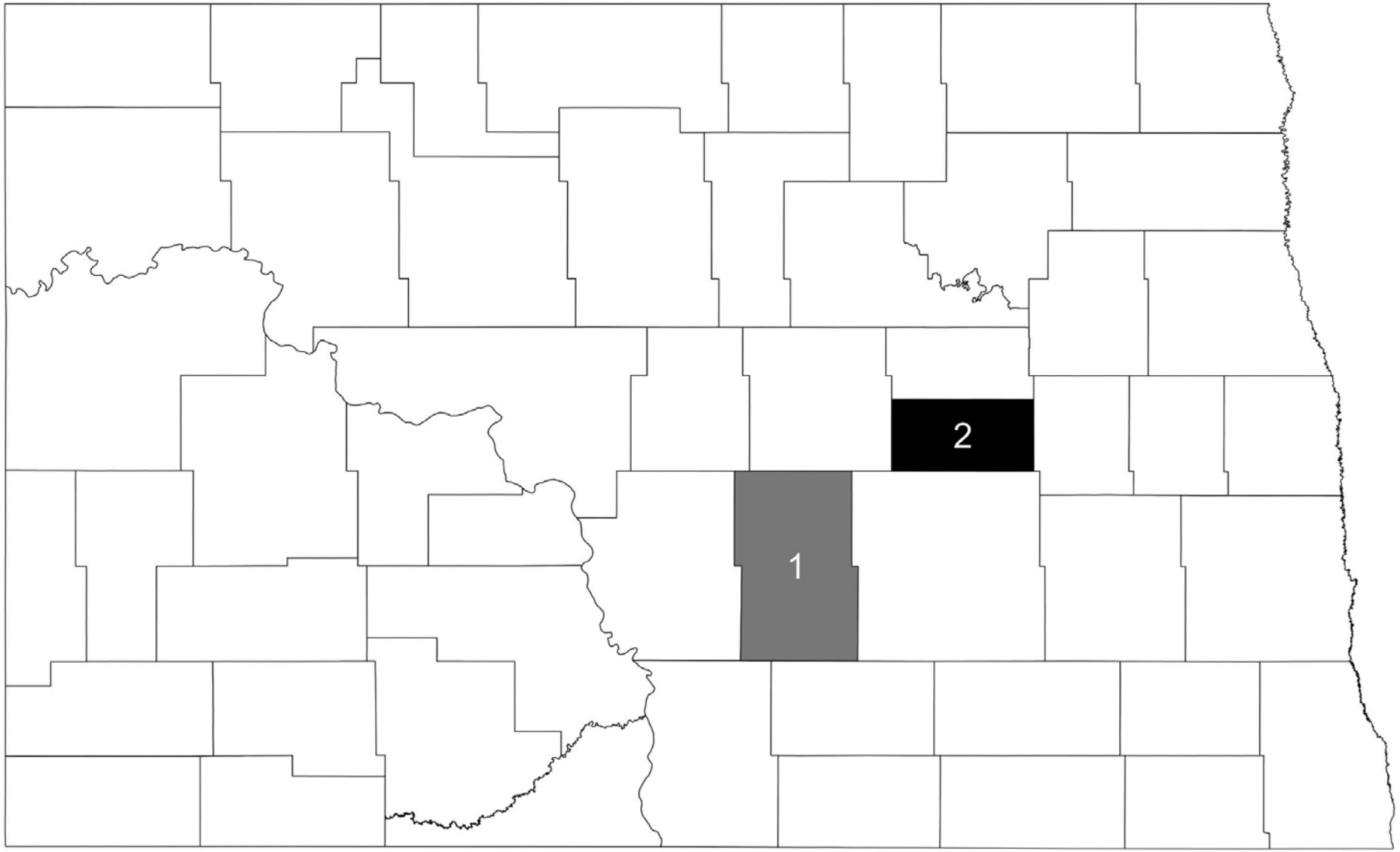
29%

Pigweeds

Detected target-site R markers per plant



Pigweeds – Three-way resistance markers



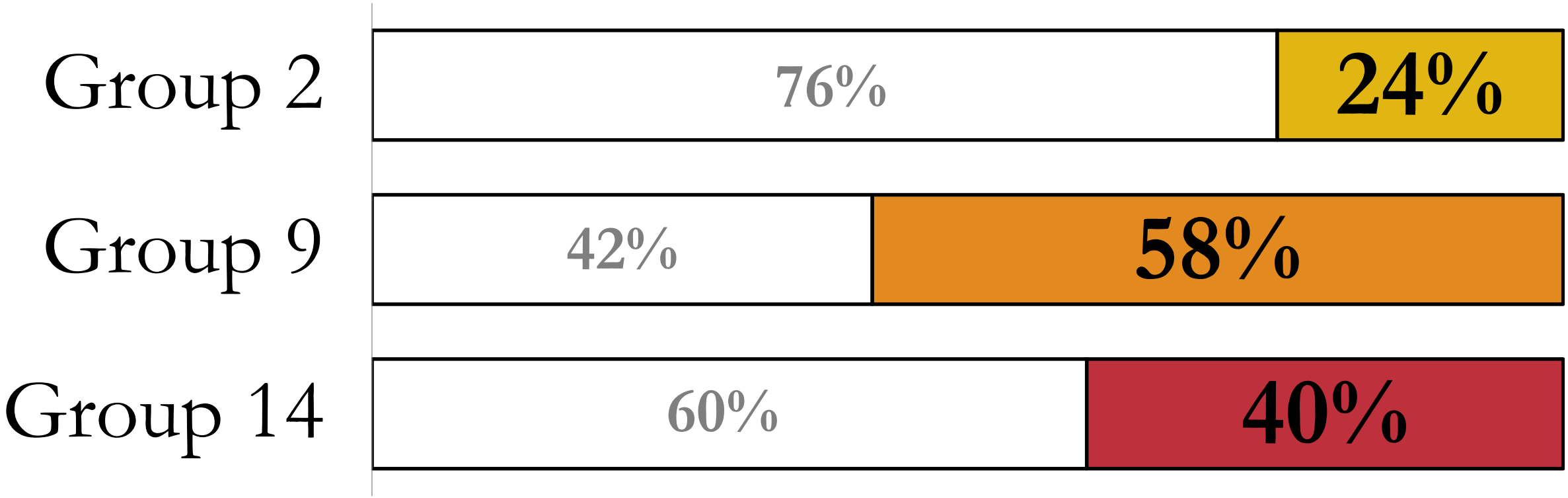
Kochia

37 Counties

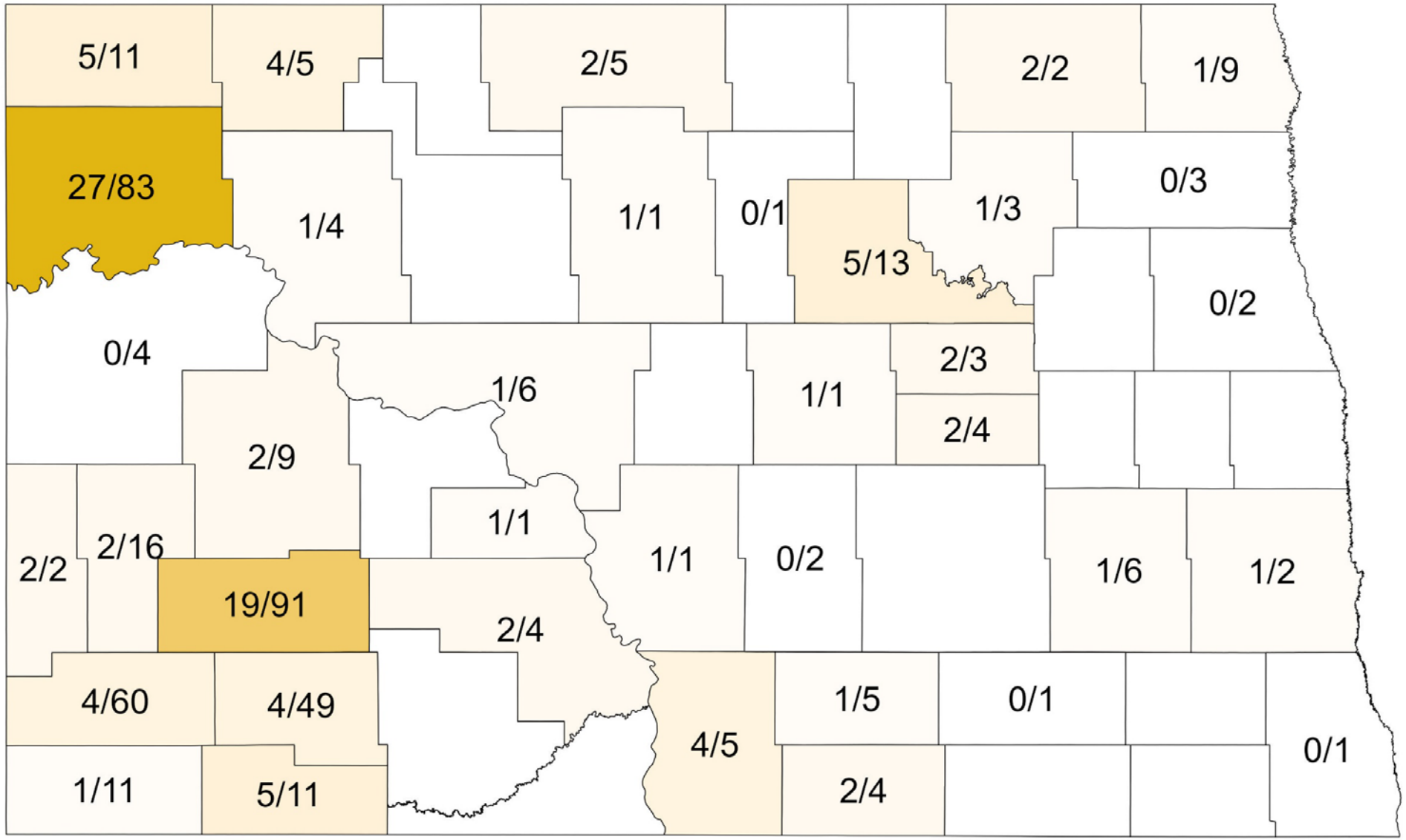
441 Plants

Kochia

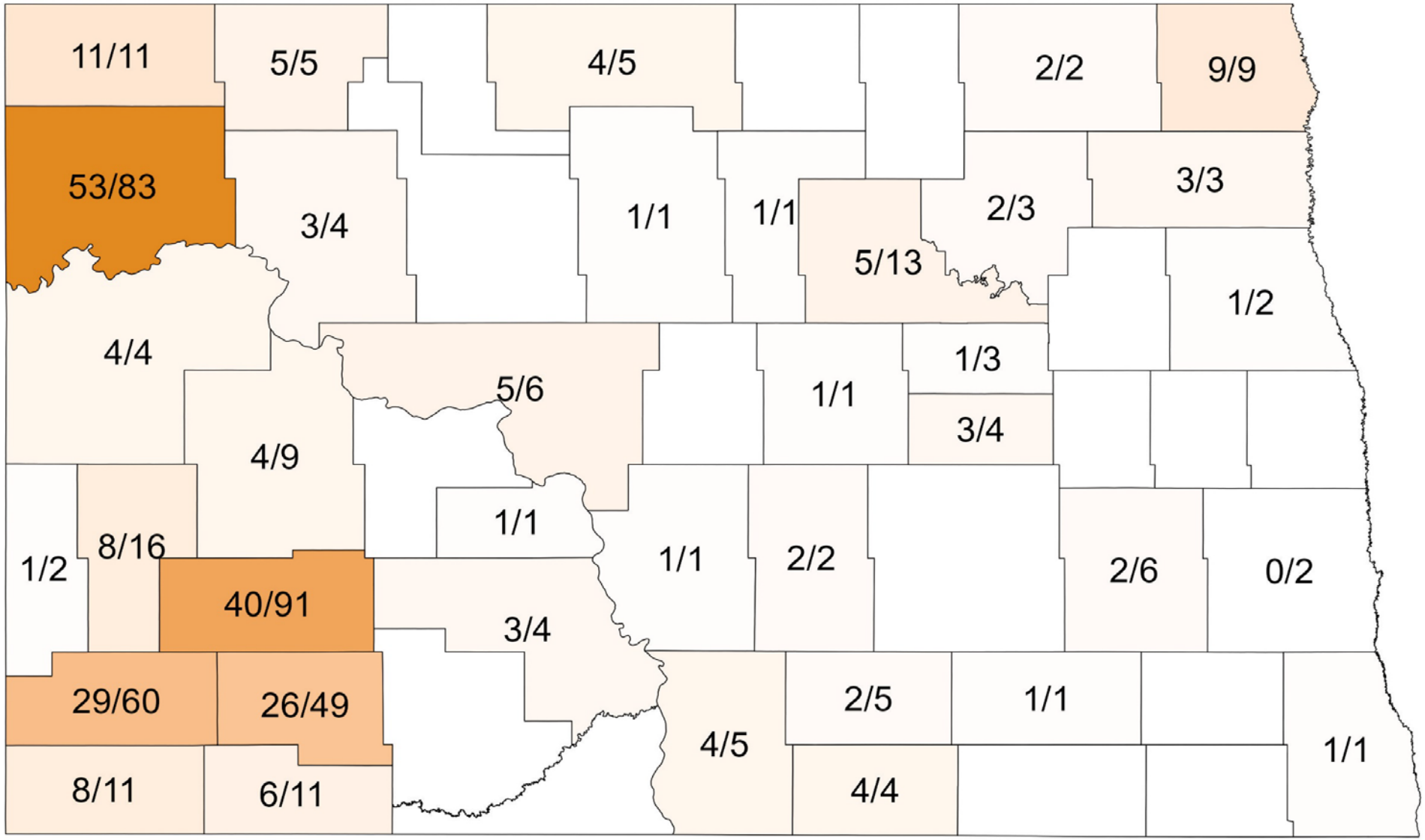
R plants by Herbicide Group



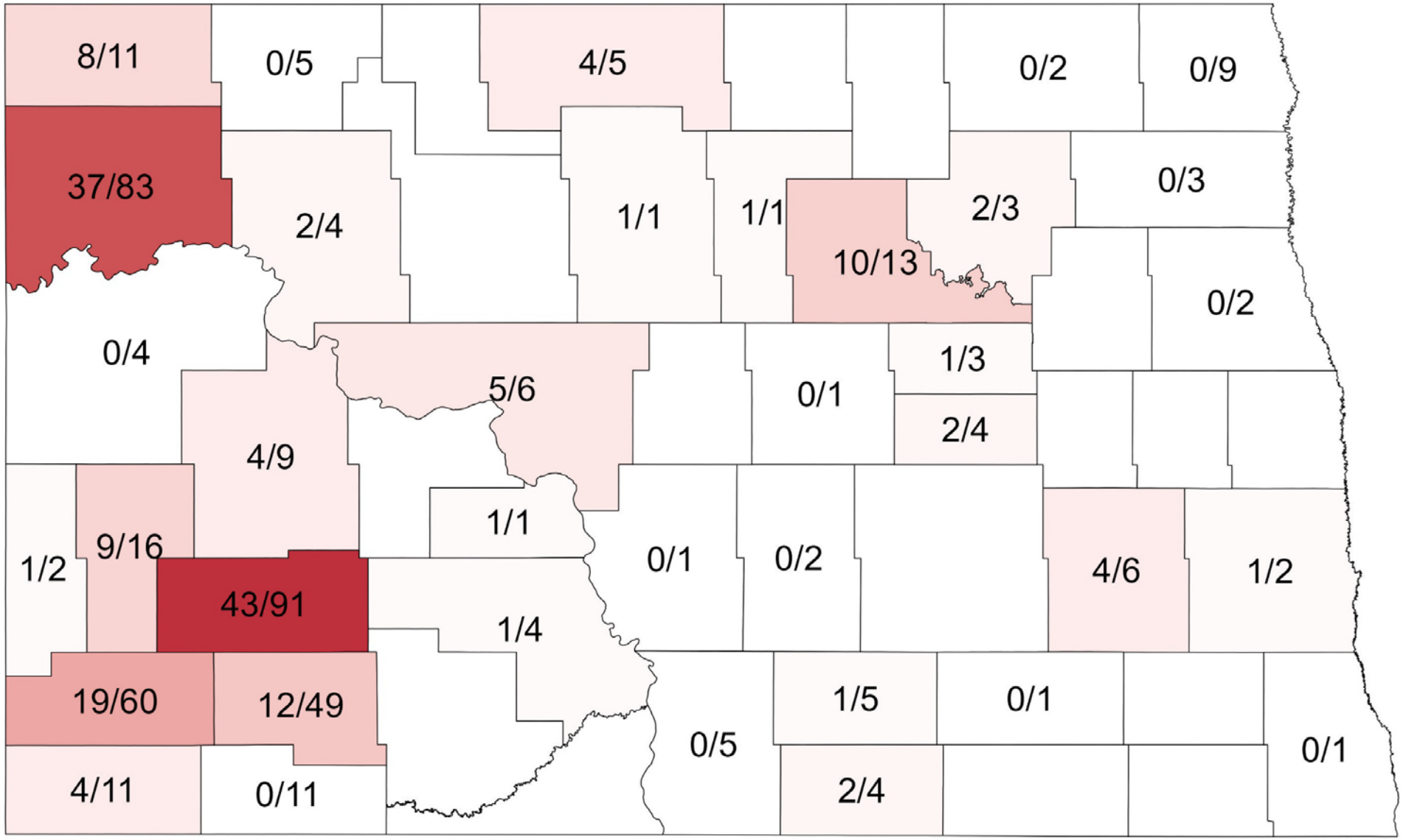
Kochia - Group 2 Resistance Marker



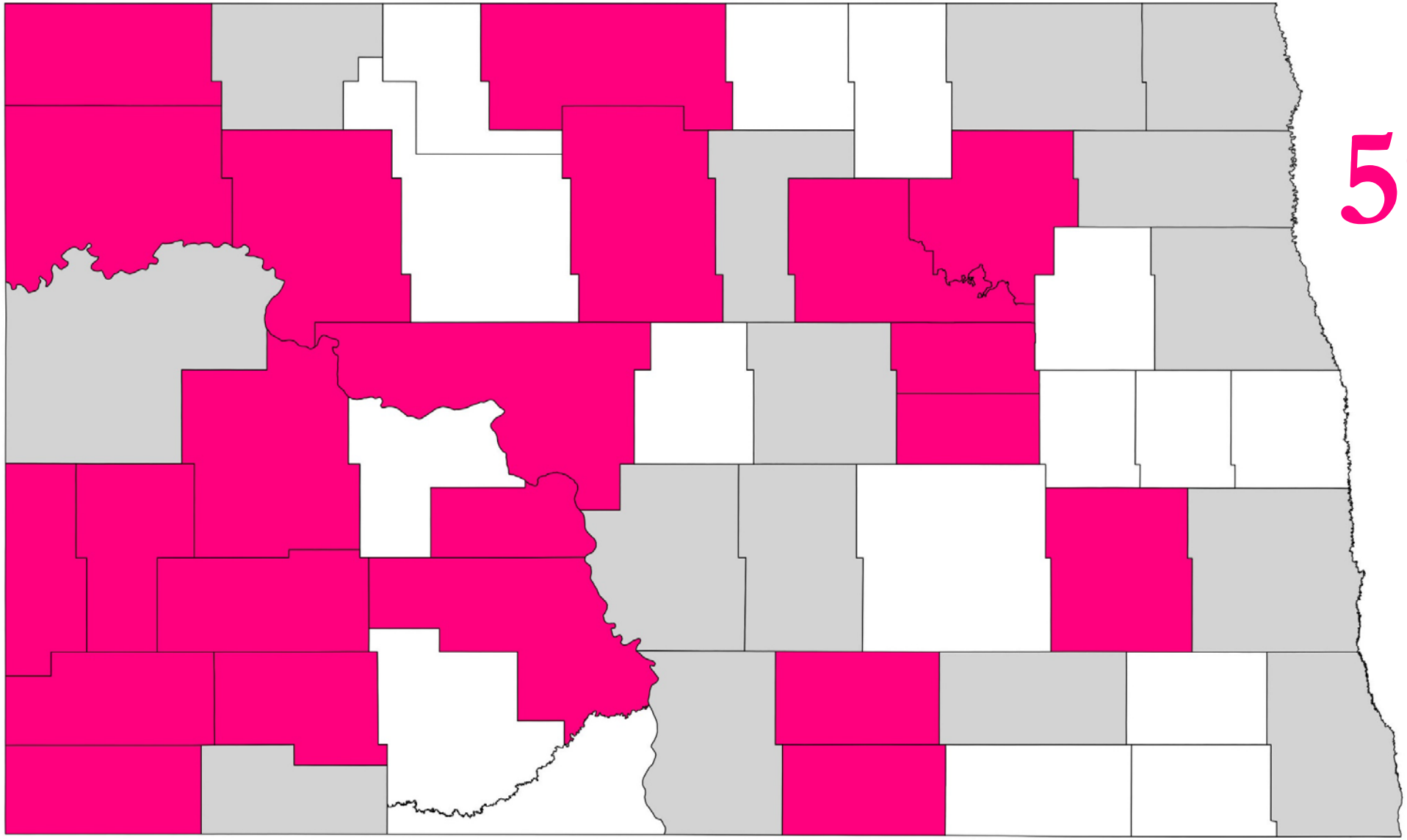
Kochia - Group 9 Resistance Marker



Kochia - Group 14 Resistance Marker



Kochia – Counties with all three R markers

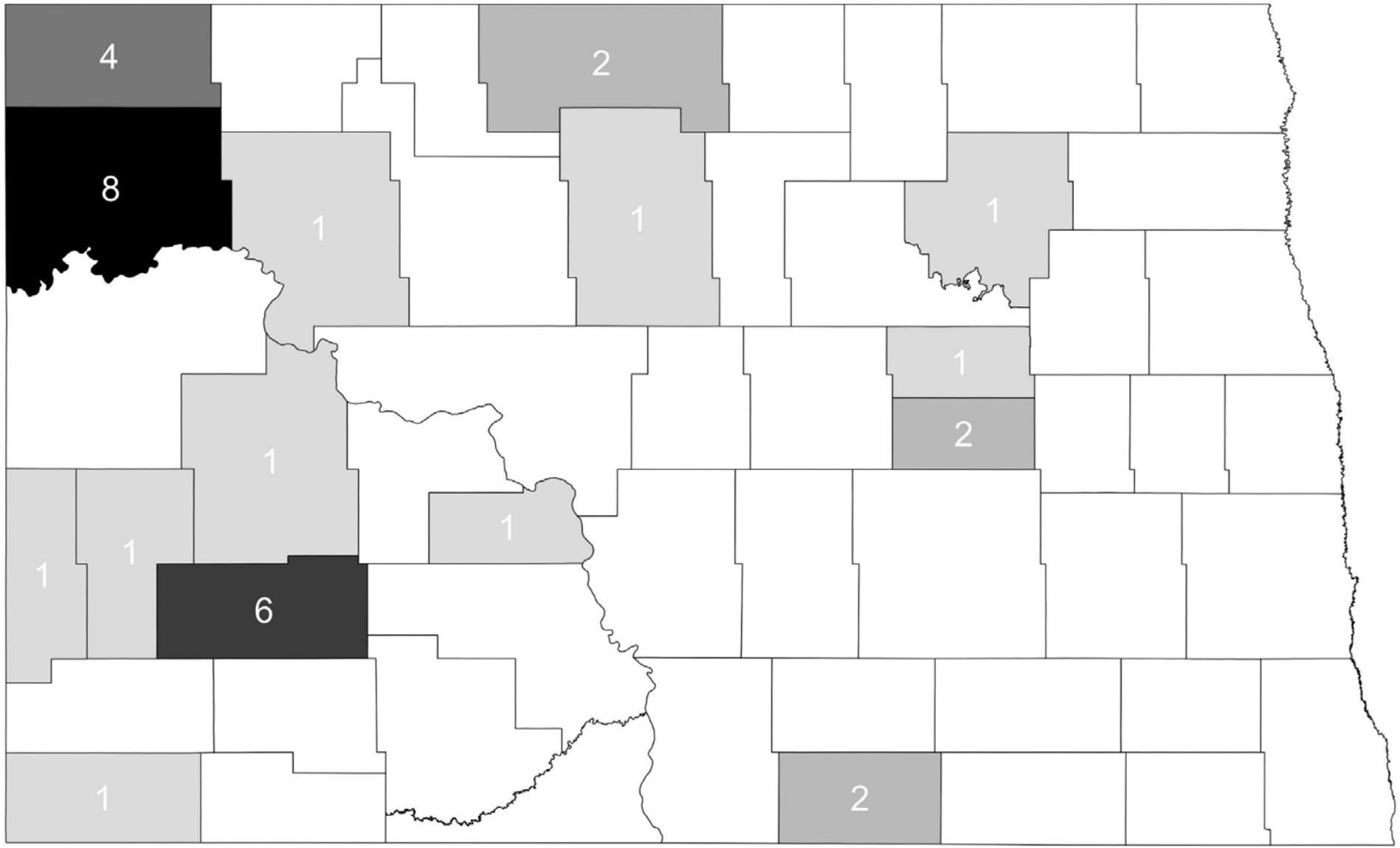


59%

Kochia

Detected target-site R markers per plant

Kochia – Three-way resistance markers



Takeaways

Widespread distribution of HR genotypes

- Kochia - Group 14 R marker in 24 counties

Stacked HR genotypes, mostly in kochia

Survey provides early detection of HR weeds

Future Tests in Weedy Grasses

Wild Oat

Green Foxtail

Group 1 Markers (ACCase Inhibitors)

Group 2 Markers (ALS Inhibitors)

We need your help

Survey success depends on volunteers

Kits at ND County Extension Offices

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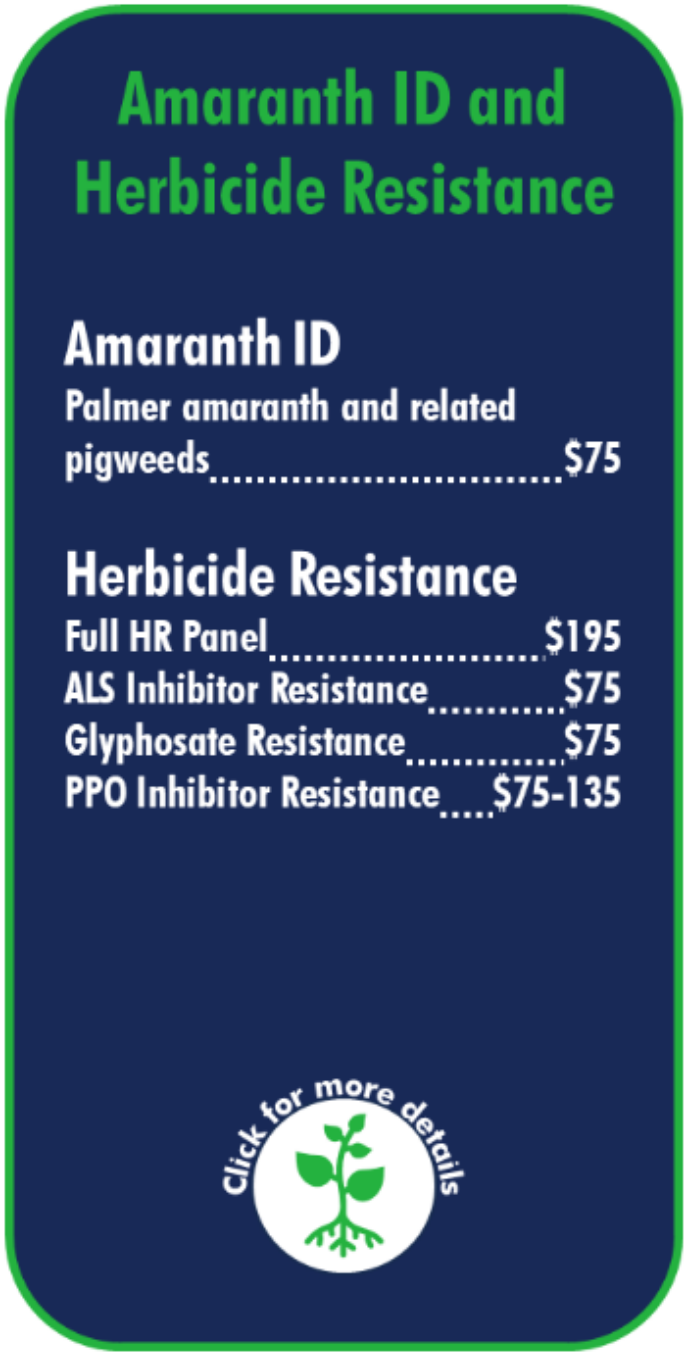
Kits at ND County Extension Offices

Request your own

Available to all, but fees for non-ND submitters

Thank you to our supporters and funders!

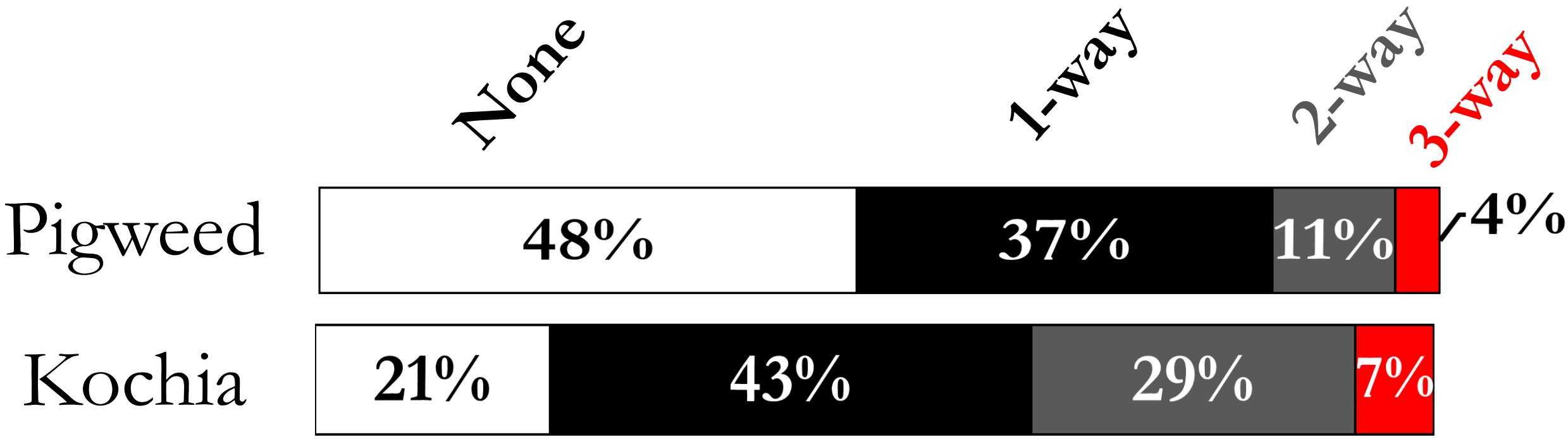


Non-ND Resident Prices

Full HR Panel = $195/sample

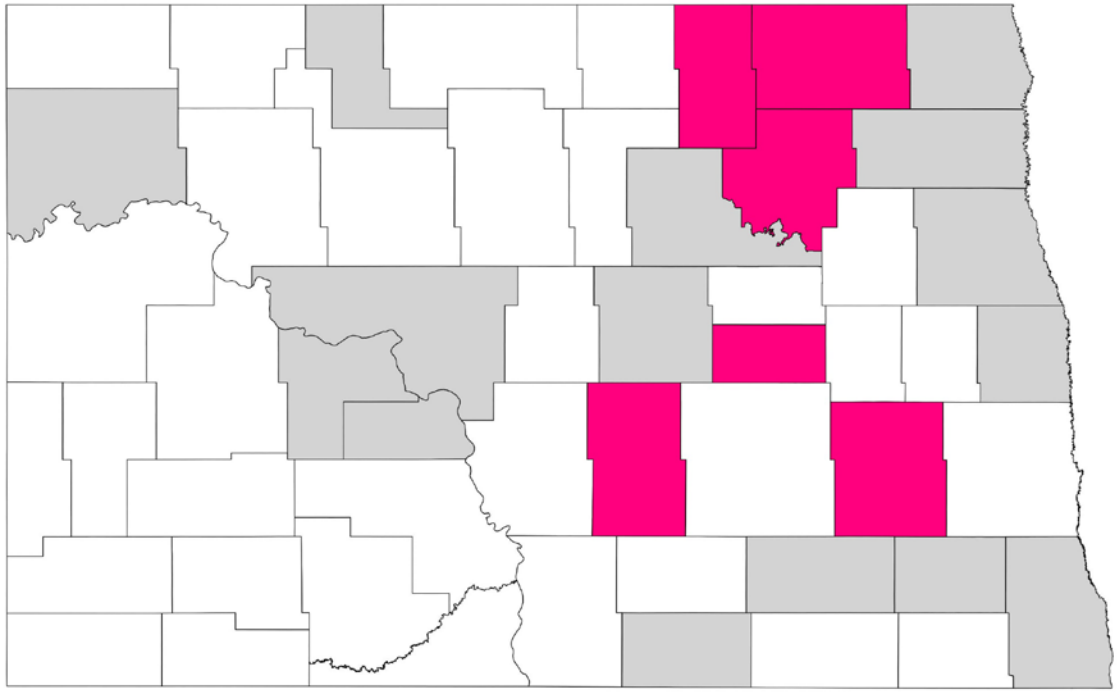
Kochia Group 14 = $135/sample

Stacked Resistances



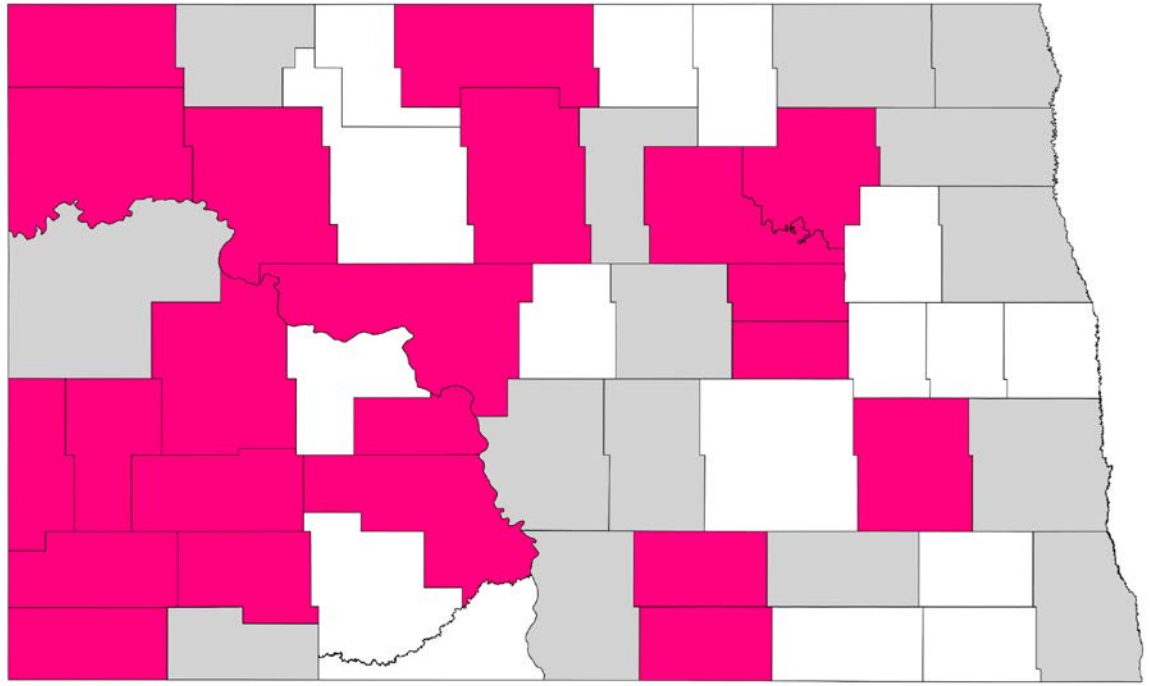
Counties with all three markers

29%



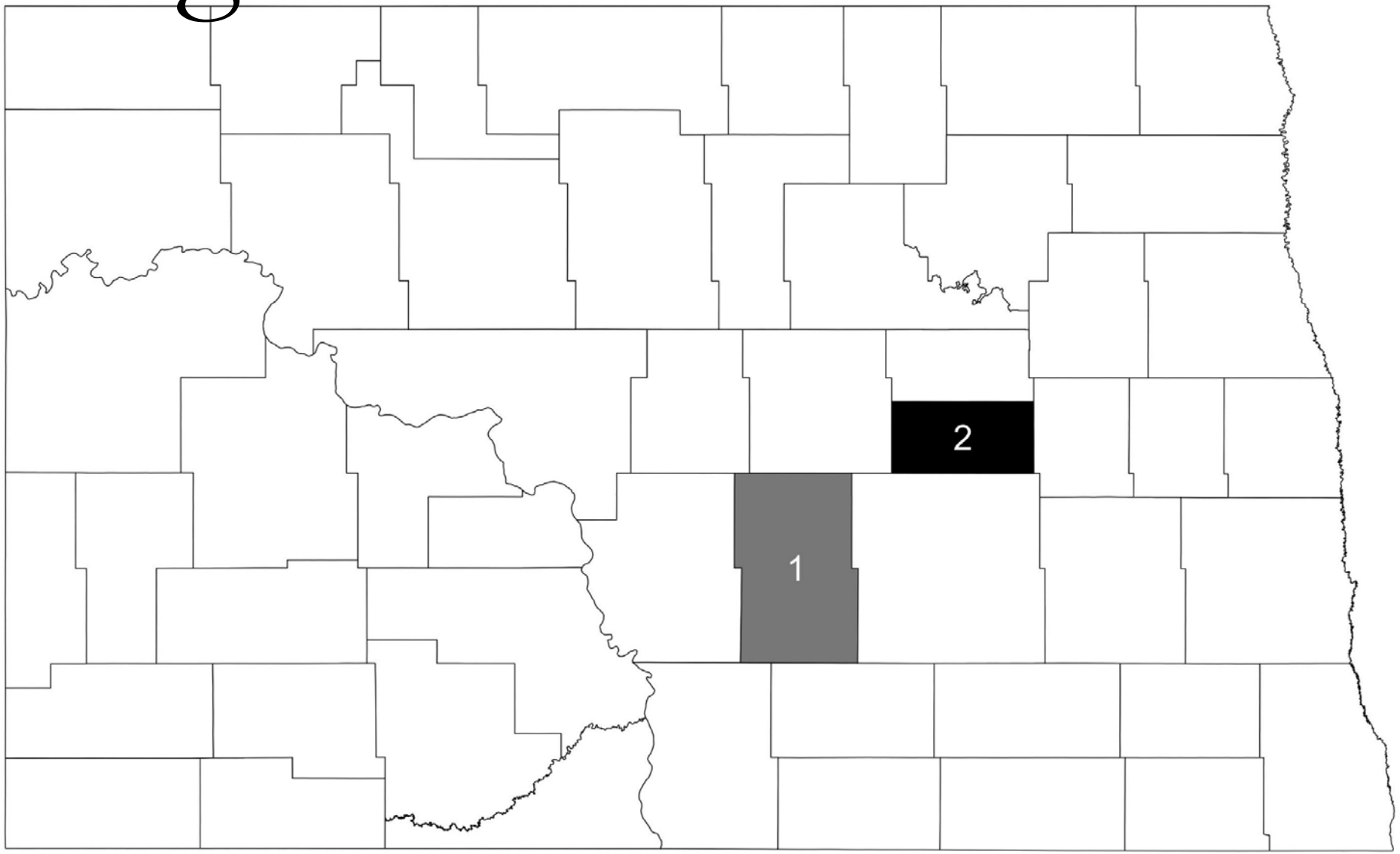
Pigweed

59%



Kochia

Pigweed



Kochia