Genetic Screening for Herbicide Resistance

Annual Update

NATIONAL AGRICULTURAL
GENOTYPING CENTER

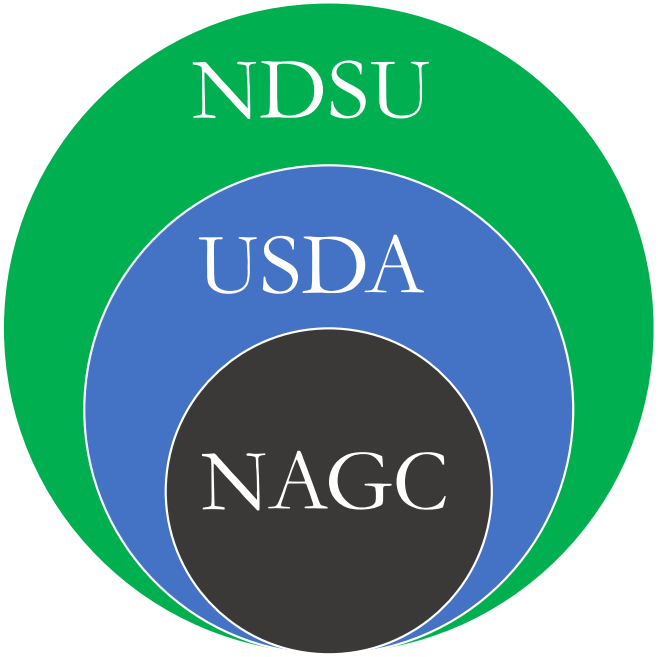
Zack Bateson, Ph.D.
Research Director

Where are we going?

- Pigweed ID Testing – Results
- Statewide Genetic Survey – Results
- Upcoming Projects
- Begging

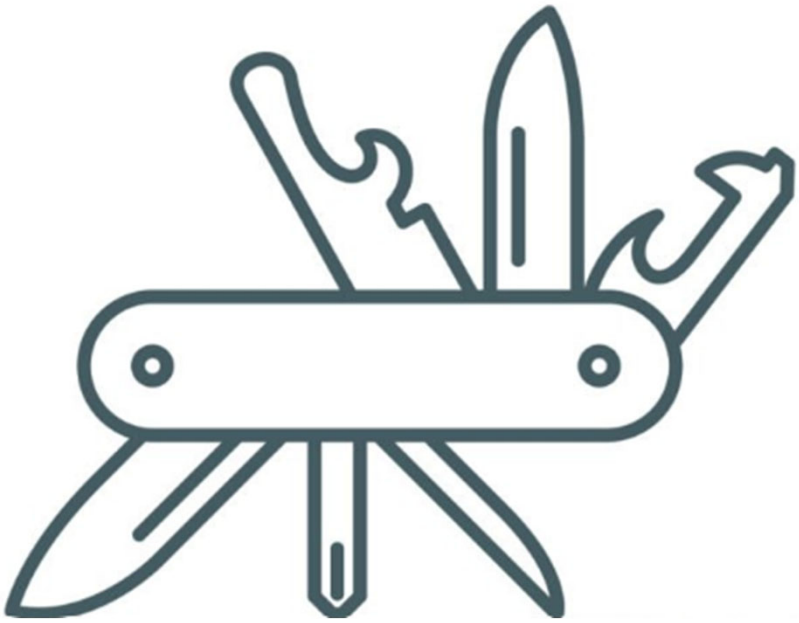
NAGC is nearby

- Not-for-profit
- Private



The People

ANAB
ACCREDITED
ISO/IEC 17025
TESTING LABORATORY



DNA Testing

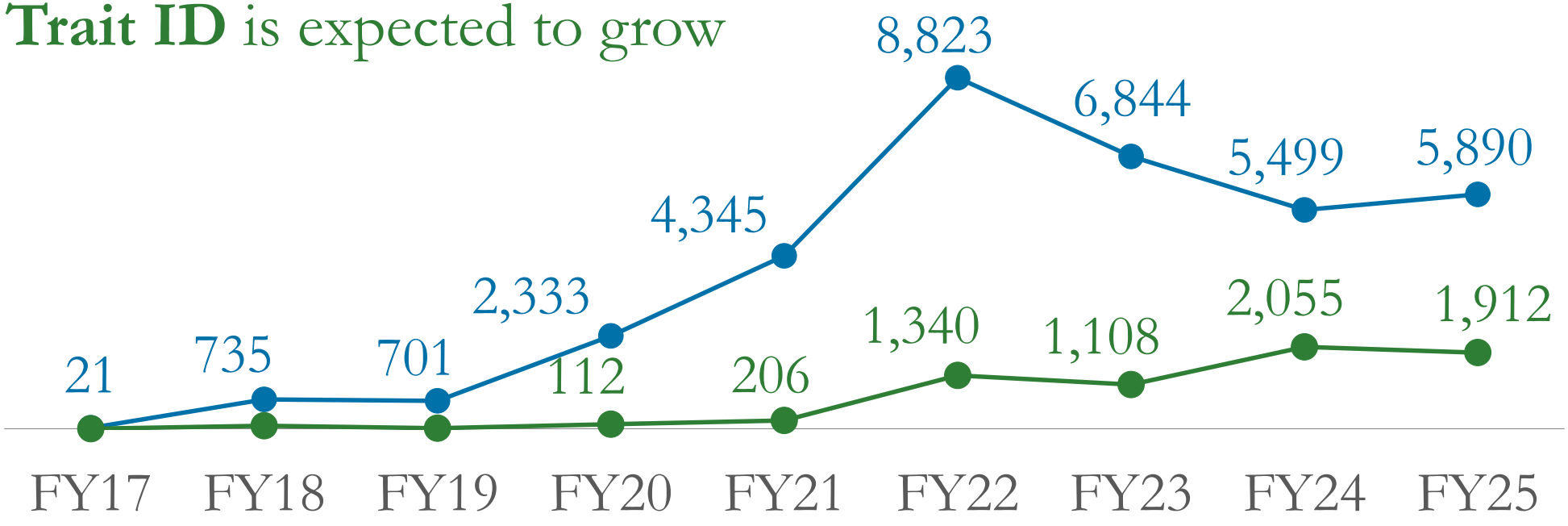
General approach

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

NAGC Testing Categories by Year

Pest ID is the largest service

Trait ID is expected to grow



36 tests for crop pests

23 tests for honey bees

5 genotyping panels for Variety ID

6 tests for weed resistance

Value of Lab Diagnostics

- Information reduces uncertainty
- Avoids chasing the wrong problem
- Early Warning System

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

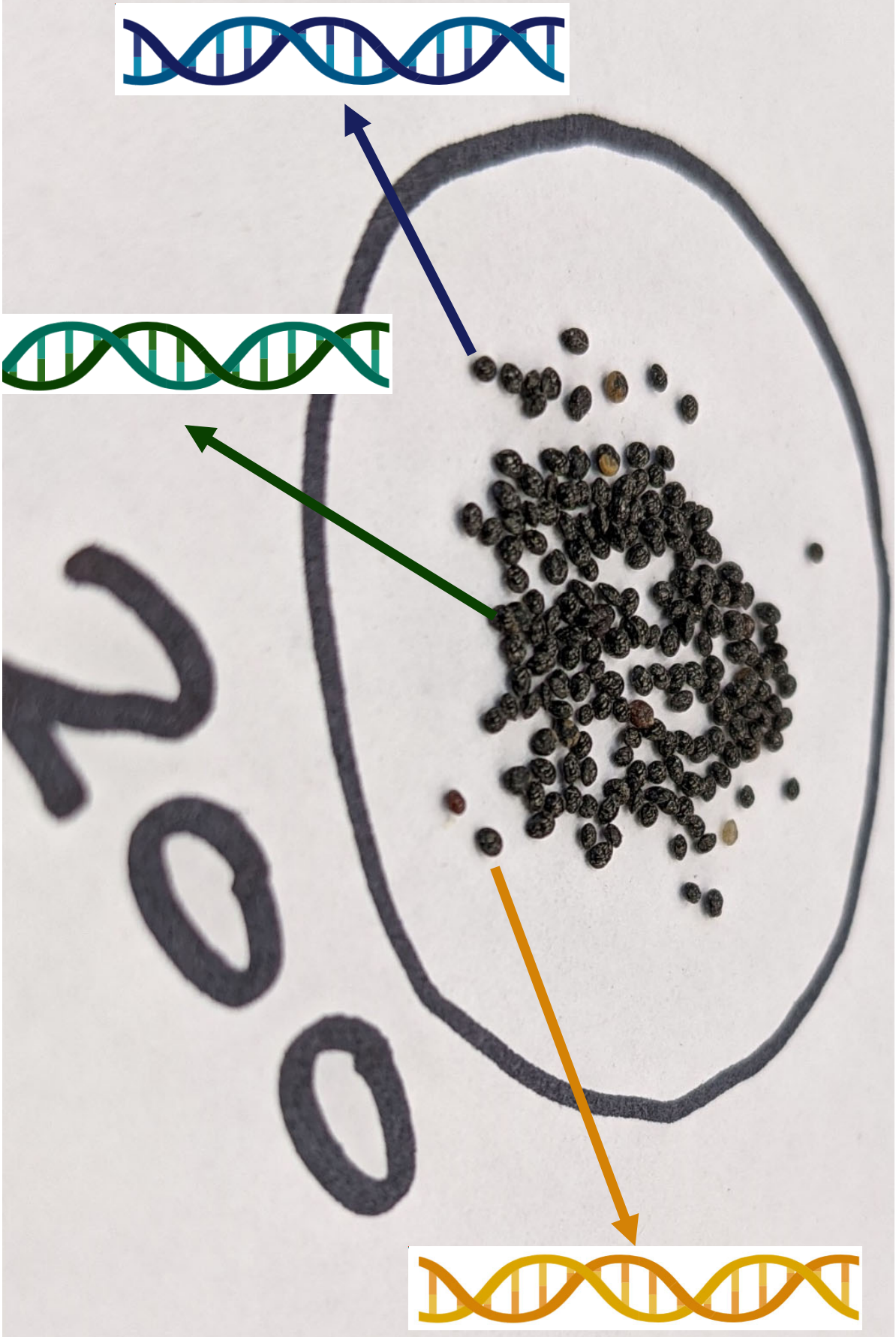
DNA

Pigweed ID

Trait ID

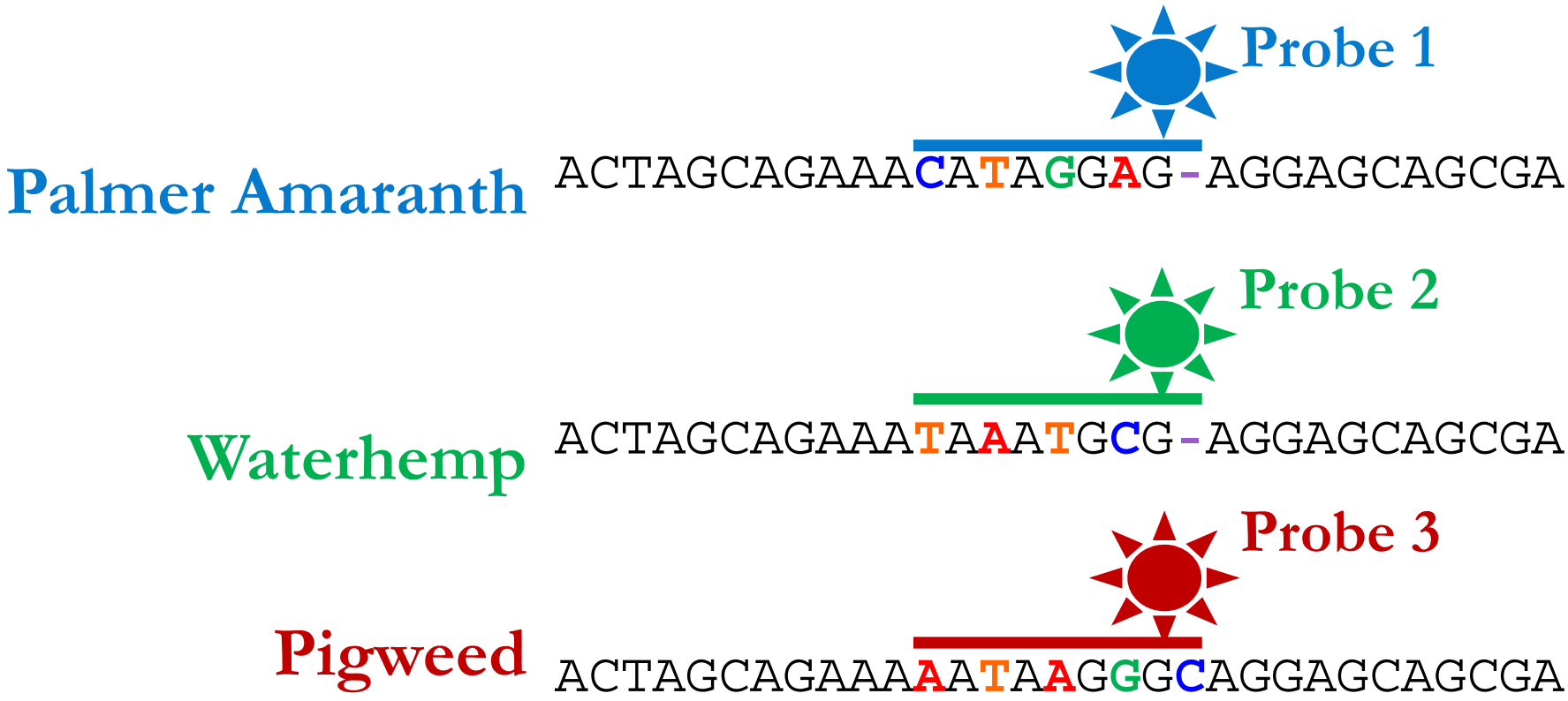
DNA

Pigweed ID



Genetic test to ID pigweeds

Probes detect & **differentiate** pigweed species



In 2025,

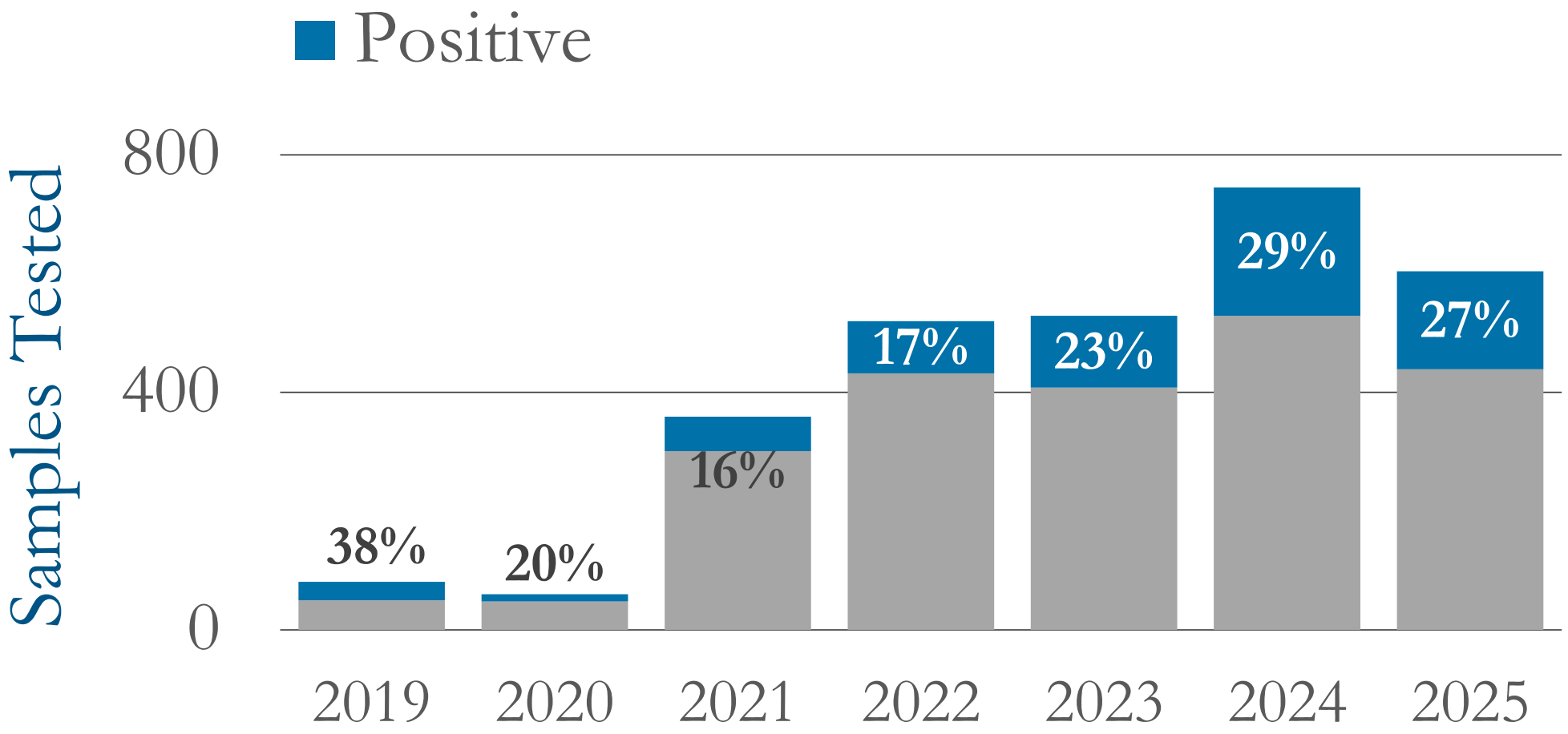
67 Submitters

604 Samples

21,555 Seeds

Pigweed ID used primarily in the West

Palmer Amaranth Detected



Outcomes from Pigweed testing at NAGC

Confirmed Palmer in new regions

Stopped further spread of Palmer in bird seed

Stopped further spread of Palmer in livestock feed

DNA

Trait ID

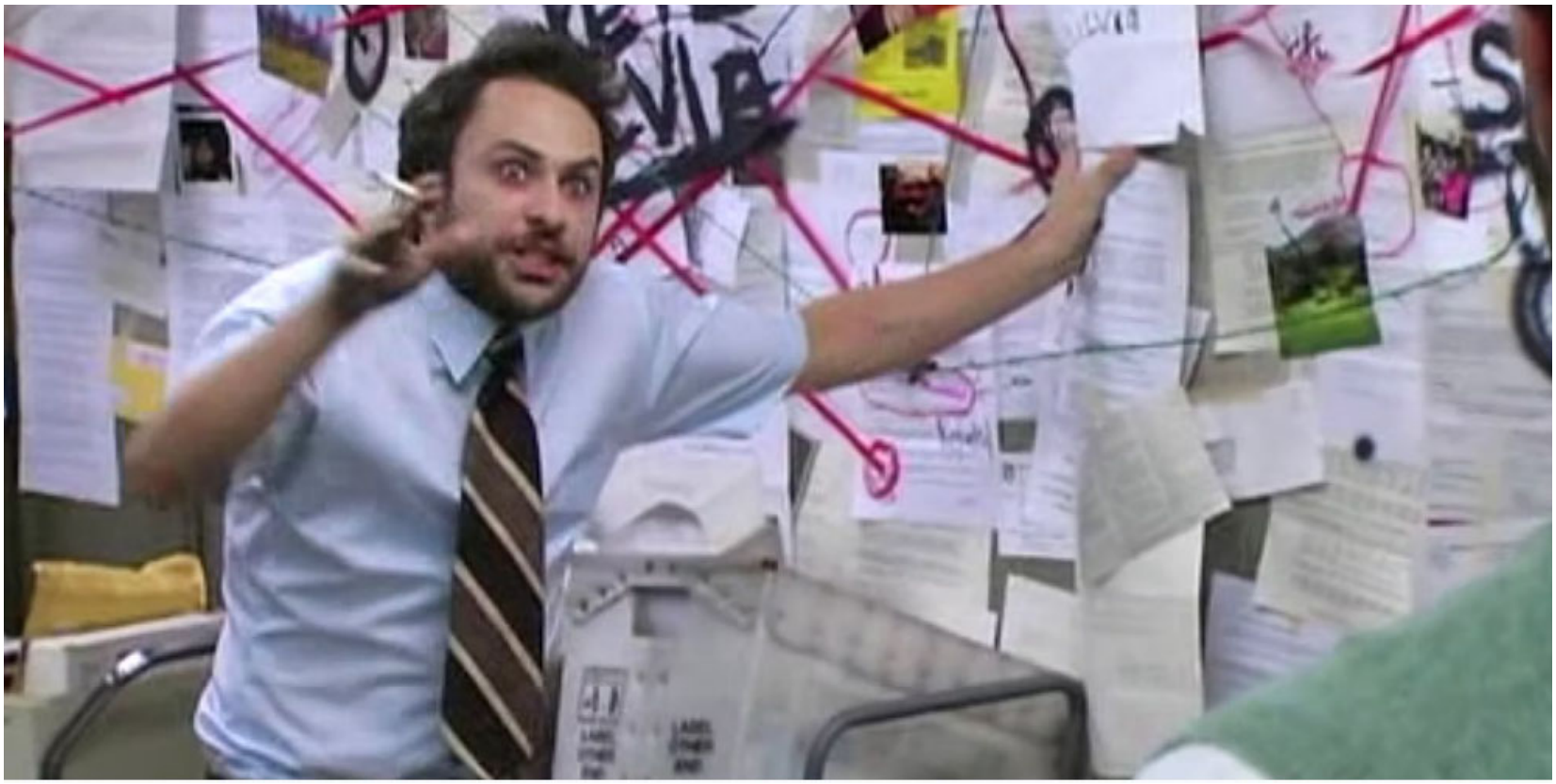
Herbicide Resistance

Non-Target-Site

Target-Site

Non-target-site mechanisms

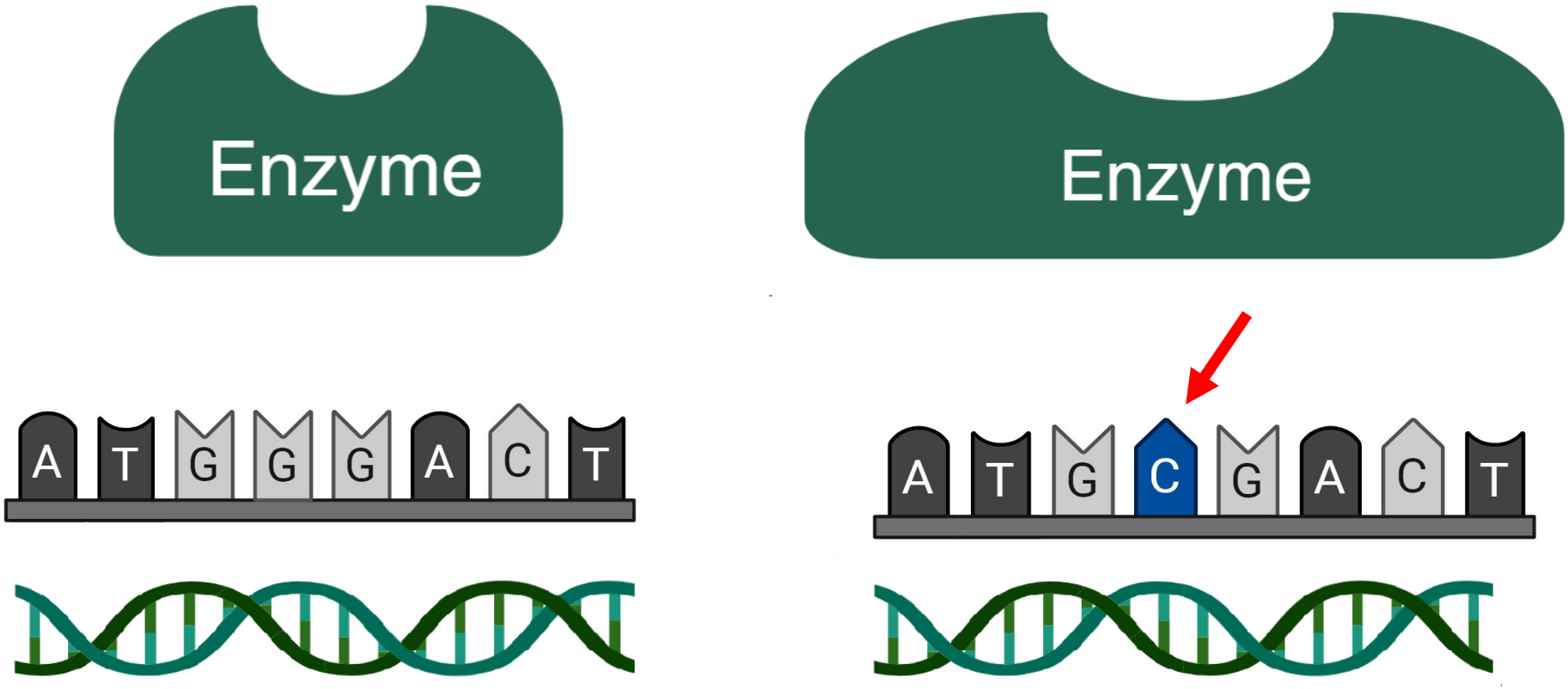
Non-target-site mechanisms



What we test

Target-Site Mechanisms

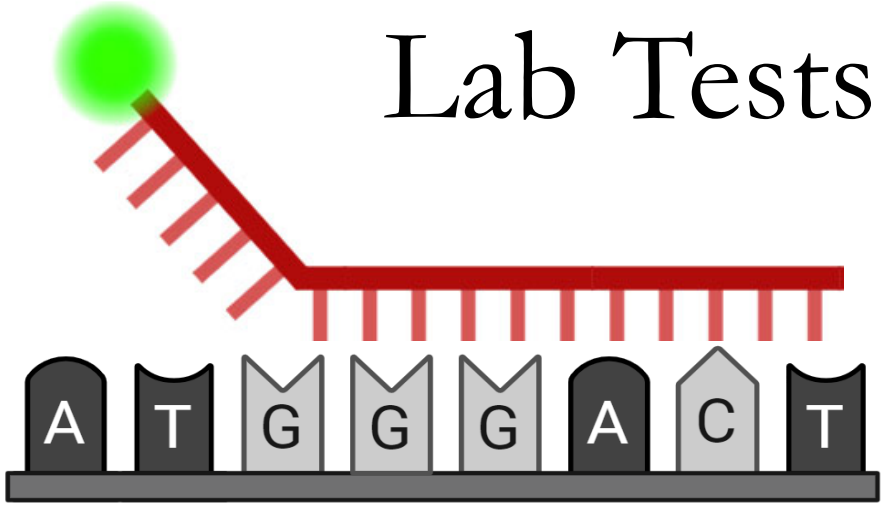
Enzyme changes shape due to a substitution

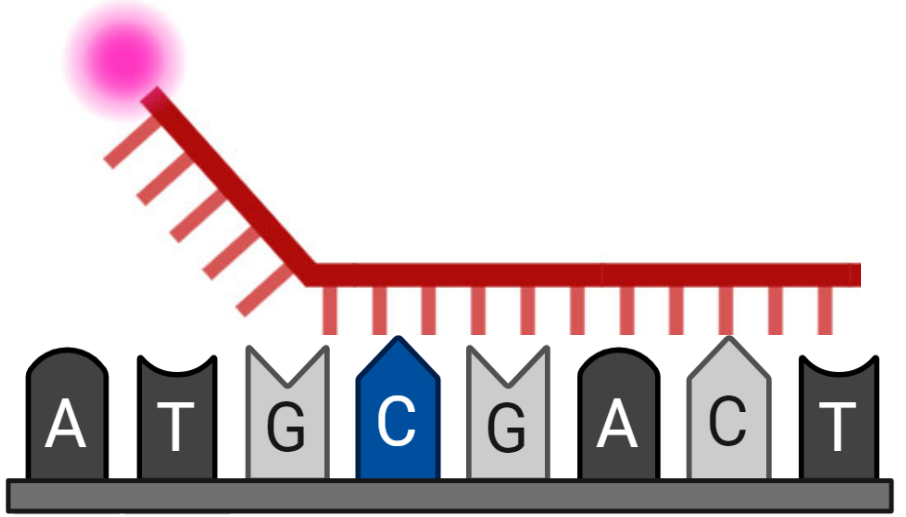


Wildtype
Genotype

Resistant
Genotype

Lab Tests

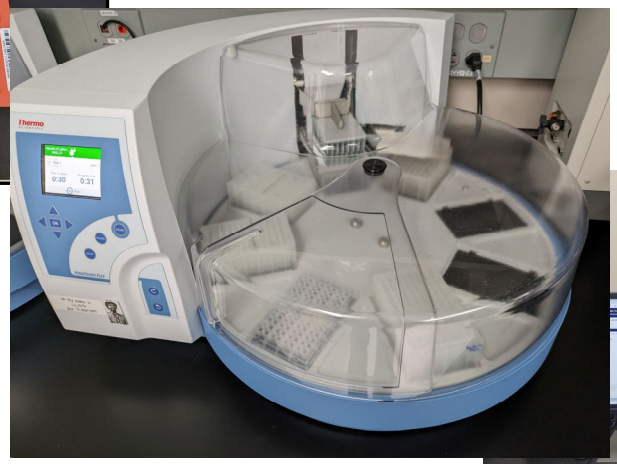


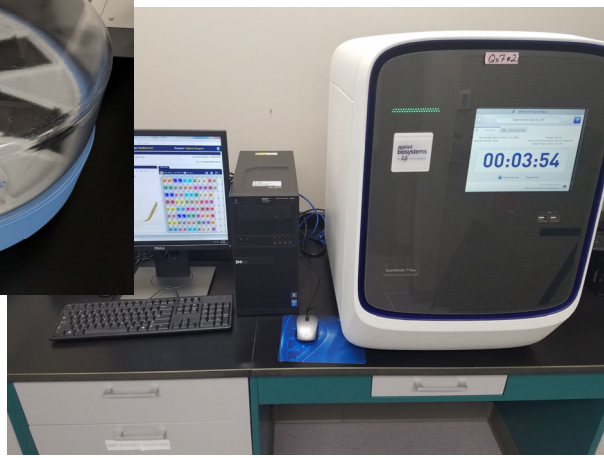


Greenhouse trials capture NTS & TS

Resource-intensive

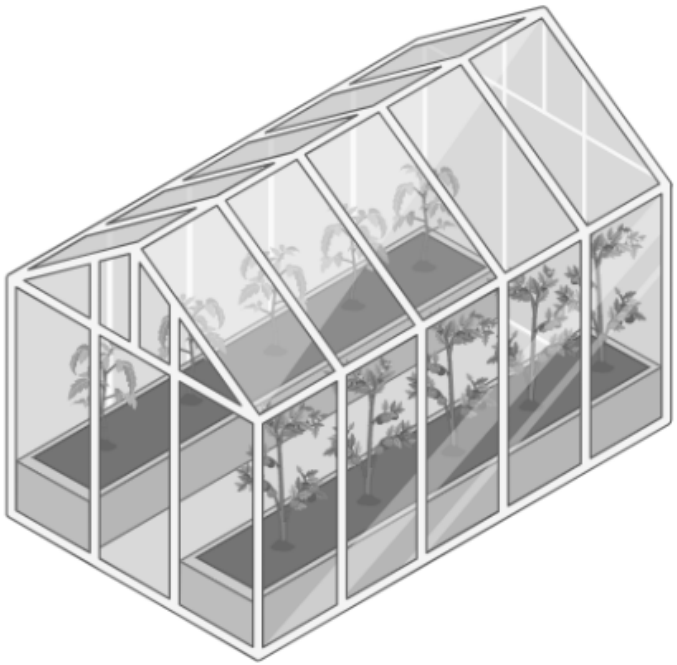
Genetic tests are fast & high-throughput





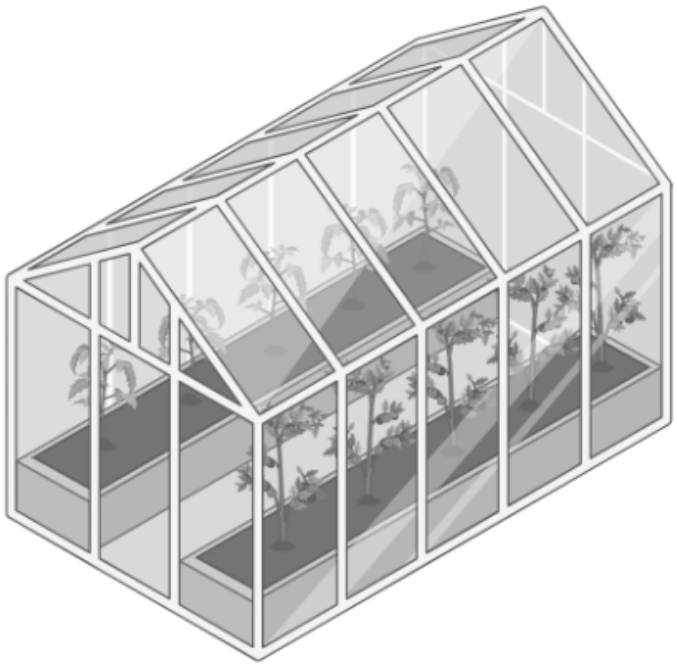
Limited to known **TS** variants

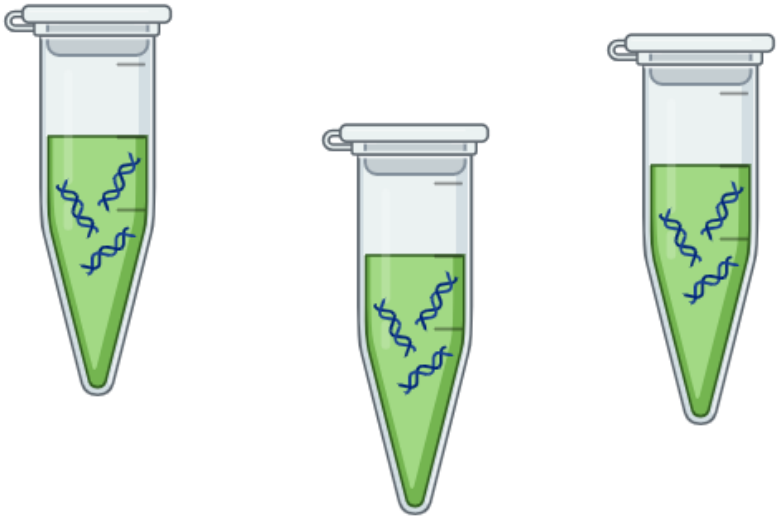
Partnership - weed diagnostic program



NDSU | EXTENSION

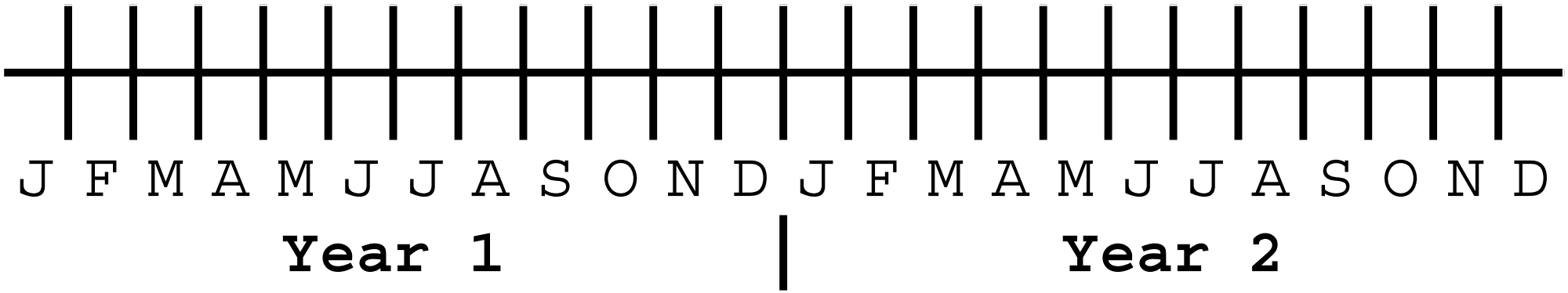
Partnership - weed diagnostic program

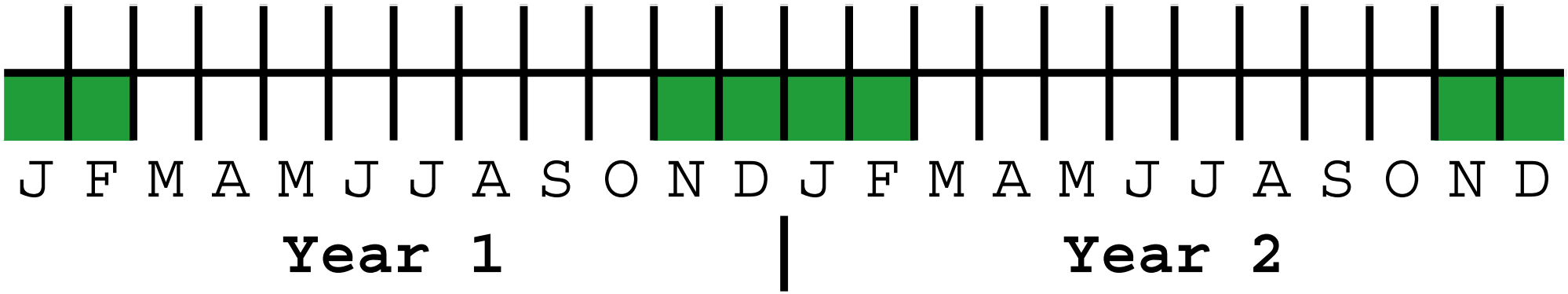




NDSU | EXTENSION

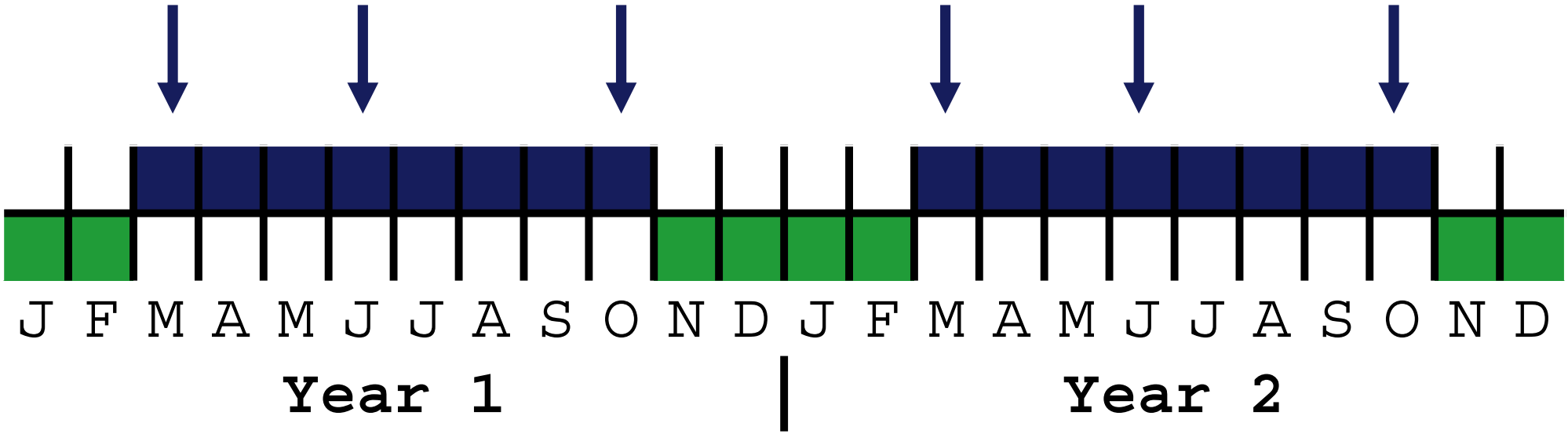
NAGC NATIONAL AGRICULTURAL GENOTYPING CENTER


J F M A M J J A S O N D J F M A M J J A S O N D
Year 1
Year 2



Greenhouse = Off Season

DNA Testing = Growing Season



Greenhouse = Off Season

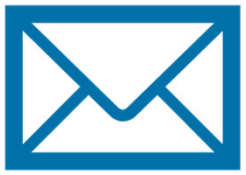
Goals of the Statewide Survey

1. Seek the freaks by genotyping
2. Easy collection & submission
3. Quick reporting to submitters
4. Make maps for regional trends

Survey limitations

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

Collect



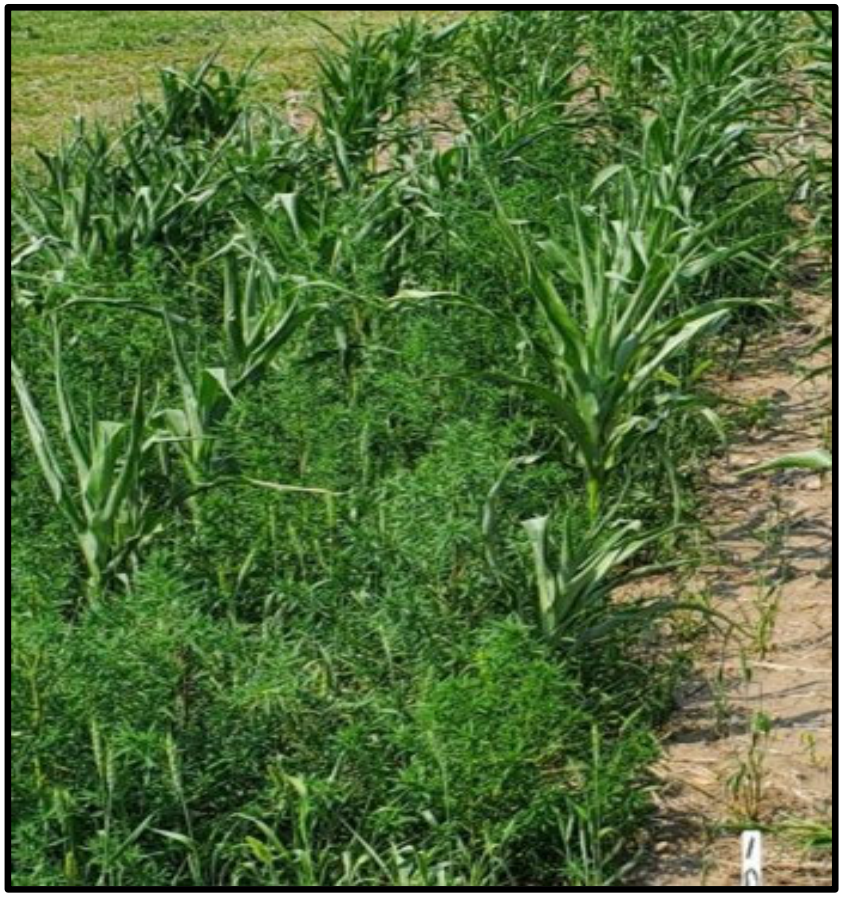
Test

Identify

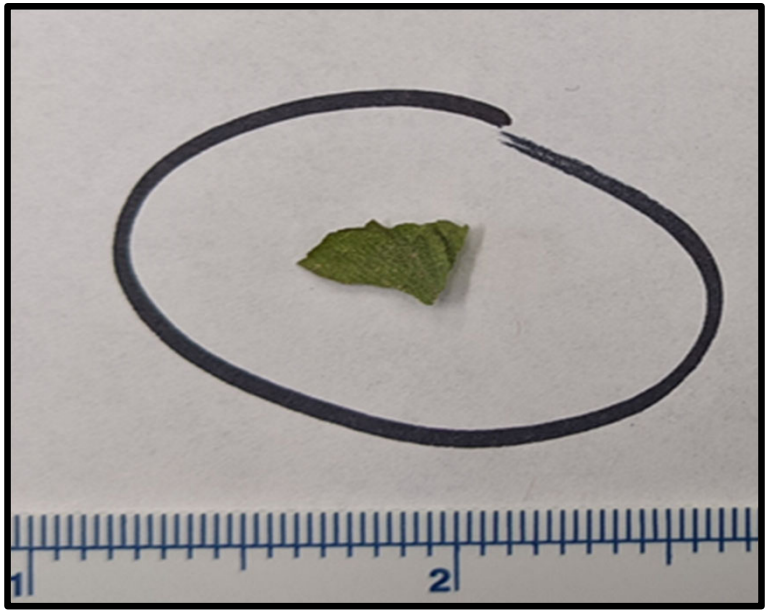
Report

Map

Focus on pigweeds & kochia



Easy Collection




NORTH DAKOTA
STATE
SCIENCE &
ENGINEERING
FAIR

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	Herbicide(s) applied to weeds/field
1			
2			
3			
4 Optional		Wild Oat or Green Foxtail	

Sponsors

NDSOYBEAN COUNCIL

NORTH DAKOTA CORN COUNCIL

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

DNA markers **associated** with resistance

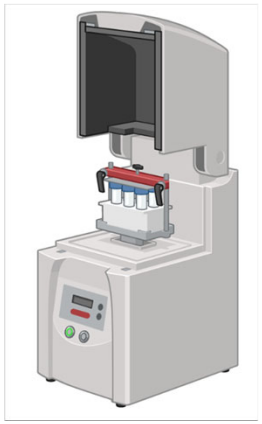
Herbicide	Pigweed	Kochia
Group 2	*ALS-W574L*	ALS-W574L
Group 9	EPSPS Copy	EPSPS Copy
Group 14	PPO-210 del	PPO

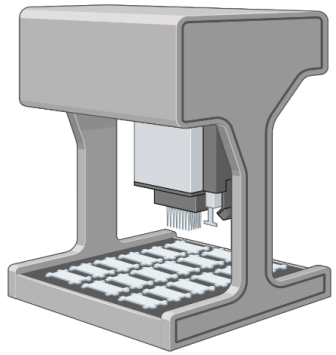
all pigweeds

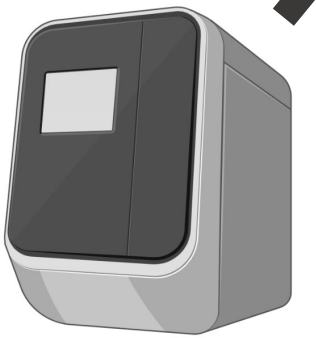
Sponsored HR testing for pigweeds and kochia

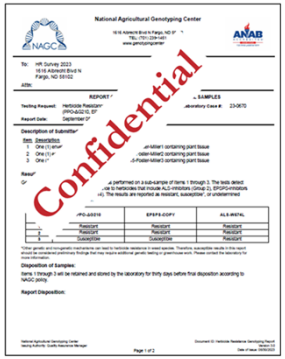
Testing Workflow

Avg = 5.7 days

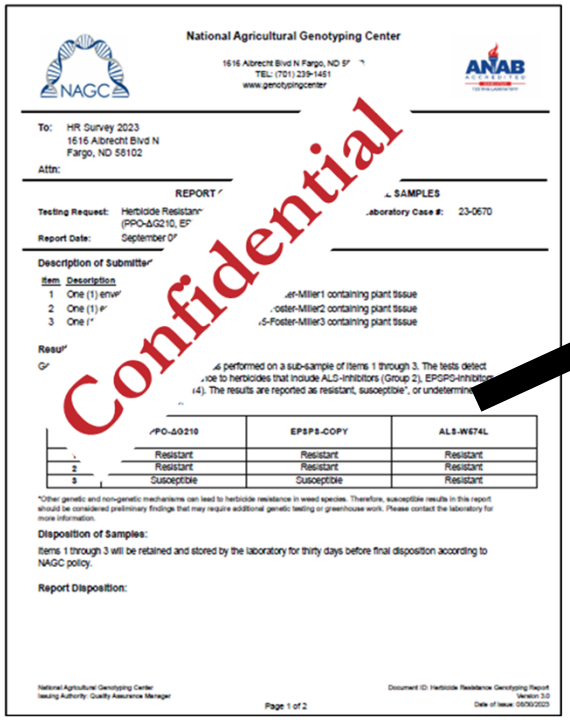








Reports to Submitters



National Agricultural Genotyping Center

1616 Albrecht Blvd N Fargo, ND 5[illegible]
TEL: (701) 239-1481
www.genotypingcenter

To: HR Survey 2023
1616 Albrecht Blvd N
Fargo, ND 58102

Attn:

REPORT [illegible] SAMPLES

Testing Request: Herbicide Resistanc[illegible]
(PPO-ΔG210, EP[illegible]

Laboratory Case #: 23-0670

Report Date: September 0[illegible]

Description of Submitte[illegible]

Item	Description
1	One (1) envi[illegible]
2	One (1) e[illegible]
3	One (1[illegible]

[illegible]er-Miller1 containing plant tissue
[illegible]oster-Miller2 containing plant tissue
[illegible]5-Foster-Miller3 containing plant tissue

Resul[illegible]

G[illegible]

[illegible]s performed on a sub-sample of items 1 through 3. The tests detect
[illegible]ce to herbicides that include ALS-inhibitors (Group 2), EPSPS-inhibitor
[illegible]4). The results are reported as resistant, susceptible*, or undetermin[illegible]

PPO-ΔG210	EPSPS-COPY	ALS-W574L
[illegible]	Resistant	Resistant	Resistant
2	Resistant	Resistant	Resistant
3	Susceptible	Susceptible	Resistant

*Other genetic and non-genetic mechanisms can lead to herbicide resistance in weed species. Therefore, susceptible results in this report should be considered preliminary findings that may require additional genetic testing or greenhouse work. Please contact the laboratory for more information.

Disposition of Samples:

Items 1 through 3 will be retained and stored by the laboratory for thirty days before final disposition according to NAGC policy.

Report Disposition:

National Agricultural Genotyping Center
Issuing Authority: Quality Assurance Manager

Page 1 of 2

Document ID: Herbicide Resistance Genotyping Report
Version 3.0
Date of Issue: 08/30/2023

Confidential

Plant	PPO	EPSPS	ALS
1	Resistant	Resistant	Resistant
2	Resistant	Wildtype	Resistant
3	Wildtype	Wildtype	Wildtype

North Dakota Survey

Results provided at three levels

1. State (2024 vs 2025)

2. County (2025 only)

3. Individual (2025 only)

Pigweeds

23 Counties

68 Plants

Pigweeds

23 Counties

68 Plants

33 waterhemp

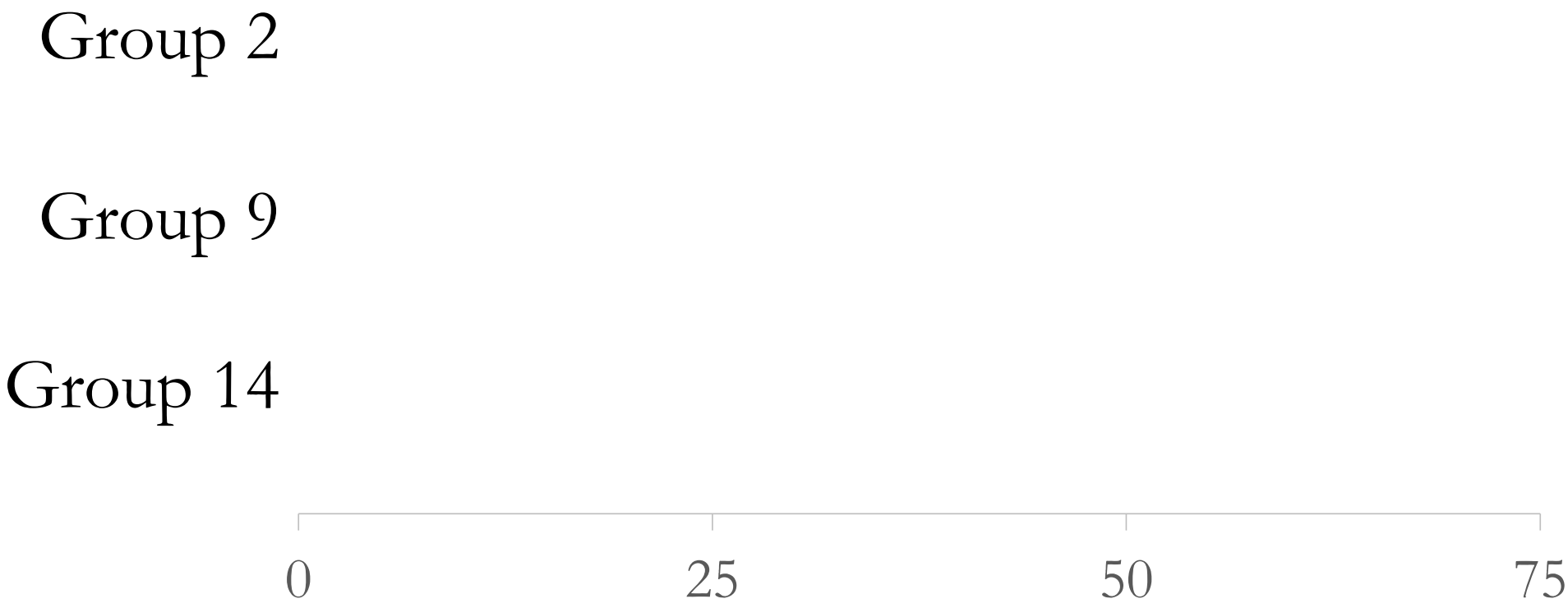
35 non-waterhemp

Kochia

36 Counties

453 Plants

Changes in statewide R marker % in **waterhemp** & **kochia** (2024 to 2025)



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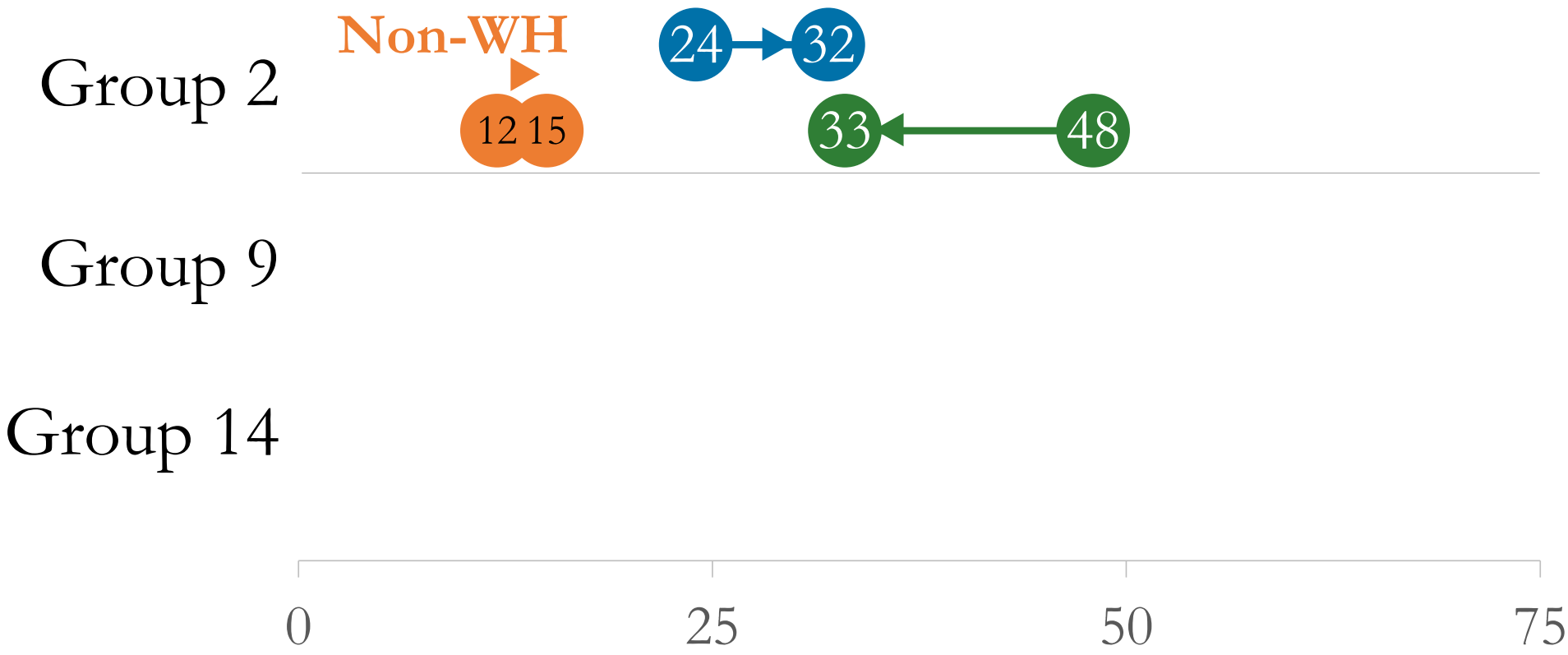

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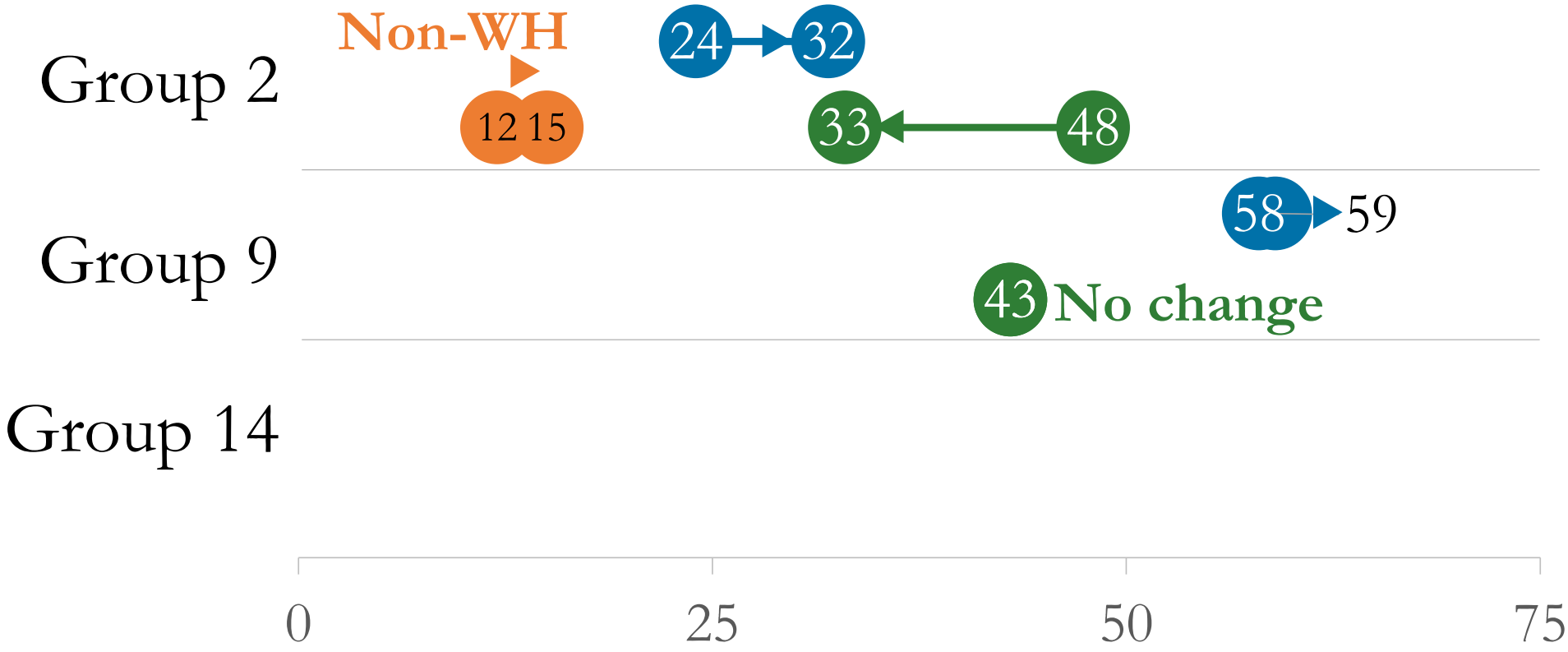

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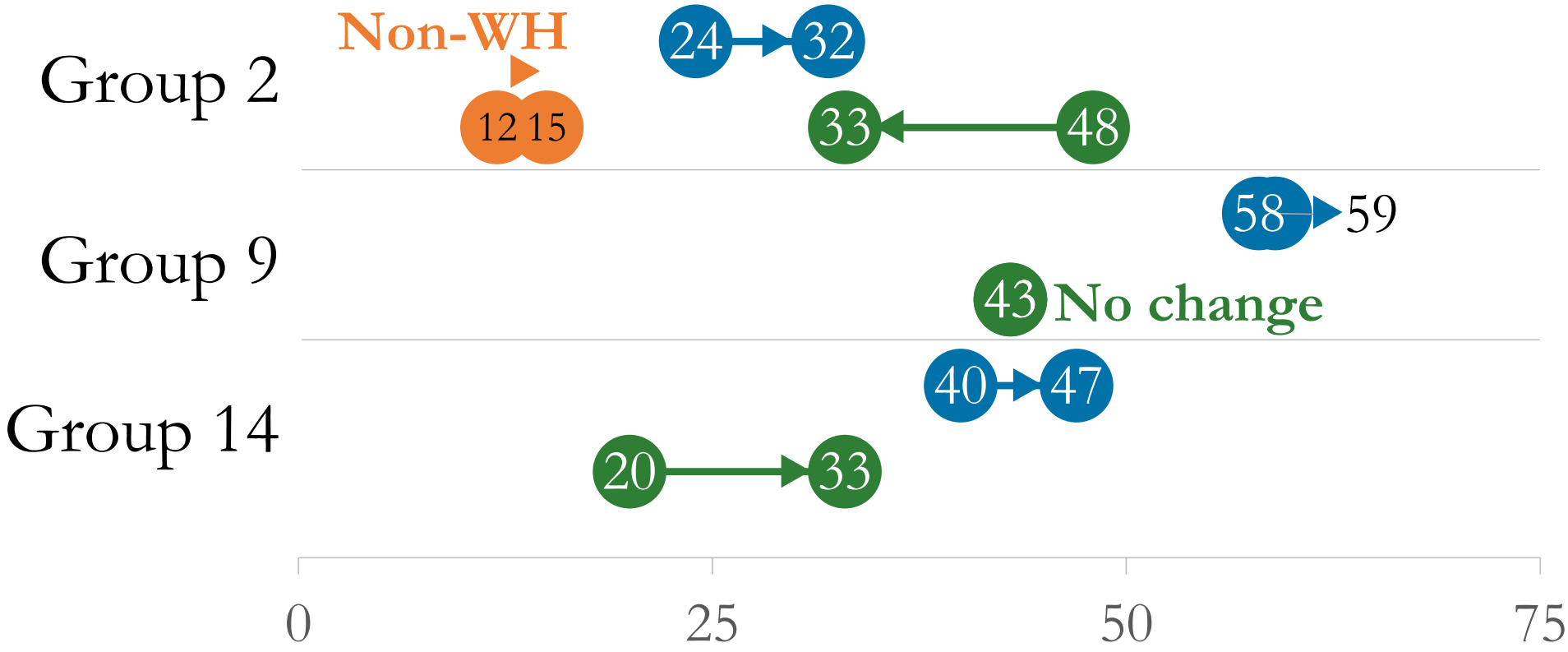
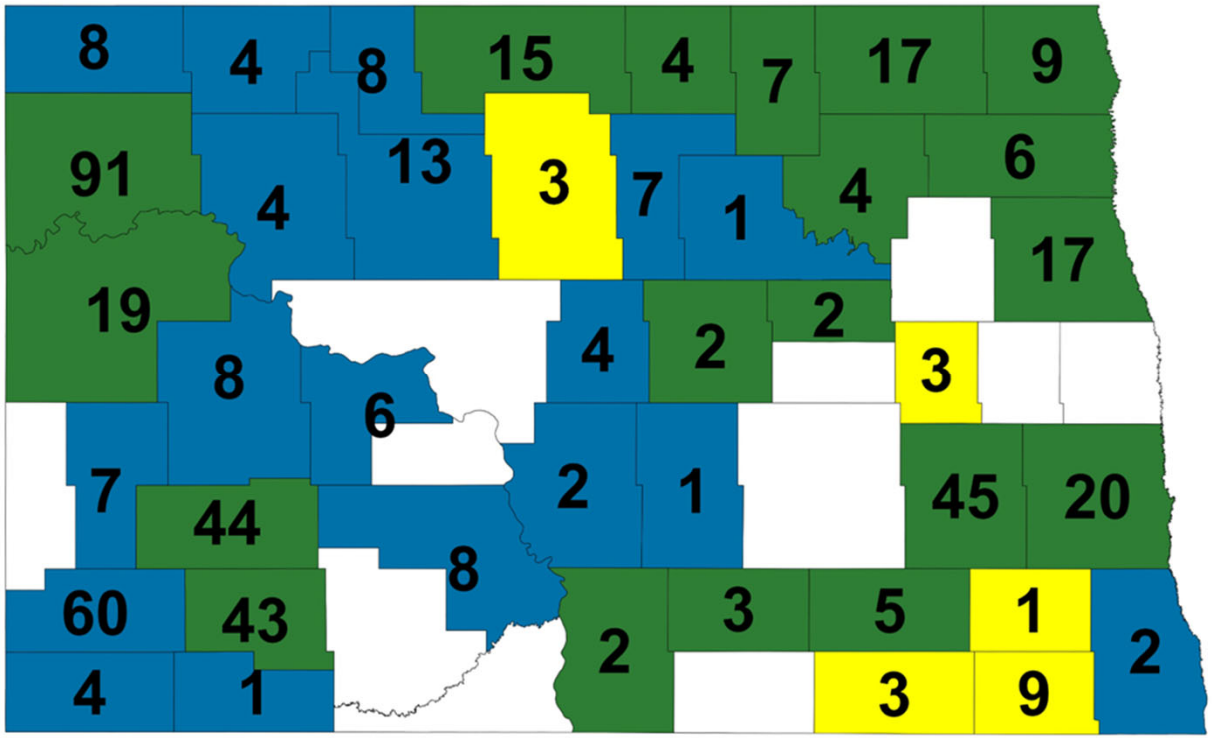


Distribution of Samples in 2025

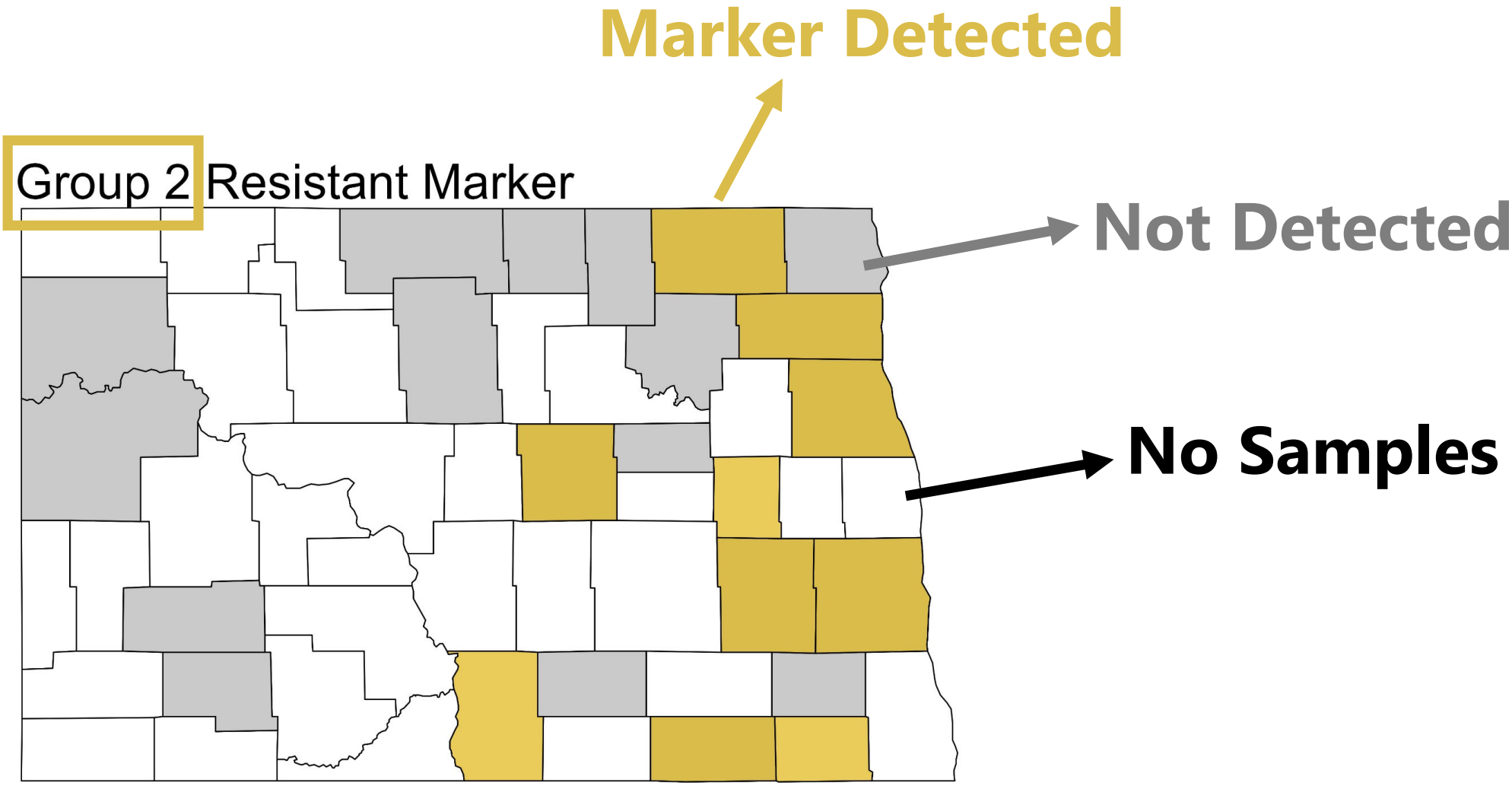


79% counties

Kochia only = blue

Pigweed only = yellow

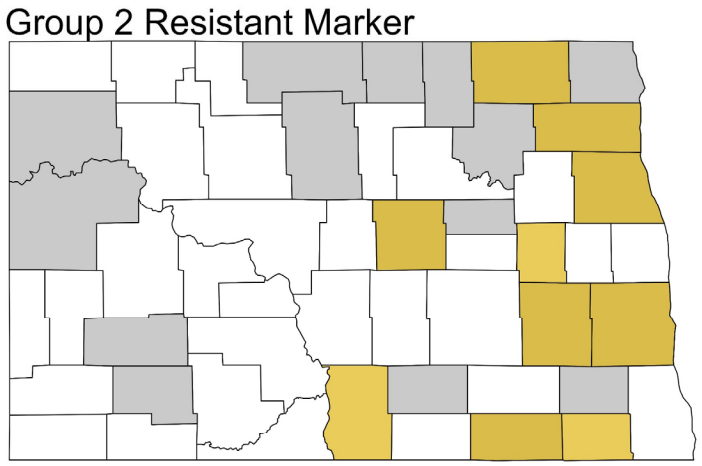
Both = green

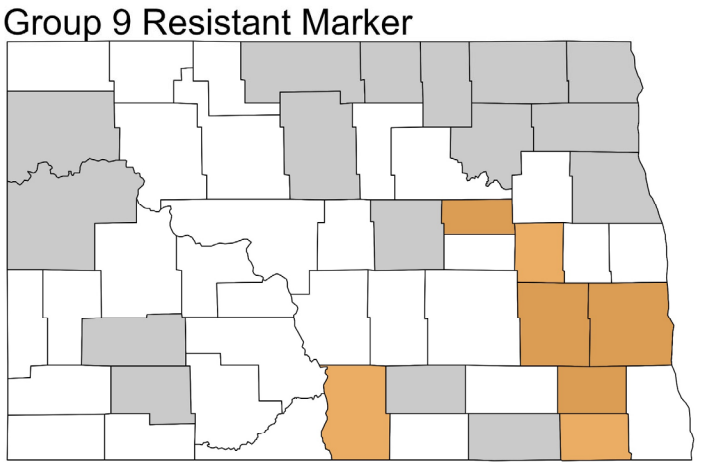

Group 2 Resistant Marker
Marker Detected
Not Detected
No Samples

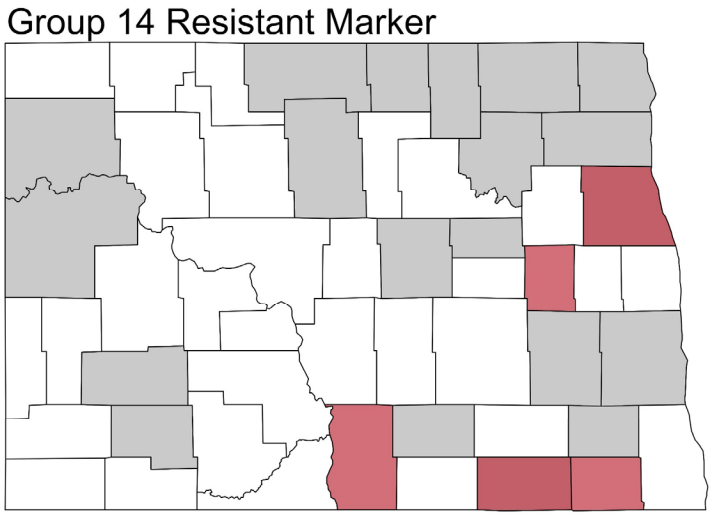
Pigweed

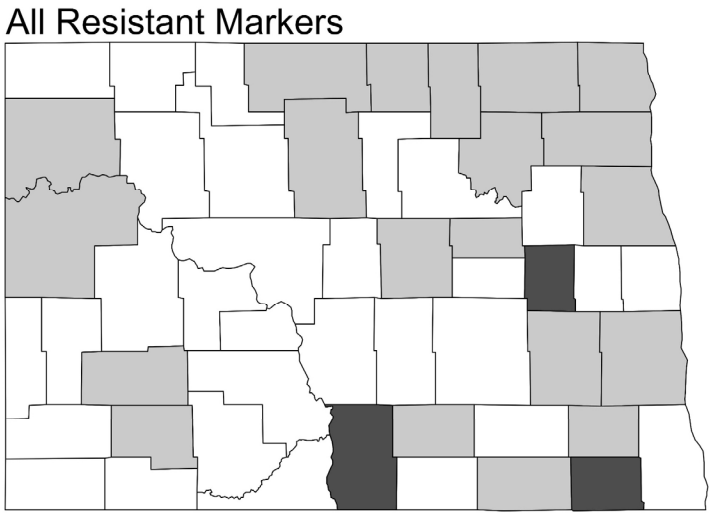
68 samples

23 counties







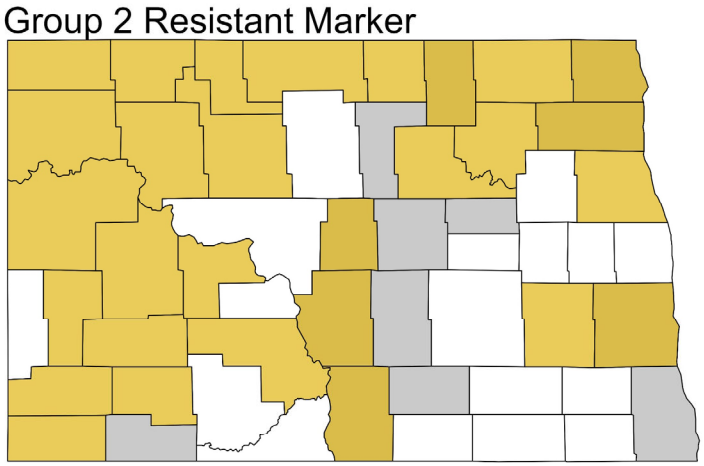


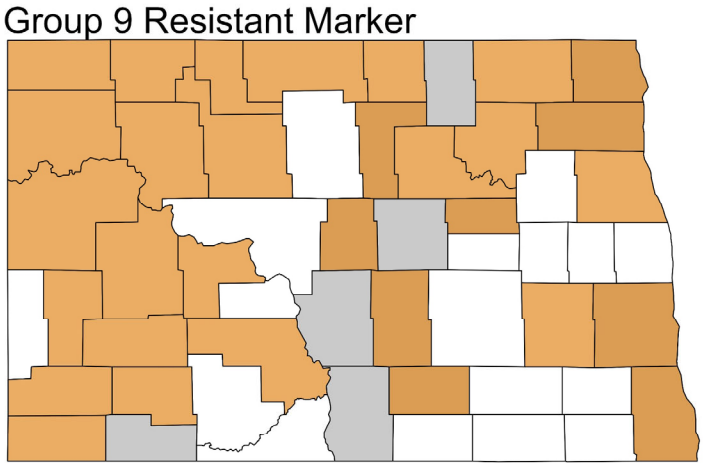
3 counties

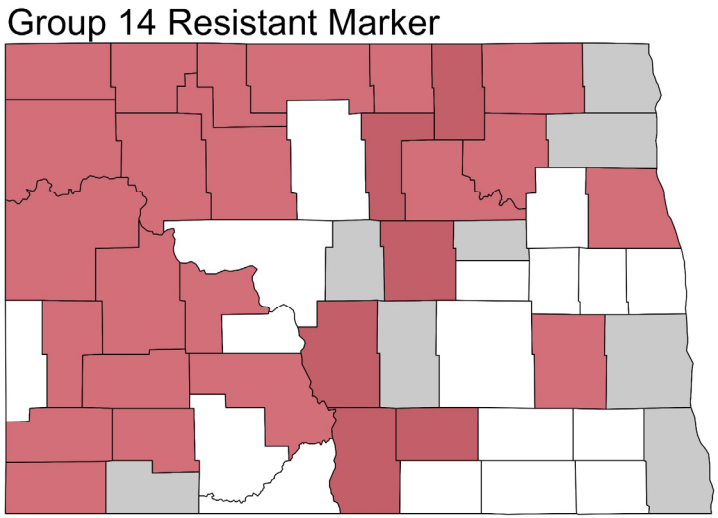
Kochia

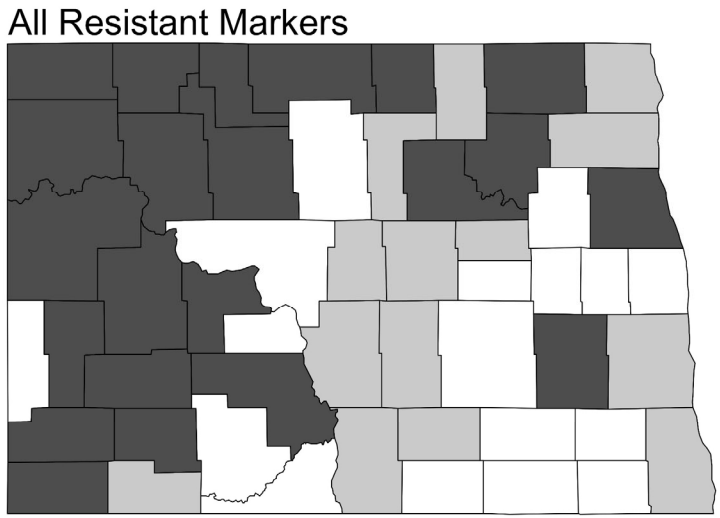
453 samples

36 counties



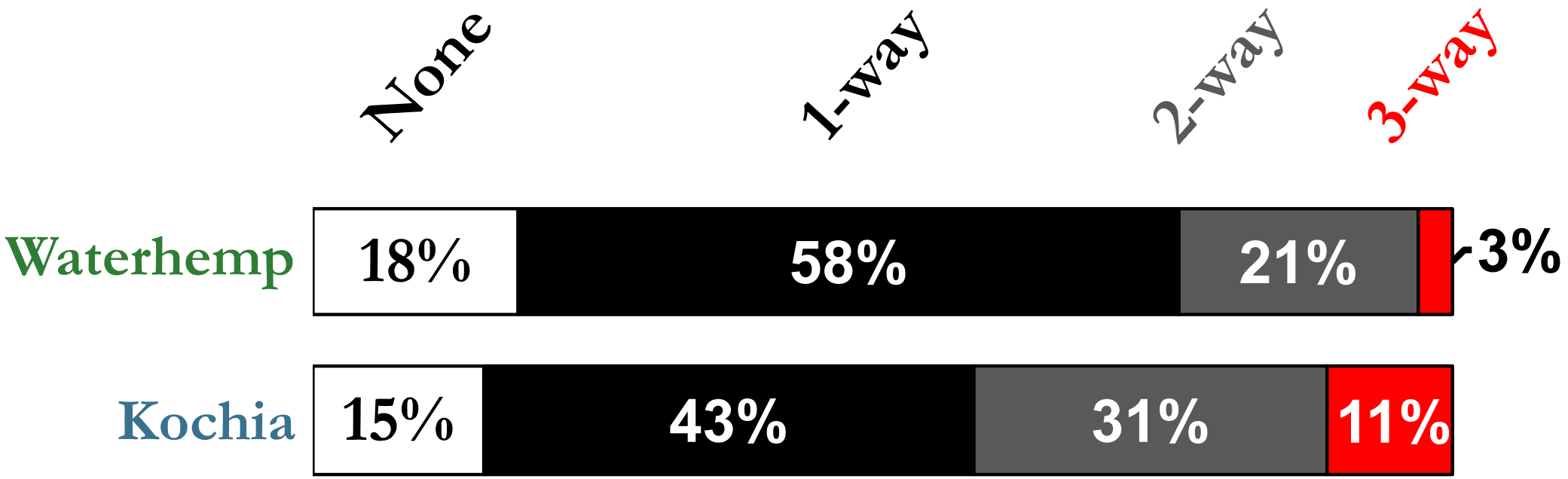






22 counties

R markers per plant



R markers per plant (stacked R)

24% of waterhemp had two or three R markers

42% of kochia had two or three R markers

Kochia

- Increased % of all R markers in 2025 vs 2024
- 61% counties sampled had all three R markers
- 42% of kochia had 2-3 R markers

Kochia

- Increased % of all R markers in 2025 vs 2024
- 61% counties sampled had all three R markers
- 42% of kochia had 2-3 R markers

Waterhemp/Pigweeds

- Increased % of Group 14 R in 2025 vs 2024
- 13% counties sampled had all three R markers.
- 24% of waterhemp had 2-3 R markers

4 out of 5 weeds

had at least one R marker

Upcoming Tests in Weedy Grasses

Green Foxtail

Wild Oat

Group 1 Markers (ACCase Inhibitors)

Group 2 Markers (ALS Inhibitors)

North Dakota populations of green foxtail & wild oat contain target-site variants

Species	Group 1	Group 2
Green Foxtail	I1781L, W2027C, D2078G, G2096A	P197S
Wild Oat	I2041N, D2078G	None yet

We need your help!

Survey success depends on volunteers

Collection kits at ND County Extension Offices

Request your own

Available to all, but fees for non-ND submitters

Future Surveys in MN & MT?

Waterhemp – all three Rs
Kochia – Group 14 R marker?

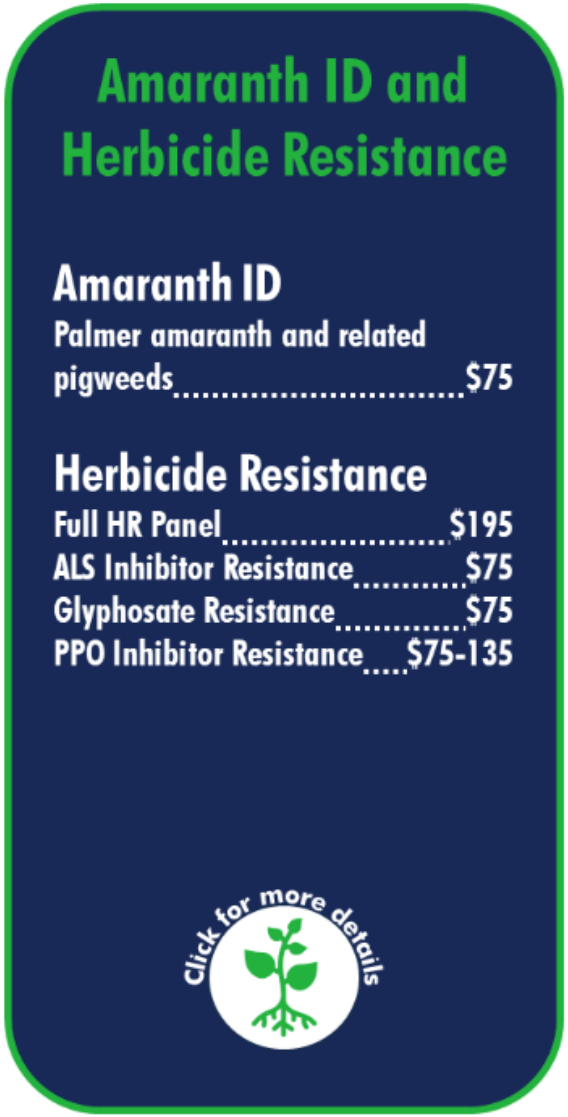
Waterhemp appeared in 2020
Kochia – Group 14 R marker +

NAGC
NATIONAL AGRICULTURAL GENOTYPING CENTER

Zack Bateson, Ph.D.
Research Director
Fargo, ND
Email: zack.bateson@genotypingcenter.com

Thank you!

Always looking for new test ideas →

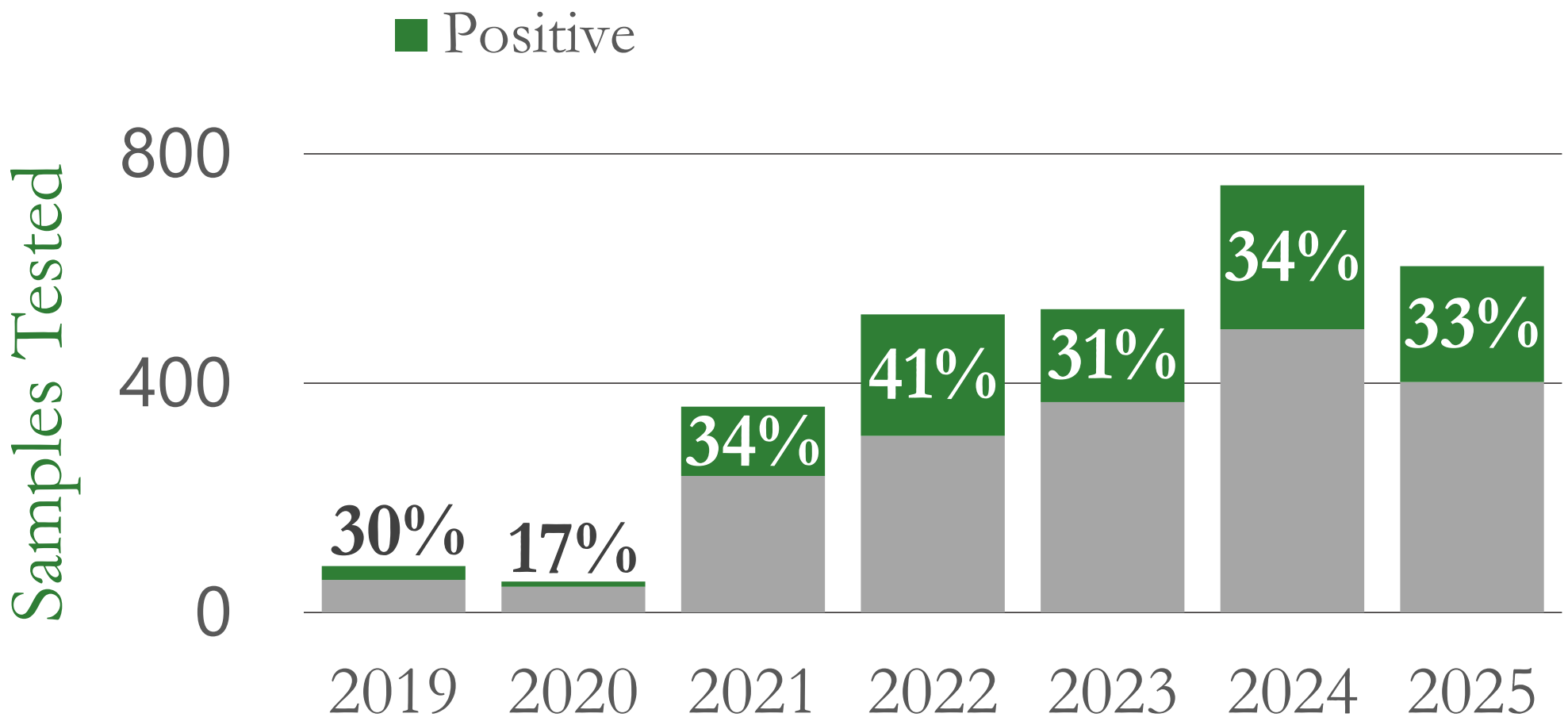


Non-ND Prices

Full HR Panel = $195/sample

Kochia Group 14 = $135/sample

Waterhemp Detected



Thank you to our supporters and funders!

ND SOYBEAN COUNCIL

NORTH DAKOTA CORN COUNCIL

NORTH DAKOTA DEPARTMENT of AGRICULTURE

Northern CANOLA GROWERS Association