Monitoring the Clubroot Spread in the Major Canola Growing Counties

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Objective: Survey and quantification of resting spores of *Plasmodiophora brassicae* from soil samples collected in North Dakota fields.

Survey Procedure:

The objective of the survey involved three components: 1. visual survey, 2. soil sampling, and 3. molecular quantification of resting spores of the clubroot pathogen.

Components 1&2. Visual survey and soil sampling: A comprehensive clubroot disease survey was carried out in eighteen counties of North Dakota, leaving no stone unturned in our quest to determine the prevalence of *Plasmodiophora brassicae*. The survey involved a visual inspection of canola crop roots, with one field in every 5,000 acres targeted for scouting in each county. Soil samples were meticulously collected from the visited fields to determine the pH of the soil and the number of resting spores per gram of soil. A minimum of three to ten fields per county were the focus of our scouting efforts.

The survey was done in two phases.

1st phase: at flowering (10% of flowering onwards)

Plants were sampled from distinct stunted patches or prematurely senescing plants in the field during the growing season. Patches visible from the edge of the field were checked by digging and observing the roots for clubroot symptoms, then soil samples were collected from those specific areas.

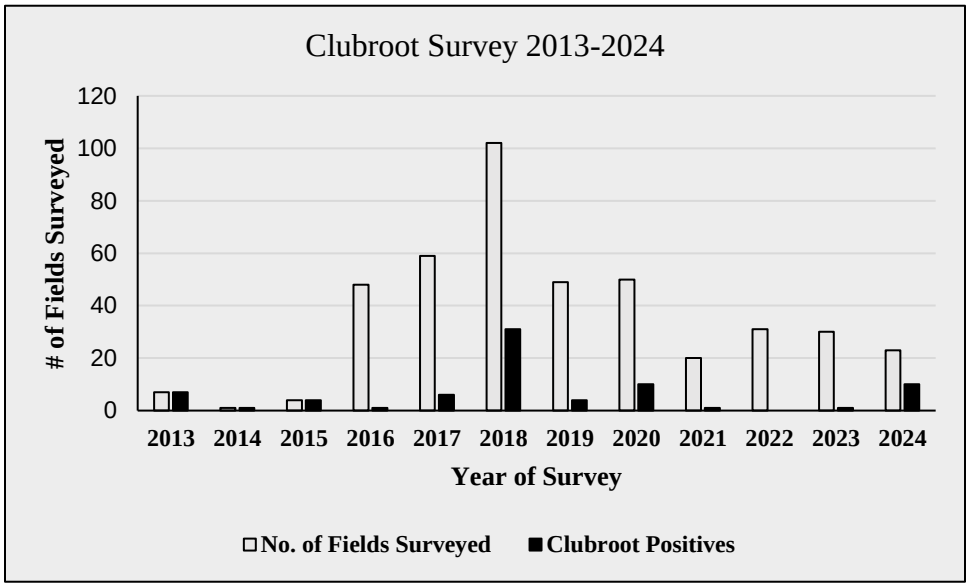
2nd phase: after swathing

Scouting at swathing was based on the methodology followed in Canada by the Alberta Agricultural and Rural Development (AARD) for their annual clubroot disease survey. Reports of AARD indicated that the probability of finding clubroot was higher if scouted at the field entrances. Hence, the survey was done starting from the main entrances/approaches in each field. The survey group walked in a "W" pattern stopping at five spots and uprooting ten consecutive stems from the ground at each spot. Each sampling point was separated by 100 meters or 328 feet. Roots of fifty stems were evaluated for the presence of clubroot and incidence. After removing excess soil, roots were visually examined for the presence of galls. At sample sites where infection was observed or suspected, root specimens with galls, along with soil, were double bagged and labeled with the field location. Infected roots and soil samples from all the fields surveyed were collected and a representative sample was submitted to Dr. Zhaohui Liu's laboratory for molecular quantification of resting spores per gram of soil. An additional half-pound of soil was sent to the NDSU Soil Testing Laboratory for pH determination.

Results: The results of the clubroot survey in North Dakota indicate ten out of the 108 fields surveyed in North Dakota showed canola roots with galls were infused by the clubroot pathogen. All the clubroot positives were found in Cavalier County (Figure 1). A sudden increase in clubroot was observed in 2024, increasing to 48% in the number of clubroot-infected canola fields. These clubroot-positive findings are the highest incidence after the endemic observed in 2018. The rise in clubroot could be attributed to the breakdown of clubroot resistance in the first-generation clubroot-resistant cultivars that were released by different companies. A drastic implementation of change in crop production practices by the growers, such as crop rotation of one in four years, is urgently needed. This situation calls for a collaborative effort

between researchers, farmers, and policymakers. Additionally, growing multiple cultivars by a grower can spread the risk and provide some insurance to the crop.

Figure 1: Fields with clubroot infections found in the last twelve years of the survey in Cavalier County.



Component 3. <u>Molecular detection of soil samples to quantify *Plasmodiophora brassicae* (the clubroot pathogen) resting spores:</u>

Soil samples were collected from major canola growing counties of North Dakota and were submitted for resting spore quantification and pH determination.

The main objective of this procedure is to quantify resting spores of the clubroot pathogen from the soil and to determine the pH of the soil. The information will be useful for growers to decide on a suitable crop for the rotation and to be aware of the infection levels of the clubroot pathogen in their fields.

<u>Results from molecular assays on soil samples</u>: The molecular assays on the soil samples collected from the year 2023 (Table 1) indicated that Walsh (75%) and Cavalier (73%) counties had the highest percentages of fields with clubroot resting spores, followed by Towner (67%) and Bottineau (60%), and the lowest obtained was in Nelson County (25%). The highest number of resting spores (807,000) per gram of soil was obtained in a field in Cavalier County and the lowest (11,000) per gram of soil was in Rolette and Towner Counties. However, the visible gall symptoms on roots were seen only in Cavalier County when the roots were uprooted in the surveyed fields.

Table 1: List of counties surveyed, the range of resting spores of clubroot obtained per gram of soil and the percentage of positive fields obtained with resting spores in various counties.

County	CR Resting Spore Range	Percent Fields with CR Positives
Cavalier	22/30 (17,000-807,000)	73
Rolette	2/5 (11,000-37,000)	16
Towner	4/6 (11,000-62,000)	67
Nelson	1/4 (35,000)	25
Walsh	3/4 (18,000-65,000)	75
Pembina	3/6 (62,000-546,000)	50
Bottineau	3/5 (546,000-1,500,000)	60
Ramsey	2/5 (306,000-318,000)	40
McLean	2/5 (550,000-1,450,000)	40
Renville	2/4 (141,000-197,000)	50
Ward	2/4 (110,000-173,000)	50
Grand Forks	2/5 (60,000-154,000)	40

Obtained pH of soil samples in various counties: The range of pH obtained in soil samples across 12 counties collected from canola-grown fields in our survey was 5.2-8.2 (Table 2). Out of which, 65% are of basic (≥7) pH, 30% are of acidic (< 6.6), and 5% are of neutral (6.6 - 7). It's crucial to note that the fields with acidic to neutral pH are significantly more vulnerable to clubroot infections. Since most of the fields surveyed have basic pH, they do not have visible galls on canola roots even though the resting spores of the clubroot pathogens are found.

Table 2: The range of pH of the soil obtained in each county in our survey.

County	Low	High
Bottineau	5.4	7.4
Cavalier	4.9	7.9
Grand Forks	6.9	8.2
McLean	5.1	7.8
Nelson	7.1	8.1
Pembina	5.6	8.2
Ramsey	6.3	7.5
Renville	5.7	8.1
Rolette	6.8	7.7
Towner	5.2	7.9
Walsh	7.4	8.1
Ward	4.9	6.1