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Understanding stem diseases in North Dakota: An assessment and educational effort.

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**Why the Research is Important to ND Soybean Farmers:**

Multiple stem diseases can cause yield loss on soybeans. In some cases, cost effective management tools (such as alteration of rotation recommendations or selection of a resistant variety) are available. However, without a better understanding of the prevalence of these diseases, and tools that facilitate easy identification of these diseases, growers are more likely to experience yield loss.

We believe determination of stem diseases prevalence combined with continual improvement of disease identification tools will help soybean growers limit yield loss now and into the future. In this project, we have conducted a robust 2-year survey of soybean fields across the state. In addition, we have updated, reprinted and distributed the Soybean Disease Diagnostic Series and continue to improve diagnostics within the NDSU Pest Management App.

**Objectives of the Research Conducted:**

1. Determine the prevalence and distribution of stem diseases throughout North Dakota.
2. Update, re-print and distribute soybean disease diagnostic cards to provide growers and agricultural professionals a resource to identify soybean stem diseases.
3. Incorporate soybean disease images into the NDSU Pest Management App.

**Description of the Research Conducted:**

*County Selection:*

In 2017 and 2018, a minimum of two dozen North Dakota Counties were selected for disease sampling. Selection of counties was based primary on soybean acreage, but other factors were considered including a history of known disease problems. Twenty-nine and 24 counties were selected in 2017 and 2018, respectively.

*Disease Assessment and Sampling:*

For accuracy and consistency, professionals who had an advanced level of training identifying stem diseases (and other agronomic issues) conducted the survey. When possible, County Extension agents conducted the survey in their counties. However, this was only the case when those agents had attended previous trainings, such as the Sudden Death Syndrome short course funded by the North Dakota Soybean Council. The rest of the survey was conducted in-person by Michelle Gilley, plant pathology research specialist at NDSU.

Soybean fields within each county were selected arbitrarily to represent the variation of the entire county. In counties with high acreage of soybeans, a minimum of 10 fields were sampled, while in lower acreage counties, fewer fields were occasionally sampled (Table 1). A total of 201 and 205 fields were selected in 2017 and 2018 respectively.

Surveyors visited fields during growth stages R6-R7 (full seed to early maturity), when stem diseases are most visually apparent and easy to identify. Two locations within each field were identified for disease assessment and sampling; specifically, an area near the field entrance and a second area thought to have a potential disease issue. If no disease issues were apparent, the second location was selected randomly. In both locations, surveyors walked a circle pattern within a one-acre square and cut ten stems at the soil line. The lower 6-8 inches of each stem were collected, bound, and mailed to NDSU plant pathology. In each field, a total of 20 stems were clipped and collected in each field (some exceptions occurred). To aid in diagnosis, surveyors recorded visual disease notes and photographs of the sites.

A total of 4,020 and 4,100 stems were received at the NDSU plant pathology department in 2017 and 2018, respectively. Each stem was inventoried and kept cool and dry until they could be evaluated. Stems were evaluated for all possible disease, including; pod and stem blight, Phomopsis seed decay, charcoal rot, Phytophthora stem rot, northern stem canker, white mold brown stem rot and anthracnose. Stems were first visually evaluated for diseases externally and photographed, then sliced longitudinally and visually evaluated. Representative samples were cultured for confirmation of disease identity as needed. Data of pod and stem blight and phomopsis seed decay were combined as differentiation between them was very difficult. Molecular confirmation for brown stem rot is underway.

*Diagnostic cards and NDSU pest management app:*

Photographs were updated on the Soybean Disease Diagnostic Series and the NDSU Pest Management App. Cards were printed and continue to be distributed, and continual app updates are being made.

**Findings of the Research Conducted:**

In 2017, the most common diseases identified were pod and stem blight / phomopsis seed decay (Table 1, 2 and 3). This was followed by charcoal rot and Northern stem canker, which were found in approximately ¼ of the surveyed fields. Anthracnose, white mold and Phytophthora stem rot were identified in less frequency. In 2018, Northern stem canker and pod and stem blight/phomopsis seed decay were the two most commonly identified diseases in the state, followed closely by anthracnose. Charcoal rot, white mold, anthracnose and Phytophthora stem rot were also identified. Brown stem rot was identified in both years, and is currently being confirmed with molecular diagnostics (data not presented).

The most commonly identified diseases (pod and stem blight / phomopsis seed decay and northern stem canker) in this study are caused by *Diaporthe/Phomopsis* species. The causal pathogens survive primarily in residue and are favored by short crop rotations and frequent rainfall. While the identification of these diseases is not a surprise, the prevalence of them across the state was higher than anticipated. This is particularly so because 2017 and 2018 were relatively dry growing seasons. While prevalence was high, surveyors generally did not notice areas of frequent high severity, but yield loss to these diseases is possible. Nationally, these diseases are of moderate concern. Between 2011 and 2014, pod and stem blight/phomopsis seed decay and stem canker (combined with southern stem canker) caused an estimated national yield loss of 80M and 36M bushels, respectively (Allen et al. 2017). While significant, these diseases caused less yield loss nationally than many other diseases in that same time period, including soybean cyst nematode (617M bushels), seedling diseases (241M bushels), charcoal rot (219M bushels) and several others (Allen et al. 2017).

Charcoal rot was highly concentrated in SE North Dakota. The disease is favored by a dry warm August and short/no rotation. Additionally, the pathogen can survive on corn and sunflower, the former being a common rotation crop of soybean in the Southeastern counties. In 2018, an epidemic of the disease occurred in Cass, Traill and Barnes counties. Surveyors noted that large portions of fields were dying prematurely; it is likely that charcoal rot caused the most yield loss of any disease identified in this project.

While white mold and Phytophthora stem rot can cause yield loss, but their prevalence in this survey was limited and sporadic. This survey was done during two relatively dry growing seasons (2017 and 2018), which is unfavorable for the development of either diseases.

The high prevalence of anthracnose is not surprising and not alarming. Anthracnose commonly occurs late in the season, and generally causes little, if any, yield loss. However, the pathogen is commonly mistaken for Northern stem canker and care should be taken to differentiate the two diseases.

Brown stem rot was visually identified in both 2017 and 2018, but data is being confirmed using molecular diagnostics. An update will be made as soon as that data is complete.

**Benefits/Recommendations to the North Dakota Soybean Farmers and Industry:**

Stem diseases are occurring widely on North Dakota soybeans, and yield loss to these diseases is possible. Identification of stem diseases in soybean fields is critical, as management tools for some of these diseases may be available. An increased effort by agriculture professionals (including Extension) on accurate identification and management of charcoal rot, northern stem canker and pod and stem blight/phomopsis seed decay may be warranted.

**Acknowledgements:**

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**References:**

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Table 1. Number of soybean fields with identified stem diseases in 29 North Dakota counties in 2017.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| County | Number of fields | Pod and stem blight / Phomopsis seed decay | Charcoal rot | Phytophthora stem and root rot | Northern stem canker | White mold | Anthracnose |
| Barnes | 10 | 10 | 6 | 0 | 3 | 2 | 3 |
| Benson | 10 | 6 | 1 | 0 | 4 | 0 | 1 |
| Bottineau | 4 | 2 | 0 | 0 | 3 | 0 | 0 |
| Cass | 13 | 12 | 11 | 0 | 1 | 0 | 3 |
| Cavalier | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| Dickey | 4 | 3 | 0 | 0 | 1 | 0 | 1 |
| Eddy | 4 | 4 | 0 | 0 | 3 | 0 | 0 |
| Foster | 5 | 5 | 2 | 0 | 0 | 1 | 3 |
| Grand Forks | 10 | 1 | 2 | 0 | 2 | 0 | 0 |
| Griggs | 4 | 4 | 0 | 0 | 1 | 1 | 2 |
| LaMoure | 10 | 8 | 1 | 0 | 1 | 2 | 0 |
| Logan | 10 | 4 | 0 | 0 | 0 | 0 | 0 |
| McHenry | 4 | 2 | 0 | 0 | 0 | 0 | 0 |
| McIntosh | 4 | 2 | 0 | 1 | 2 | 0 | 0 |
| McLean | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| Pembina | 10 | 8 | 1 | 0 | 2 | 1 | 0 |
| Pierce | 3 | 2 | 0 | 0 | 0 | 0 | 1 |
| Ramsey | 10 | 4 | 0 | 0 | 0 | 0 | 1 |
| Ransom | 4 | 4 | 0 | 0 | 1 | 2 | 1 |
| Renville | 4 | 2 | 0 | 0 | 0 | 0 | 1 |
| Richland | 10 | 10 | 6 | 3 | 4 | 3 | 0 |
| Sargent | 7 | 6 | 5 | 0 | 1 | 2 | 5 |
| Steele | 10 | 9 | 4 | 0 | 3 | 2 | 0 |
| Stutsman | 4 | 4 | 0 | 0 | 3 | 1 | 2 |
| Towner | 10 | 2 | 0 | 1 | 4 | 0 | 0 |
| Traill | 10 | 9 | 7 | 0 | 1 | 0 | 6 |
| Walsh | 10 | 5 | 0 | 0 | 3 | 1 | 5 |
| Ward | 10 | 1 | 0 | 0 | 1 | 0 | 0 |
| Wells | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Total | 201 | 133 | 46 | 5 | 45 | 18 | 36 |

Table 2. Number of soybean fields with identified stem diseases in 24 North Dakota counties in 2018.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| County | Number of fields | Pod and stem blight / Phomopsis seed decay | Charcoal rot | Phytophthora stem and root rot | Northern stem canker | White mold | Anthracnose |
| Barnes | 10 | 10 | 2 | 1 | 10 | 2 | 8 |
| Benson | 10 | 5 | 0 | 0 | 10 | 0 | 7 |
| Cass | 10 | 10 | 5 | 0 | 8 | 3 | 3 |
| Cavalier | 10 | 1 | 1 | 0 | 10 | 0 | 7 |
| Dickey | 10 | 9 | 0 | 0 | 6 | 5 | 5 |
| Eddy | 2 | 1 | 0 | 0 | 2 | 0 | 1 |
| Emmons | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Foster | 8 | 0 | 0 | 1 | 6 | 0 | 3 |
| Grand Forks | 10 | 6 | 6 | 0 | 5 | 0 | 4 |
| LaMoure | 10 | 5 | 1 | 0 | 8 | 3 | 1 |
| Logan | 10 | 8 | 1 | 0 | 10 | 0 | 2 |
| McIntosh | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nelson | 10 | 3 | 3 | 0 | 9 | 0 | 3 |
| Pembina | 10 | 2 | 0 | 0 | 3 | 0 | 0 |
| Ramsey | 10 | 1 | 0 | 0 | 9 | 0 | 2 |
| Ransom | 5 | 2 | 0 | 0 | 0 | 5 | 0 |
| Richland | 10 | 5 | 1 | 0 | 3 | 1 | 4 |
| Sargent | 5 | 2 | 1 | 0 | 4 | 1 | 4 |
| Steele | 10 | 10 | 5 | 0 | 9 | 0 | 10 |
| Stutsman | 10 | 8 | 1 | 0 | 10 | 2 | 4 |
| Towner | 10 | 1 | 0 | 0 | 7 | 0 | 0 |
| Traill | 11 | 6 | 5 | 0 | 6 | 0 | 9 |
| Walsh | 10 | 7 | 1 | 0 | 9 | 0 | 5 |
| Ward | 10 | 1 | 0 | 0 | 4 | 0 | 0 |
| Total | 205 | 103 | 33 | 2 | 148 | 22 | 82 |

Table 3. Number of soybean fields with identified stem diseases in 31 North Dakota counties in 2017 and 2018.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| County | Number of fields | Pod and stem blight / Phomopsis seed decay | Charcoal rot | Phytophthora stem and root rot | Northern stem canker | White mold | Anthracnose |
| Barnes | 20 | 20 | 8 | 1 | 13 | 4 | 11 |
| Benson | 20 | 11 | 1 | 0 | 14 | 0 | 8 |
| Bottineau | 4 | 2 | 0 | 0 | 3 | 0 | 0 |
| Cass | 23 | 22 | 16 | 0 | 9 | 3 | 6 |
| Cavalier | 11 | 2 | 1 | 0 | 11 | 0 | 8 |
| Dickey | 14 | 12 | 0 | 0 | 7 | 5 | 6 |
| Eddy | 6 | 5 | 0 | 0 | 5 | 0 | 1 |
| Emmons | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Foster | 13 | 5 | 2 | 1 | 6 | 1 | 6 |
| Grand Forks | 20 | 7 | 8 | 0 | 7 | 0 | 4 |
| Griggs | 4 | 4 | 0 | 0 | 1 | 1 | 2 |
| LaMoure | 20 | 13 | 2 | 0 | 9 | 5 | 1 |
| Logan | 20 | 12 | 1 | 0 | 10 | 0 | 2 |
| McHenry | 4 | 2 | 0 | 0 | 0 | 0 | 0 |
| McIntosh | 6 | 2 | 0 | 1 | 2 | 0 | 0 |
| McLean | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| Nelson | 10 | 3 | 3 | 0 | 9 | 0 | 3 |
| Pembina | 20 | 10 | 1 | 0 | 5 | 1 | 0 |
| Pierce | 3 | 2 | 0 | 0 | 0 | 0 | 1 |
| Ramsey | 20 | 5 | 0 | 0 | 9 | 0 | 3 |
| Ransom | 9 | 6 | 0 | 0 | 1 | 7 | 1 |
| Renville | 4 | 2 | 0 | 0 | 0 | 0 | 1 |
| Richland | 20 | 15 | 7 | 3 | 7 | 4 | 4 |
| Sargent | 12 | 8 | 6 | 0 | 5 | 3 | 9 |
| Steele | 20 | 19 | 9 | 0 | 12 | 2 | 10 |
| Stutsman | 14 | 12 | 1 | 0 | 13 | 3 | 6 |
| Towner | 20 | 3 | 0 | 1 | 11 | 0 | 0 |
| Traill | 21 | 15 | 12 | 0 | 7 | 0 | 15 |
| Walsh | 20 | 12 | 1 | 0 | 12 | 1 | 10 |
| Ward | 20 | 2 | 0 | 0 | 5 | 0 | 0 |
| Wells | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Total | 406 | 236 | 79 | 7 | 193 | 40 | 118 |