

NORTH DAKOTA POTATO WILT SURVEY - 1977

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ABSTRACT

A potato wilt survey conducted in two parts was performed during the 1977 growing season in five counties of North Dakota. Results indicate *Fusarium* spp. is the major wilt pathogen of potatoes. *Verticillium* spp. and *Erwinia carotovora* var. *atroseptica* (blackleg organism) were also found in high percentages in wilted plants. *Colletotrichum* and *Rhizoctonia* were isolated in nearly equal proportions. A high percent of wilted plants were found to contain more than one wilt-causing organism which indicated that mixed infection occurred. The interaction of wilt organisms in multiple infections increases the complexity of the potato wilt disease and makes control much more difficult.

Wilting of potato plants in the field can be caused by several pathogenic organisms. Symptoms may be frequently misinterpreted, and the diseased potato plants are then improperly diagnosed. For this reason a survey was conducted during the 1977 growing season to determine the actual agents of wilt in the major potato producing areas of North Dakota.

Wilting is a response of the plant to a water stress. This may be the result of environment or the presence of a pathogenic organism which disrupts the passage of water in the potato plant. Pathogenic organisms such as *Fusarium* and *Verticillium* spp. induce wilting by causing root damage or plugging of the water conducting tissues of the plant. *Rhizoctonia solani* (Kuhn) and *Colletotrichum atramentarium* (Berk. & Br. (Taub.) cause root damage, *Rhizoctonia* attacks the potato plant throughout the growing season. It damages roots, stolons and stems which weakens the plant and may reduce stands. *Colletotrichum* is a weak pathogen and becomes apparent late in the growing season. Early maturation of potato vines in a dry season may be caused by *Colletotrichum*.

Fusarium spp. and *Verticillium* spp. are frequently the most important wilt causing fungi of potatoes in North Dakota. Both fungi can be soil and tuber borne. They enter the plant through below ground parts and colonize its vascular system. Water movement is thereby restricted, resulting in wilting and premature death of the plant.

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Wilting of potato plants may also be caused by soft rotting of the potato stem tissue by *Erwinia carotovora* var. *atroseptica* (Van Hall (blackleg organism). In North Dakota this bacterium is primarily tuber borne. In most cases blackleg development is associated with seed piece decay.

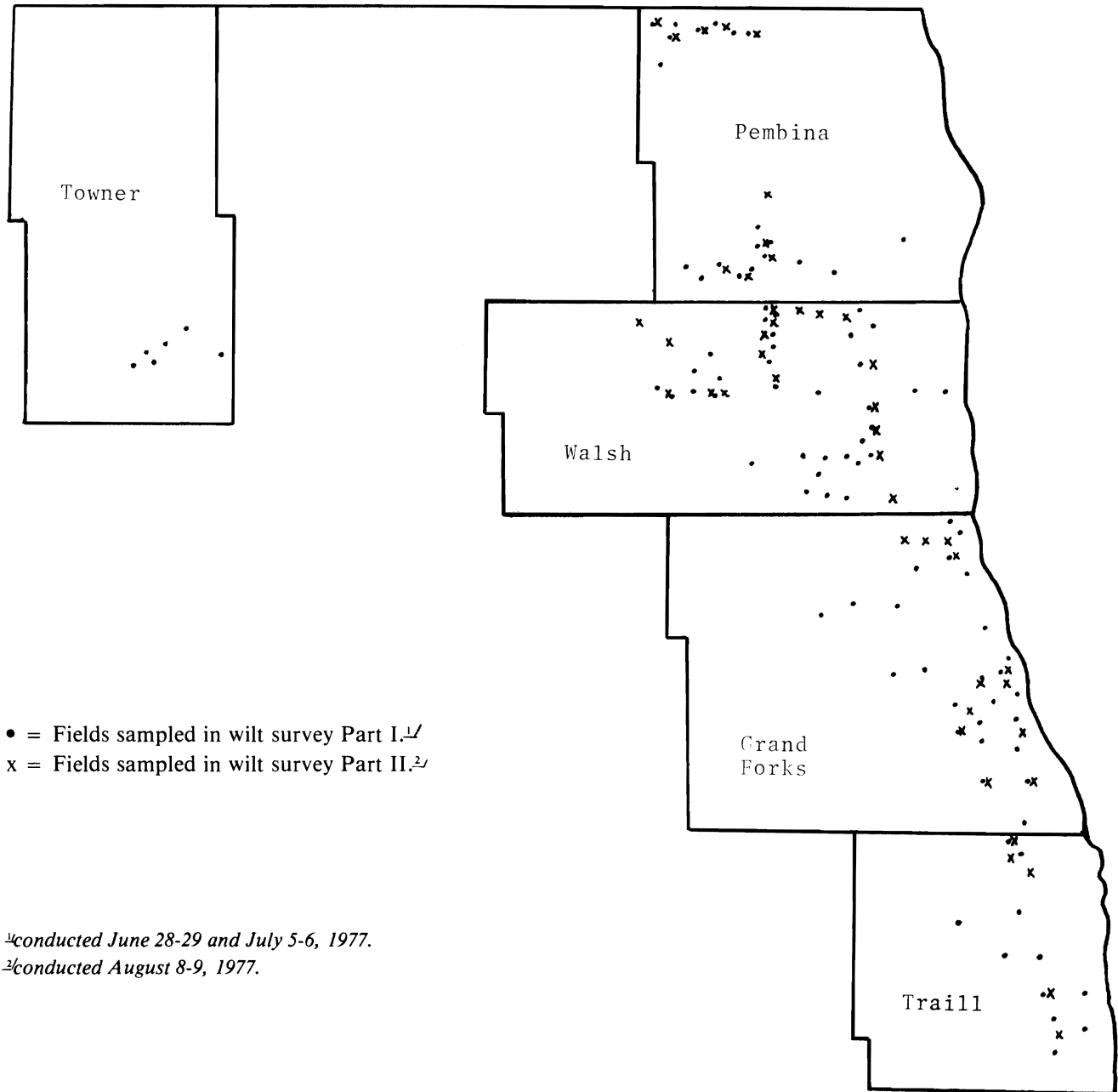
The objective of this survey was to learn which of these pathogens is the major agent of wilt and what associations, if any, exist among them.

Materials and Methods

The wilt survey was conducted in two parts, the first on June 28 and 29 and July 5 and 6, 1977, and the second on August 8-9, 1977. In the first part of the survey samples were taken in five counties based on the percentage of potato acreage in those counties. Walsh, Grand Forks, Pembina, Traill and Towner counties were surveyed, and these counties account for approximately 97 percent of the potato acreage in N. Dak. In part I of the wilt survey 96 fields were sampled, while in part II, 45 fields were sampled. Towner county was omitted in part II.

Field sampling within counties was distributed as indicated in the map (Fig No. 1). Criteria used to determine sample size and distribution were, as previously mentioned, based on percent of potato acreage and size of fields. Thus, a certain number of fields were sampled in each county. Each field sampled was between 40 and 100 acres. Four plants showing wilt symptoms or vascular discoloration and four plants without wilt or vascular discoloration were collected

Figure 1. Distribution of field sampling among counties for potato wilt survey — 1977.



randomly from each field. The total number of fields surveyed in part I represented 20 percent of the total potato acreage in North Dakota. Some 12,000 isolations were performed to determine the total percent incidence of each wilting organism.

Alcohol agar was used to isolate *Verticillium* spp. (2). Potato sucrose agar was used mainly to isolate *Fusarium* spp. (1). Additional amounts of streptomycin sulphate were used in both media to inhibit bacterial contaminations. Steward's medium (3) was used to isolate pectinolytic *Erwinia* spp. This media is commonly used in testing for the presence of blackleg organisms in potatoes.

One stem was selected from each plant and kept at 4-5°C until processing. The processing consisted of trimming leaves and roots and washing the stem thoroughly in running tap water. The stem surface was

sterilized in two solutions: first in 70 percent ethanol for 2 minutes and then in 12 percent chlorox for 2 minutes. The stem was divided into two stem pieces by cutting at the soil line. Eight cross sections were taken from each top stem piece, four of them were placed on a petri plate containing alcohol agar (AA), and the other four were placed on potato sucrose agar (PSA). Eight cross sections were also taken from the bottom stem piece. The vascular tissue was removed from these eight cross sections with a sterile cork borer and plated on AA and PSA. This was done to avoid the abundant saprophytes which prevailed even after surface sterilization. The remaining part of the bottom stem piece was used to obtain plant sap to test for *Erwinia* spp. The bottom stem piece was squeezed with sterile pliers. The sap squeezed from each stem was streaked on Steward's medium (SM) to detect *Erwinia* spp.

Table 1. Percent of Organisms Isolated from Wilted and Healthy Appearing Potato Plants Collected in Five Counties in North Dakota in the 1977 Potato Wilt Survey Part I.¹

WALSH					
Association	Colletotrichum	Fusarium	Verticillium	Rhizoctonia	Erwinia
Total Incidence	15.5	61.2	34.9	23.3	35.7
Mixed Infection	15.5	36.4	17.8	20.9	30.2
Alone	---	24.8	17.1	2.3	5.4
PEMBINA					
Total Incidence	7.6	50.0	33.3	22.7	30.3
Mixed Infection	7.6	27.3	19.7	19.7	15.2
Alone	---	22.7	13.6	3.0	15.2
GRAND FORKS					
Total Incidence	6.4	60.6	39.4	12.8	31.9
Mixed Infection	6.4	30.9	22.3	10.6	23.4
Alone	---	29.8	17.0	2.1	8.5
TRAILL					
Total Incidence	5.7	60.0	51.4	17.1	31.4
Mixed Infection	5.7	40.0	28.6	14.3	22.9
Alone	---	20.0	22.9	2.9	8.6
TOWNER					
Total Incidence	---	50.0	14.3	21.4	14.3
Mixed Infection	---	21.4	---	21.4	---
Alone	---	28.6	14.3	---	14.3
NORTH DAKOTA ^{2/}					
Total Incidence	9.8	58.3	36.7	19.5	32.3
Mixed Infection	9.8	32.8	19.8	17.2	23.4
Alone	---	25.4	16.9	2.4	8.9

¹Wilt survey I - June 28-29 and July 5-6, 1977.

²Average of all wilted plants collected in Part I regardless of county.

Results and Discussion

Wilt Survey - Part I:

Results obtained from the first part of the wilt survey are presented in Table 1. Although variation occurs between counties, the position of each wilting organism in relation to the other organisms stays relatively the same. The occurrence of *Fusarium* spp. as a wilting organism ranged from 50 percent total incidence in Pembina and Towner counties to 61.2 percent total occurrence in Walsh county. *Fusarium* spp. was also found to be the sole wilting agent in 25.4 percent of the samples containing *Fusarium* spp. The presence of *Verticillium* spp. and the blackleg organism, *Erwinia corotovor* var. *atroseptica* in wilted plants was approximately the same from county to county with the averages of all counties being 36.7 percent and 32.3 percent respectively. However, *Verticillium* spp. was found to be the only wilting agent in the plants collected more frequently than was the blackleg organism. *Verticillium* spp. was the sole pathogen in 16.9 percent of the samples from which it was isolated. *Erwinia* was the sole pathogen in only 8.9 percent of the samples containing it. The presence of *Rhizoctonia* in wilted plants generally varied little from county to county. Although *Rhizoctonia* was isolated from nearly 20 percent of all the plants collected, it was severe enough to cause wilt in a potato plant by itself in only 2 percent samples containing it. In wilt caused by *Rhizoctonia* the main stem of the potato plant would be "torched off" below the soil line. *Colletotrichum* sp., a relative newcomer to the North Dakota potato grower was present in nearly 10 percent of all stems collected in the five counties. It was not isolated from any of the plants sampled in Towner county, but was found in varying degrees of occurrence in all other counties. In Walsh county, 15.6 percent of all plants were infected with *Colletotrichum*. It, however, was not found to be the sole wilting agent in any of the plants collected. It seems to increase the wilt symptoms when it occurs in combination with another wilting pathogen.

Each wilting organism was isolated most frequently in mixed infections (Table 1). Since *Fusarium* sp., *Erwinia* sp., and *Verticillium* sp. were the organisms most frequently isolated from wilted and healthy appearing plants, it is to be expected that these organisms were found most frequently in combination with other organisms (Table 2). However, it is interesting to note that a high percentage of mixed infections were of multiple combinations, i.e., more than two of the wilting agents were isolated from the same plant.

Wilt Survey - Part II

The second part of this potato disease survey was conducted to determine if any shift in the populations of wilt producing organisms would occur (Table 3). A decrease in the occurrence of blackleg was anticipated since this disease expresses itself relatively early in the growing season; plants with blackleg generally die and disappear. *Erwinia* spp. dropped from 32.3 percent (Table 1) to 8.8 percent (Table 3). The total incidence of *Fusarium* spp. rose slightly to 61 percent and its presence alone as the wilting agent went up slightly to nearly 29 percent (Table 3). The occurrence of both *Verticillium* spp. and *Rhizoctonia* dropped slightly. However, the presence of *Rhizoctonia* as the sole wilting agent increased while *Verticillium* decreased. Although these differences may be slight and non-significant, the role *Colletotrichum* sp. played in the wilt situation as the summer progressed is interesting. Its presence in all of the plants collected increased. *Colletotrichum* was the sole pathogen in 11.3 percent of the samples containing it in the four counties surveyed in the second part. These data indicate that more attention should be given to *Colletotrichum* sp. as a significant primary wilt pathogen.

Various combinations of potato wilt pathogens were isolated from wilted potato plants in the second survey (Table 3). The organisms most commonly isolated were again found in various combinations with each other

Table 2. Percent Associations of Organisms from Wilted and Healthy Appearing Potato Plants Collected in North Dakota in the 1977 Potato Wilt Survey Part I.

	Colletotrichum	Fusarium	Verticillium	Rhizoctonia	Erwinia
Colletotrichum	---	3.6	0.3	0.6	0.6
Fusarium	3.6	25.4	7.4	5.3	7.1
Verticillium	0.3	7.4	16.9	1.5	4.1
Rhizoctonia	0.6	5.3	1.5	2.4	2.4
Erwinia	0.6	7.1	4.1	2.4	8.9
Multiple ¹					
Combinations	4.7	9.5	6.5	7.4	9.5

¹Indicates a combination of more than 2 organisms were isolated from a plant.

Table 3. Percent of Organisms Isolated from Wilted and Healthy Appearing Potato Plants Collected in Four Counties in North Dakota in the 1977 Wilt Survey Part II.¹

WALSH					
Association	Collectotrichum	Fusarium	Verticillium	Rhizoctonia	Erwinia
Total Incidence	33.3	68.1	26.1	11.6	13.0
Mixed Infection	20.3	39.1	13.0	10.1	11.6
Alone	13.0	29.0	13.0	1.5	1.5
PEMBINA					
Total Incidence	32.4	55.9	41.2	2.9	8.8
Mixed Infection	20.6	20.6	26.5	2.9	8.8
Alone	11.8	35.3	14.7	---	---
GRAND FORKS					
Total Incidence	26.2	64.3	23.8	11.9	2.4
Mixed Infection	14.3	31.0	11.9	7.1	2.4
Alone	11.9	33.3	11.9	4.8	---
TRAILL					
Total Incidence	28.6	28.6	64.3	14.3	7.1
Mixed Infection	28.6	28.6	50.0	7.1	---
Alone	---	---	14.3	7.1	7.1
NORTH DAKOTA^{2/}					
Total Incidence	30.8	61.0	32.1	10.7	8.8
Mixed Infection	19.5	32.1	18.9	7.6	7.6
Alone	11.3	28.9	13.2	3.1	1.3

¹Wilt Survey Part II - August 8-9, 1977.

²Average of all wilted plants collected in Part II, regardless of county.

(Table 4). *Verticillium* spp. and *Fusarium* spp. were frequently isolated with *Colletotrichum*. More research into the interaction of these potato wilt organisms is being conducted. In the second survey, most of the mixed infections occurred in combinations of more than two organisms, with the exception of *Rhizoctonia*.

Summary and Conclusions

Summary of the results of these two surveys are presented in Tables 5 and 6. Potato plants sampled in the growing areas of North Dakota from year to year have indicated the predominance of *Fusarium* spp. as the primary wilting agent of potatoes in our state. Results obtained in the 1977 wilt survey corroborate these findings. Considering both dates of the wilt survey and all plants collected in the potato growing areas of North Dakota, *Fusarium* spp. was the most frequently isolated pathogen both in combination or alone. The second most frequently isolated wilt pathogen was *Verticillium*. The bacteria causing blackleg were isolated

less frequently than *Fusarium* spp. and *Verticillium* spp., and its occurrence alone was infrequent. Both *Rhizoctonia* and *Colletotrichum* were isolated infrequently as the sole pathogen. The association of *Colletotrichum* with other wilt organisms is being studied. More than two wilt-causing organisms were frequently associated in the same wilted potato (Table 6). Several organisms may be parasitizing a potato plant at the same time, and the wilted condition of a plant we see may seldom be caused by a single organism. Potato wilts are rather poorly understood. This study of the interaction of all wilt producing organisms on potato may provide information useful to potato breeders and plant pathologists in developing control programs. Harvesting and/or cultural practices performed by a grower may lessen or increase the occurrence of wilt, *Rhizoctonia* and blackleg in his fields. Research is being conducted into the effect of cultural practices and crop rotation on populations of several of these organisms and the expression of their diseases.

Table 4. Percent Associations of Organisms from Wilted and Healthy Appearing Potato Plants Collected in North Dakota in the 1977 Wilt Survey Part II.

	Colletotrichum	Fusarium	Verticillium	Rhizoctonia	Erwinia
Colletotrichum	11.3	9.4	5.7	0.0	0.0
Fusarium	9.4	28.9	8.8	5.7	2.5
Verticillium	5.7	8.8	13.2	0.0	0.6
Rhizoctonia	0.0	5.7	0.0	3.1	0.0
Erwinia	0.0	2.5	0.6	0.0	1.3
Multiple ¹					
Combinations	4.4	6.3	3.8	1.9	4.4

¹Indicates a combination of more than 2 organisms were isolated from a plant.

Table 5. Percent of Organisms Isolated from Wilted and Healthy Appearing Potato Plants Collected in North Dakota Wilt Survey of 1977 (Part I & II).

NORTH DAKOTA

Association	Colletotrichum	Fusarium	Verticillium	Rhizoctonia	Erwinia
Total Incidence	16.5	59.2	35.2	16.7	24.8
Mixed Infection	12.9	32.6	19.5	14.1	18.3
Alone	3.6	26.6	15.7	2.6	6.4

Table 6. Percent Associations of Organisms from Wilted and Healthy Appearing Potato Plants Collected in North Dakota in the 1977 Wilt Survey (Part I & II).

	Colletotrichum	Fusarium	Verticillium	Rhizoctonia	Erwinia
Colletotrichum	3.6	5.4	2.0	0.4	0.4
Fusarium	5.4	26.6	7.8	5.4	5.6
Verticillium	2.0	7.8	15.7	1.0	3.0
Rhizoctonia	0.4	5.4	1.0	2.6	1.6
Erwinia	0.4	5.6	3.0	1.6	6.4
Multiple ¹					
Combinations	4.4	8.4	5.6	5.6	7.8

¹Indicates a combination of more than two organisms were isolated from a plant.

References

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