

BACTERIAL WILT AND TUBER BROWN ROT AS A POTENTIAL THREAT TO POTATO PRODUCTION IN NORTHEAST FLORIDA

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Abstract. Bacterial wilt (BW) and tuber brown rot caused by *Pseudomonas solanacearum* E. F. Smith was a major disease problem affecting Irish potatoes (*Solanum tuberosum* L.) grown in Northeast Florida (NEF) until the mid 1940's. Historical records suggest that reductions in the incidence and severity of BW in NEF coincided with the introduction and rapid grower acceptance of the cultivar Sebago. 'Sebago', which has a degree of tolerance to BW, was the predominant potato cultivar grown in NEF for nearly 40 yr. Recently 'Atlantic', which has greater yield potential and is more acceptable to potato chip processors than 'Sebago', has replaced 'Sebago' as the principal cultivar grown in NEF. 'Atlantic' is highly susceptible to BW. In this paper we trace the history of BW in NEF, compare incidence and severity of the disease in 'Atlantic' and 'Sebago', and discuss the potential for losses due to BW in NEF.

History of bacterial wilt in northeast Florida. Irish potatoes were first grown commercially in northeast Florida (NEF) during the 1890's and by 1919 nearly 13,000 acres were in production (12). During the 1980's the potato acreage has varied from 19,500-25,000 acres. Significant crop losses due to plant diseases have occurred in NEF potato production ever since the crop was grown. Bacterial wilt (BW) and tuber brown rot caused by *Pseudomonas solanacearum* E. F. Smith was apparently an important disease problem from the beginning. The disease, called bacterial blight in the early literature, was 1 of the 5 discussed in the first potato disease bulletin published in Florida (9) and until the late 1930's was considered second in importance only to late blight caused by *Phytophthora infestans* (Mont.) D. By.

Bacterial wilt varied considerably in intensity from season to season. Burger (1) in 1921 reported the disease in 75% of NEF potato fields. Tucker (14) stated that the disease was less prevalent in the Hastings area during 1931 than earlier, but that it was still severe in other locations such as the La Crosse area in Alachua County. He hypothesized that increased acidity of soil due to cultivation reduced severity of BW. Tucker reported in the same publication that 'Green Mountain' was less severely affected than 'Spalding Rose' which was at that time the standard cultivar in NEF. Eddins (3) cited losses ranging from 1.8 to 8.9% during 1932-38 with the disease being most severe during 1935. Eddins (2) attributed the severe losses during 1935 to unusually warm dry weather conditions during March and April. None of the above sources indicated how percent losses to disease were estimated.

In a classic series of experiments performed during 1929-35 Eddins (2) demonstrated that severity of BW and brown rot could be reduced by lowering soil pH with S during the summer and then returning the pH to suitable crop production levels in the fall through use of lime. He also

demonstrated experimentally that 'Green Mountain', 'Katahdin', and 'Sebago' were tolerant to the disease (5). The sulfur-lime treatment was never widely used, probably due to its cost and the availability of the BW wilt tolerant cultivars.

'Katahdin' and later 'Sebago' proved to be extremely popular with NEF growers and within 5 years after the introduction of 'Katahdin' the 2 cultivars were planted on >90% of the NEF acreage (Table 1).

Table 1. Percentage Northeast Florida potato acreage planted to different potato cultivars and relative losses due to bacterial wilt during 1938-1978.^z

Season ^y	Cultivars planted (%)			Losses due to bacterial wilt (%)
	Spaulding Rose	Katahdin	Sebago	
1938	74	25	—	1.0
1939	39	51	—	3.0
1940	10	79	—	1.0
1941	2	77	7	0.5
1942	—	45	45	0.2
1943	—	35	60	0.5
1944	—	28	65	Tx
1945	—	15	80	1.0
1946	—	—	95	ND ^x
1947	—	—	95	<1
1948	—	—	90	<1
1949-1978	—	—	95	<1

^z1938-49 data from (4) and (5), 1949-78 data based on AREC records. Cultivar data from (5).

^y1933-37 losses ranged from 1.5 to 8.9%, averaging 3.4%.

^xOnly a trace of BW observed in 1944. No data for 1946 since project was discontinued because BW was no longer a major production problem in NEF.

Incidence of BW in NEF declined dramatically with the introduction and rapid grower acceptance of 'Katahdin' and 'Sebago'. Only a trace of the disease was observed during 1944 when 93% of the NEF acreage was planted to these varieties and the Florida Experiment Station project dealing with control of BW was terminated in 1946 (4, 5, unpublished Expt. Sta. records).

Reports of BW remained negligible in NEF until the relatively dry 1976 season. During 1976 several isolated severe outbreaks of the disease were reported in growers' fields. In each case the grower had applied the nonvolatile nematicide aldicarb for nematode control after having fumigated his field with dichloropropane-dichloropropene mixture (DD) during the previous 4-6 yr and had also planted a wilt-susceptible cultivar such as 'FL 1-62', 'Superior', or 'Red La Soda' (D. P. Weingartner, unpublished observations).

History of 'Atlantic' in NEF. 'Atlantic' was first tested during 1972 in NEF as pedigree number B6987-56. The cultivar was released jointly in 1976 by the Agricultural Research Service of the USDA, and the Florida, New Jersey, Maine, and Virginia Agricultural Experiment Stations. The average tuber yields, tuber specific gravity and total solids of 'Atlantic' tubers were greater than those of 'Sebago', and potato chip color was comparable to 'Sebago', in experiments performed at the Hastings Agricultural Research and Education Center each year during 1973-1976 (Table 2). Comparable observations were made during extensive testing of the cultivar in NEF growers' fields during 1975-77 (13).

Table 2. Comparison of yields, US Size A tubers, specific gravities, total solids and potato chip color of 'Atlantic' and 'Sebago' cultivars during 1973-77.^z

Variable	Cultivar	
	Atlantic	Sebago
Yield US Size A tubers (cwt/acre)	265 ^y	191
Specific gravity	1.082	1.065
Total solids (%)	20.1	16.5
Chip color (1-9) ^x	2.8	2.9

^zData and table adapted from (13).

^yValues are mean values for the five seasons.

^x1 = lightest and 9 the darkest color with 1-2 being highly desirable, 3-4 commercially acceptable, 5 borderline and unacceptable.

Although 'Atlantic' was extensively tested on growers' farms, the high relative susceptibility of the cultivar to BW was not realized until 1977. During 1977 the disease was observed to be dramatically more severe in a 4-5 acre block of 'Atlantic' potatoes than it was in 'Sebago' planted in the same field. The relatively high susceptibility of 'Atlantic' to BW was confirmed experimentally in artificially contaminated soil by Jaworski et al. (10) in experiments performed in Georgia during 1978 and 1979. Experiments performed on our research farm in naturally infested soil have also repeatedly confirmed that 'Atlantic' is more susceptible to BW and tuber brown rot in NEF than is 'Sebago' (Tables 3, 4 and 5).

Table 3. Incidence of bacterial wilt in 'Atlantic' and 'Sebago' cultivars during 1982, 1983, and 1984.

Cultivar	Wilted plants/25 linear ft (no.)		
	1982	1983	1984
Atlantic	1.2 ^z	5.9 ^z	5.2 ^z
Sebago	0.7	1.3	0.9

^zAll differences significant at P = 0.01.

Table 4. Comparison of tuber brown rot in 'Atlantic' and 'Sebago' cultivars during 1982-84 using 3 different means of comparison.^z

Cultivar	1982	1983	1984
	Severity rating ^y (1-10)	Tubers affected ^x (%)	Culls ^w (cwt/acre)
Atlantic	1.7	9.2	30.7
Sebago	1.4	2.5	1.3

^zAll differences significant at P = 0.01.

^ySeverity rated 1-10 as tubers from each plot passed across a grading table with 1 = no tubers affected and 10 = all tubers 100% diseased.

^xBased on presence of brown rot in random samples of 20 US Size A tubers/plot.

^wBased on the mean weight of tubers with visible brown rot which were culled from plots at the time of grading.

During 1977-1981 it was apparent that acreage of 'Atlantic' in NEF was rapidly increasing and that of 'Sebago' decreasing. Based on a telephone survey made of NEF growers during the summer of 1982 'Atlantic' and 'Sebago' constituted, respectively, 40.7% and 34.6% of the NEF potato acreage (Table 6).

Although no systematic survey of growers' fields has been made to determine the extent of losses due to the disease, growers' reports of BW incidence in NEF have increased since the acreage of 'Sebago' has decreased (D. P. Weingartner, unpublished observations). Usually crop losses

Table 5. Comparison of bacterial wilt incidence and tuber brown rot in 'Atlantic' and 'Sebago' cultivar potatoes in an experiment performed during 1983.^z

Cultivar	Wilted plants /25 linear ft (no.)	Brown rot (%)	Yield US Size A tubers ^x cwt/acre
Atlantic	10.5	20.5	80
Sebago	0.7	3.2	136

^zAll differences significant at P = 0.01.

^yBased on number of tubers with brown rot observed in random samples of 20 tubers from each plot.

^xDifferences are means from aldicarb treated and nontreated plots of a large split plot experiment.

Table 6. Percent northeast Florida (NEF) potato acreage planted to different cultivars.

Cultivars	Season	
	1982 (%)	1984 ^y (%)
Atlantic	40.7	56.6
Sebago	34.6	27.9
Other	24.7 ^z	15.5 ^y

^zBased on a survey of 20% of NEF potato acreage 'La Chipper' constituted 17.2% and mixed cultivars the remaining acreage.

^yBased on a survey of 48% of the NEF potato acreage. 'La Chipper' constituted 6.9% and mixed cultivars the remaining acreage.

have been confined to small sections of fields, however, several growers have estimated their losses at 1-5%. We have determined that losses in BW infested fields can be reduced if growers plant 'Sebago' and apply a preplant fumigant such as DD (15, D. P. Weingartner, unpublished observations). When informed of this management option, several growers related that they could not plant 'Sebago' because their preseason contracts with potato chip companies specified delivery of 'Atlantic'. 'Atlantic' is preferred to 'Sebago' by the potato chip industry because it yields approximately 12% more potato chips and also uses less frying oil due to its higher level of solids (13). It seemed therefore that some growers were planting 'Atlantic' on farms having past histories of BW and were risking substantial crop and financial loss because of cultivar specifications in their preseason chipping contracts. This type of limitation on a grower's ability to select disease resistant cultivars would obviously place constraints on any management program suggested for controlling BW or other diseases. Thus during the summer of 1984 a telephone survey was made of potato growers representing 48% of the NEF acreage. The objectives were to estimate whether there was a potential detrimental impact of preseason contract specifications on growers' selection of cultivars, and to estimate the NEF acreage planted to 'Atlantic'.

Survey results. The survey results are based on responses of 37 growers who planted 12,011 acres or approximately 48% of the 1984 NEF potato acreage. Preseason contracts were held by 81.1% of the growers surveyed and this was 45.6% of the total 1984 NEF potato acreage. Most growers, however contracted only portions of their crop, often <50%. Sixty percent of the contracts specified cultivar and of these 66.6% specified 'Atlantic'. 'Atlantic' and 'Sebago' constituted, respectively, 55.6 and 27.9% (Table 6) of the 1984 NEF potato acreage. Based on the survey, 38.7% of the NEF acreage planted to 'Atlantic' and 21.9% of the total potato acreage was planted to this cultivar due to specifications of preseason contracts.

Discussion and Conclusions

The small geographic area within the NEF production system coupled with the existence of reliable historical records enables us to trace an interesting cultivar-disease scenario. Historically, the early NEF potato deal developed *mainly because* the area provided the only new potatoes available for eastern fresh markets during mid-April to mid-May (12). During the 1930's 'Spaulding Rose' was the predominant cultivar grown in NEF for these markets (Table 1). 'Sebago', which ultimately replaced 'Spaulding Rose', is a late maturing cultivar (5) and when 'Sebago' is planted in late January and harvested during mid-April to mid-May its tubers are usually immature and therefore are susceptible to skinning and surface dehydration, especially around lenticels. This often results in 'Sebago' having extensive browned areas and sunken lenticels on the tuber surface giving an undesirable appearance for fresh market potatoes (7).

Grower acceptance of 'Sebago' occurred rapidly, increasing from 7% to 95% of the NEF acreage within 6 seasons (i.e. 1941-46, Table 1). Eddins et al. (6) attributed the rapid increase in popularity of 'Sebago' to its producing greater yields than the other cultivars. Reduced incidence of BW (Table 1) and severity of late blight (16) were apparently unexpected fringe benefits. Another unexpected result was a change in the market destination of the NEF potato crop from the fresh market to potato chip processing. The first 'Sebago' was sent to potato chip processors in the late 1940's, probably in 1949 (12). It is not clear from the literature or experiment station records whether it was demand for chipping potatoes or increasing disfavor of fresh market buyers for NEF 'Sebago' which prompted the first chip test. However, the latter seems likely because University of Florida research on shipping quality of NEF potatoes was being performed at that time (8). By 1953 one-third of the crop was being processed (9). The volume increased to >50% by 1973 (11). Literature and experiment station records suggest, therefore, that NEF growers intentionally switched from 'Spaulding Rose' to 'Sebago' due to higher yields of the latter. This switch inadvertently led to better control of late blight (16) and BW, but at the same time led to a shift in markets from northern fresh markets to potato chip processing. The change in cultivars was intended and the change in markets by accident.

Another significant change in cultivar preference has occurred during the past several seasons. 'Atlantic' has replaced 'Sebago' as the predominant cultivar. Although some growers may be planting 'Atlantic' due to its greater yield potential and other characteristics, our survey indicates that at least 38.7% is being planted due to demands of potato chip processors. It is likely, and some growers so stated, that substantial additional noncontracted acreage is being planted to 'Atlantic' because NEF growers are aware that buyers prefer it over 'Sebago'. The current change in cultivars is different, therefore, from previous changes in that it is the market which is dictating the change rather than the growers themselves.

It is clear that 'Atlantic' is more susceptible to BW than is 'Sebago'. Although not all farms in NEF have a history of BW, it is significant that >65% of the NEF acreage is

being planted to highly susceptible cultivars. There have been isolated incidences of severe losses to BW even though weather conditions have been only moderately conducive to its development. Losses have occurred when: growers have caused unintentional root damage when making mid-season applications of liquid nitrogen; highly susceptible cultivars have been planted in nonfumigated fields; and susceptible cultivars have been planted for several years in succession in the same field.

If optimum weather conditions for BW were to occur in NEF, it is highly likely that severe crop losses would be sustained due to the large percentage of fields planted to 'Atlantic' and other susceptible cultivars such as 'Superior'. This situation can be alleviated in several ways. First, all growers should examine past records to determine whether BW was ever observed on their farms (many NEF potato fields have been planted to potatoes annually for >70 yr). Secondly, growers whose farms have a history of BW should plant 'Sebago' and apply a soil fumigant for nematode control. 'Ontario' is also highly tolerant to BW and has potential as a fresh market cultivar. Thirdly, growers should rotate 'Atlantic' with BW tolerant cultivars such as 'Sebago' or 'Ontario' (Note both 'Sebago' and 'Ontario' are susceptible to corky ringspot disease which can be controlled with certain nonvolatile nematicides (15)). Fourthly, potato chip contracts must allow potato growers flexibility in selecting cultivars so that tolerance and/or resistance can be used in disease management programs.

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