Estimates of U.S. Crop Losses to Procaryote Plant Pathogens

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ABSTRACT

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Loss figures were obtained for diseases caused by 43 bacterial species, seven mycoplasmalike organisms, and three rickettsialike organisms in 31 states in 1975, 1976, and 1977. The most frequently mentioned pathogens were *Erwinia amylovora* and *E. carotovora*. Of 17 diseases cited as most important in a state, eight also were cited as second or third in importance in other states. Pathogens of greatest significance were, in decreasing order: *Xanthomonas vesicatoria, E. carotovora, Agrobacterium tumefaciens, Corynebacterium sepedonicum, X. malvacearum, E. amylovora, Pseudomonas glycinea,* and *P. syringae*. The pathogen causing the greatest dollar-loss per year (54.5×10^6) was *P. glycinea* in Iowa. Dollar-losses from *P. albo-precipitans* and *P. andropogonis* are not among the top 14 in this survey but were in the top 10 in a similar survey published in 1971.

Additional key words: mycoplasma, phytobacteria, rickettsia, spiroplasma, survey

This report is in response to a request by the Bacteriological Committee of the American Phytopathological Society to update a 1971 summary of crop losses caused by procaryotes (1). Estimating crop losses from plant diseases, especially when objective data are sparse, is a difficult and often subjective procedure that is subject to bias of the estimator. We are grateful for efforts of colleagues who estimated losses caused by procaryotic pathogens in their states.

This report summarizes our findings from a uniform national survey completed in the spring of 1978. A brief report was presented at the Third International Congress of Plant Pathology at Munich in August of 1978 (2).

Questionnaires were sent to selected agricultural experiment station personnel in 50 states. Additionally, several USDA scientists were contacted. We requested that each investigator list pathogens and hosts, in order of economic importance in the state. Gross dollar-loss estimates were requested for crop years 1975, 1976, and 1977. Requests also were made for total research efforts on bacterial plant pathogens, numbers of students in training, and employment opportunities in phytobacteriology; the latter data are too inconclusive to report now.

Several explanations are needed relative to our tabulation of the data. 1) If a range of loss was given (eg, $1,000–$5,000) or if two respondents from the same state gave different loss figures for the same disease, we used the lowest figure. 2) We combined losses of potatoes from *Erwinia carotovora* and *E. atroseptica* to conform to some reports listing such losses under "Erwinia soft rot." 3) We included listings of unspecified bacteria on unnamed crops in totals but omitted them from other calculations. 4) For mycoplasmalike organisms, we followed common names. Spiroplasmas include those associated with stubborn disease of citrus, corn stunt, and aster yellows; "others" include agents associated with Pierce's disease of grape, phony peach, and ratoon stunt. 5) We had difficulty in assigning losses when occasionally hosts were not clearly defined ("deciduous fruit trees" instead of "peach," "ornamentals" instead of "roses," "vegetables" instead of "carrots," etc). 6) Additionally, several respondents qualified the designated causal agent as "suspected" or listed only common names of diseases. In the latter instance we substituted the name of the pathogen generally accepted as the causal agent of the disease.

Several ways were chosen to present the data from the survey. First, we summarized most frequently mentioned

Table 1. Importance of procaryote plant pathogens in two U.S. surveys

Pathogen or disease	States designating (no.) Occurrence[a] 1978	Occurrence[a] 1971	#1 Importance 1978	#1 Importance 1971	Importance rating index[b] (1978)
Acetobacter spp.	...	1	...	1	...
Acetomonas spp.	...	1	...	1	...
Agrobacterium tumefaciens	10	16	2	3	2.4
Corynebacterium insidiosum	4	8	2	3	...
michiganense	6	5			
nebraskense	1	...	1	...	...
sepedonicum	5	8	1	1	2.3
Erwinia amylovora	17	13	3	11	2.1
carotovora and/or *atroseptica*	16	18	7	6	2.5
rubrifaciens	1	...	...	1	...
stewartii	6	5	...	...	...
tracheiphila	9				
Peach X disease	4	...	1	...	...
Phony peach	4		2		
Pseudomonas albopreciptans	1	...	...	1	...
glycinea	8	5	2	...	1.9
lachrymans	5	5	...	...	...
phaseolicola	7	6	1	1	...
solanacearum	5	6	1	1	...
spp.	...	...	1	...	...
syringae	13	10	1	3	1.6
Ratoon stunt	1	...	1	...	...
Stubborn disease of citrus	2	...	1	...	...
Xanthomonas campestris	10	...	...	...	...
malvacearum	7	6	3	3	2.3
phaseoli	12	8	...	...	...
pruni	11	11	...	...	...
vesicatoria	10	9	1	1	2.5

[a] Data from Alcorn et al (1).

[b] Of the 17 organisms or diseases cited as most important in the current survey, eight also were recorded as second and (or) third most important by other states. An index was calculated for each of the eight based on 3 = first importance, 2 = second, and 1 = third. Each rating is a number obtained by summing the products obtained by multiplying the number of states designating each category of importance by the points awarded the ranking and dividing the total by the number of citations.

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Table 2. States with the greatest loss from diseases caused by procaryotes, 1975–1977

Pathogens or diseases cited	(no.)	Total losses ($ × 10^6) 1977	1976	1975	Hosts (in order of greatest loss) 1	2	3	Pathogens or diseases in order of importance 1	2	3
California	17	0.6	53	46	Fruit	Grape	···	*Agrobacterium tumefaciens*	Pierce's disease	*Pseudomonas syringae*
Florida	11	8	8	8	Vegetable	Tomato	···	*Erwinia carotovora*	*Xanthomonas vesicatoria*	*P. cichorii*
Georgia	3	12	5	8	Peach	···	···	Phony peach	*P. syringae*	*X. pruni*
Iowa	1	55	56	60	Soybean	···	···	*P. glycinea*	···	···
Louisiana	11	7	13	18	Sugarcane	Cotton	Sweet potato	Ratoon stunt	*X. malvacearum*	*Streptomyces*
Minnesota	12	23	23	23	Alfalfa	Potato	Soybean	*Corynebacterium insidiosum*	Erwinia soft rot	*P. glycinea*
Montana	2	6	12	24	Wheat	Barley	Safflower	*P. syringae*	*X. translucens*	···
Nebraska	8	7	7	8	Corn	Bean	Soybean	*C. nebraskense*	*X. phaseoli*	*Corynebacterium* spp.
S. Carolina	12	12	11	11	Tomato	Tobacco	Peach	*P. solancearum*	Erwinia soft rot	*X. pruni*
Wisconsin	23	NA	5	5	Bean	Potato	Cucumber	Erwinia soft rot	*P. syringae*	*E. tracheiphila*

Table 3. Aggregate estimated U.S. losses from major pathogens or diseases caused by the procaryotes[a]

Pathogens or diseases	Year 1977	1976 ($ × 10^6)	1975	Reporting states (no.) 1978 (31)	1971[b] (25)
Pseudomonas glycinea	59	64	63	8	2
Agrobacterium tumefaciens	2	23	21	10	8
Corynebacterium insidiosum	16	17	16	4	4
P. syringae	8	18	29	13	6
Phony peach	1	20	17	4	···
Erwinia soft rot	11	14	11	16	10
Ratoon stunt	NA	10	14	1	···
P. solanacearum	10	9	8	5	···
Xanthomonas malvacearum	11	5	5	7	···
Pierce's disease	10	3	1	3	···
X. phaseoli	4	5	5	12	5
Corynebacterium nebraskense	4	3	4	1	···
Erwinia amylovora	2	5	4	17	13
Lethal yellowing	3	3	3	1	···
P. alboprecipitans	···	···	···	···	1
P. andropogonis	···	···	···	···	1
X. vesicatoria	···	···	···	···	4

[a] Two states gave no loss estimates for any year; 13 others omitted estimates for losses for at least 1 yr.
[b] Data from Alcorn et al (1).

pathogens or diseases and attempted to classify or rank the estimated importance of diseases (Table 1). We alphabetically listed the 10 states reporting greatest losses (Table 2), ranked losses from specific diseases in decreasing order of importance (Table 3), and summarized losses by causal agent, host, and state for 1976—the year in which our estimates were most complete (Table 4). Of the 17 most important pathogens or diseases (Table 1), eight also were reported as second or third in importance by several states. Therefore, a rating index was devised in an attempt to determine the relative overall ranking of the eight pathogens.

Responses were received from 31 states in this survey; 38 were represented in the 1971 summary (1). Aggregate losses

Table 4. Summary of 1976 loss estimates for 43 species of bacteria and for diseases caused by seven mycoplasmalike organisms, three spiroplasmas, and three rickettsialike organisms

Genus	Species or disease	Loss 1976[a] ($ × 10^6)	No. 1 state reporting	Main hosts	States reporting
Agrobacterium	*tumefaciens*	23.0	California	Fruit and nut	10
Corynebacterium	*flaccumfaciens*	0.2	Oklahoma	Mung bean	1
	insidiosum	17.0	Minnesota	Alfalfa	4
	michiganense	0.2	Minnesota	Tomato	6
	nebraskense	3.0	Nebraska	Corn	1
	sepedonicum	1.8	Maine	Potato	5
	unnamed	0.04	Nebraska/Texas	Wheat, many hosts	2
Erwinia	*amylovora*	4.7	California	Pear	17
	chrysanthemi	2.3	North Carolina	Tobacco	3
	atroseptica and/or	14.0	Minnestoa	Potato	16
	carotovora	14.0	Minnesota	Potato	16
	nimipressuralis	?	Vermont	Elm	1
	stewartii	0.2	Alabama	Corn	6
	tracheiphila	0.9	Wisconsin	Cucumber	9
Pseudomonas	*alboprecipitans*	0.01	Florida	Sweet corn	1
	alliicola	0.5	New York	Onion	1
	andropogoni	0.9	Oklahoma	Sorghum	1
	chichorii	?	Florida	Lettuce	2
	coronafaciens	Trace	Wisconsin	Oats	1
	glycinea	65.0	Iowa	Soybean	8
	lachrymans	0.5	Wisconsin	Cucumber	5
	marginalis	?	California	Lettuce	1
	phaseolicola	2.0	Idaho	Bean	7
	pisi	0.02	Wisconsin	Pea	1
	savastanoi	0.2	California	Olive	2
	sojense	0.1	Wisconsin	Soybean	1
	solanacearum	9.4	South Carolina	Tobacco, tomato	11
	spp.	0.1	Texas	Ornamentals	2
	syringae	18.0	Montana	Wheat	13
	tabaci	0.1	Wisconsin	Tobacco	1
	tomato	?	New York/California	Tomato	2

(continued on next page)

Table 4. (*continued from preceding page*)

Genus	Species or disease	Loss 1976[a] ($ × 10^6)	No. 1 state reporting	Main hosts	States reporting
Xanthomonas	*alfalfae*	0.1	Minnesota	Alfalfa	1
	campestris	1.0	Florida	Crucifers	10
	corylina	0.1	Oregon	Filbert	1
	fragariae	0.07	Wisconsin	Strawberry	1
	geranii	?	Vermont	Geranium	1
	holcicola	0.09	Oklahoma	Sorghum	1
	juglandis	2.2	California	Walnut	3
	malvacearum	15.0	Louisiana	Cotton	7
	pelargoni	0.01	California	Geranium	2
	phaseoli	5.0	Nebraska	Bean	12
	ph. f. *sojense*	0.3	Oklahoma	Soybean	2
	pruni	2.0	Georgia	Peach	11
	translucens	1.0	Montana	Wheat	2
	vesicatoria	1.5	---	---	-
Mycoplasmalike	Pear decline	1.6	California	Pear	1
	Buckskin	0.9	California	Cherry	1
	Peach X	0.03	Connecticut	Peach	4
	Peach rosette	0.3	South Carolina	Peach	1
	Potato	0.1	North Dakota	Potato	1
	Bunch wilt	0.01	Louisiana	Pecan	1
	Lethal yellowing	3.0	Florida	Coconut	1
Spiroplasma	Corn stunt	0.06	Mississippi	Corn	3
	Stubborn disease	1.0	Arizona	Citrus	2
	Aster yellows	0.2	North Dakota	Flax	4
Rickettsialike	Pierce's disease	3.0	California	Grape	3
	Phony peach	20.0	Georgia	Peach	4
	Ratoon stunt	10.0	Louisiana	Sugarcane	1

[a] 1976 figures were used for this table because they were more complete than were those for 1975 or 1977.

reported here are approximately three to four times greater than those reported in 1971. It is of considerable interest that most pathogens listed in 1971 as being of the greatest economic importance, first in importance in the various states, and/or most frequently cited also occur in one or more of these categories in this survey (Tables 1 and 3). The continued importance of these pathogens emphasizes the continued need for research on their epidemiology and control.

In 1971 mycoplasmalike organisms were cited as causal agents by only four respondents (1), but in this survey there were 27 citations of diseases caused by these pathogens, spiroplasmas, and rickettsialike organisms (Table 4). Their financial impact (approximately $40 × 10^6 in 1976) constitutes a significant proportion of total losses ascribed to procaryote pathogens. Accordingly, we wonder if plant pathology students currently receive laboratory training regarding these organisms commensurate with the organisms' increasing economic importance nationwide.

We wish to emphasize that our report is based on a faithful compilation of data furnished by knowledgeable colleagues but that we do not know the basis of their information. Objective data on losses caused by bacterial plant pathogens are indeed sparse, and we hope that this summary may engender interest in more accurate surveys.

LITERATURE CITED

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