SURVEY OF FUNGICIDE SPRAYING PRACTICE FOR POTATO LATE BLIGHT IN PRINCE EDWARD ISLAND, 1972'

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Abstract

All the seed potato acreage surveyed in P.E.I. was treated with one or more fungicide sprays to control late blight. Despite the fact that late blight was not prevalent in 1972, farmers applied an averaqe of 5.4 sprays and used over 81 metric tons (aoprox 180 thousand lb) fungicide to protect 32,000 acres at an estimated total cost (fungicide and application) of about $0.5 million. Mancozeb was the fungicide most commonly used followed by maneb and metiram, the three accountinq for 90% of the total. About half the farmers employed a routine spray schedule. Fewer sprays were applied to early cultivars and those possessinq some resistance to blight than to late cultivars and those with no resistance. Almost three-quarters of the farmers used the same spray schedule for all the potato acreage on their farm and almost all used top killers. Four thousand acres were surveyed on 133 farms which qrew a total of 15,000 acres of potatoes. The farms were selected in proportion to the potato acreage in each farm size group.

Introduction

Approximately 250,000 acres of potatoes (18) worth $100 million were grown in Canada in 1972. Forty thousand of these acres, including 32.4 thousand acres of seed potatoes, were grown in Prince Edward Island, where the warm humid climate usually favors the development of late blight disease caused by the fungus Phytophthora infestans (Mont.) de Bary. Losses due to bliqht may be substantial if no fungicides are used, and methods have been developed to measure these losses (8,9). Attempts have been made in many countries to develop cultivars resistant to P. infestans using either hyoersensitive or vertical resistance (19) controlled by one or more r qenes (1) or using field or horizontal resistance controlled by many genes (2,12). Since neither approach has yet led to success (16) fungicide snrayinq remains the only effective method of disease control available to farmers. Much research work has been done on the efficacy of new fungicides (5, 6, 7) and on the optimum frequency and timing for fungicide spray schedules (4). In conjunction with fungicide spraying, forecasting schemes are operated in many countries (10, 20, 21), the basis of which is the noting of critical weather periods conducive to the develonment of blight, followed by appropriately timed warnings to farmers for the spraying of their potato crops (3).

The number of sprays required depends on the proqress and severity of the epidemic. In Prince Edward Island some crops are sprayed ten or more times but detailed information on the current spray programs operated by farmers is lacking. The object of this study was to collect information on current fungicide spraying practices for late blight control of seed potato producers in Prince Edward Island, who grow about 80% of the province's total potato acreage.

Methods

Farms were assigned to twelve size groups according to their 1971 seed potato acreaqe and a random sample of farms was selected within groups (see Pig. 1 for distribution) so that the numbers selected were approximately proportional to the acreage in each size group (Table 1).

A table of sampling numbers (Table 2) was used to select a field of potatoes at random. The seed potato fields on each selected farm were numbered and the field to be surveyed was chosen by referring to the table. For example, if there were six potato fields on the first farm visited, field no. 3 was selected and then 3 was deleted before the sampling table was used on another farm. A

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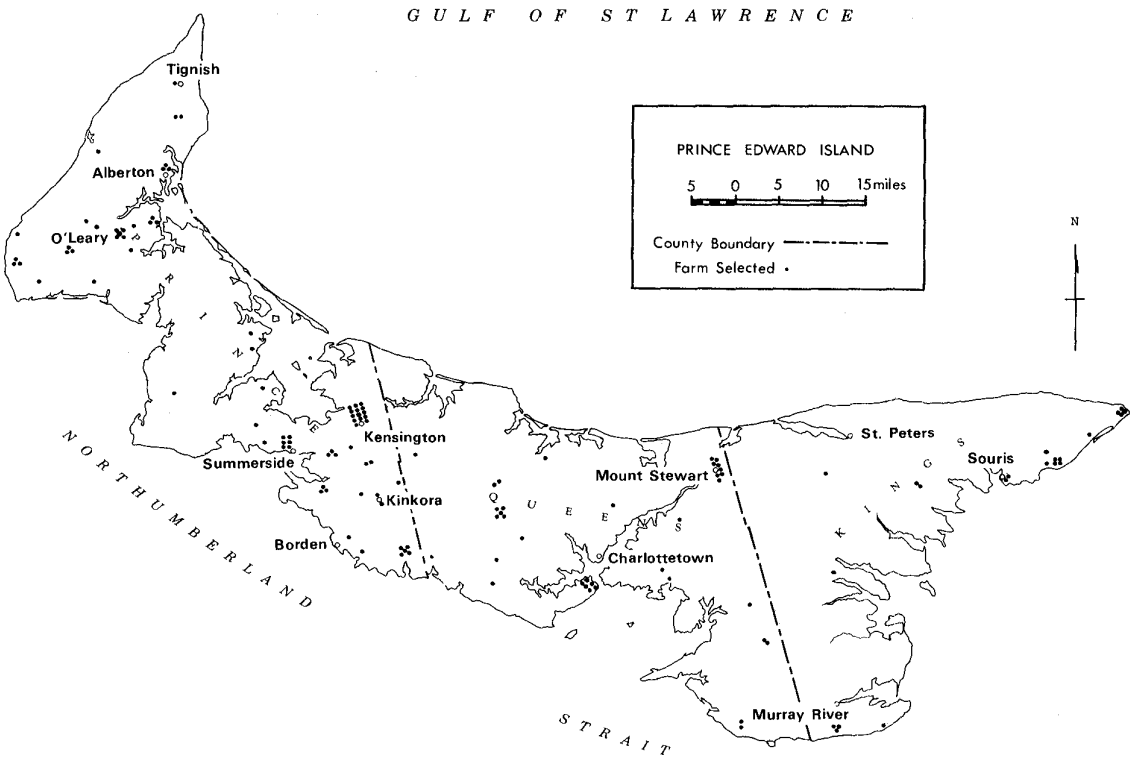

Figure 1. Approximate location of farms in the 1972 survey of fungicide spraying practice for potato late blight.

Table 1. Distribution by number and potato acreage of seed potato farms in Prince Edward Island, 1972

Size group	Seed potato acreage/farm	Farms surveyed			All seed potato farms*	
		No.	Acreage surveyed	Acreage grown	No.	Acreage
1	up to 10	24	162	181	441 (49)	2,419 (7)
2	11- 20	10	103	157	174 (19)	2,526 (8)
3	21- 30	10	118	248	74 (8)	1,879 (6)
4	31- 40	7	130	237	35 (4)	1,244 (4)
5	41- 50	7	322	319	26 (3)	1,194 (4)
6	51-100	19	672	1,491	73 (8)	5,337 (16)
7	101-200	33	1,515	4,549	55 (6)	7,697 (24)
8	201-300	15	764	3,642	19 (2)	4,590 (14)
9	301-400	4	225	1,423	4 <1	1,320 (4)
10	401-500	1	15	476	2 <1	861 (3)
11	501-600	1	20	558	3 <1	1,698 (5)
12	over 600	2	69	1,641	2 <1	1,641 (5)
Total		133	4,015	14,922	908 (100)	32,406 (100)

* Figures in parentheses are number or acreage as percentage of total.

reserve list of farms was also selected for each size group and these farms were used as alternatives if any of the selected farms could not be surveyed.

Table 2. Sampling numbers for selecting a random potato field

Number of potato fields/farm										
2	3	4	5	6	7	8	9	10	11	12
1	3	4	1	3	3	7	2	10	1	11
2	1	1	4	5	5	8	1	4	7	3
	2	2	3	4	4	5	5	6	5	1 2
		3	5	6	6	4	9	8	9	7
			2	2	7	2	6	2	8	2
				1	2	1	8	3	6	8
					1	3	7	5	4	1
						6	4	9	2	4
							3	1	1 1	9
								7	3	5
									10	10
										6

For each field selected the following information was requested by questionnaire from the grower: grower's name and address: acreage and cultivar grown in the field selected: date of planting: name and amount of fungicide applied (lb/acre, volume/acre); method- and dates of application; estimated amount of blight on foliage (none to severe) at date of top killing; method and date of top killing; date of harvest; total potato acreage grown, by cultivar: and the uniformity of spray scheduling for all fields. The questionnaires were delivered to the growers in June and collected in the autumn by agricultural officers who used the visits to clarify any points in the questionnaire with the farmers. Before the questionnaires were processed, the distribution of acreage in 1972 was compiled, based on 1972 seed potato statistics. The percentage acreage of the size groups was used as weights to calculate provincial averages, e.g. amount of fungicide apnlied per acre. Some of the questionnaires were not fully completed and, therefore, tables may be based on different numbers of farms. The data were coded and tabulated by computer.

Results

All the fields surveyed were treated with fungicides and received from 1 to 12 spray applications, the provincial weighted average being 5.4 sprays. Table 3 shows that, in general, the more potatoes a farmer grew the more frequently he sprayed. Farms growing 100 acreas or less of seed potatoes applied an average of 4.4 funqicide sprays compared with 5.9 €or those growing more than 100 acres. One-tenth of the crops sampled had received the first fungicide application by the end of June and approximately half of the crops had been sprayed by mid-July (Table 4). One-third of the bliqht susceptible, early maturing Irish Cobbler crops had been sprayed by the end of June, whereas only a very small percentage of Kennebec and Sebago and no Netted Gem crops had been sprayed during the same period.

Table 3. Number of fungicide sprays appliedtocontrol late blight in P.E.I., 1972

Size group	Potato acreage per farm	Average number of fungicide sprays
1	up to 10	4.0
2	11- 20	4.6
3	21- 30	4.3
4	31- 40	4.2
5	41- 50	4.8
6	51-100	4.9
7	101-200	5.5
8	201-300	6.1
9	301-400	7.0
10	401-500	8.0
11	501-600	5.0
12	over 600	8.0
1-12	Overall weighted mean	5.4

Table 4. Dates of first application of fungicides

Period	Percentage of crops receiving first fungicide spray
June 20 - June 24	5
June 25 - July 1	5
July 2 - July 8	5
July 9 - July 15	20
July 16 - July 22	32
July 23 - July 29	14
July 30 - Aug 5	14
Aug 6 - Aug 12	4
Aug 13 - Aug 19	<1
Aug 20 - Aug 26	<1

To characterize the timing of sprav applications, spray schedules were classified into regular (routine) or irregular schedules. A schedule was arbitrarily defined as regular when the intervals between any two consecutive sprays were within 2 days of each other. The classification could only be applied to farmers who sprayed three times or more. Half of these farmers snrayed

regularly, usually on a 7-, 10- or 14-day basis, while the other half, who sprayed irregularly, had a mean interval of 8–19 days between sprays. One late blight warning was issued on August 4, 1972, but it did not stimulate farmers to spray. Late blight was not prevalent in 1972 and over 90% of the farmers interviewed had not observed late blight on the foliage and the remainder had seen only trace or slight infections.

Of the four main cultivars surveyed, Sebago received the least number of sprays (average of 4.2) followed by Irish Cobbler (4.5) and Kennebec (5.9), whereas Netted Gem received the most (6.7).

Ground sprayers were used almost exclusively. Only one farmer used aircraft spraying exclusively, while two farmers used both ground and aircraft sprayers.

Over three-quarters of the farmers treated their crops with the same chemical at the same rate and volume throughout the season. The remainder of the farmers changed the chemical during the season or applied a mixture of chemicals and/or used different volumes of water. Nine out of 10 farmers applied the same spray schedule to all the potato acreage on the farm.

Wettable powder formulations were used on nine-tenths of the acreage and liquid formulations (Table 6) on the remaining tenth. The most widely used fungicide was mancozeb, followed by maneb and metiram. These three fungicides accounted for approximately 90% of the fungicide usage, and the remaining 10% was captafol, nabam, or copper. Most farmers applied sprays at the medium volume (60 gals water/acre).

Table 5. Specifications of fungicide program for late blight of seed potatoes in P.E.I., 1972

Common name of fungicide	Percentage of acreage treated	Avg quantity of a.i.* applied (lb/acre)		Estimated total quantity of a.i. applied to total acreage	
		Each application	Season	('000 lb)	(metric tons)
Wettable powder					
Mancozeb	41	1.51	7.5	100	45
Maneb	25	1.25	5.4	44	20
Metiram	25	1.20	4.4	36	16
Copper	1				
Liquid					
Captafol	6				
Nabam	2				

* a.i. = active ingredient.

Estimates of quantities of active ingredient (a.i.) of the three fungicides most commonly used are given in Table 5 and are based on the data recorded for approximately 4,000 acres of potatoes in the 133 fields on separate farms. However, since 9 out of 10 farmers applied the same spray schedule to all their potato acreage, the data collected can be said to represent the total potato acreage (14,900 acres) on the farms surveyed (Table 1); this latter acreage is nearly half of the total seed potato acreage (32,406 acres, Table 1) grown in P.E.I. in 1972.

Top killers were used by 97% of the farmers, diquat and dinoseb being used on 70% and 30% of these farms, respectively. Some farmers mixed fungicides with the top killers to kill any late blight spores that may have been present. Table 6 shows that, on the average, the cultivars Irish Cobbler and Kennebec were tor, killed at approximately the same time: Sebago was the next to be top

Table 6. Number of cropsoffour cultivars top killed during weekly intervals, expressed as a percentage of the total number of crops for each cultivar

Period (week)	Percentage of crops top killed			
	Irish Cobbler	Kennebec	Sebago	Netted Gem
Aug 24 - Aug 30	14	16	2	
Aug 31 - Sept 6	29	27	17	14
Sept 7 - Sept 13	14	37	16	
sept 14 - Sept 20	29	10	40	14
Sept 21 - Sept 27	14	7	21	29
Sept 28 - Oct 4		3	5	29
Oct 5 - Oct 10				14
Oct 11 - Oct 17				
Total number of fields	9	34	68	8

killed and was followed by Netted Gem. Consequently, the cultivars Irish Cobbler and Kennebec had to be protected by fungicide for a shorter period than Sebago, which needs orotection for a shorter duration than Netted Gem.

Discussion

Most of the plantinq was done during the latter part of May and continued until late June. The development and control of late blight is particularly influenced by weather and in 1972 the climate was not favorable for the late blight fungus because ueriods of high relative humidity (over 90%) were infrequent and short (7). The survey results suggest that spraying nractices €or late blight control may differ for big and small farms and for different cultivars; but it is important to note that the survey data per se can be used as evidence only to report and not to explain these differences. This does not preclude the interpretation of survey results using previously gained knowledqe to advance plausible explanations for the reported differences found in practice. For example, there were probably two reasons why different cultivars received different numbers of funqicide sprays. Of the four varieties listed in Table 6, Sebago is the only cultivar with field resistance in the foliage or tuber. The other three cultivars are more susceptible than Sebago to the predominant Phytophthora infestans race 1, 4 (nersonal communication, W. A. Hodgson) and this may explain why they receive more sprays than Sebago. The number of sprays annlied to the other three cultivars were related to the earliness of the variety because the earlier the variety the shorter the lenqth of the blight urotection period. Consequently, the late cultivar Netted Gem received more swrays than the earlier cultivars Irish Cobbler and Kennebec.

The practice of routine spraying, irrespective of the presence of blight or prevalence of weather conducive to the develonment of late blight, can be considered as an insurance against the disease but it certainly contributed to the substantial quantities of fungicide used. Despite the fact that late blight was not urevalent and that weather conditions conducive to the development of the disease occurred infrequently (7), over 80 tons of the active ingredient component of fungicides were applied to the seed potato acreaqe in P.R.I.

costs

The cost of late blight control can vary considerably but mainly depends on whether the farmer does the spraying himself or uses the more expensive contract spraying. Almost all growers use their own sprayer but, because each operates under different conditions, it is difficult to obtain accurate cost estimates for spraying apulication (11). Estimates of apulication costs vary from $0.90 (personal communication, J. Lovering) to 51.32 per acre (17). Fungicide cost can also vary, depending on quantitv purchased, etc., but $1.00 ner lb (0.8 lb a.i.) can be used as a working average (11). Based on these cost estimates and on the data from Table 5, the cost ner application per acre would vary from $2.40 to $2.82. Assuming 5.4 snrays per season the total cost per acre per season would be of the order of 513.00 to $15.25, with the cost of fungicide accountinq for 1/2 to 2/3 of the total cost. In addition a very small percentage of the acreaqe was snrayed on contract by ground or aircraft, with costs per acre of approximately $2.00 and $1.75 respectively, not including the cost of the funqicide.

Based on the above estimates the total cost of the late blight control nroqram for approximately 32,000 acres of seed potatoes in P.E.I. in 1972 was between $420,000 and $500,000.

Comparative studies

According to this survey the averaqe number of sprays applied per acre was 5.4, which is similar to the fiqure of 5.1 reported by Scott (17) for New Brunswick in 1967 and 1968. Except for the findinqs reported in this paper, there is no detailed information available funqicide spraying practices in Canada but comparative data are available for Great Britain from three surveys (13, 14, 15) carried out in 1958, 1963, and 1968. Comparing the 1968 British survey data with the findings reported here, some similarities and differences were noted. Whereas all the crops were treated for blight in P.E.I., only 60% of the crops were treated by funqicide in Britain. In both countries mancozeb was the predominant funqicide and maneb ranked second. Tin funqicides were used in Britain to a considerable extent but none were used in P.E.I. In both countries the number of sprays applied varies for different cultivars and depends on the resistance of the cultivar to late blight. In Britain the cultivar King Edward received more sprays than the more resistant Majestic, and a similar situation was noted for the varieties Kennebec and Sebaqo in P.E.I. About half the farmers in P.E.I. sprayed on a routine basis compared with 75% in Britain, but the averaqe number of sprays applied was much greater in P.E.I. (5.4) than in Britain (3.3). For comparative purposes the weiqhted mean number of sprays for the total British acreaqe would be 2.0 compared with 5.4 snravs for P.E.I. However, both the percentaqe of crops sprayed and the number of snravs applied per acre increased consistentlv in Britain during 1958–1963–1968 (13, 14, 15) and therefore, the 1968 fiqure of 2.0 may be an underestimate for 1972. In conclusion, it can be said that all aspects of the late bliqht proqram are more intensive in P.E.I. than in Britain. A series of survevs in

Canada, similar to those conducted in Britain would allow fungicide usage and practice to be monitored and provide a system for studying the effectiveness of implementing research knowledge to farming practice.

Acknowledgments

We gratefully acknowledge the assistance of Mr. S. I. Wong in preparing the data and figures. We also thank the participating farmers, who at some inconvenience to themselves, provided the information, which was kindly collected by personnel of Plant Protection Division, Production and Marketing Branch, Agriculture Canada.

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