Bacterial blight of field bean: disease progress, yield loss, and crop canopy development in principal cultivars in Ontario[1]

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Similar disease progress curves were developed from the results of disease assessments for bacterial blight ***[Xanthomonas phaseoli]*** on Sanilac, Seafarer, and Kentwood field bean ***[Phaseolus vulgaris]*** cultivars in field plots over a 3-year period 1974-76. Although losses due to bacterial blight were substantial, mean 3-year losses were similar among the varieties, Seafarer 32%, Kentwood 32.2%, and Sanilac 33.1%. Crop canopy development was influenced by the onset and intensity of disease, a hastening of maturity and senescence, and early defoliation of infected plants. In 1975, when yield losses were greatest, differences in canopy development between control plots and infected plots were also the greatest.

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Les resultats de l'évaluation des effets de la brûlure bacterienne ***[Xanthomonas phaseoli]*** sur les cultivars de haricot sec ***(Phaseolus vulgaris)*** Sanilac, Seafarer, et Kentwood, cultives en parcelles pendant 3 ans (1974 a 1976), ont donne des courbes analogues d'evolution de la maladie. Bien que les pertes de recolte etaient appreciables, les pertes moyennes entre les variétés ont ete pratiquement comparables, soit 32, 32.2 et 33.1% pour Seafarer, Kentwood et Sanilac respectivement. Le declenchement et l'intensite de la maladie. l'accélération de la maturité et de la senescence, ainsi que la defoliation précoce des plants infectés, ont influé sur la densite du feuillage. C'est en 1975 (année de baisse maximale de rendement) que les differences dans la densite du feuillage des parcelles témoins et infectees ont ete les plus marquees.

Sanilac, Seafarer, and Kentwood are now the principal white field bean cultivars grown in southwestern Ontario. Sanilac was released in 1957, Seafarer in 1969, and Kentwood in 1973. The cultivar Seafarer accounts for approximately half of the white bean acreage in southwestern Ontario. All three cultivars are susceptible to common blight and fuscous blight caused by ***Xanthomonas phaseoli*** (E.F. Sm.) Dows. and ***Xanthomonas phaseoli*** var. ***fuscans*** (Burkh.) Starr and Burkh., respectively, but little is known regarding the relative degree of susceptibility of each cultivar to the two blight organisms.

Initially when bacterial blight became a serious problem in Ontario following the introduction of Sanilac, field surveys were conducted (2, 3, 8) that revealed the presence of the heretofore unreported fuscous blight as well as a higher incidence of common blight in Sanilac than in the older cultivar Michelite. The diseases are similar in symptom expression, and in culture the causal bacteria differ only in the production of a pigment (8) by the fuscans organism. Michelite gradually disappeared from the scene because of its susceptibility to anthracnose. At present, bacterial blight is at a tolerable level as determined by ground surveys and as monitored by aerial infrared photography (4, 5, 6). However the quantitative differences in disease incidence and yield loss among the three cultivars are not known.

This study was conducted to compare disease progress among the three cultivars throughout the season, to assess the effects of the disease on yield loss and crop canopy development as shown by sequential aerial infrared photography, and to establish any quantitative differences among the cultivars with respect to susceptibility to blight. Percent ground cover has been utilized to assess growth, and to determine maturity, vigour, and yield potential (1). It was thought that this technique might detect differences in susceptibility not determined by other means.

Methods and materials

Field tests

The experiment was carried out for 3 years, 1974-76. The experimental design consisted of a randomized block 54.9 x 64 m (160 x 190 ft) containing 24 plots each measuring 4.6 x 7.6 m (15 x 25 ft). Each plot contained 7 rows 76 cm (2.5 ft) apart and 7.6 m (25 ft) long. There were eight plots of each cultivar, four inoculated with a mixture of isolates of ***Xanthornonas phaseoli*** var. ***fuscans*** and ***Xanthornonas phaseoli*** and four plots left untreated. There was a 6.1 m (20 ft) roadway between plots.

Seeding was carried out each year during the last week of May; however in 1974 the plots had to be reseeded on June 12 because of low emergence caused by seed corn maggot injury. Because of the late seeding in 1974 inoculation was delayed until July 16; as a result fewer disease assessments were made and harvest was

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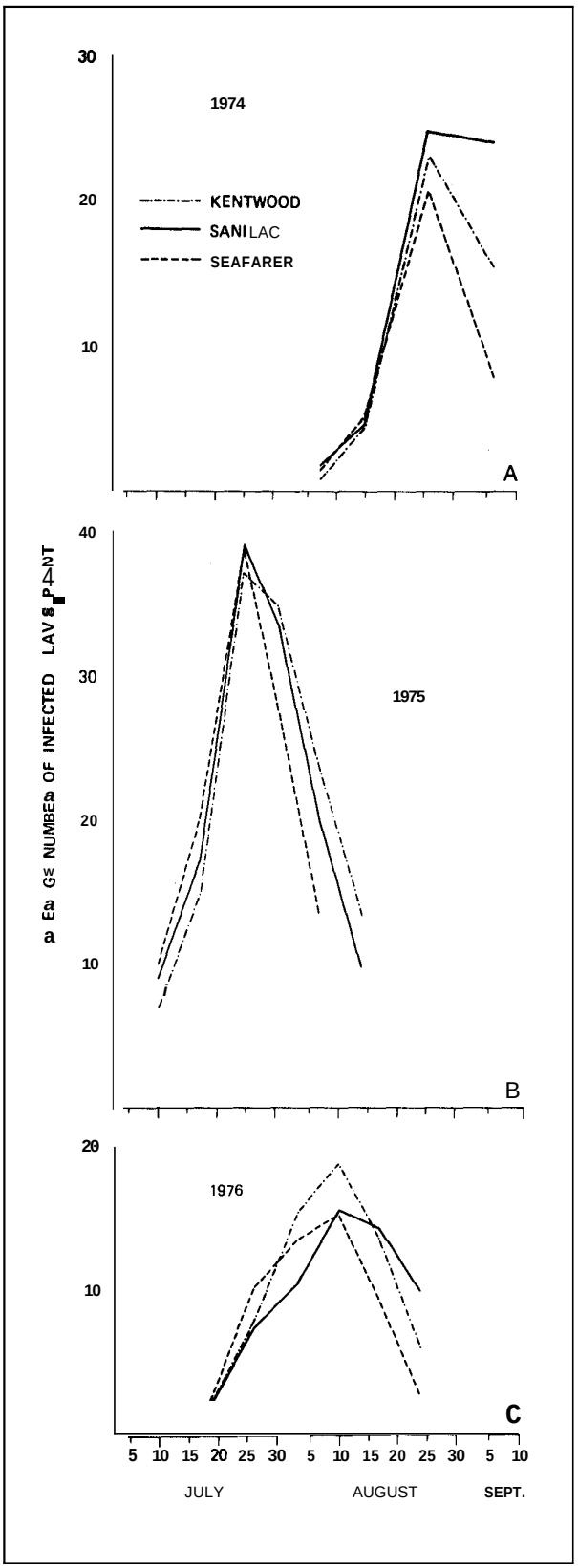

Figure 1. Progress of bacterial blight throughout the growing season, 1974-76, based on the weekly assessment of the number of infected leaves on Sanilac, Seafarer, and Kentwood.

delayed until the last week of September. After emergence, plots were thinned out *so* that each plot contained an equal number of plants. This was possible in 1975 and 1976 but not in 1974 because of low emergence in the cultivar Sanilac.

Inoculum was prepared by mixing equal numbers of suspended cells of the two organisms of common and fuscous blight. Plants were inoculated at the 3 to 4 leaf stage 3 weeks after planting by applying an aqueous suspension of the two organisms with a knapsack sprayer.

Beginning with the first evidence of disease, the number of infected leaves per plants was determined at weekly intervals throughout the growing season. Ten plants per plot selected at random were tagged *so* that the same plants were assessed each time.

In 1974 four assessments were made from August 7 to September 6. In 1975 and 1976, six assessments were made from July 10 to August 14 and July 19 to August 24, respectively. The number of infected pods per tagged plant was recorded. For seed weight the outside row on each side of the plots was discarded as well as 76 cm (2.5 ft) of row at each end of the plots. Weights were recorded 1 month after harvest.

Ground cover measurements (canopy development)

Ground cover measurements were made according to the method of Gerbermann et al. (1) utilizing sequential aerial photography. The photography was taken weekly on the day the plants were assessed for disease or as close to that day as possible depending on weather conditions. A Bell-47C helicopter at an altitude of approximately 121.9 m (400 ft) was used for all flights. Exposures were made with a boom-mounted Maurer 70 mm camera positioned for vertical photography. The camera was fitted with a 38-mm Biogon f/4.5 lens, which produced an approximate scale of 1:1,670 (i.e. size of image to distance on ground). Exposing rate was six frames per second and the air speed was approximately 40 knots. Kodak Aerochrome Infrared 2443 film was used throughout the 3 years.

Results and discussion

Disease progress

The three cultivars showed similar disease patterns each year (Fig. 1 A-C). In all 3 years the number of infected leaves reached a maximum during August followed by the early defoliation of heavily infected leaves. This explains the peaking effect in Fig. 1 A-C. Infection levels were consistent for each cultivar, but maximum infection levels differed considerably in the 3 years. Average

Table 1. Comparative Susceptibility of Kentwood, Sanilac, and Seafarer field beans to pod infection by bacterial blight, 1974-76

Year	Cultivar	Avg no.* pods/plant	Avg no. pods infected No./plant	%
1974	Kentwood	28.3	3.4	11.8
	Sanilac	55.2	7.8	14.1
	Seafarer	34.7	4.6	13.3
1975	Kentwood	17.7	14.8	83.5
	Sanilac	23.9	20.9	87.3
	Seafarer	24.1	19.2	79.8
1976	Kentwood	28.8	6.0	20.9
	Sanilac	29.6	8.2	27.8
	Seafarer	23.1	5.4	23.2

* Based on 4 reps of 10 plants/rep.

Table 2. Comparative yield losses of Kentwood, Sanilac, and Seafarer field beans caused by bacterial blight, 1974-76

Cultivar	Treatment	1974 Yield†	1974 % Loss	1975 'field	1975 % Loss	1976 Yield	1976 % Loss	Average Yield	Average % Loss
Kentwood	Control	2995.3	6.0	2807.3	62.2	3673.6	30.7	3158.5	32.2
	Infected	2814.0		1061.1		2545.4		2140.4	
Sanilac	Control	2471.5	28.8	2491.6	50.9	3785.1*	19.6	2916.1	33.1
	Infected	1759.6		1222.3		3042.3		2008.1	
Seafarer	Control	3619.9	22.1	2914.7	55.8	2485.6	22.4	3339.9	32.0
	Infected	2820.7		1289.5		2706.5		2272.0	

† Kg/hectare.
* Excludes 2 plots which had extensive groundhog damage.

infection levels in 1976 were the lowest, with 15 to 19 infected leaves per plant, while in 1975 they approached 40 leaves per plant.

The average number of infected pods at harvest (Table 1) varied considerably from year to year but was consistent among cultivars within years. The higher number of pods per plant in Sanilac in 1974 may be explained by the lower emergence of that cultivar, resulting in larger plants and an increased number of pods. In 1974, corresponding to lower yield losses, the average percentage of pods infected varied between 11.8% and 14.1% among the three cultivars; in 1975, corresponding to higher yield losses, infection ranged from 79.8% to 87.3%. In 1976 infection varied from 20.9% to 27.8%.

Yield loss

Over the 3-year period there were very slight differences in mean yield losses among the three cultivars (Table 2). Mean 3-year losses however were substantial, Seafarer 32%, Kentwood 32.2%, and Sanilac 33.1%. In 1975 we reported a yield loss factor of 38 (7). which is slightly higher than the losses reported here. Considerable variability in environmental factors resulted in different year to year losses; 1974, 6.0-22.1%; 1975, 50.9-62.2%; 1976, 22.4-30.7%.

The increase in losses and in number of leaves infected in 1975 may possibly be explained by the higher mean temperature in July (22.4°C) and also the higher total rainfall in July of over 10 cm. The mean temperature in

Table 3. Influence of bacterial blight on growth of field beans determined from ground cover measurements from sequential aerial photographs of field plots

	Percent ground cover					
	Kentwood		Sanilac		Seafarer	
Date	Control	Infected	Control	Infected	Control	Infected
1974						
7 Aug.	75.7	81.2	76.4	55.6	89.6	86.1
16 Aug.	91.6	93.1	84.0	67.4	91.6	84.0
30 Aug.	98.6	97.2	91.6	76.4	95.0	88.0
5 Sept.	100.0	96.5	92.4	70.1	99.3	95.8
16 Sept.	97.9	92.4	87.5	60.0	88.9	72.2
1975						
10 June	28.3	26.3	23.1	25.8	26.6	26.8
20 June	38.4	38.4	38.4	37.0	41.9	43.2
27 June	49.8	52.0	52.2	56.1	54.0	49.4
22 July	88.4	82.8	95.4	91.5	85.2	80.5
31 July	90.8	76.7	96.2	90.9	83.8	75.6
7 Aug.	86.8	68.0	91.2	83.0	73.9	58.7
1976						
24 June	16.2	20.4	17.7	16.8	15.8	17.5
7 July	54.5	55.8	49.0	50.4	52.3	55.4
15 July	81.4	83.4	77.9	82.2	79.7	82.3
21 July	92.3	93.1	94.4	90.9	93.1	90.3
28 July	95.1	95.2	94.4	94.4	95.1	88.2
4 Aug.	95.1	93.0	99.1	95.8	93.8	86.6
11 Aug.	96.5	93.0	100.0	97.2	93.8	86.1
18 Aug.	97.9	89.6	97.2	88.2	91.0	81.9
30 Aug.	97.2	84.0	95.8	84.0	88.2	73.6

July 1974 and 1976 was between 19.4° and 20°C and rainfall was less than 7.6 cm. The August mean temperature was slightly higher in 1975 than in the other years but precipitation was lower. Surprisingly, relative humidity was lower (66%) in 1975 than in 1974 (74%) or 1976 (76%). In all probability, mean temperature and relative humidity have less effect on the development of an epiphytotic than the number and extent of favorable periods for the initiation and spread of the disease.

Ground cover

In all 3 years crop ground cover or canopy development was influenced by disease onset and intensity of disease (Table 3). In 1975, when yield losses and disease intensity were greatest, differences in canopy development between control and infected plots were also the greatest. During the period June 10 to June 27, when infection was at a low level, canopy size was similar in both the control and infected plots. Following the peak in infection level on July 22, control canopies continued to increase in size whereas the canopies of the infected plots of the three varieties decreased. By August 7 the average size of the control canopies was 15% larger than that of the infected plots. In 1974, when losses were smaller, canopy development in control and infected plots continued almost parallel until harvest for Kentwood, which showed only a 6% yield loss. Wide differences occurred in canopy development between the control and infected plots in Sanilac, which showed the greatest loss. Seafarer, in which loss was intermediate, did not show as great a difference in canopy development as Sanilac but had a canopy difference of over 16% on September 16. In 1976, canopy differences were not apparent, except for Seafarer, until August 18; by August 30 canopy differences between control and infected plots ranged from 12% to 15%.

Over the 3 years the consistently smaller canopy (development in infected plots in relation to control plots was due to a number of factors: a general slowing down of growth in infected plots during and following the onset of infection; a hastening of maturity and senescence of infected plants, which were harvested 4 to 7 days before those in control plots; and defoliation due to drying out of severely affected leaves.

From these results, it is apparent that Sanilac, Seafarer, and Kentwood are equally susceptible to bacterial blight and that losses of equal magnitude can be expected. The importance of producing disease-free Breeder seed for pedigreed and commercial bean production is therefore emphasized; it is also essential that monitoring of seed through the Select and Foundation grades be continued.

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