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The effects of black-currant yellows virus and a strain of reversion virus on yield

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SUMMARY

Black-currant yellows virus restricted the growth of bushes var. Baldwin and Wellington XXX and decreased the total weight of fruit harvested in six seasons by 70%. The size and number of fruits were decreased and in one season ripening was retarded. Virus spread naturally to only four of 250 other bushes in the trial.

A strain of reversion virus which caused transitory vein-pattern symptoms did not restrict vegetative growth, yet decreased the number and size of fruits. In contrast to the more severe effects of prevalent virulent strains, the total crops from the Wellington XXX and Baldwin bushes were decreased by 50 and 33% respectively. The virus spread to fifteen of the 136 healthy bushes and to at least six of the 108 bushes previously infected with yellows virus.

The black-currant gall mite (*Phytoptus ribis* Nal.) increased more rapidly on the Wellington XXX bushes than on those of Baldwin. In each variety the infestation was much greater on reverted than on other bushes, apparently because infection with reversion virus decreased natural resistance to mites.

INTRODUCTION

Reversion virus has long been known to cause a widespread and serious disease of black currants in Britain and some other European countries. The possibility of other viruses affecting the crop received little attention until Posnette (1952) described the symptoms of what appeared to be two distinct viruses, which were referred to as black-currant yellows and black-currant vein-pattern. This paper describes a field experiment to determine the effects of these two viruses on the yield of the two main commercial varieties of black currant. During the experiment the virus which caused vein-pattern was found to affect slightly the shape and venation of leaves and it is now regarded as a strain of reversion virus, although it did not cause the usual sterility (Thresh, 1963).

MATERIALS AND METHODS

Virus sources. The black-currant yellows virus was collected from a naturally infected bush, var. Seabrook's Black, at a nursery near Oxford (Posnette, 1952). The virus was transmitted readily by patch grafts, but not by the aphids *Hyperomyzus lactucae* L., *H. pallidus* H.R.L., *Nasonovia ribis nigri* Mosley, *Aphis grossulariae* Kltb. and *A. schneideri* Börn; a vector has not been found. Symptoms appeared annually in mature leaves formed in June and later, as a yellowish green mottle affecting large sectors or whole laminae.

The reversion virus was collected from a naturally infected bush, var. Baldwin, in a plantation near Harrietsham, Kent. Affected leaves showed a chlorotic vein-banding arranged in a 'fern leaf' pattern alongside the main veins (Posnette, 1952). The effects on flowers and leaf-shape and venation were noticed first in the second year of the cropping trial, when all the bushes of both varieties infected with the Harrietsham isolate showed slight leaf symptoms of reversion disease and reduced hairiness of the flowers. The chlorotic vein-pattern has since been shown to be an early transitory symptom caused by some strains of reversion virus (Thresh, 1963).

Planting material. The experiment was planted with 1-year-old bushes of the varieties Baldwin and Wellington XXX. These had been grown in nursery rows from cuttings collected from healthy bushes and from others inoculated by bark patch-grafts in 1951, with either black-currant yellows virus or reversion virus. Although symptoms developed in the source bushes in 1952, virus was incompletely systemic and most of the cuttings taken that autumn were healthy. Bushes from cuttings collected in 1953 showed the appropriate symptoms and were transplanted to the experimental area in November 1954. The bushes were cut back at planting and again the following winter.

Experimental design. The Wellington XXX bushes were arranged in six rows 8 ft. apart with thirty-six bushes 4 ft. apart in each row. The healthy and infected bushes were planted to form nineteen 3×3 Latin squares, with the remaining bushes in incomplete blocks. Twenty-seven Baldwin bushes were planted 4 ft. apart at the ends of each Wellington XXX row to form forty-four randomized blocks. The remaining bushes formed incomplete blocks.

Records. The weight of fruit from each bush was recorded annually from 1957 to 1961. In 1960 and 1961, samples of fifty detached fruits were weighed from the bushes of ten blocks selected at random in each variety. Virus symptoms were recorded annually, and in December 1960 and 1961 counts were made of buds which were galled following infestation with the black-currant gall mite (*Phytoptus ribis* Nal.).

Spray programme. The bushes were sprayed according to the programme recommended for commercial plantations. Endrin at 0·04%, or lime sulphur (at 50% low volume or 2% high volume) were applied in spring to control gall mite, with DDT to control capsids and other insects. A copper spray with cotton-seed oil was applied after picking to control leaf spot caused by *Pseudopeziza ribis* Kleb.

RESULTS

Effect on growth and crop

Black-currant yellows virus. Infected bushes of both varieties were conspicuously smaller than the controls throughout the experiment. The total weight of fruit harvested was decreased by about 70% compared with healthy controls (differences for each variety significant at $P = < 0{\cdot}01$). There were considerable differences between years; the light crops in 1957 and 1960, when there was severe frost damage, were affected much more than the heavier crops in 1959 and 1961 (Fig. 1). Yellows virus decreased both fruit size and number (Table 1). The delayed ripening of fruit from the yellows bushes in 1957 was not noted in other years.

Table 1. *The effects of virus infection on the size and number of fruit per bush*

Variety	Symptoms	Wt. of single fruit (g.) 1960	Wt. of single fruit (g.) 1961	No. of fruit* 1960	No. of fruit* 1961
Wellington XXX	Yellows	0·672	0·496	338	2379
	Reversion†	0·633	0·506	789	4037
	None (healthy)	1·029	0·661	1455	5494
		(all ±0·032)	(all ±0·021)		
Baldwin	Yellows	0·607	0·369	448	2829
	Reversion†	0·514	0·372	1413	6468
	None (healthy)	0·821	0·530	1879	6767
		(all ±0·020)	(all ±0·013)		

* Estimated mean number per bush based on total crop weight and mean weight of individual fruits.
† Harrietsham isolate.

Reversion virus. The atypical reversion virus had no effect on the amount of vegetative growth, but decreased the total crops from the Wellington XXX and Baldwin bushes by 50 and 33%, respectively, compared with healthy controls (differences for each variety significant at $P = < 0{\cdot}01$). As with the yellows virus there were differences between seasons, with the least effect in 1959 and 1961 (Fig. 1). The fruit size of both varieties was decreased similarly and the reduction in fruit number was much greater for Wellington XXX than for Baldwin (Table 1).

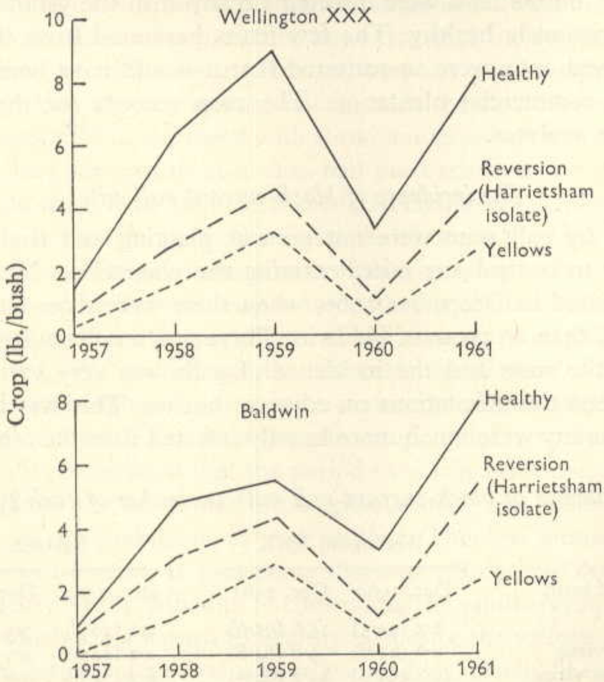

Fig. 1. Effect of two viruses on the yield of two varieties of black currant. (1·64 lb. per bush is equivalent to 1 ton per acre.)

Natural spread of viruses

Black-currant yellows virus. Three healthy bushes of Wellington XXX and one Baldwin bush already infected with reversion virus developed yellows symptoms during the 7 years of the experiment. A total of 250 healthy and reverted bushes were exposed to infection, which indicates a slow rate of natural spread despite the randomized block design with many adjacent bushes touching in the rows. Whatever the vector it must be very inefficient, perhaps because it is uncommon, inactive or rarely feeds on black currants.

Reversion virus. Symptoms typical of the Harrietsham isolate of reversion virus were seen in twelve Wellington XXX and three Baldwin bushes of the 136 which were previously healthy, and in three Wellington XXX bushes and three Baldwin bushes of the 108 already infected with the yellows virus. The affected bushes were scattered throughout the plot, symptoms were often restricted to a few shoots and they were so difficult to detect that some may have been overlooked in bushes already affected severely by the yellows virus. The restricted symptoms and average crops recorded indicated that spread occurred in the final years of the trial.

The experimental area was more than ½ mile from any other known sources of infection and only three bushes developed the conspicuous flower and leaf symptoms typical of virulent strains of reversion virus. Presumably this infection had been introduced by mites entering the crop in the final years of the trial, as there was no evidence of secondary spread. All three bushes were distant from each other in the Wellington XXX blocks; two were infected already with the yellows virus, whereas the third was previously healthy. The few fruits harvested from the contaminated bushes in 1960 and 1961 were so scattered that it would have been uneconomic to pick them in a commercial plantation. The crop records for these bushes were omitted from the analyses.

The incidence of black-currant gall mite

Buds affected by gall mite were not seen at planting and routine sprays were applied annually to control any mites entering the plantation. Nevertheless, many bushes were infested in December 1960, when there were more galls on bushes of Wellington XXX than on those of Baldwin. There was no obvious pattern of spread along or across the rows and the incidence of galls was very variable, with great differences between the infestations on adjacent bushes. This was because reverted bushes of each variety were much more heavily infested than the others (Table 2).

Table 2. *The incidence of black-currant gall mite on bushes of each type and variety**

	Wellington XXX		Baldwin	
Type of bush	Dec. 1960	Dec. 1961	Dec. 1960	Dec. 1961
Healthy	1·2 (34·5)	14·6 (91·6)	0·1 (10·9)	3·5 (84·4)
Yellows virus	0·6 (25·7)	9·6 (84·8)	0·2 (11·9)	2·3 (80·9)
Reversion virus	20·8 (94·6)	44·2 (98·3)	8·2 (70·6)	9·8 (98·0)

* Data for the mean number of galls recorded per bush with the percentage of bushes with one or more galled buds in parentheses.

The infestation of mites was menacing a nearby cultural trial and control measures were intensified in 1961. In February, six reverted bushes, which were the only ones to have more than fifty galls, were pruned to leave only a few buds on each shoot near ground level. In March the galls on the other bushes were removed and endrin was applied just before flowering, yet many more galls were recorded in December than previously. There were more galls on the Wellington XXX bushes than on the Baldwin, with the reverted bushes again more heavily infested than the rest. The results support previous suggestions that reversion disease increases the plant's susceptibility to mites (Lees, 1923, Swarbrick & Berry, 1937) and this has been confirmed (Thresh, 1964).

Failure to check the infestation in 1961 emphasizes the difficulty of controlling mites once they have become established in a plantation with many reverted bushes. The results also confirm that cutting back bushes or removing galls are ineffective control measures (Hatton, Amos & Tydeman, 1925; Massee, 1926). In our experiment some galls were probably overlooked because of the difficulty of locating them on fruiting bushes, especially near ground level. Moreover, the galls were not removed until nearly grape-stage, when some may have been obscured by developing leaves.

DISCUSSION

The severe effects of black-currant yellows virus on growth and yield emphasize the importance of preventing its spread. The virus has been found only at one nursery in Oxfordshire, and in a few fruiting plantations established with bushes from there. Yellows may be more widespread than this, however, since the symptoms are difficult to recognize without considerable experience; they are not usually apparent until June or July, when they may be inconspicuous, as in the cool overcast conditions of 1963. The symptoms may be confused with those due to soil or nutritional factors, as at Oxford where the poor growth of bushes had been attributed to poor drainage.

Failure to set and ripen fruit has been considered characteristic of reversion disease (Lees, 1917; Amos & Hatton, 1927; Swarbrick & Thompson, 1932; Collingwood & Brock, 1961). The possibility that some strains of the virus may be less virulent and that commercial varieties differ in sensitivity to infection has not been appreciated. There is no detailed information on the prevalence of the disease, or on the relative importance of the different virus strains, and the economic significance of reversion cannot be determined. It is thought to be the most important disease affecting the crop in Britain, yet it was not assessed in an otherwise comprehensive survey of the crop, in which Rendell (1961) considered that the period over which reversion virus could be controlled determined the economic life of plantations. The main costs of black-currant growing are in establishment and picking. The low annual costs may be covered even where infection is prevalent; diseased plantations are often retained despite the low yield and the difficulty of controlling the rapid spread of mites among infected bushes, which are a hazard to healthy bushes in the vicinity.

Where infection with virulent strains is widespread yields may be less than 1 ton per acre, but where other strains occur crops may attain or even exceed the low national average of $1\frac{1}{2}$–2 tons per acre. The symptoms of infection with the Harrietsham isolate of reversion would be overlooked by all but the most experienced observers; bushes with such symptoms and those infected with even less virulent strains would be virtually indistinguishable from healthy bushes, yet, as our results indicated, their increased susceptibility to gall mites may diminish the effectiveness of acaricidal treatments.

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