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WILD BRAMBLES IN RELATION TO SPREAD OF VIRUS DISEASES IN CULTIVATED BLACK RASPBERRIES

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ABSTRACT

FIVE years (1931 to 1935) of field experience and study of virus disease occurrence in large experimental black raspberry plantings in western New York have provided definite information on the relationships of different wild bramble species to the spread of mosaics, leaf curl, and streaks into and within cultivated black raspberry plantings.

In this region, wild red raspberries (*Rubus ideaus*, principally variety *strigosus*) are numerous. They have been found to be infected usually with one or the other, or both, mosaic viruses, but do not show marked symptoms. They support steady populations of the principal mosaic vector aphid, *Amphorophora rubi*. As might be expected, wild red raspberries proved to be an important factor in mosaic spread into the experimental plantings. In fact, mosaic control by inspection and roguing was impossible until the wild red raspberries in the vicinity of the subject plantings had been eradicated. In one instance, mosaic spread in significant quantity from wild red raspberries into an experimental field 1,235 feet distant.

Other wild bramble species, largely blackberries (mostly *R. allegheniensis*) and black raspberries (*R. occidentalis*), were also prevalent but in no instance did they appear to play any part in mosaic spread. These species were rarely mosaic infected and were relatively unfavorable hosts for the carrier aphid.

Leaf curl was encountered but rarely in wild brambles, but a few instances were found in both red and black raspberries. Spread of curl from wild hosts into experimental plantings was very slow, but took place as readily from distant as from nearby sources. The aphid vector of leaf curl (*Aphis rubicola*) is common on all wild and cultivated raspberries in western New York.

A few streak infections were found in wild black raspberries and blackberries. Spread of streak from these wild host sources appeared to be of little importance. In one experimental black raspberry planting, however, where some streak inoculum existed, the presence of wild blackberries nearby seemed to accelerate greatly the spread of the disease within the planting. The blackberries were suspected of harboring the unknown vector of black raspberry streak.

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INTRODUCTION

Wherever raspberries are grown in this State, wild brambles occur, usually in great abundance. In rather extensive experience in all of the principal berry-growing counties in western and west-central New York, the writer has never observed a cultivated raspberry planting site where one or more types of wild Rubus did not exist somewhere in the close vicinity. Wild red raspberries (*Rubus ideaus*, principally variety *strigosus*) are the most numerous species and may be found in fence rows, in the borders of wood-lots and of cultivated fields, along roadsides and banks of streams, in fact, almost everywhere where the land is well drained and is not systematically cultivated or closely pastured, or covered with dense forest growth. Wild blackberries (largely *Rubus allegheniensis*) are less abundant but still are very common, growing in large, dense and vigorous clumps. The wild black raspberry (*Rubus occidentalis*) is a third prevalent species.

Wild Rubus are known to be hosts of the raspberry viruses and of the insect vectors thereof, and they have been suspected generally of playing a part in virus disease spread in cultivated raspberry plantings. With wild brambles so prevalent over the State and the virus disease problems in cultivated raspberries so acute, obviously more specific information about their relationships is needed.

In western New York during the past five years (1931–1935), an extensive field project has been conducted on the control of virus diseases in cultivated black raspberries.[1] Early in this work, the rôle of the wild brambles as infection sources appeared significant. Thereafter, frequent surveys were made to determine the occurrence of virus infections in all the species of wild Rubus thruout the region, and

[1]The beginning of this project and the first season's results have been reported in Bulletin No. 601 (now out of print) of this Station.

observations were made on the insect vector populations on these wild hosts. In certain of the experimental cultivated black raspberry plantings, the records of virus disease occurrence seemed to demonstrate markedly the influence of wild brambles on disease spread. The presentation of these observations and field demonstrations is the object of this present bulletin. It is believed that such information will enable raspberry growers to direct their virus disease control efforts more effectively.

As is true in most sections of the State, the mosaic viruses are of predominant importance in raspberries in western New York. Consequently, a discussion of wild brambles in relation to spread of mosaics constitutes the major portion of this bulletin. Notes on the less important virus troubles, leaf curl and streaks, are included.

MOSAICS

OCCURRENCE IN WILD BRAMBLES

The majority of the wild red raspberries observed in western New York have been affected with *green mosaic*[2] or *yellow mosaic,* or both. Yellow mosaic seems to be somewhat the more frequent. Wild stocks of this species appear resistant to the effects of mosaic infection and usually show but slight symptoms. Complete masking of the diseases during the warm summer months is common in them.

No instances of mosaic infection were ever noted in any of the wild black raspberries. In view of the prevalence of green mosaic in the cultivated black raspberries of the region, this finding was most unexpected.

Mosaic infections in the wild blackberries were rare, only a few cases being found in wastelands near heavily-infected cultivated red raspberries.

No mosaic cases were observed in any of the other relatively uncommon wild Rubus species.

OCCURRENCE OF VECTORS ON WILD BRAMBLES

The chief vector of raspberry mosaics, the large raspberry aphid, *Amphorophora rubi*, maintains a steady population on most of the wild red raspberry stocks, quite in contrast to its widely fluctuating populations on cultivated raspberries. This is no doubt a result of the fact that

[2]Previously, this disease has been called by the confusing terms of "red-raspberry mosaic" or "red mosaic." The more fitting name "green mosaic" has been adopted by the writer and is used thruout this publication.

the wild red raspberries are usually growing in protected and shaded locations where the effects of high winds, driving rains, and summer heat are somewhat abated. In consequence of steadier colonization, winged forms of *A. rubi* are much more common on the wild red raspberries than on the cultivated raspberries. Peak infestation was reached in mid-June each season, with a secondary peak in October. Aphid population on wild red raspberries was favored by increased vigor of host growth, that is, the taller and more rapidly growing raspberry clumps invariably carried much heavier than average populations of *A. rubi*. Counts made near Brant and North Collins June 12, 1933 showed 23 *A. rubi* per shoot on extra-vigorous wild red raspberries growing in partial shade, 8 per shoot on medium growth, and only 3 per shoot on low stunted growth in an open pasture lot.

Wild black raspberries appear to be much less favorable hosts of the large raspberry aphid. Single specimens and small colonies were found occasionally on young shoots in late May and early June of each season, but strong colonization on this host was never observed, and in no instance was the infestation on a given plant seen to survive thru the summer. No winged forms were found.

No *A. rubi* were ever observed occurring naturally on wild blackberries. In a number of trials at different times, when transferred artificially from cultivated red raspberries to the tips of wild blackberry shoots, *A. rubi* refused to feed and crawled away. When confined to the tips of young blackberry shoots in small celluloid and cloth cages, most individuals starved to death without attempting to feed, while the youngest aphids fed sporadically, growing weaker gradually and dying in 2 to 4 days.

Two other raspberry aphids known to be less efficient as carriers of mosaic, *Amphorophora rubicola* and *A. sensoriata*, were found only occasionally. The former occurred in colonies on the fruit-spur foliage of wild red raspberries early each spring. The latter was observed on the under sides of trailing black raspberry shoots in late summer and fall, feeding only on the canes proper. Neither of these species is considered an important factor in general mosaic spread in western New York.

SPREAD FROM WILD BRAMBLES INTO EXPERIMENTAL BLACK RASPBERRY PLANTINGS

The raspberry mosaic control project in western New York included a detailed study of virus disease occurrence in 22 special plantings of

black raspberries. These plantings were made by cooperating berry growers, with stock chosen for its relative freedom from virus diseases.[3] Two standard varieties, Cumberland and Plum Farmer, were represented. Size of plantings ranged from one-sixth of an acre to six and one-half acres. Most of the fields were located in southwestern Erie County. A wide variety of environmental circumstances and cultural conditions were manifested.

When these experimental black raspberry plantings were set out in the spring of 1931, probably none and certainly very few of the individual plants therein were mosaic infected. This was especially true of the stock of the Cumberland variety. In the parent fields of this variety in Ohio, the total incidence of both green mosaic and yellow mosaic combined was but 0.12 per cent in 1929 and 0.09 per cent in 1930, all of which had been rogued out as soon as discovered. In the first inspection of the experimental Cumberland plantings in western New York during July and early August, 1931, the rare mosaic cases discovered were all current season infections and not systemic carry-over cases. It does not appear probable, therefore, that internal mosaic infection sources in these plantings could have been of any consequence.

All spread of mosaic viruses from infected wild hosts into the experimental plantings apparently came from wild red raspberries. That such spread can take place was proved experimentally by collecting *A. rubi* from infected wild red raspberries and placing them on cheesecloth-caged or isolated uncaged healthy black raspberry plants. Trial inoculations of this sort gave 4 infections of 5 in 1932, 6 of 6 in 1933, and 4 of 7 in 1934. And that mosaic invasion from this source takes place naturally on a very important scale was demonstrated by the records of disease incidence in some of the experimental fields.

Wild red raspberries in the environs were considered responsible for some portion of the mosaic occurrence in 11 of 14 Cumberland plantings and in 6 of 8 Plum Farmer plantings. In three instances, all Cumberland plantings, wild red raspberries were deemed accountable for all of the mosaic invasion. The history of mosaic occurrence in these fields is given in Table 1. Spread from internal mosaic infection sources in these plantings was kept at a minimum by a systematic program of inspection and roguing. Two inspections in 1931, four in 1932, four in 1933, three in 1934, and one in 1935, were made, with the ex-

[3]Stock of the experimental plantings was obtained from the Ohio Small Fruit Improvement Association. Data on virus disease occurrence in this stock was supplied by the Ohio Agricultural Experiment Station.

ception of planting 1 which was taken out by the grower in the autumn of 1933. Immediately upon discovery, virus-affected plants were burned in place, to kill the insect vectors, before they were dug. In spite of this, mosaic incidence increased steadily during the first two years, July 1, 1931 to June 30, 1933.

TABLE 1.—MOSAIC OCCURRENCE BY YEARS, IN THREE EXPERIMENTAL BLACK RASPBERRY PLANTINGS, CUMBERLAND VARIETY, WHERE WILD RED RASPBERRIES WERE THE SOLE INFECTION SOURCE.

BEFORE WILD BRAMBLE ERADICATION

PLANTING	AVERAGE NUMBER OF PLANTS	JULY 1, 1931, TO JUNE 30, 1932			JULY 1, 1932, TO JUNE 30, 1933		
		Green mosaic, per cent	Yellow mosaic, per cent	Total, per cent	Green mosaic, per cent	Yellow mosaic, per cent	Total, per cent
1	3,333	0.14	0.27	0.41	1.37	1.49	2.86
2	11,807	0.41	0.35	0.76	1.38	1.29	2.67
3	4,247	0.33	0.05	0.38	4.65	0.44	5.09

AFTER WILD BRAMBLE ERADICATION

PLANTING	AVERAGE NUMBER OF PLANTS	JULY 1, 1933, TO JUNE 30, 1934			JULY 1, 1934, TO JUNE 30, 1935		
		Green mosaic, per cent	Yellow mosaic, per cent	Total, per cent	Green mosaic, per cent	Yellow mosaic, per cent	Total, per cent
1	3,333	0.21	0.54	0.75*	...	...	...
2	11,807	0.63	0.87	1.50	0.08	0.32	0.40
3	4,247	1.04	0.36	1.40	0.12	0.17	0.29

*Planting 1 was taken out by the grower in the autumn of 1933 because of successive anthracnose epidemics. Consequently, records for the third year in this planting are incomplete, lacking the spring inspection of 1934.

All wild red raspberries in the vicinities, mostly within 1,000 feet, of these three plantings were eradicated in the spring of 1933. In the succeeding two years, July 1, 1933 to June 30, 1935, mosaic incidence in these plantings declined consistently. Weather conditions undeniably were more favorable to spread of mosaic in 1931 and 1932 than in subsequent seasons, but nevertheless it is believed that the chief factor responsible for the mosaic reduction in the last two years was the elimination of the wild red raspberries.

Results in the case of planting 3 were particularly striking. Conditions pertaining to external mosaic infection sources about this planting

as they existed in 1932 are illustrated on the map shown in Fig. 1. The rise and decline of mosaic incidence within this field are shown graphically in Fig. 2.

Planting 1 presented an interesting case because of the conditions under which the mosaic spread occurred. Here, the inoculum sources consisted of two separate extensive lots of vigorous wild red raspber-

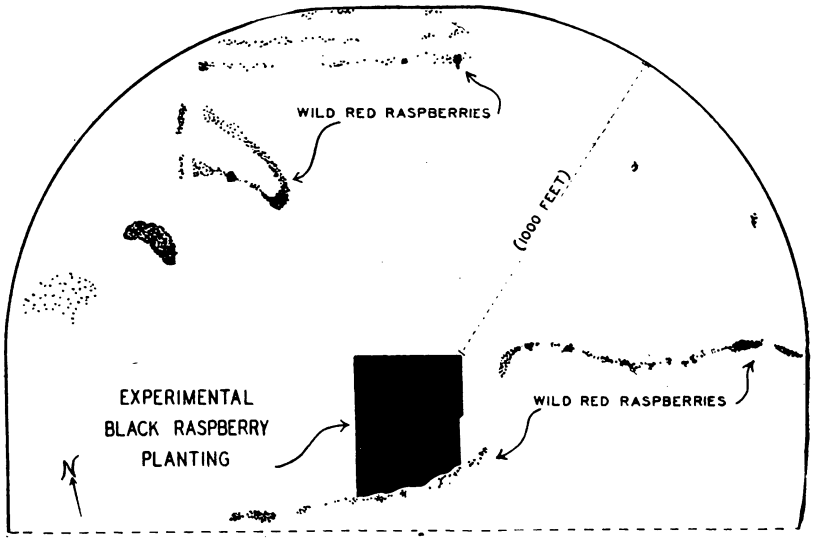

FIG. 1.—TYPICAL DISTRIBUTION OF WILD RED RASPBERRIES ABOUT A CULTIVATED BLACK RASPBERRY PLANTING IN WESTERN NEW YORK.

1932 map of experimental black raspberry Planting 3 (Table 1) and its environs near Brant, N. Y. Size of planting 2½ acres. All wild brambles within the 1,000-foot radius were on approximately the same level as the planting.

ries. One lot, infected principally with green mosaic, was located at a distance 650 feet south of the nearest border of the experimental field and at an elevation approximately 80 feet lower. The second lot, infected heavily with yellow mosaic, was 1,235 feet distant in a southwest direction and about 60 feet lower. There were practically no barriers to insect spread by air currents between them and the planting. Distribution of the mosaic infections within planting 1 indicated that the two sources of mosaic inoculum were about equally responsible for the disease invasion that occurred, totaling 3.27 per cent in the first two years.

An interesting feature of mosaic invasion from wild red raspberries is the uncommonly high proportion of yellow mosaic cases (Table 1). Yellow mosaic is usually an infrequent disease in black raspberries. In the project as a whole, the ratio of green mosaic cases to yellow mosaic cases was approximately 7 to 1; but in these three particular plantings where wild red raspberries were responsible for the mosaic occurrence,

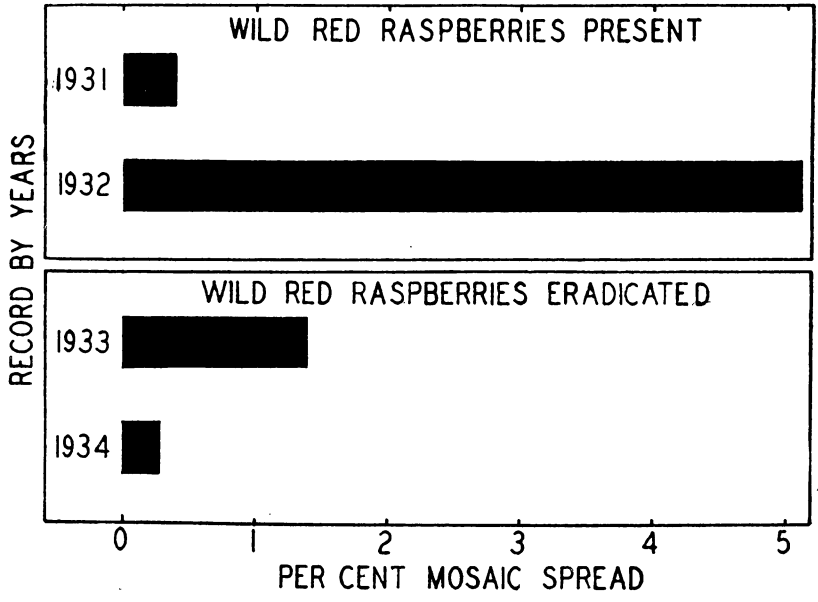

FIG. 2.—MOSAIC CONTROL MADE POSSIBLE BY ERADICATING WILD RED RASPBERRIES.

A graphic history of mosaic incidence in experimental black raspberry Planting 3 (Table 1). Planting was set in spring of 1931. Average number of plants 4,247. Mosaic infections were rogued at two inspections in 1931, four in 1932, three in 1934, and one in 1935. Since autumn infections cannot all be detected until the following spring, to compute the spread occurring during a calendar year the record of the first inspection in the ensuing spring was added. Thus, 1931 spread represents inspections up to June 30, 1932; 1932 spread, from July 1, 1932, to June 30, 1933; etc., as per Table 1.

the ratio was 5 to 3. In two of them, yellow mosaic cases actually outnumbered those of green mosaic. It also is interesting to note the greater persistence of the yellow mosaic disease within the experimental fields after the external sources of infection had been eliminated (Table 1, July 1, 1933 to June 30, 1935).

CONCLUSIONS AND RECOMMENDATIONS

The above observations and experiences would seem to warrant these conclusions: **Wild red raspberries** are a widespread and serious source of mosaic infection for healthy cultivated raspberries. Other wild brambles are of little consequence in mosaic spread.

In any raspberry mosaic control project, the territory in the vicinity of the cultivated planting of healthy stock should be surveyed thoroly for the presence of wild red raspberries. This survey should cover all land within 1,000 feet of the planting in all directions, and a greater radius if practicable. All wild red raspberries discovered should be eradicated,[4] even tho no mosaic symptoms are visible on them. Said survey and eradication campaign might well be conducted prior to setting out of the healthy stock; certainly during its first growing season.

Eradication of wild black raspberries, blackberries, and dewberries in the vicinity of healthy raspberry plantings might prove profitable also, thru eliminating sources of other diseases and of insect pests, but their riddance is not considered requisite to mosaic control.

LEAF CURL

Leaf curl of raspberries is rather rare in western New York. In the wild brambles, four widely separated instances of this virus disease were found: Three in red raspberries and one in black raspberries. The sole vector of the curl viruses, the small raspberry aphid (*Aphis rubicola*), is abundant during the whole of each growing season on all species of raspberries, both wild and cultivated, in western New York.

Every instance of curl occurrence in wild brambles was responsible for slight spread of the disease into an experimental planting. Altogether this spread involved only ten plants. These infections occurred one year or later after the plantings had been set out and in fields in which no previous curl cases had appeared, so that there was no doubt that the wild bramble sources were responsible for the infections.

In the case of one planting, seven plants became infected as a result of spread taking place from a vigorous curl-infected clump of wild red raspberries 635 feet away to the south and at an elevation 80 feet lower. In another planting, a single infection resulted when the disease spread from wild red raspberries located at a distance of 925 feet in an easterly

[4]Tests of various bramble eradication methods are reported and recommendations given in a forthcoming bulletin from this Station (Bulletin No. 674).

direction and at approximately the same elevation. The other two single-plant spreads came from closely adjacent infection sources.

Leaf curl symptoms on infected wild brambles are always prominent and easily seen. Even tho the disease is uncommon, curl infections should be looked for in wild brambles in the vicinity of cultivated raspberry plantings. All diseased plants discovered should be eradicated promptly.

STREAKS

The *mild streak* disease was found on only one wild bramble plant, a black raspberry. Infections with the *severe streak* virus were found in five plants of wild black raspberry, three in one location and two in another. This disease was observed in three distinct plants of wild blackberry, all in one locality (Fig. 3). The streak diseases are not known to affect red raspberries.

Altho an insect vector is suspected, the natural mode of streak transmission has never been determined experimentally.

Direct spread of the streak diseases from infected wild brambles into experimental plantings was seemingly quite incidental. The single case of mild streak found occurring on a wild black raspberry plant apparently accounted for one mild streak infection within the nearby planting in 1931 and two in 1932. This infection source was eradicated in the spring of 1933 and no further occurrence of mild streak was recorded in any of the experimental plantings. The spread of severe streak from the few infected wild brambles into the experimental plantings could not be measured with certainty. Incipient infections of severe streak undoubtedly were present in the plantings when they were set,[5] and these served as internal sources of spread to an extent overshadowing that from sources outside.

In all but one of the 22 experimental plantings the proportion of severe streak remained low (0.0 to 1.0 per cent), with a general trend toward reduction as a result of the inspection and roguing program. The history of severe streak incidence in this exception, a Cumberland planting, is shown in chart form in Fig. 4. Following only 0.31 per cent severe streak in this planting in 1931, the disease became epidemic in the second season, 1932, when 1,097 infections were discovered among 10,922 plants (10.04 per cent infection). All affected plants were burned and dug out. The next year, only 73 plants in 9,539 (0.76 per

[5]In the source stock in Ohio, severe streak was the most frequent virus trouble with an incidence of 0.36 per cent in the Cumberland plantings in 1930.

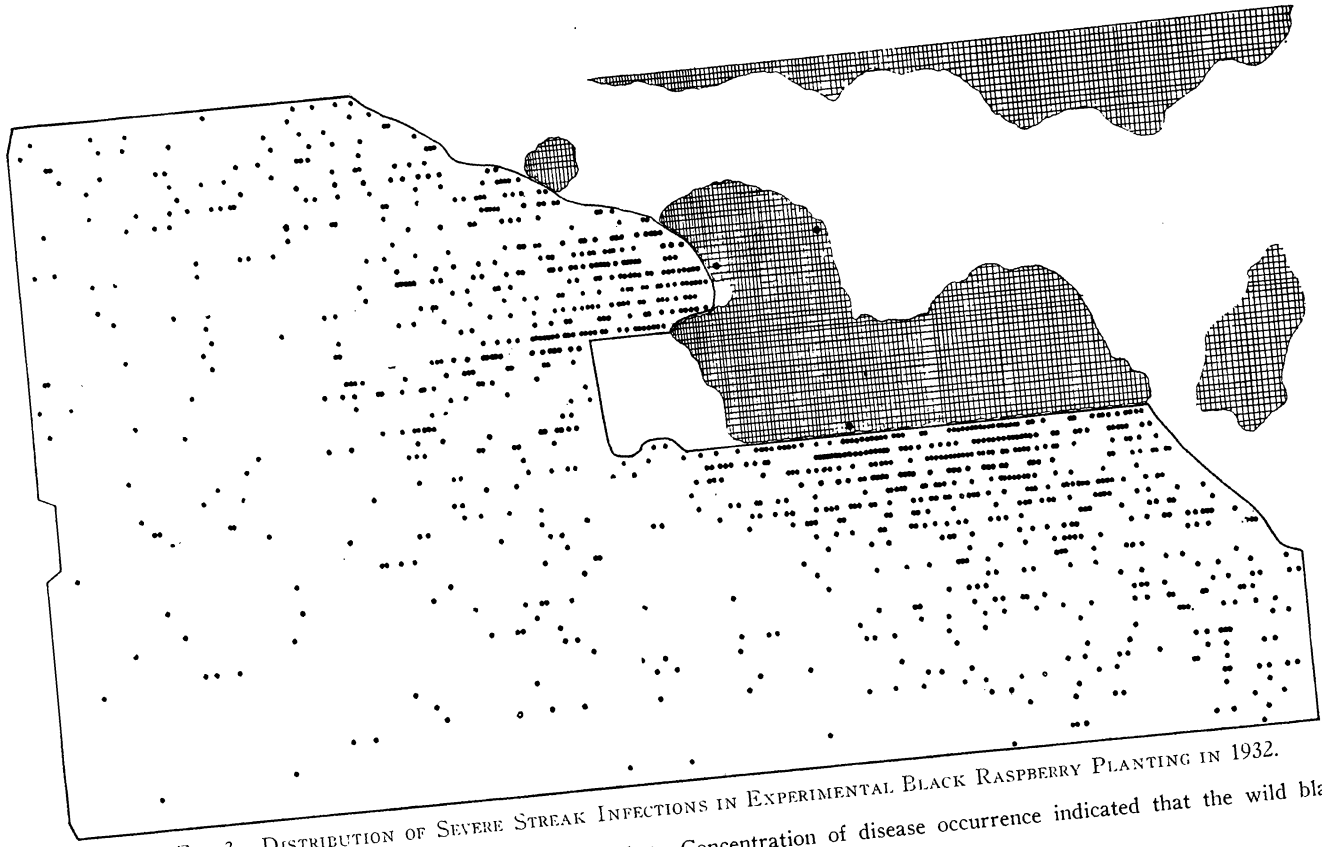

FIG. 3.—DISTRIBUTION OF SEVERE STREAK INFECTIONS IN EXPERIMENTAL BLACK RASPBERRY PLANTING IN 1932.

Dots indicate infections; cross rules, blackberry thickets. Concentration of disease occurrence indicated that the wild blackberries were in some way responsible for its spread among the raspberries.

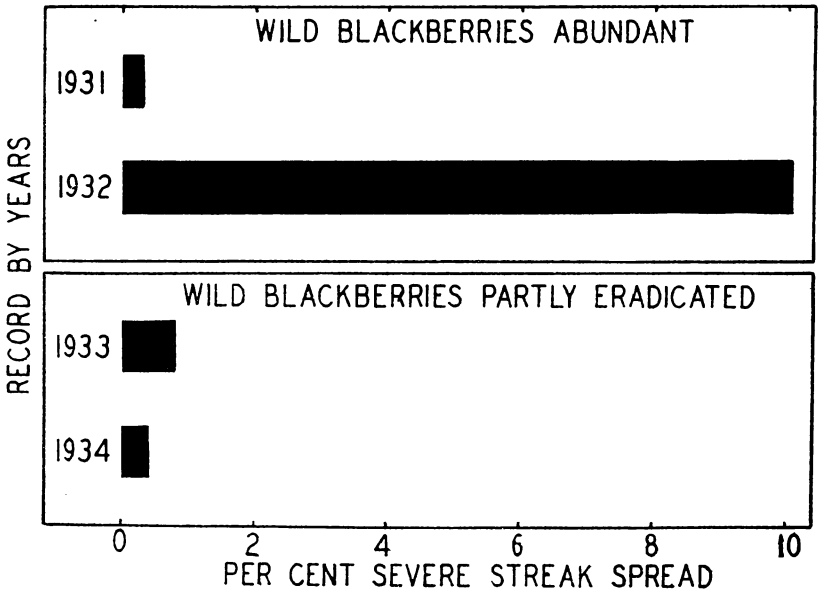

FIG. 4.—INFLUENCE OF ADJACENT WILD BLACKBERRY THICKETS ON SEVERE STREAK OCCURRENCE IN A BLACK RASPBERRY PLANTING.

A graphic history of severe streak incidence in experimental Cumberland black raspberry planting B at Brant, N. Y. Planting was set in spring of 1931. Original number of plants 10,603; average number of plants 9,224. Streak infections were rogued at two inspections in 1931 and four in 1932. Thereafter, roguing was discontinued, but two inspections were made in 1933 and two in 1934 to record additional infections.

cent) were infected. The east portion of the planting was taken out by the grower in the spring of 1934 and, in the ensuing growing season, of the remaining 5,832 plants only 20 (0.35 per cent) became infected with severe streak.

Distribution of severe streak infections in this field in the epidemic season of 1932 (Fig. 3) indicated that wild blackberries, occupying tracts of wasteland in the southeast corner, were responsible in some way for the spread of the disease. The decline in severe streak incidence that followed in 1933 and 1934 pointed further to some connection between the wild blackberries and the streak epidemic, for the wasteland tract was cleared in the winter and spring of 1933, and altho the wild blackberries were not eliminated their vigor and abundance were reduced markedly. Removal of diseased plants within the planting in 1932, without replacement later, effected a partial separation of the black raspberries from the wild blackberries, and this separation was

increased by the complete removal of the east portion of the field in 1934. It would appear that these operations, i.e., partial subjugation of the wild blackberries and increasing the distance between them and the raspberries, resulted in a drastic curtailment of the spread of severe streak.

This experience agrees with findings in Pennsylvania[6] that epidemic spreads of severe streak in black raspberries are associated with the existence of blackberries in the immediate vicinity.

Additional confirmation of this idea is to be had from a general experience with severe streak occurrence in western New York. This disease is not frequent in the majority of the native plantings of black raspberries of that section. It is prevalent on one farm, however, and this is the only farm on which for several years blackberries have been grown extensively along with the streak susceptible Cumberland variety of black raspberries.

The rôle of blackberries in accelerating the spread of severe streak in black raspberries can be only a speculation until the natural method of transmission of the disease is discovered. The most logical explanation of severe streak spread in the particular instance mentioned above seems to be that infected plants within the experimental raspberry planting provided the virus inoculum, which was spread about by vector agents, presumably insects, emigrating from the wild blackberry thickets.

Circumstantial evidence, then, would indicate that wild blackberries close by, even tho healthy, should be considered a menace to black raspberry stock in which infection sources of severe streak already exist. In such cases, eradication of the wild blackberries is regarded as highly essential to control of the disease in the black raspberries. Conversely, if no streak infection sources are present in the black raspberries, wild blackberries in the vicinity presumably will not cause any spread of viruses.

SUMMARY

In western New York **wild red raspberries** are numerous and are usually infected with one or the other, or both, mosaic viruses. Most stocks show but slight symptoms of mosaic infection. The wild red raspberries support steady populations of the mosaic vector aphid, *Amphorophora rubi*. They were found to be an important factor in the spread of the mosaic diseases into cultivated plantings of healthy rasp-

[6]Thornton, J. K. Blackberries: Possible source of streak infection in black raspberries. *Phytopath.*, **25**: 959–961. 1935.

berries. In three experimental black raspberry plantings where wild red raspberries in the vicinity constituted the sole likely sources of mosaic infection, the incidence of mosaics steadily increased for the first two years in spite of a systematic inspection and roguing program. After the wild red raspberries were eradicated, mosaic incidence in these same plantings steadily diminished for the following two years.

In any raspberry mosaic control project in this State, one of the first procedures should be to eradicate all wild red raspberries in the vicinity. This eradication program should cover the area within at least 1,000 feet of the healthy planting in all directions.

Other wild bramble species, largely blackberries and black raspberries, did not appear of consequence in the spread of mosaics.

Leaf curl was found in wild red and black raspberries in only four instances. The vector of leaf curl, *Aphis rubicola*, is common on all wild raspberries in western New York. Spread of this disease into the experimental plantings was very slow, but took place over long distances as readily as from closely adjacent sources. Brambles infected with leaf curl show marked symptoms all thru the growing season. To guard against possible invasions of this disease coming from wild hosts, all wild red and black raspberries in the vicinity of healthy plantings should be looked over and any that are obviously curl infected should be eradicated.

The streak viruses were found infecting wild blackberries and black raspberries in a few instances. Direct spread from these wild sources into the experimental plantings was thought to be of slight importance. Experiences with an epidemic of severe streak in one planting, however, suggested that wild blackberries were indirectly responsible for the disease spread. The rôle of the blackberries was most probably that of harboring vectors of the streak virus. It is recommended that in the case of black raspberry plantings containing some severe streak infections, any wild blackberries growing close by should be regarded as a menace and should be eradicated.