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CONTENTS

EXPERIMENTS WITH THE ASTER-YELLOWS VIRUS FROM SEVERAL STATES

HENRY H. P. SEVERIN

TRANSMISSION OF CALIFORNIA ASTER YEL- LWS TO POTATO BY CICADULA DIVISA

HENRY H. P. SEVERIN AND FRANK A. HAASIS

TRANSMISSION OF CALIFORNIA ASTER AND CELERY-YELLOWS VIRUS BY THREE SPECIES OF LEAFHOPPERS

HENRY H. P. SEVERIN

UNIVERSITY OF CALIFORNIA • BERKELEY, CALIFORNIA

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TRANSMISSION OF CALIFORNIA ASTER YELLOW TO POTATO BY CICADULA DIVISA¹

HENRY H. P. SEVERIN² AND FRANK A. HAASIS³

(Contribution from the Division of Entomology and Parasitology, California Agricultural Experiment Station, University of California, cooperating with the United States Department of Agriculture Bureau of Entomology.)

INTRODUCTION

KUNKEL⁽¹⁾ FAILED TO TRANSMIT New York aster yellows to potato (*Solanum tuberosum*) by means of the insect vector, *Cicadula divisa* Uhl. [*C. sexnotata* (Fall.)]. The following varieties of potatoes were either immune or highly resistant to the aster-yellows disease: Irish Cobbler, Green Mountain, Bliss Triumph, and Spaulding Rose.

An investigation was undertaken to determine whether potato plants could be experimentally infected with California aster yellows. A study of the symptoms and incubation period of the disease in the plant was made. Attempts were made to recover the virus from infected plants by means of previously noninfective leafhoppers. Trips were made to the potato fields in the delta districts of the San Joaquin Valley to determine whether this virus disease occurs under natural conditions, and observations were made on the relative abundance of the leafhopper on potato plants during the season.

METHODS

The varieties of potatoes used were Bliss Triumph, White Rose, and potatoes grown from seeds. The potatoes were grown in 12-inch flower pots or in large wooden pickle tubs filled with peat soil. The potato plants were enclosed in large cages and inoculated with yellows by 20 to 40 infective leafhoppers. Males were used rather than females so as to avoid egg deposition. The insects inoculated the plants during a period of 1 to 10 days and then the cages containing the males were removed from the plants. The inoculated plants were fumigated with Nico-Fume tobacco-paper insecticide after inoculation and were kept in

¹ Received for publication March 15, 1934.

² Associate Entomologist in the Experiment Station.

³ Assistant in Entomology and Plant Pathology at Cornell University, Ithaca, New York; formerly a graduate student at the University of California.

a greenhouse free from leafhoppers or out-of-doors in insect-proof cages. Check or control plants grown from the same tubers were used. Noninfective leafhoppers were kept on some of the control plants, while others were kept free from insects.

RESULTS

During a period of five years, 104 potato plants were inoculated with the California aster-yellows virus by means of infective *Cicadula divisa*, and 50 per cent of the inoculated plants developed symptoms of the disease, as is shown in table 1.

TABLE 1
RESULTS OF INOCULATION OF POTATO PLANTS WITH YELLOWS VIRUS BY
CICADULA DIVISA

Dates leafhoppers inoculated plants	Number of potato plants inoculated	Number of leafhoppers on each plant	Number of plants infected	Number of plants healthy	Per cent of plants infected
Sept. 12-15.....	14	25	14	0	100.0
Sept. 18-23.....	13	20	13	0	100.0
Oct. 8-9.....	12	30	7	5	59.3
Oct. 9-11.....	11	30	1	10	9.0
Oct. 16-17.....	8	25	4	4	50.0
Oct. 17-18.....	8	25	0	8	0.0
Oct. 30-Nov. 2.....	5	25	2	3	40.0
Feb. 1-4.....	1	40	0	1	0.0
Feb. 11-21.....	2	40	0	2	0.0
Feb. 21-28.....	1	40	1	0	100.0
Mar. 10-19.....	1	40	0	1	0.0
Apr. 12-May 9*.....	1	20	0	1	0.0
Apr. 15-May 9*.....	2	20	0	2	0.0
Apr. 18-May 9*.....	2	20	0	2	0.0
Apr. 26-May 13*.....	4	20	2	2	50.0
June 5-18.....	4	25	2	2	50.0
June 9-18.....	5	25	3	2	60.0
June 11-18*.....	4	35	1	3	25.0
June 11-18.....	5	35	1	4	20.0
July 7-18.....	1	25	1	0	100.0
Total or percentage.....	104	52	52	50.0

* Potato plants grown from seeds.

Symptoms.—The most pronounced symptoms which appeared on potato plants infected with the California aster-yellows virus were purple slender sprouts (figs. 1A, 2A, B, 3 C-M) and purple sessile aerial tubers⁴ (figs. 1B, 4) which developed from the axils of the leaves. Sometimes aerial tubers developed at the end of the sprouts (figs. 1A, 3B). Fre-

⁴ Richard and Blood⁽²⁾ described and figured aerial tubers in their contribution on psyllid yellows of the potato. H. L. Blood, E. S. Schultz, and M. Shapovalov have examined potato plants showing symptoms of California aster yellows, and all agreed that the symptoms were not identical with those of psyllid yellows.

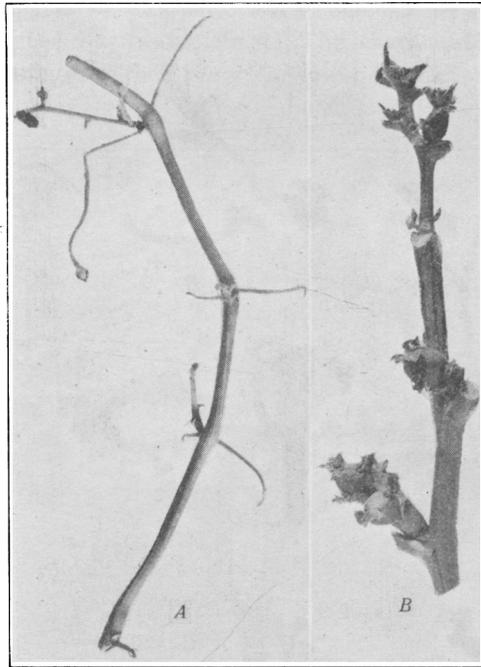


Fig. 1.—Stems of potato plant infected with yellows with leaves removed: *A*, slender sprouts; *B*, sessile aerial tubers growing from buds at the nodes.

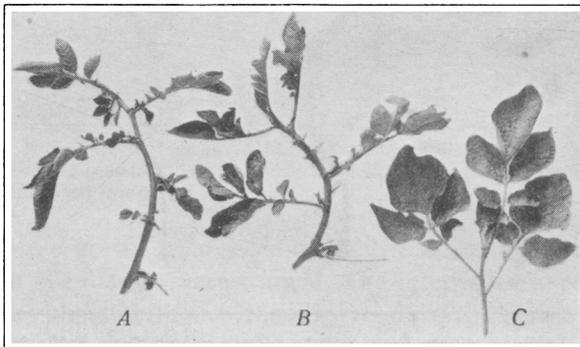


Fig. 2.—*A*, *B*, Shoots from potato plant infected with yellows showing slender sprouts growing from the axils of the leaves; *C*, shoot from check or control plant from the same tuber.

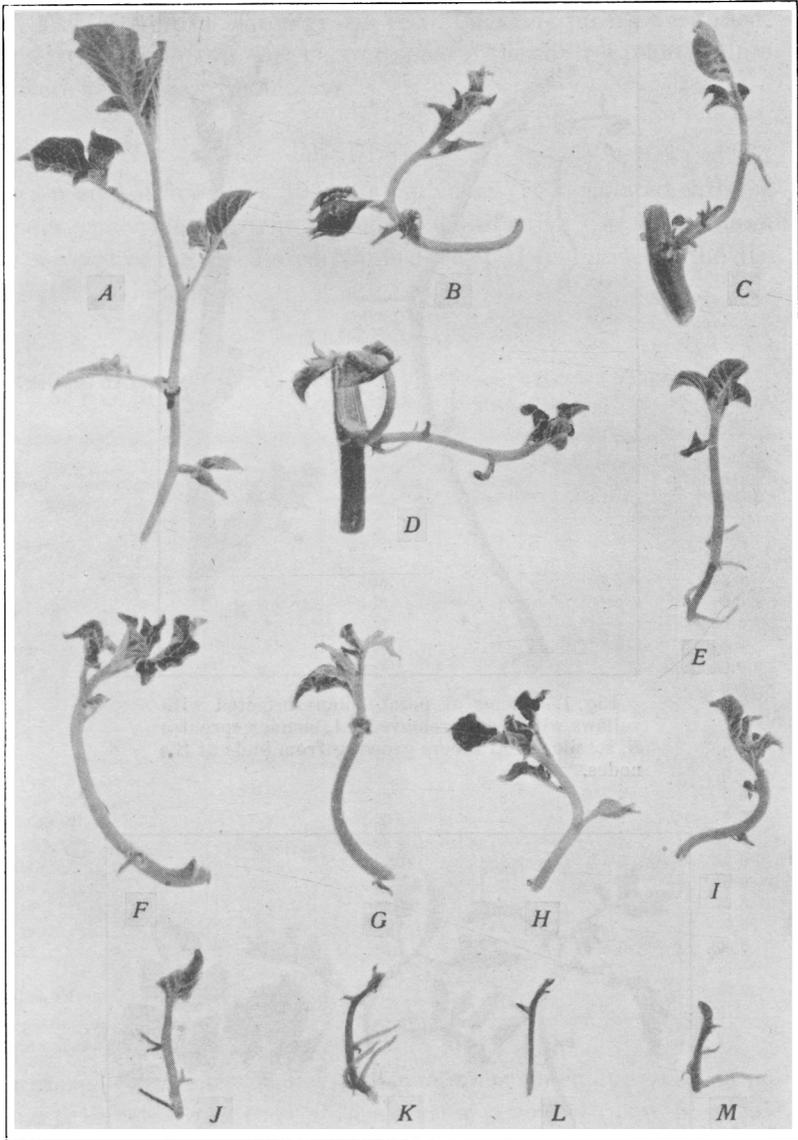


Fig. 3.—Axillary shoots from potato plants grown from seeds infected with yellows: *A*, normal leaves; *B*, aerial tuber; *C–I*, curved petioles with terminal leaflets and lateral sprouts; *J–M*, petioles with lateral sprouts which may represent the veins of undeveloped leaves.

quently dwarfed leaves developed on the aerial tubers (fig. 1*B*). The margins of the leaves were rolled inward (figs. 2*A, B*) with the petioles often bent or curved downward (fig. 4). The leaves and stems were brittle. In the later stages of the disease the lower leaves turned yellow and became dry (fig. 4).

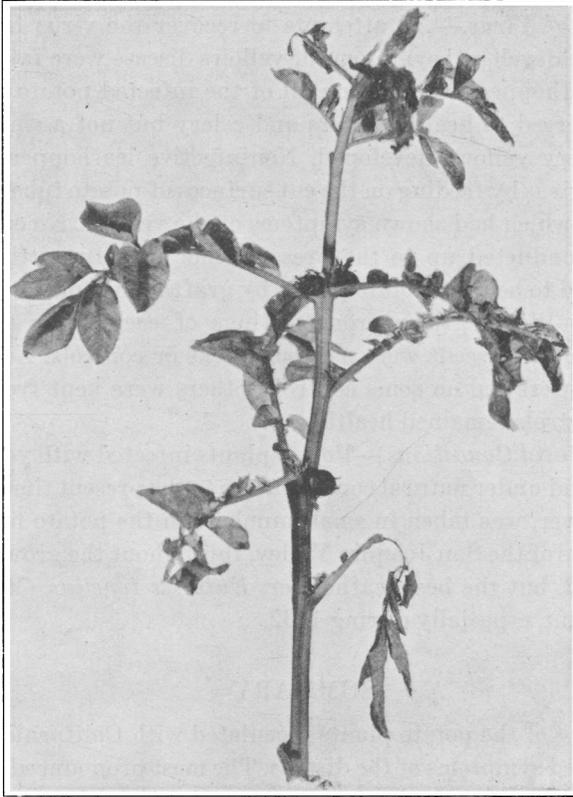


Fig. 4.—Shoot from potato plant infected with yellows showing sessile tubers growing from the axils of the leaves, and dried lower leaf.

Potato plants grown from seeds were infected with yellows and the symptoms of the disease were studied. The internodes were shortened and secondary shoots with or without leaves developed from the axils of the leaves (fig. 3*B–J*). The secondary shoots frequently developed purple, slender, lateral sprouts, which may represent veins of leaflets which failed to develop (fig. 3*C–M*) as in the case of shoe-string mosaic of tomatoes. Purple aerial tubers sometimes grew on the secondary shoots (fig. 3*B*).

Incubation Period of Disease in the Plant.—The length of time that elapsed from the inoculation of the potato plants until slender sprouts or aerial tubers developed in the axils of the leaves was considered as the incubation period of the disease and varied as follows: autumn 20 to 37 days; late winter and early spring 50 to 63 days; and summer 27 to 40 days.

Recovery of Virus.—All attempts to recover the virus from potato plants which developed symptoms of yellows disease were failures. Non-infective leafhoppers were fed on all of the infected potato plants and were transferred to healthy asters and celery but not a single case of aster or celery yellows developed. Noninfective leafhoppers failed to recover the virus by feeding on the cut surfaces of potato tubers obtained from plants which had shown symptoms of the yellows. No experiments have been conducted up to the present time on transmitting yellows from infected to healthy potato plants by grafting or budding.

Controls.—Plants grown from cuttings of each tuber and potato plants grown from seeds were used as checks or controls. Noninfective leafhoppers were fed on some controls, others were kept free from insects. All controls remained healthy.

Under Natural Conditions.—Potato plants infected with yellows have not been found under natural conditions up to the present time. *Cicadula divisa*, however, was taken in small numbers in the potato fields in the delta districts of the San Joaquin Valley, throughout the growing season in 1930–1932, but the beet leafhopper, *Eutettix tenellus* (Baker) was more abundant, especially during 1932.

SUMMARY

Fifty per cent of the potato plants inoculated with California aster yellows developed symptoms of the disease. The most pronounced symptoms of the disease were purple slender sprouts and aerial tubers arising from the axil of the leaves. The incubation period of the disease varied from 20 to 63 days during the four seasons. The virus was not recovered from infected potato plants nor from potato tubers obtained from plants showing symptoms of yellows. The disease has not been found in potato fields under natural conditions up to the present time, but *Cicadula divisa* was taken in potato fields.

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