

WEEDS AS POSSIBLE CARRIERS OF LEAF ROLL AND RUGOSE MOSAIC OF POTATO¹

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INTRODUCTION

The host range of certain viruses, such as curly top of sugar beets (13),³ aster yellows (9), and cucumber mosaic (7), includes many different families of plants. It is known that certain viruses—for example, the latent virus of apparently healthy⁴ potatoes (3, 6, 11, 15)—may be masked in one host but show definite mottling in other hosts and a necrotic effect in still others. The symptoms of a virus may also appear as a mottling on one host and as at chlorosis when the virus is transferred to a different host. For example, Hoggan (4) found that when Johnson's tobacco virus no. 1 was transmitted to *Capsicum annuum* L. a chlorotic condition without mottling was produced.

Rugose mosaic and leaf roll are two of the most important virus diseases of potato (*Solanum tuberosum* L.) in Oregon. The former occurs in all parts of the State, whereas the latter is confined principally to the potato-growing areas east of the Cascade Mountains. In some sections of the State these diseases are difficult to control by roguing. It seems probable that weeds may serve as hosts of these and other virus diseases of potato and may be a source of infection when growing near potato fields.

In the summer of 1929, while inspecting potato fields in central Oregon that showed a large percentage of leaf roll, the writer discovered many plants of nightshade (*Solanum villosum* Mill.). Upon examination it was found that a number of these plants were infected with a disease resembling leaf roll. Infected plants were slightly dwarfed and their leaves were rolled, leathery, and chlorotic, whereas healthy plants in the same field were vigorous and had leaves of a normal green color.

A potato field showing about 50 percent rugose mosaic was found in the same section. Many of the plants displayed typical current-season symptoms of rugose mosaic, namely, necrosis and dropping of the leaves. Nightshade was likewise abundant in this field, but a thorough examination of several hundred plants did not reveal a single one that showed mottling or necrosis. It was therefore thought that this weed might not be a host of rugose mosaic; subsequent experiments have indicated, however, that it is.

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³ Reference is made by number (italic) to Literature Cited, p. 31.

⁴ Apparently healthy potatoes are regarded as healthy in commercial practice, but they harbor in masked condition a virus disease which has been called "latent virus."

A study of the host range of the viruses that affect cultivated plants is of primary importance in formulating a program for their control. Since symptoms of the same virus may vary on different species of plants and even on different varieties of the same species, it is also essential to determine the symptomatology of these virus diseases on the various hosts. In order to learn more about host relationships of potato viruses, the experiments reported in this paper were begun in the fall of 1929.

REVIEW OF LITERATURE

The importance of weeds as hosts of virus diseases of potato has been mentioned in some publications (10, 12, 16, 17), but very few specific data have been presented bearing upon the relation of such hosts to the spread of these diseases to potatoes under natural field conditions.

Quanjer (10) states that tobacco (*Nicotiana tabacum* L.), *Atropa belladonna* L., *Datura stramonium* L., *Hyoscyamus niger* L., *Solanum nigrum* L., and *S. dulcamara* L., when infected by grafting or by means of aphids, are able to carry leaf roll although they do not show symptoms of it, as is indicated by the fact that the disease can be transmitted back to potatoes by grafting the vines with tops of such infection carriers. The species of aphids used and the percentage of infection secured are not given. The writer (2) has transmitted leaf roll by means of *Myzus persicae* (Sulz.) from potato to tomato, pepper, *Datura stramonium*, *D. tatula* L., *S. nigrum*⁵ and *S. dulcamara*.

Quanjer's crinkle, as pointed out by Johnson (7), is probably identical with Schultz and Folsom's (12) rugose mosaic. Quanjer claims to have transmitted crinkle by grafting to tomato (*Lycopersicon esculentum* Mill.), *Solanum nigrum*, *Datura stramonium*, *Atropa belladonna*, and *Hyoscyamus niger*. He states that the symptoms resembled those of potato, but makes no reference to return inoculation to potato.

Schultz and Folsom (12) found that the tomato is susceptible to mild mosaic and rugose mosaic. Young and Morris (17) transmitted rugose mosaic from potato to tomato. Fernow (8) secured but one disease when he transferred juice from diseased or healthy potatoes to other solanaceous plants. He referred to this as virus B. Blodgett (1) attempted to inoculate pepper plants with the virus of yellow-dwarf disease of potatoes and also with inoculum from apparently healthy potatoes. All the peppers inoculated from potato, either from the yellow-dwarf tubers or from the healthy tubers, showed the same type of symptom, namely, a severe necrosis of the leaves and stems. He does not state whether return inoculations to potato were made from peppers inoculated with yellow dwarf. Johnson (5) found that "healthy" potato virus and vein banding from tobacco, when inoculated into pepper plants, sometimes produced chlorotic rings and necrosis, followed by defoliation. These symptoms never developed from the "healthy" potato virus alone, and the vein-banding virus was not recovered when return inoculations were made to tobacco. Johnson (6) was the first to demonstrate the presence of one or several viruses in practically all so-called healthy commercial American

⁵ A later and more accurate determination of this species establishes it as *Solanum villosum*. The two species are decidedly similar, but *S. villosum* is the more hairy of the two and its calyx lobes are broad and triangular and united for half their length, whereas *S. nigrum* is glabrous and its calyx lobes are narrow and separate almost to the base.

varieties of potatoes. Valleau (15) reported similar results. Schultz (11) found that when certain apparently healthy potato varieties were tuber-grafted with each other and with seedlings, necrotic streaks developed on some of the varieties and seedlings.

Johnson (5) refers to a disease occurring naturally on tobacco as "vein banding," on account of the narrow bands of dark-green tissue that appear along the veins of the leaves of affected plants. He transferred this virus from tobacco to tomato, petunia (*Petunia hybrida* Vilm.), and species of *Physalis*. Valleau and Johnson (16) transmitted the vein-banding virus from tobacco to apparently healthy young Irish Cobbler potato plants and produced typical rugose-mosaic symptoms. When the vein-banding virus was transmitted to potato seedlings free from the latent virus of healthy potatoes, it caused a disease characterized by nearly normal color, faint mottling, rugoseness, and only slight distortion of the leaves.

Smith (14) found that when juice of mosaic-affected potatoes was pricked into healthy tobacco plants a ring spot developed. Transmission by the aphid *Myzus persicae* of a virus from mosaic potatoes to tobacco resulted in vein banding. When juice from healthy potatoes was transmitted no symptoms appeared. Koch (8) found that the rugose mosaic of potato consists of two distinct viruses. One is easily transmitted by aphids; the other, the "mottle," or latent virus of apparently healthy potato, can be transmitted mechanically but not by aphids. The aphid-transmitted or vein-banding virus, when transferred to tobacco, caused only a clearing of the veins. When transmitted mechanically, the combined rugose-mosaic viruses (vein-banding virus plus latent virus) produced spot necrosis on tobacco.

MATERIALS AND METHODS

The following plants were grown from seed and studied as hosts of virus diseases of potato: jimsonweed (*Datura stramonium* and *D. tatula*), nightshade (*Solanum villosum*), bitter nightshade (*S. dulcamara*), groundcherry (*Physalis* sp.), tomato (*Lycopersicon esculentum*), redpepper (*Capsicum annuum* L.), and petunia (*Petunia hybrida*).

Tubers known to be infected with rugose mosaic or leaf roll and also those from apparently healthy potatoes were planted in pots in the greenhouse. When potatoes infected with rugose mosaic or so-called healthy potatoes served as the source of inoculum, the leaf-mutilation method was used; that is, the leaves from the diseased plants were macerated and the extracted juice was rubbed into the leaves of healthy plants. Previous studies had shown that the incubation period of rugose mosaic is from 3 to 4 weeks; therefore 6 weeks after the plants were inoculated, juice was extracted from their leaves and rubbed into the leaves of a series of healthy potato plants. Potato plants containing the latent virus will manifest necrotic spots on the leaves if they are inoculated by leaf mutilation with the vein-banding virus (fig. 1).

In the spring of 1931, aphids (*Myzus persicae*) were colonized on a Burbank potato plant affected with rugose mosaic and were then transferred to three Marglobe tomato plants. No symptoms developed except a faint clearing of the veins, nor did these tomato plants appear to be stunted in their growth. This species of aphid

does not transfer the latent virus of apparently healthy potatoes, as was determined in tests including nearly 100 plants; it transmits only the vein-banding component of the rugose mosaic. This aphid-transmitted virus has been transferred mechanically by leaf mutilation from tomato to apparently healthy potatoes, potato seedlings, and other solanaceous plants. Valteau and Johnson (16) found this

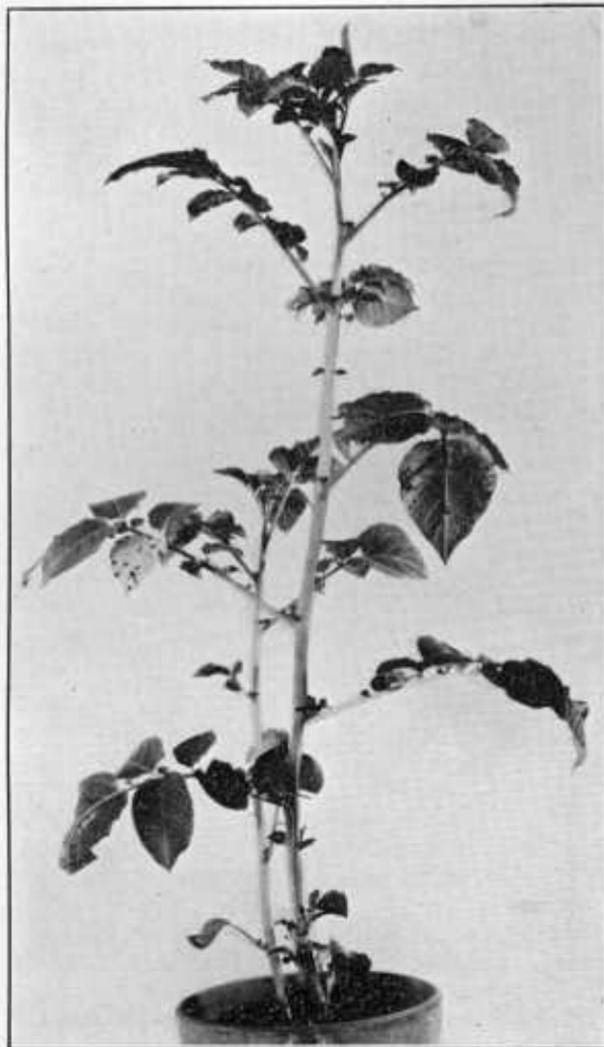


FIGURE 1.—American Giant (Pride of Wisconsin) potato plant containing the latent virus; inoculated by leaf mutilation with vein-banding mosaic from an infected potato plant; shows necrotic spots on leaves.

virus occurring naturally on tobacco and referred to the disease as vein banding. In the present paper the term "vein banding" is used for the aphid-transmitted component of rugose mosaic.

The aphid-transmission method was used to transmit leaf roll, since it cannot be transmitted by leaf mutilation. Aphids (*Myzus persicae*) were colonized under muslin-covered insect cages on potato plants infected with leaf roll and left there for 2 weeks or more. About 20 of the aphids were then transferred to each of the plants that were to be inoculated and left there for 6 days. The cages were then removed and the plants were fumigated to kill the aphids. About 20 to 25 days after inoculation, when symptoms of leaf roll appeared, non-viruliferous aphids were colonized on these plants and later transferred to young healthy potato plants, which were also fumigated after 6 days.

The greenhouse was fumigated frequently. Numerous potato plants and other solanaceous plants were growing in the greenhouse, but not a single case of leaf roll developed on any of the uninoculated plants.

The aphids used were obtained from carnation plants growing in one of the greenhouses and were colonized on cabbage plants and egg-

plants growing under muslin-covered insect cages. Occasionally these aphids were transferred to potato plants to determine whether the aphids were free from the leaf-roll virus; in all cases the potato plants remained healthy.

SYMPTOMS OF RUGOSE MOSAIC, VEIN BANDING, AND LEAF ROLL ON VARIOUS PLANTS

SYMPTOMS ON JIMSONWEED

Two species of jimsonweed (*Datura stramonium* and *D. tatula*) developed a pronounced mottling when inoculated by leaf mutilation with juice from apparently healthy potato plants or from potato plants affected with rugose mosaic. The mottling was characterized by large yellowish-green blotches on the leaves.

Attempts were made to transmit the rugose mosaic by leaf mutilation from either species of *Datura* inoculated with this disease to potato plants, but all results were negative (table 1).

TABLE 1.—Cross inoculations with rugose mosaic from potato by leaf mutilation

Species tested	Plants inoculated with rugose mosaic from potato		Return inoculations to potato plants		
	Total	Infected	Total	Infections	Notes
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	
<i>Solanum villosum</i>	10	7	15	13	Latent-virus mottling.
<i>Physalis</i> sp.....	10	6	10	8	Latent-virus mottling and some rugosity.
<i>Petunia hybrida</i>	10	7	(^a)	-----	
<i>Lycopersicon esculentum</i>	25	25	30	27	
<i>Datura tatula</i>	10	0	10	0	Latent-virus mottling.
<i>Datura stramonium</i>	10	0	10	0	Do.
<i>Capsicum annuum</i>	15	0	10	0	Necrosis, like that caused by the latent virus.
<i>Solanum dulcamara</i>	10	0	10	0	No symptoms.

^a No return inoculations to potato.

The vein-banding mosaic failed to produce any symptoms when introduced into jimsonweed, nor could the virus be recovered by making return inoculations into young potato plants (table 2). Valleau and Johnson (16) reported similar results.

TABLE 2.—Cross inoculations of aphid-transmitted vein-banding component of rugose mosaic by means of leaf mutilation

Species tested	Plants inoculated with vein banding from tomato		Return inoculations to potato plants	
	Total	Infected	Total	Infections
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
<i>Solanum tuberosum</i> (seedling).....	20	17	(^a)	-----
<i>Solanum tuberosum</i>	20	18	(^a)	-----
<i>Solanum villosum</i>	10	10	6	6
<i>Physalis</i> sp.....	10	7	10	7
<i>Lycopersicon esculentum</i>	15	15	(^a)	-----
<i>Datura stramonium</i>	10	0	6	0
<i>Petunia hybrida</i>	10	8	6	6

^a No return inoculations to potato.

Datura does not appear to be a host of the vein-banding component of rugose mosaic, but it is very susceptible to the latent virus of apparently healthy potatoes. In the summer of 1930, 6 plants of *Datura stramonium* and 6 of *D. tatula* were planted in a potato field, and every one of these weeds developed a pronounced mottling as a result of natural transmission of the latent virus from apparently healthy potato plants. It was not determined whether this transmission was due to insect transfer or to other means, such as the processes of cultivation or mechanical contact of the leaves caused by the wind.

Leaf roll was transmitted by aphids from potato to *Datura stramonium* and *D. tatula* and from these weeds to potato (table 3). On the two species of *Datura*, leaf roll was characterized by a distinct chlorosis

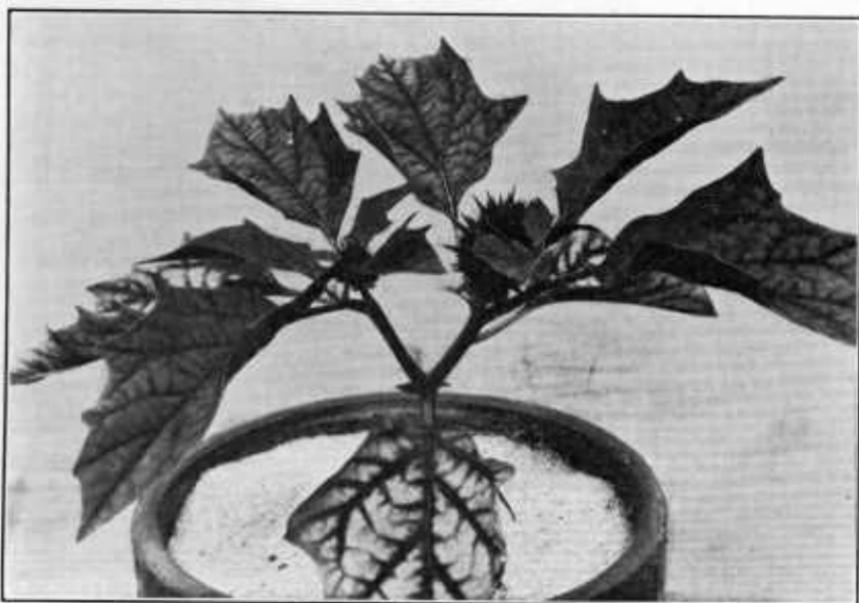


FIGURE 2.—*Datura stramonium* infected with leaf roll through the agency of aphids (*Myzus persicae*) that were transferred from an infected potato plant; shows chlorosis and rolling of leaves.

and rolling of the leaves, which became leathery as the disease progressed (fig. 2).

TABLE 3.—Cross inoculations with leaf roll by means of aphids (*Myzus persicae*)

Source of inoculum	Species tested	Plants inoculated with leaf roll		Return inoculations to potato		
		Total	Infected	Total	Infections	
		Number	Number	Number	Number	
Potato	<i>Datura tatula</i>	5	5	4	3	
	<i>Datura stramonium</i>	10	9	10	7	
	<i>Solanum villosum</i>	12	10	7	6	
	<i>Solanum dulcamara</i>	9	(a)	6	5	
	<i>Capsicum annuum</i>	5	4	8	b 3	
	<i>Lycopersicon esculentum</i>	15	13	9	7	
	<i>Physalis</i> sp.....	10	0	10	0	
	<i>Solanum tuberosum</i>	11	10			
	<i>Datura tatula</i>	<i>Lycopersicon esculentum</i>	4	3	(c)	
		<i>Solanum villosum</i>	6	5	(c)	
Tomato	<i>Datura stramonium</i>	2	2	(c)		
	<i>Lycopersicon esculentum</i>	6	5	(c)		

(a) Apparently symptomless carrier of leaf roll.

(b) Symptoms not typical of leaf roll.

(c) No return inoculations to potato.

SYMPTOMS ON NIGHTSHADE

Nightshade (*Solanum villosum*) developed a pronounced mottling when inoculated with juice from apparently healthy potato plants or from those infected with rugose mosaic. When infected plants were growing in the greenhouse or under muslin-covered insect cages, the mottling was quite distinct. In the summer of 1930 three nightshade plants infected with rugose mosaic were planted outdoors, but during the summer the symptoms were completely masked and it was impossible to recognize the disease on the plants. However, rugose mosaic was readily transmitted from infected *Solanum villosum* to potato by leaf mutilation (table 1).

Vein-banding virus alone caused a faint vein banding in some of the nightshade leaves, but the symptoms were generally difficult

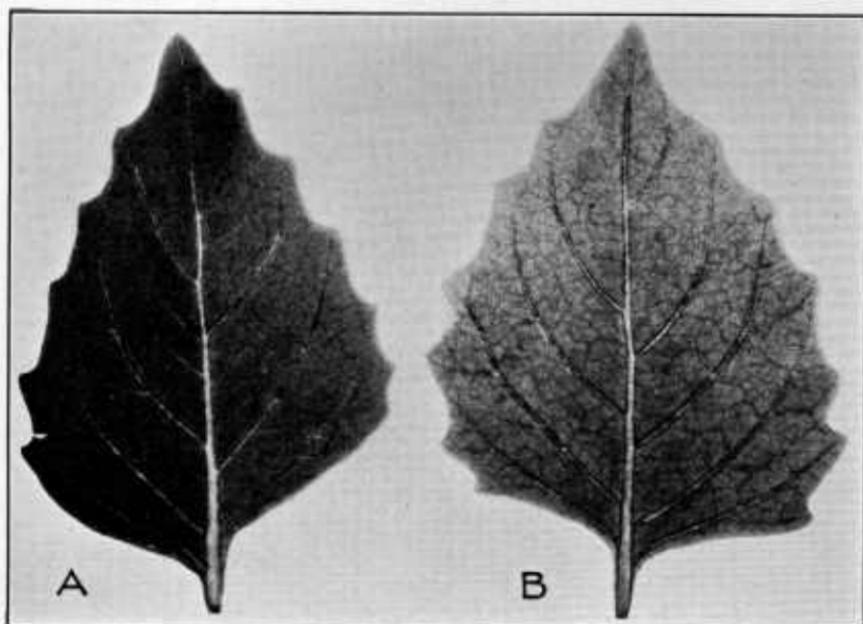


FIGURE 3.—Leaves of *Solanum villosum*: A, Healthy leaf; B, leaf from plant inoculated by leaf mutilation with vein-banding mosaic from an infected tomato plant, showing dark bands along veins characteristic of the disease.

to detect (fig. 3). The virus from such infected weeds can be readily transferred by leaf mutilation to apparently healthy potatoes, causing typical rugose-mosaic symptoms (table 2).

The leaf-roll virus was readily transmitted from potato to nightshade and returned to potato by *Myzus persicae*. The symptoms on nightshade were distinct chlorosis and rolled leaves (fig. 4). The disease was first apparent in some of the younger leaves, which became leathery as the disease progressed; finally all leaves of the plant showed leaf-roll symptoms (table 3).

SYMPTOMS ON BITTER NIGHTSHADE

Bitter-nightshade plants (*Solanum dulcamara*) were inoculated with juice from healthy potato plants and also from potato plants affected with rugose mosaic, but no symptoms of any kind developed, nor

was it possible to recover the rugose-mosaic virus when return inoculations were made to potato (table 1).

When leaf roll is transferred by aphids from potato to bitter-nightshade plants the disease may show very strikingly. One plant to which the disease was transmitted ceased growing and became very much stunted, although it remained alive. The leaves became chlorotic and stiff. Other bitter-nightshade plants inoculated at the same time in a similar manner, although carrying the virus, appeared healthy. Leaf roll was transmitted from both types of plant back to potato (table 3).

SYMPTOMS ON TOMATO

When a tomato plant (*Lycopersicon esculentum*) was inoculated with juice from an apparently healthy potato plant, a faint mottling of pale-green areas developed which was distributed irregularly

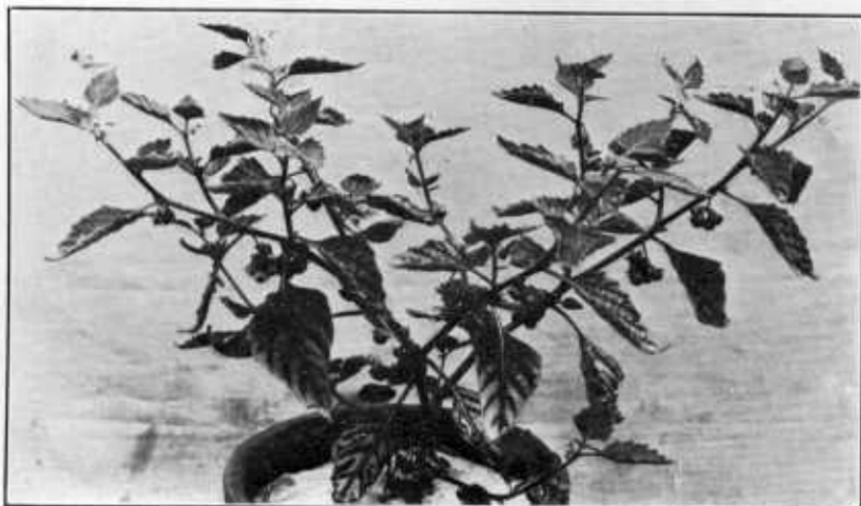


FIGURE 4.—*Solanum villosum* infected with leaf roll through the agency of aphids (*Myzus persicae*) that were transferred from an infected potato plant; shows chlorosis and rolling of leaves.

over the surface of the leaf. Inoculations from potatoes infected with rugose mosaic generally caused a necrosis of the leaves. This disease was readily transmitted from infected tomato plants back to potato. In some cases, instead of a necrosis, mottling developed that was indistinguishable from the type caused by the latent virus. Three tomato plants showing such symptoms were grown in the field under cages during the summer of 1930, but they did not develop necrosis. When juice from these plants was inoculated into potato, however, typical symptoms of rugose mosaic resulted (table 1).

In the spring of 1931, aphids (*Myzus persicae*) from a Burbank potato plant infected with rugose mosaic were transferred to three Marglobe tomato plants. Six weeks after inoculation the tomato plants appeared healthy except for a faint clearing of the veins. Return inoculations by leaf mutilation from each of the three plants into potato plants already carrying the latent virus resulted in typical rugose-mosaic symptoms. This indicated that the aphids had

transmitted the vein-banding component of rugose-mosaic virus to each of the three tomato plants, causing only a slight clearing of the veins and apparently not interfering with normal growth. As previously indicated, in the transfer of leaf roll from potato to solanaceous weeds by *M. persicae* where only leaf roll and not the latent virus was transmitted, this species of aphid is unable to transmit the latent virus.

When the vein-banding virus was transferred by leaf mutilation from tomato to potato seedlings and to plants raised from tubers from second-year seedlings, only an interveinal type of mottling developed, without necrosis or rugosity. These plants remained vigorous for a long time and their growth did not appear to be appreciably checked by the disease. However, when potato seedlings were inoculated by leaf mutilation with the latent virus of apparently healthy potatoes, a severe necrosis of leaves and stems developed, causing the death of the plants 16 days after inoculation (fig. 5).



FIGURE 5.—Potato seedling showing necrosis on leaflets 12 days after inoculation by leaf mutilation with the latent virus from an apparently healthy potato plant.

Leaf roll was also readily transferred from potato to tomato by aphids (table 3). The symptoms were not very distinct. The leaves showed practically no rolling but became rigid and somewhat leathery; no stunting of the plant was observed.

Two tomato plants infected with leaf roll were inoculated with tomato mosaic, and although the latent virus was not present, the combination of the leaf-roll virus and tomato mosaic developed typical streak.

Leaf roll was readily transmitted from tomato to potato by means of aphids (fig. 6); it has also been transferred from tomato to jimsonweed and nightshade in the same way.

SYMPTOMS ON GROUNDCHERRY

When the common groundcherry (*Physalis* sp.) was inoculated by leaf mutilation with the latent virus from an apparently healthy potato plant, a faint mottling developed. Inoculation with virus from potatoes infected with rugose mosaic caused a more pronounced mottling and some rugosity, but apparently no necrosis (fig. 7).

Rugose mosaic was also readily transferred from infected *Physalis* to potato (table 1).

When groundcherry plants were inoculated with the vein-banding virus, no symptoms developed; 5 weeks after inoculation, however,



FIGURE 6.—American Grant (Pride of Wisconsin) potato plant infected with leaf roll through the agency of aphids (*Myzus persicae*) that were transferred from an infected tomato plant.

when inoculum from a number of the inoculated plants was transferred to potato plants infected with latent virus, typical rugose-mosaic symptoms developed.

No symptoms were evident after *Physalis* plants were inoculated by means of aphids with leaf roll from potato, nor could the disease be retransferred from such inoculated plants to potato (table 3).

SYMPTOMS ON REDPEPPER

When young redpepper plants (*Capsicum annuum*) were inoculated by leaf mutilation with the latent virus from apparently healthy potato plants or the juice from those infected with rugose mosaic, severe necrosis and leaf dropping resulted (table 1). Apparently there were no differences in the symptoms caused by the two viruses. Transfers to potato of juice from peppers inoculated with rugose



FIGURE 7.—Groundcherry (*Physalis* sp.) showing mottling and rugosity of the leaves produced by inoculating the plant by leaf mutilation with juice from a potato plant infected with rugose mosaic.

mosaic, however, failed to produce any symptoms. No inoculations were made with the vein-banding virus alone.

During the summer of 1930 eight pepper plants were planted in a potato field, but no necrosis or leaf dropping due to probable natural transmission from the potatoes developed.

Attempts were made to transfer leaf roll by means of aphids from potato to pepper. Some rolling and chlorosis developed in the affected plants. When the disease was transferred back to potato some rolling developed, but the symptoms were not typical of leaf roll. Further testing is needed before pepper can be classified as a host of leaf roll (table 3).

SYMPTOMS ON PETUNIA

Plants of petunia (*Petunia hybrida*) were inoculated by leaf mutilation with rugose mosaic from potatoes (fig. 8). Of the 10 plants inoculated, only 1 developed severe necrosis; the other 9 showed no symptoms of disease. No return inoculations from these plants to potato were made. Later inoculations with rugose mosaic have resulted in a mottling or a necrosis of the petunia leaves in a very large percentage of the plants inoculated.

When the vein-banding virus was inoculated into petunia, a faint clearing of the veins developed. ¹ After the plants became older these



FIGURE 8.—Petunia showing necrosis on some of the leaves as a result of inoculation by leaf mutilation with juice from a potato plant infected with rugose mosaic.

symptoms disappeared. Return inoculations from these plants to potatoes carrying the latent virus developed typical rugose-mosaic symptoms.

No attempt was made to transmit leaf roll to this host.

TRANSMISSION OF LEAF ROLL AND RUGOSE MOSAIC BY INSECTS OCCURRING ON POTATO PLANTS

It was considered important to determine whether insects that feed on potato plants under natural conditions are able to transmit virus diseases from infected weeds to potato. Accordingly two large muslin-covered insect cages were built. In the larger cage the following plants infected with leaf roll were interplanted among 85 healthy potato plants: *Solanum villosum*, 6 plants; *Datura stramonium*, 4 plants; tomato, 1 plant. Insects collected from a field of healthy

potatoes at the Oregon Agricultural Experiment Station at Corvallis, Oreg., were introduced into the cage. During the growing season 11 percent of the potato plants developed current-season symptoms of leaf roll. At digging time the progenies of all the potato plants were saved, and in the spring of 1931 they were planted in the field. Of the 433 tubers planted, 355 (82 percent) developed into plants showing typical tuber-perpetuated leaf-roll symptoms.

In the smaller cage, 6 *Solanum villosum* plants and 2 tomato plants, all of which were infected with rugose mosaic, were planted among 52 healthy potato plants. Miscellaneous insects, collected from the same field of healthy potatoes as were the insects used to transmit leaf roll, were introduced into the cage in order to determine whether they would spread rugose mosaic from the weeds to the potato plants.

During the growing season 10 percent of the potato plants developed current-season symptoms of rugose mosaic. The progenies from all the plants were saved and planted in the field in 1931. Of the 157 tubers planted, 84 (53 percent) developed typical tuber-perpetuated rugose mosaic; but in addition to this, 9 plants (6 percent) developed tuber-perpetuated leaf-roll symptoms. Since the smaller cage did not have a double door like that built in the larger one, and since the two cages adjoined each other, there is a possibility that some insects from the larger cage were accidentally introduced into the smaller one. No leaf roll was present in the field from which the insects were collected, nor were any current-season symptoms of leaf roll evident in the plants of the smaller cage during 1930.

Specimens of the insects used in these transmission experiments were sent for identification to H. Morrison, of the Bureau of Entomology, United States Department of Agriculture. The following species were identified: *Myzus persicae*, *Illinoia solanifolii* (Ashm.), *Epitrix subcrinita* Lec., *Sciara* sp., *Chironomus* sp., *Empoasca* sp., cicadellid species, *Nabis alternatus* Parsh., *Lygus pratensis* (L.), and *Philaenus spumarius* Fall.

Experiments are now in progress to determine the ability of each of these insects to transmit the virus diseases of the potato.

ATTEMPTS TO TRANSMIT THE LATENT VIRUS BY MEANS OF INSECTS

It is of interest to know whether or not the latent virus of apparently healthy potatoes is readily transmitted by insects. This information is of importance in determining whether promising new potato seedlings should be grown in isolation from apparently healthy potatoes in order to keep them from becoming infected with the latent virus. This knowledge is also valuable in the testing of potato seedlings for resistance to virus diseases. The symptoms of some of these diseases on potatoes free from the latent virus are very mild, and this may erroneously be interpreted as resistance or tolerance of the potatoes to virus diseases.

In order to secure some data on insect transmission of the latent virus, five different species of insects occurring on potato, namely, western potato flea beetle (*Epitrix subcrinita*), leaf hopper (*Empoasca* sp.), tarnished plant bug (*Lygus pratensis*), spittle bug (*Philaenus spumarius*), and *Nabis alternatus*, were collected from a field of healthy potatoes.

In the late summer of 1931, 8 to 10 insects from each of these 5 species were transferred to 5 separate lots, respectively, consisting of 12 individually caged jimsonweed plants. The insects were left on the plants for 7 days; the plants were then fumigated to kill the insects, and the cages were removed. In all cases the jimsonweeds remained normal, with the exception of those to which the spittle bug (*Philaenus spumarius*) had been transferred. These 12 plants developed large yellow blotches on the leaves about 12 days after the insects had been transferred to them. The type of mottling was not quite typical of that caused by the latent virus.

To determine whether the mottling was due to the latent virus or to an enzyme or a toxin injected by the insect, this same species of insect was collected from an alfalfa field and transferred to 10 tomato plants and 10 jimsonweeds. No symptoms developed on the tomato plants, but some blotches were evident on the jimsonweeds about 12 days after the spittle bugs had been transferred to them.

Additional spittle bugs (*Philaenus spumarius*) were collected from a potato field and transferred to 10 tomato plants, none of which developed any symptoms.

No symptoms developed when 10 tomato plants were inoculated by leaf mutilation with juice from jimsonweeds that showed yellow blotches on the leaves after spittle bugs collected from potato plants had fed on them.

These experiments will have to be repeated on a larger scale, and other insects occurring on potato will have to be tested, before any final conclusions can be drawn; but the results secured so far do not indicate that the latent virus of apparently healthy potatoes is readily transmitted by insects.

DISCUSSION AND CONCLUSIONS

It has been demonstrated that certain weeds growing in or near potato fields may, under natural conditions, become infected with potato-virus diseases. Insects naturally occurring on potato plants are able to transmit leaf roll and rugose mosaic from weeds to potato.

When solanaceous weeds become naturally infected with rugose mosaic, only the vein-banding virus may be present; the symptoms caused by this virus on weeds are very difficult to detect.

The fact that vein banding caused only mild mottling on potatoes free from the latent virus, in contrast to the severe disease it develops on apparently healthy potatoes carrying the latent virus, suggests that the effects of certain potato-virus diseases, namely, vein banding and leaf roll, may be greatly intensified by the presence of the latent virus.

Potato seedlings that were inoculated with leaf roll remained alive and vigorous in pots in the greenhouse considerably longer than did apparently healthy potato plants carrying the latent virus that were inoculated with leaf roll.

Weeds infected with leaf roll generally show chlorosis, rolling of the leaves, and a tendency to be leathery.

SUMMARY

Rugose mosaic was transmitted by leaf mutilation from potato to *Solanum villosum*, *Physalis* sp., tomato, and petunia.

Aphids (*Myzus persicae*) did not transmit the latent virus from apparently healthy potatoes to other solanaceous plants.

From potatoes infected with rugose mosaic, *Myzus persicae* transmitted to tomatoes only the vein-banding component of the virus complex.

The vein-banding virus alone causes very faint symptoms in susceptible host plants, characterized in soft-leaved plants by a banding of the veins.

The vein-banding virus when inoculated into apparently healthy potato plants (carrying the latent virus) causes typical rugose-mosaic symptoms; when inoculated into potato seedlings free from the latent virus, vein banding causes only a faint type of mottling.

Leaf roll was transmitted by *Myzus persicae* from potato to *Solanum villosum*, *S. dulcamara*, *Datura stramonium*, *D. tatula*, and *Lycopersicon esculentum*.

Insects naturally occurring on potato can transmit leaf roll and rugose mosaic from infected weeds to potato.

Five different species of insects naturally occurring on potato failed to transmit the latent virus of apparently healthy potatoes to jimson-weed.

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