# A SPECIFIC MOSAIC DISEASE IN NICOTIANA VISCOSUM DISTINCT FROM THE MOSAIC DISEASE OF TOBACCO

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During the summer of 1915 many plants of *Nicotiana viscosum* and first-generation plants of the cross *N. tabacum* ♀ × *N. viscosum* ♂ were grown in the field at Arlington, Va. Late in the season three plants of *N. viscosum* and one of the hybrid plants showed unmistakable symptoms of a typical mosaic disease. From the fact that the species viscosum and its hybrids had never before shown symptoms of disease from inoculations made with the virus of the ordinary mosaic disease of tobacco, these affected plants were taken into the greenhouse for further study. It has now been established that this mosaic disease affecting *N. viscosum* and its hybrids is biologically very different from the ordinary form of mosaic disease affecting varieties of *N. tabacum*, tomatoes (*Lycopersicon esculentum*), etc. Ordinary tobacco and also tomatoes appear to be quite immune from the type of mosaic disease in *N. viscosum*. Experiments have shown that this mosaic disease is infectious to plants of *N. viscosum*, although it appears that the disease is not as readily transferred by needle inoculations as the ordinary form of the mosaic disease, and longer periods of time are usually required before the disease comes into evidence.

A number of distinct varieties of *N. tabacum* have been crossed with *N. viscosum*, including Maryland Mammoth, White Burley, and Connecticut Broadleaf. In these crosses the pollen of *N. viscosum* has been transferred to the pistils of *N. tabacum*. In size, general appearance, and habit of growth first-generation plants of these crosses resemble much more closely the female parent (*N. tabacum*) than the male parent (*N. viscosum*). In general appearance the leaves and blossoms also resemble very closely the leaves and blossoms of the female parent. These first-generation plants inherit more strongly the visible physical characteristics of the female parent. They possess, however, certain physiological characteristics peculiar to the male parent (*N. viscosum*). This is indicated by the fact that they, like *N. viscosum*, appear to be immune to that form of mosaic disease which affects varieties of *N. tabacum*, but are susceptible to the mosaic disease affecting *N. viscosum*. The disease is readily obtained in these hybrids by grafting upon them scions taken from plants of *N. viscosum*. It is much more difficult to obtain the disease by needle inoculations. All phases of catacorolla in the blossoms and mottling and distortions in the leaves are shown in these hybrids affected with the

Journal of Agricultural Research,
Dept. of Agriculture, Washington, D. C.
gl

Vol. VII, No. 11
Dec. 11, 1916
G—101

mosaic disease of *N. viscosum* as in ordinary tobacco plants affected with the common form of the mosaic disease (Pls. 35 and 36.) The mosaic disease of *N. viscosum* produces more or less mottling and distortion in the blossoms of these plants. The abnormality known as catacorolla, however, has never appeared in connection with the disease.

TABLE I.—*Inoculations made with the expressed sap of scions of N. viscosum grafted upon ordinary tobacco (N. tabacum)*

| Number of plants inoculated (Connecticut Broadleaf). | Date of inoculations. | Material used. | Symptoms of mosaic disease in scion of *N. viscosum*. | Results. |
|---|---|---|---|---|
| | 1915. | | | |
| 10 | Dec. 16 | Sap of scion of *N. viscosum* grafted on mosaic stock of *N. tabacum* several weeks. | None..... | All healthy. |
| 10 | 16 | .....do..... | ...do..... | 3 mosaic. |
| 10 | 16 | Tap water (control)..... | ..... | All healthy. |
| | 1916. | | | |
| 10 | Jan. 5 | Sap of scion of *N. viscosum* grafted upon mosaic stock of *N. tabacum* till scion was in bloom. | None..... | 7 mosaic. |
| 10 | 5 | Sap of stock upon which above scion was grafted (symptoms in stock severe). | ..... | 10 mosaic. |
| 10 | 5 | Sap of scion of *N. viscosum* grafted upon mosaic stock of *N. tabacum* till scion was in bloom. | None..... | 2 mosaic. |
| 10 | 5 | Tap water (control)..... | ..... | All healthy. |
| 10 | 8 | Sap of scion of *N. viscosum* grafted on stock of *N. tabacum* several weeks. | None..... | Do. |
| 10 | 8 | Tap water (control)..... | ..... | Do. |
| 10 | 12 | Sap of scion of *N. viscosum* grafted several weeks on stock of *N. tabacum*. | None..... | Do. |
| 10 | 12 | .....do..... | ...do..... | Do. |
| 10 | 12 | .....do..... | ...do..... | Do. |
| 10 | 29 | Sap of scion of *N. viscosum* grafted upon stock of *N. tabacum* till scion was in bloom. | ...do..... | Do. |
| 10 | 29 | .....do..... | ...do..... | Do. |
| 10 | 29 | .....do..... | ...do..... | Do. |
| 10 | 29 | .....do..... | ...do..... | Do. |
| 10 | 29 | .....do..... | ...do..... | Do. |
| 10 | 29 | Sap of scion of *N. viscosum* grafted upon stock of *N. tabacum* several weeks. | ...do..... | Do. |
| 10 | 29 | Tap water and healthy sap..... | ..... | Do. |

Although the species *N. viscosum* is susceptible to a mosaic disease peculiar to itself, this species of Nicotiana appears to be immune to the ordinary form of mosaic disease affecting *N. tabacum*. Likewise, first-generation plants of the cross *N. tabacum* ♀ × *N. viscosum* ♂ appear to be quite as immune from the disease as the species *N. viscosum*. All

methods of inoculation which have been attempted with these plants have been without success. It has been shown that the virus was not present in these plants by extracting the sap of all parts of the plants and testing its infectivity by making inoculations into young tobacco plants. These inoculations have never produced infection. Furthermore, many successful grafts have been made between *N. tabacum* and *N. viscosum*, using *N. tabacum* as the stock. As soon as the *N. viscosum* scion had started to grow, the stock (*N. tabacum*) was inoculated with the ordinary form of the mosaic disease. Scions of *N. viscosum* in many instances remained upon the mosaic stocks for many weeks and finally blossomed, yet symptoms of the mosaic disease never appeared in the blossoms or leaves. In all instances inoculation tests have been made to determine if the infective principle of the disease was present in the sap of the immune scions. As shown in Table I, these scions in many instances appeared to be entirely free from infection. In other instances the sap proved to be more or less infectious to tobacco plants. Why the sap of the scion should carry the infective principle at one time and not at another can not at present be explained.

The mosaic disease affecting *N. viscosum* appears to be identical in all its symptoms with the mosaic disease of tobacco (*N. tabacum*). The virus of the disease, however, has behaved very differently from the virus of the mosaic disease of tobacco in all inoculation tests. With the exception of *Datura fastuosa* (Golden Queen variety), and *Datura stramonium*, no other plants of the solanaceous family have been found susceptible to the virus of the mosaic disease affecting *N. viscosum*. Although peppers and tomatoes are very susceptible to the virus of the mosaic disease of tobacco, these plants appear to be immune from the virus of the mosaic disease affecting *N. viscosum*, or at least highly resistant to it, since the most persistent and rigorous needle inoculations have failed to produce infection. The most rigorous methods of inoculation have also failed to produce either the mosaic disease of tobacco or the mosaic disease of *N. viscosum* in the Irish potato (*Solanum tuberosum*).

*Datura stramonium* is the only solanaceous plant which has given evidence of being susceptible to both mosaic diseases. Inoculations made at different times with different lots of virus producing the mosaic disease in *N. tabacum* have given very different results. In some tests the plants were highly resistant to infection. In other tests similar methods of inoculation gave a high percentage of mosaic-diseased plants. It has not been determined whether this variability indicates differences in the infective properties of the virus or differences in the relative resistance of different lots of plants. In one experiment 18 young vigorous plants of *Datura stramonium* were divided into two lots of 9 plants each. One lot was inoculated at many points in the stems and leaves with the virus of the mosaic disease of *N. viscosum*. The remain-

ing 9 plants were inoculated in the same manner with the virus of the mosaic disease of *N. tabacum.* For a period of several weeks numerous inoculations were made from time to time in each lot of plants. The plants of each lot were also cut back severely several times and the virus inoculated into all cut surfaces. The plants were kept under observation for several months. Every plant in the series inoculated with the virus of the mosaic disease of *N. viscosum* developed the disease, the first observable symptoms appearing 21 days after the first inoculation. In this experiment the datura plants proved to be highly resistant to the virus of the mosaic disease of *N. tabacum*, as none became diseased. In those plants affected with the mosaic disease of *N. viscosum* the symptoms were particularly malignant. The leaves became greatly curled, wrinkled, and depauperate. Mottling of the leaves, however, was less marked than in those instances where *Datura stramonium* has been affected with the mosaic disease of *N. tabacum.*

The virus of the mosaic disease affecting *N. viscosum* differs from the virus of the mosaic disease of tobacco as follows:

| CHARACTERISTICS OF THE VIRUS OF THE MOSAIC DISEASE OF TOBACCO (N. TABACUM) | CHARACTERISTICS OF THE VIRUS OF THE MOSAIC DISEASE AFFECTING N. VISCOSUM |
|---|---|
| (1) Transmission through the seed has never occurred. | (1) Transmission through the seed has never occurred. |
| (2) Incubation period short (minimum 6 days). | (2) Incubation period in *N. viscosum* rather long (minimum may be several weeks). |
| (3) Needle inoculations readily produce the disease. | (3) Needle inoculation rather uncertain. Grafts of mosaic-diseased shoots of *N. viscosum* upon susceptible plants readily produce infection. |
| (4) All attempts to infect belladonna (*Atropa belladonna*) and *Solanum tuberosum* have been unsuccessful. | (4) All attempts to infect belladonna and *Solanum tuberosum* have been unsuccessful. |
| (5) All attempts to infect pokeweed (*Phytolacca decandra*) have been unsuccessful. | (5) All attempts to infect pokeweed have been unsuccessful. |
| (6) All attempts to infect the hybrid *N. tabacum* ♀ × *N. viscosum* ♂ have been unsuccessful. | (6) The hybrid *N. tabacum* ♀ × *N. viscosum* ♂ is susceptible, manifesting typical symptoms of the disease. |
| (7) Highly infectious to tomatoes. | (7) All attempts to infect tomatoes have been unsuccessful. |
| (8) Infectious to the pepper (*Capsicum cerasiforme*). | (8) All attempts to inoculate the pepper have been unsuccessful. |
| (9) All attempts to infect sweet peas have been unsuccessful. | (9) All attempts to infect sweet peas have been unsuccessful. |
| (10) All attempts to infect *Datura fastuosa* (Golden Queen variety) have been unsuccessful. | (10) *Datura fastuosa* (Golden Queen variety) is susceptible, manifesting symptoms more or less typical of the disease. |
| (11) Affects Jimson weed (*Datura stramonium*) producing typical symptoms. | (11) Affects Jimson weed, producing symptoms very similar to those produced |

| | |
|---|---|
| Jimson weed, however, sometimes shows considerable resistance to the mosaic disease affecting *N. tabacum*. | by the ordinary mosaic disease of tobacco. |
| (12) Highly infectious and particularly malignant to *N. rustica*. | (12) All attempts to infect *N. rustica* have been unsuccessful. |

The writer is of the opinion that this distinctive type of mosaic disease affecting *N. viscosum* has in some manner originated from the ordinary form of mosaic disease, possibly through the agency of insect transmission in the field. This does not seem improbable, since practically every susceptible plant in a half-acre field of ordinary tobacco in which the *N. viscosum* plants were grown became mosaic; and throughout the season both species were infested with great numbers of flea beetles. It is possible that insects may become efficient transmitters of disease where ordinary methods of artificial inoculation fail.

During the same season the writer's attention was called to the occurrence of typical symptoms of the mosaic disease in peppers grown in a field near by. To all outward appearances the plants were affected with a severe mosaic disease which gradually spread over the field and persisted in all affected plants. Tomato plants in adjoining rows, however, were unaffected. The expressed sap from the most severely attacked pepper plants failed to produce the mosaic disease in young tobacco plants (*N. tabacum*). Whether this mosaic disease was infectious to healthy pepper plants or might have been in any way related to the mosaic disease affecting *N. viscosum* was not determined.

In this connection it is interesting to note that various European investigators have reported that they were unable to inoculate other species of solanaceous plants with the virus of the mosaic disease of tobacco with which they worked. Thus, Mayer [1] failed to produce the disease in other solanaceous plants.

Iwanowski [2] has stated that the mosaic disease of tobacco does not occur upon *Datura stramonium* or *Hyoscyamus niger*.

Iwanowski,[3] in a later publication, stated that he had never known *Nicotiana rustica* to be affected by the mosaic disease.

Koning [4] also failed to communicate the mosaic disease of tobacco to *Datura stramonium*, *Hyoscyamus niger*, *Solanum tuberosum*, and *Petunia nyctaginifolia*.

Westerdijk,[5] working with a mosaic disease which was infectious to tomatoes, reported that she could not communicate this disease to

[1] Mayer, Adolf. Ueber die Mosaikkrankheit des Tabaks. *In* Landw. Vers. Stat., Bd. 32, p. 450–467, pl. 3. 1886.

[2] Iwanowski, D. Über die Mosaikkrankheit der Tabakspflanze. *In* Bul. Acad. Imp. Sci. St. Petersb., n. s. v. 3 (v. 35), no. 1, p. 67–70. 1892.

[3] Iwanowski, D. Über die Mosaikkrankheit der Tabakspflanze. *In* Centbl. Bakt. [etc.] Abt. 2, Bd. 5, No. 8, p. 250–254, 2 fig. 1899.

[4] Koning, C. J. Der Tabak . . . p. 71–86, fig. 13–15. Amsterdam, 1900.

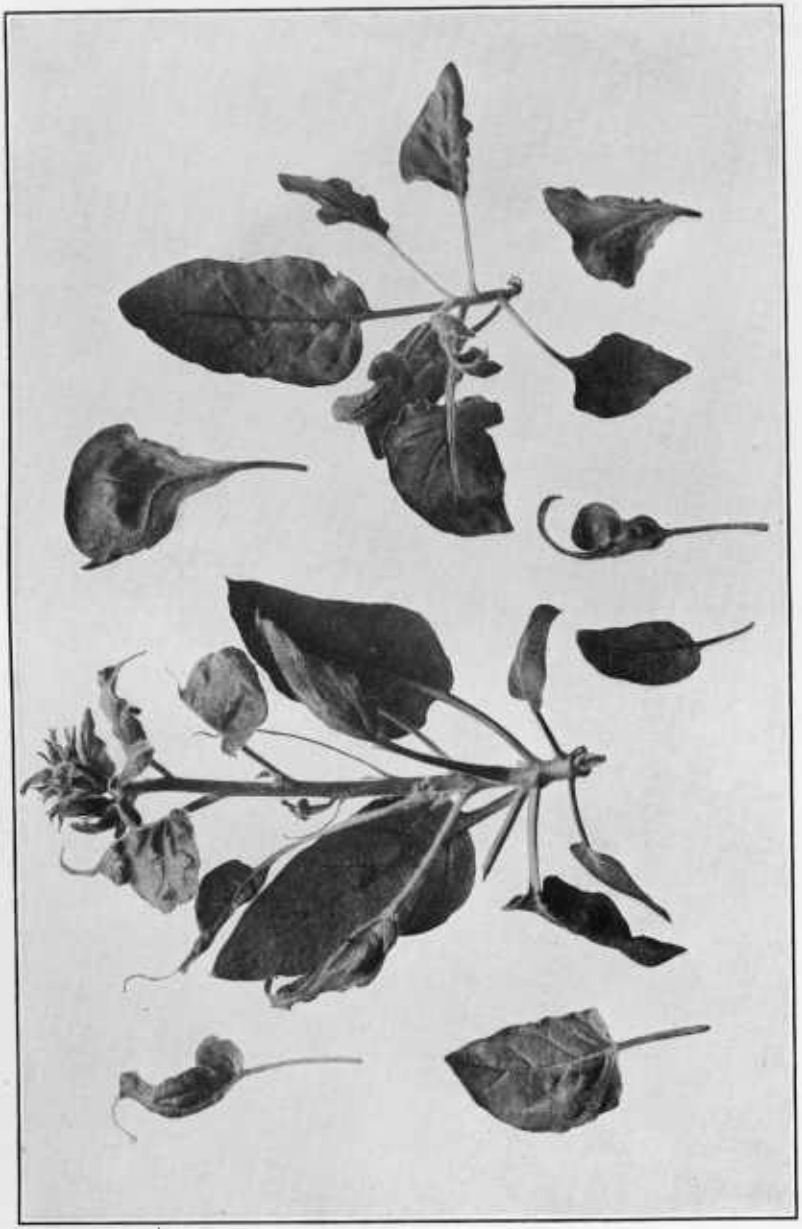
[5] Westerdijk, Johanna. Die Mosaikkrankheit der Tomaten. 19 p., 3. pl. Amsterdam, 1910. [Meded. Phytopath. Lab. "Wille Commelin Scholten." Amsterdam.]

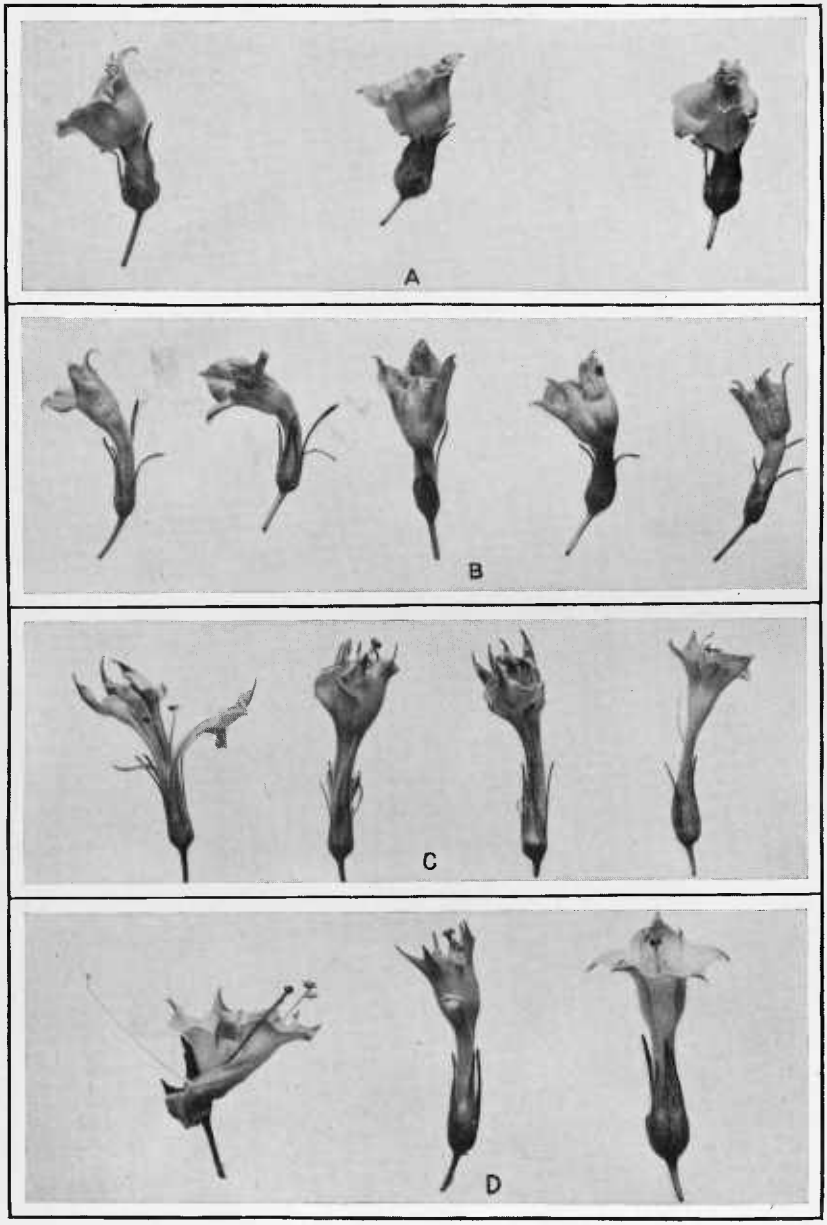
tobacco. Likewise, she could not infect tomato plants with the sap of a mosaic disease of tobacco with which she worked.

The constancy of these negative results is rather striking. It is possible that the type of mosaic disease with which European investigators worked may not have been quite so readily communicable to plants of other species and genera of the solanaceous family as the type in the writer's possession. It has been more or less generally believed in Europe that *N. rustica* was even immune to the mosaic disease affecting tobacco. In the writer's experience the virus of the common form of the mosaic disease is not only very infectious but particularly malignant to plants of *N. rustica*. Likewise, the disease is readily communicable to all the more distinct varieties of tomatoes, petunia, *Datura stramonium*, and is highly infectious to *Hyoscyamus niger*.

PLATE 35

Leaves of *Nicotiana viscosum* affected with the mosaic disease. This mosaic disease does not affect ordinary tobacco (*N. tabacum*); nor does the mosaic disease affecting ordinary tobacco affect *N. viscosum*.




A
B
C
D

## PLATE 36

A.—Normal blossoms from healthy plants of *Nicotiana viscosum*.

B.—Depauperate blossoms from mosaic plants affected with the mosaic disease peculiar to *N. viscosum*. This disease is distinct from the ordinary form of the mosaic disease affecting varieties of *N. tabacum* and does not affect them.

C, D.—Blossoms showing catacorolla, etc., as a result of the mosaic disease affecting *Nicotiana viscosum*. These are from first-generation plants of the cross Connecticut Broadleaf tobacco ♀ × *N. viscosum* ♂. This hybrid appears to be immune from the ordinary mosaic disease affecting the female parent, but is susceptible to the mosaic disease affecting the male parent, *N. viscosum*. Although this mosaic disease has never produced instances of catacorolla in *N. viscosum*, all phases of catacorolla are produced in the hybrid. Catacorolla is a common malformation in varieties of *N. tabacum* as a result of the ordinary form of the mosaic disease.