Resistance in Tobacco Breeding Line NC 744 to Potato Virus Y and Inoculation by Aphids

G. V. GOODING, JR., Department of Plant Pathology, and G. G. KENNEDY, Department of Entomology, North Carolina State University, Raleigh 27695

ABSTRACT

Gooding, G. V., Jr., and Kennedy, G. G. 1985. Resistance in tobacco breeding line NC 744 to potato virus Y and inoculation by aphids. Plant Disease 69:396-397.

The rate of detection of potato virus Y (PVY) in tobacco breeding line NC 744 and PVY-resistant parent Virgin A Mutant was slower than in the other parent, commercial tobacco cultivar Coker 86. NC 744 was more resistant than Coker 86 to inoculation with PVY by *Myzus persicae* and *Aphis gossypii*.

Additional key words: aphid transmission, *Nicotiana tabacum*

Flue-cured tobacco (*Nicotiana tabacum* L.) breeding line NC 744, developed by the anther-culture technique (1) from Virgin A Mutant (VAM) (TI 1406) (11) and Coker 86 (2), was released in 1980 as a source of tolerance to the MM and MN strains (8) and of resistance to the NN strain (8) of potato virus Y (PVY) in the southeastern United States (3). Resistance and tolerance are used as defined by Russell (12). The performance of NC 744 was compared with that of two commercial cultivars of flue-cured tobacco, Speight G-28 and McNair 944, in 1979–1980 in Carteret County, NC, where PVY is known to be endemic (5,7). The incidence of the two strains that predominated in these field trials, the potato strain (6) and the MM strain (8), was significantly lower in NC 744 than in the two commercial cultivars in 1979 (8). Mean virus incidence was 4% in NC 744, 21% in Speight G-28, and 20% in McNair 944, with the two strains distributed essentially equally among cultivars. Several suppositions were examined to explain the lower incidence of PVY in NC 744 than in the commercial cultivars. The concentration of the virus in leaves of NC 744, Speight G-28, and McNair 944 about 2 wk after symptom expression was not significantly different (7). The effect of virus concentration on aphid transmissibility (12) therefore was apparently not a factor in the observed differences in virus incidence. Johnson and Pirone (10) reported neither a significant difference in PVY concentration between VAM and Burley 21, a commercial burley tobacco cultivar, nor efficiency of acquisition by *Myzus persicae* Sulzer of PVY from VAM or Burley 21.

We report that PVY detection in NC 744 and VAM is slower than in Coker 86 and that the inoculation efficiency of PVY into NC 744 by *M. persicae* and *Aphis gossypii* (Glov.) is less than into Coker 86.

Paper 9379 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh 27695.

Accepted for publication 5 December 1984 (submitted for electronic processing).

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

MATERIALS AND METHODS

Coker 86 was the flue-cured commercial tobacco cultivar used in this study, even though the reduced virus incidence in NC 744 in the 1979–1980 field tests was based on a comparison with cultivars Speight G-28 and McNair 944. Coker 86 was used because it was a parent of NC 744 and because virus incidence in it did not significantly differ from Speight G-28, McNair 944, or several other commercial cultivars in previous field tests.

The MM strain of PVY (8), the most common on flue-cured tobacco in the southeastern United States (G. V. Gooding, Jr., *unpublished*), was used in these studies. The agar gel double-diffusion technique was used for serological detection of PVY (4). Bioassay was effected by mechanical inoculation to Burley 21 plants. Experiments were conducted in a controlled-temperature chamber (24 ± 4 C) in a greenhouse without supplemental lighting.

Rate of detection. Rate of PVY detection was compared among NC 744, VAM, and Coker 86 in plants of the same age in 10-cm-diameter pots. Plant sizes of all three entries were similar, with the largest leaf about 20 cm long. The entire adaxial surfaces of the two largest leaves on each plant were inoculated with a cotton swab dipped in 600-mesh Carborundum and then in infected leaf tissue of Burley 21 macerated in 0.5 M $Na_2HPO_4 \cdot KH_2PO_4$ (pH 7.2) (1 g of tissue:2 ml of buffer). Each trial consisted of 12 inoculated and three uninoculated plants of each entry. Inoculated and uninoculated plants of all entries were randomized on a greenhouse bench.

Comparative rates of PVY detection in NC 744, VAM, and Coker 86 were determined by assaying the leaf above the uppermost inoculated leaf on each of three plants for PVY at different time intervals after inoculation. The leaf to be assayed was macerated with a mortar and pestle after removing the primary vein. Crude juice, after removal of pulp by squeezing through cheesecloth, was diluted 1:1 with distilled H_2O for serological assay and 1:1 with buffer for bioassay.

Inoculation efficiency by aphids. Colonies of *M. persicae* and *A. gossypii* were maintained on plants of Burley 21 tobacco and Top Mark cantaloupe (*Cucumis melo* L.), respectively. Aphids were starved for 2 hr by holding them in plastic petri dishes, then single aphids were allowed a virus acquisition probe of 10–30 sec from a systemically infected Burley 21 leaf and transferred to NC 744 or Coker 86 seedlings in 4-cm-diameter pots and allowed an inoculation probe of 5–20 sec. Aphids were killed mechanically; the were plants sprayed with acephate and placed on a greenhouse bench. Fourteen days later, plants that were still asymptomatic were serologically assayed for virus.

RESULTS AND DISCUSSION

Virus was detected in both NC 744 and VAM more slowly than in Coker 86 (Table 1), and NC 744 was more resistant than Coker 86 to inoculation with PVY by both *M. persicae* and *A. gossypii* (Table 2).

Virus was detected in the leaf above the inoculated leaf sooner in Coker 86 than in NC 744 or VAM. This may have resulted from slower virus movement, replication, or a combination of these two factors (12). Regardless of the reason, depression in the rate of viral increase in breeding line NC 744 could be of epidemiological significance because it affects aphid transmission.

Depression of virus and resistance to inoculation by aphids apparently are factors involved in the lower incidence of PVY that usually occurs in NC 744 than

Table 1. Comparative rate of movement of the MM strain of potato virus Y in *Nicotiana tabacum* cv. Coker 86 (C 86), breeding line NC 744, and Virgin A Mutant (VAM)

	Virus detection by different techniques[a] (days after inoculation)[b]																	
	4			6			8			12								
	Sym	Bio	Ser	Sym	Bio	Ser	Sym	Bio	Ser	Sym	Bio	Ser						
Entry	1[c] 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2
C 86	0 0[d]	2 3	0 0	3 3	3 3	3 3	... ...	... ...	... ...	... ...	... ...	... ...						
NC 744	0 0	0 0	0 0	0 0	2 3	0 0	0 0	3 3	3 3	3 3	3 3	3 3						
VAM	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 1	0 0	3 3	3 3	3 3						

[a]Sym = symptoms, Bio = assay by mechanical transmission to Burley 21, and Ser = serological assay.
[b]Leaf immediately above inoculated leaf assayed for virus.
[c]Trial 1 and trial 2.
[d]Number of plants in which virus detected in assayed leaf. Three plants used per treatment.

Table 2. Efficiency of inoculation by aphids of the MM strain of potato virus Y into *Nicotiana tabacum* cv. Coker 86 and breeding line NC 744

Aphid species Tobacco cultivar	Transmission trial[a]						
	1	2	3	4	5	6	Total[b]
Myzus persicae							
Coker 86	8	6	5	10	6	5	40
NC 744	3	0	0	6	3	3	15
Aphis gossypii							
Coker 86	7	0	0	5	9	8	29
NC 744	5	0	0	3	0	1	9

[a]Number of plants infected; inoculation attempts made with one aphid on each of 10 plants in each trial.
[b]*M. persicae* $X^2 = 19.67$ ($P < 0.001$); *A. gossypii* $X^2 = 13.9$ ($P < 0.001$) (df = 1).

in commercial flue-cured cultivars in the United States. In addition, the first author has observed a lower PVY incidence in NC 744 than in commercial U.S. cultivars in Costa Rica, Chile, and Hungary. This implies that this resistance may not be virus-strain or vector-species specific.

Depression of PVY in NC 744 and resistance to aphid inoculation delays but does not always prevent high virus incidence, however. In one field in the 1980 tests (7), >99% of the NC 744 plants were infected by the time the last leaves were harvested. This is expected since the effect of these resistances on the total virus spread would be determined in part by the size of the vector population. Very large vector populations could offset the reduced probability of virus transmission by individual aphids that results from the resistance. A similar situation has been described with cucumber mosaic virus on tobacco (13).

NC 744 has limitations as a breeding line for the development of PVY-resistant flue-cured cultivars; i.e., sensitivity to blue mold and intolerance to chewing insects (9). It currently is the only breeding line available that is tolerant and/or resistant to PVY strains in the southeastern United States, however. Its resistance to virus movement and to inoculation by aphids complements its tolerance to PVY.

LITERATURE CITED

1. Burk, L. G., Chaplin, J. F., Gooding, G. V., Jr., and Powell, N. T. 1979. Quantitative production of anther-derived haploids from a multiple disease resistant tobacco hybrid. I. Frequency of plants with resistance or susceptibility to tobacco mosaic virus (TMV), potato virus Y (PVY) and root knot (RK). Euphytica 28:201-208.
2. Chaplin, J. G., Burk, L. G., Gooding, G. V., Jr., and Powell, N. T. 1980. Registration of NC 744 tobacco germplasm. Crop. Sci. 20:677.
3. Gooding, G. V., Jr. 1971. Viruses of tobacco in North Carolina. Plant Dis. Rep. 55:1013.
4. Gooding, G. V., Jr. 1975. Serological identification of tobacco viruses. Tob. Sci. 19:127.
5. Gooding, G. V., Jr., and Lapp, N. A. 1980. Distribution, incidence and strains of potato virus Y in North Carolina. Tob. Sci. 24:200-203.
6. Gooding, G. V., Jr., Lapp, N. A., and Wilson, G. L. 1982. Potato leafroll virus and potato virus Y in seed-potatoes used to plant the North Carolina potato crop. Am. Pot. J. 59:125-129.
7. Gooding, G. V., Jr., Todd, F. A., Burk, L. G., and Chaplin, J. F. 1982. Comparative effect of vein banding and black shank on *Nicotiana tabacum* cvs. McNair 744, Speight G-28 and breeding line NC 744 with and without Ridomil. Tob. Sci. 26:1-3.
8. Gooding, G. V., Jr., and Tolin, S. A. 1973. Strains of potato virus Y affecting flue-cured tobacco in the southeastern United States. Plant Dis. Rep. 57:200-214.
9. Gooding, G. V., Jr., Wernsman, E. A., and Rufty, R. C. 1985. Reaction of *Nicotiana tabacum* cv. Havana 307 to strains of potato virus Y, tobacco vein mottling and tobacco etch viruses and to *Peronospora tabacina*. Tob. Sci. In press.
10. Johnson, M. C., and Pirone, T. P. 1982. Evaluation of tobacco introduction 1406 as a source of virus resistance. Phytopathology 72:68-71.
11. Koelle, G. 1961. Genetische analyse einer Y-virus (Rippenbraune) resistenten mutante der tabaksorte Virgin A. Der Zuchter. 31:71-72.
12. Russell, G. E. 1978. Plant breeding for pest and disease resistance. Butterworths, London. 485 pp.
13. Troutman, J. L., and Fulton, R. W. 1958. Resistance in tobacco to cucumber mosaic virus. Virology 6:303-316.