

## Tolerance of *Nicotiana tabacum* Cultivars Dixie Bright 244-2, McNair 30, and Golden Stock Penish to Strains of Potato Virus Y

Eun Kyung Park and G. V. Gooding, Jr.\*

*Korea Ginseng and Tobacco Research Institute, Suwon 170, Korea*

*\*Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695, U. S. A.*

## PVY 系統들에 對한 잎담배 品種 Dixie Bright 244-2, McNair 30 및 Golden Stock Penish의 耐病性 反應

朴 銀 景 · G. V. Gooding, Jr.\*

韓國人蔘煙草研究所 耕作試驗場

\*North Carolina 州立大學校 植物病理學科

### ABSTRACT

The reaction of seven cultivars of *Nicotiana tabacum* to eight naturally occurring strains of potato virus Y from tobacco and one from potato was determined by mechanical inoculations in greenhouse tests. Dixie Bright 244-2, McNair 30, and Golden Stock Penish were highly tolerant to three mild strains, two from the United States and one from Korea, and to four severe strains, one each from the United States, West Germany, South Africa, and Korea. They also had some tolerance to a severe strain from Child and one from United States. Virus concentration in infected leaf tissue was virus strain-and cultivar-dependent.

*Key words:* tolerance, PVY strains, tobacco.

### 要 約

韓國을 비롯한 5個國에서 잎담배로부터 8系統, 감자로부터 分離된 1系統 등 모두 9系統의 PVY에 對한 잎담배 品種別 耐病性を 溫室內에서 調査하였다. 調査된 品種中 Dixie Bright 244-2, McNair 30, 및 Golden Stock Penish 등의 品種은 7가지의 PVY 系統에 對해 높은 耐病性 反應을 보였다. 以外 Chile 및 US-NN 系統에 對해서도 感受性品種에 비해 耐病性を 나타냈다. 品種別 病徵의 甚, 輕에 따른 葉中 바이러스의 濃度는 接種된 바이러스 系統과 品種에 따라 다르게 나타나 葉中 바이러스 濃度에 따른 耐病性 程度 區分은 할 수 없었다.

## INTRODUCTION

Many strains of potato virus Y (PVY) have been isolated from naturally infected tobacco (*Nicotiana tabacum* L.) plants in different countries (1,5,6,10,12, 13). These strains can be differentiated as mild or severe according to symptoms induced in commercial cultivars of tobacco. The mild strains induce various degrees of mottling and vein banding, with a slight reduction in growth, but the severe strains cause leaf necrosis, malformation of leaves, and severe growth reduction. The severe strains result in serious yield losses with the amount of loss dependent on virus strain, cultivar, and time of infection (11,15,16). Potato virus Y is recognized as causing serious disease problems in the tobacco crop in several countries (5,6,10,13,14,16).

The diversity of PVY strains and their mode of transmission by aphids make control difficult. The most practical approach to PVY control, using current technology, is the development of resistant cultivars (5). Various sources of resistance to PVY have been reported in the genus *Nicotiana* (2,8,13), but until recently (5,7), the relevance of these sources of resistance to the various strains of PVY has not been emphasized.

This report describes the reactions of seven cultivars of *N. tabacum* to nine strains of PVY. Three of these cultivars, Dixie Bright 244-2, Golden Stock Penish, and McNair 30, have been reported tolerant to a severe strain of PVY in Korea (14). The purpose of this study was to determine the reactions of these tobacco cultivars to other strains of PVY from different countries.

## MATERIALS AND METHODS

**Tobacco Cultivars.** Seven cultivars of *N. tabacum* were used for this study. Four of them, Burley 21, NC 95, NC 2326, and Havana 307, are being, or have been, utilized as commercial cultivars worldwide. The other three, McNair 30, Golden Stock Penish, and Dixie Bright 244-2, were obtained from Korea Ginseng and Tobacco Research Institute, and have been reported to be resistant to a severe strain of PVY in Korea (14).

**PVY strains.** Eight naturally occurring strains of PVY from tobacco and one from potato were used. They have been previously described (5, 15) and were as follows: (1) US-P, a mild strain from potatoes in the United States(US); (2) US-MM, a mild strain from tobacco in the US; (3) US-MN, a strain from tobacco in the US that is mild on root knot nematode (RKN)-susceptible tobacco cultivars and severe on RKN resistant cultivars; (4) US-NN, a strain from tobacco in the US that is severe in RKN susceptible and resistant cultivars; (5) EUROPE-WG, a veinal necrosis inducing strain from tobacco in West Germany; (6) CHILE, a severe strain from tobacco in Chile; (7) SA, a severe strain from tobacco in South Africa; (8) VN, a severe strain from tobacco in Korea; and (9) VB, a mild strain from tobacco in Korea.

**Evaluation techniques.** Each strain-cultivar combination consisted of five inoculated and three noninoculated plants. Plants were grown in 10-cm-diameter clay pots in a greenhouse ( $26\pm 5^{\circ}\text{C}$ ). Cultivars were the same age and similar in size when inoculated. At the time of inoculation, the largest leaf of Burley 21 was 8-10 cm long. The two largest leaves on each plant were inoculated with a cotton swab dipped in 600-mesh carborundum and then in crude juice from an infected Burley 21 leaf macerated in 0.02M  $\text{Na}_2\text{HPO}_4$ - $\text{KH}_2\text{PO}_4$  buffer, pH 7.0 (1 g of tissue; 3 ml of buffer). Symptoms were recorded 4 wk after inoculation. Asymptomatic plants were assayed serologically by the agar-gel double-diffusion technique (4) and by reinoculation on tobacco cultivar Burley 21. This experiment was repeated three times.

The infectious viral concentration in leaves was compared between certain strain-cultivar combinations. The two largest systemically infected leaves from each of five inoculated plants were harvested 4 wk after inoculation. Juice from the leaves was extracted with a leaf squeezer, combined, and diluted  $1 \times 10^{-3}$  -  $1 \times 10^{-5}$  in phosphate buffer. Each dilution was assayed for infectivity on three Burley 21 plants. Results were recorded 3 wk after inoculation. The experiment was conducted twice.

## RESULTS

The cultivar McNair 30 showed indistinct mottling

or very mild vein banding along the small veins, and little or no reduction in plant growth was observed with infections of all strains except the CHILE and US-NN. The mild symptoms that developed on McNair 30 with all strains except the CHILE and US-NN were difficult to differentiate from noninoculated healthy plants. Serological or biological assay was

usually necessary to establish that the plants were infected. This cultivar, however, showed 30% reduction in growth and leaf necrosis with the CHILE and US-NN strains, but was still more tolerant than NC 2326 and NC 95. Among the other cultivars screened in this experiment, Dixie Bright 244-2, Golden Stock Penish, and Havana 307 were similar to McNair 30 in

Table 1. Reaction of *Nicotiana* cultivars to nine strains of potato virus Y<sup>a</sup>

PVY strain	Reaction of cultivars to different strains of PVY <sup>b</sup>																				
	Burley 21			NC 2326			NC 95			Dixie Bright 244-2			McNair 30			Golden Stock Penish			Havana 307		
	M	S	N	M	S	N	M	S	N	M	S	N	M	S	N	M	S	N	M	S	N
US-P	1	5	0	1	5	0	1	10	10	1	0	0	1	0	0	1	0	0	1	0	0
US-MM	3	10	10	2	10	10	3	10	0	1	5	0	1	0	0	1	5	0	1	0	0
US-MN	3	20	0	3	30	0	-	-	100	1	10	0	1	<5	0	1	<5	0	1	<5	0
US-NN	3	10	0	3	80	70	3	80	70	2	20	30	1	30	20	2	10	15	2	10	0
EUROPE-WG	1	20	10	2	30	10	1	20	10	1	0	<5	1	<5	0	1	<5	<5	1	<5	0
CHILE	3	60	30	3	70	30	3	80	30	2	20	<5	2	30	20	2	40	10	3	30	10
SA	3	50	10	2	30	5	2	60	30	1	0	0	1	<5	0	1	0	0	1	<5	0
VN	3	60	30	3	60	40	3	70	30	1	0	0	1	0	0	1	0	0	1	<5	0
VB	1	10	0	1	5	0	1	20	0	1	0	0	1	0	0	1	0	0	1	0	0

<sup>a</sup> Test was conducted in greenhouse at  $26 \pm 5^\circ\text{C}$  on plants grown in 10-cm-diameter clay pots. Plants were inoculated at 3-4 leaf stage of growth. Symptoms were recorded 4 wk after inoculation. Five plants were inoculated in each treatment and the experiment was repeated 3 times with essentially identical results. Ratings are the average of the results on five plants.

<sup>b</sup> M = mottling - 1 = mild; 2 = moderate; 3 = severe.

S = stunting - visual estimate of percent reduction in growth compared with noninoculated check.

N = visual estimate of percentage of necrotic tissue on the plant.

- = plants killed so no data recorded.

Table 2. Comparison of viral concentrations in four cultivars of tobacco infected with each of three PVY strains

PVY strain	Cultivar	Infectivity by dilutions <sup>a</sup>					
		$10^{-3}$		$10^{-4}$		$10^{-5}$	
		T-I	T-II	T-I	T-II	T-I	T-II
VN	McNair 30	+	+	+	+	-	-
	Golden Stock Penish	+	+	+	+	-	-
	Dixie Bright 244-2	+	+	+	+	-	-
	NC 2326	+	+	+	+	+	+
US-MM	McNair 30	+	+	+	+	-	-
	Golden Stock Penish	+	+	+	+	-	-
	Dixie Bright 244-2	+	+	+	+	+	+
	NC 2326	+	+	+	+	+	+
CHILE	McNair 30	+	+	+	+	-	-
	Golden Stock Penish	+	+	+	+	-	-
	Dixie Bright 244-2	+	+	+	+	-	-
	NC 2326	+	+	+	+	-	-

<sup>a</sup> Juice from the two largest leaves from each of five inoculated plants/treatment was extracted 4 wk after inoculation, diluted in 0.02M phosphate buffer (pH 7.0), and inoculated on three Burley 21 plants. The test was repeated twice (T-I and T-II) and data infection (+) or no infection (-), were recorded 3 wk after inoculation.

tolerance. The rest of the cultivars showed leaf necrosis and stunting with severe strains and prominent mottling and/or vein banding to mild strains. The results of all three trials were essentially identical so only the results from one trial are reported (Table 1).

Infectious viral concentrations of seven strains of PVY in McNair 30, Golden Stock Penish, Dixie Bright 244-2, and NC 2326 were strain-and cultivar-dependent. Virus concentration in each entry was the same for 1) strains VN, VB, US-MN, US-NN, and 2) strains CHILE and US-P. Therefore, only the virus concentration in representative strains VN, CHILE, and US-MM, which differed from all others, are reported (Table 2).

## DISCUSSION

Knowledge of host and pathogen variation are well-recognized factors related to breeding resistant cultivars. This and previous studies emphasize the importance of choosing a source of tolerant germplasm to use in a breeding program that will be effective against the strain(s) of PVY that occur in the geographic area where the germplasm is to be deployed.

Earlier breeding programs for PVY resistance concentrated on Virgin A Mutant (8) as a germplasm source because of its immunity to the EUROPE-WG (9) and US-NN (2) strains of PVY. Flue-cured tobacco breeding line NC 744 from one (3) of these programs has been experimentally grown in the southeastern U.S., Chile, Costa Rica, and Hungary. No PVY strains which cause necrosis on breeding line NC 744 were observed on the plantings in Costa Rica or the U.S., but strains which cause necrosis on it have been observed in Chile and Hungary (5). NC 744, like Virgin A Mutant, has the disadvantage of being very susceptible to *Pernospora tabacina* Adam (Syn. *P. hyoscyami* [de Bary] f.sp. *tabacina* Adam) (9) and chewing insects (18). These factors limit its utility even in countries where it is resistant to local strains of PVY.

Recognition of the wide variation that exists in strains of PVY in tobacco (1,5) has led to recent emphasis on horizontal resistance in breeding programs (5,7,14). Tobacco cultivar Havana 307 was recently reported as tolerant to most recognized strains of PVY (7). In our results, Dixie Bright 244-2, McNair 30, and Golden Stock Penish were similar to Havana

307 in their reaction to these PVY strains.

Infectious virus concentration in leaf tissue was related to the severity of disease symptoms in the cultivars tested with some strains but not others. Viral concentration has been previously reported to be strain-cultivar dependent (7,17,19) and our results confirm that selection of resistant germplasm based on virus concentration must be approached with caution.

Based on the results of this study, Dixie Bright 244-2, McNair 30, and Golden Stock Penish may be useful sources of PVY tolerance in the development of commercial tobacco cultivars.

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