

Individual and Combined Effects of Tobacco Mosaic Virus and Potato Virus Y on Burley Tobacco

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ABSTRACT

Inoculation with tobacco mosaic virus (TMV) or potato virus Y (PVY) reduced plant height, plant weight, and leaf weight of burley tobacco cultivars susceptible to these viruses. There was little difference in the reaction of the cultivars Burley 21, Burley 37, or Burley 49 to PVY, or in the effects of PVY or TMV in Burley 37.

Simultaneous inoculation with TMV+PVY produced effects similar to inoculation with PVY alone in Burley 21 and Burley 49, but generally synergistic effects in Burley 37.

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Information concerning the effects of viruses on plants generally have been limited to estimates of yield losses (6), changes in microstructure or physiology (1, 2) or the effect on symptom expression or virus concentration in plants inoculated with more than one virus (5). There are few data concerning the effect of viruses on specific characteristics of tobacco, such as plant height, leaf number, leaf weight, and total plant weight.

The objective of this study was to determine the effect of tobacco mosaic virus (TMV) and potato virus Y (PVY), separately and together, on leaf abscission, leaf weight, plant height, and plant weight of three cultivars of burley tobacco.

MATERIALS AND METHODS.—Burley tobacco (*Nicotiana tabacum* L.) cultivars 'Burley 21' (Bu 21), 'Burley 37' (Bu 37), and 'Burley 49' (Bu 49) were used in greenhouse tests. The cultivars are susceptible to PVY and Bu 37 is also susceptible to TMV. Bu 21 and Bu 49 carry the *N. glutinosa* factor for local lesion resistance to TMV (3, 4). All cultivars were inoculated with PVY and PVY+TMV; Bu 37 was also inoculated with TMV.

Plants approximately 35 days old were transplanted to a soil:sand:peat mixture (1:1:1) in 5-inch clay pots and placed on a greenhouse bench. Seven to 10 days after transplanting, one half of the plants were inoculated by rubbing two leaves previously dusted with Carborundum (320-mesh) with a distilled water homogenate of leaf tissue from plants systemically infected with TMV, PVY or TMV+PVY. Each virus inoculation was repeated three times with a minimum of 15 plants per replicate. Uninoculated control plants were included in each replicate. All plants were fertilized weekly with approximately 200 ml of a soluble fertilizer solution prepared by dissolving 250 cc each of 25-0-20 and 6-25-15, and 100 cc of 13-0-44 in 24 gal of water.

Sixty days after inoculation, plant height, total aboveground plant weight, the number of nonabscised leaves 15.0 cm or greater in length, and the total leaf weight were recorded for each plant. Fresh weights were used for all weight determinations.

Significance of the results was determined by comparing the means for each parameter of inoculated and uninoculated plants by use of the "Student's" *t*-test. Least significant difference between responses of each cultivar to the virus treatments and between the effects of each virus treatment on the three cultivars was determined.

RESULTS.—All plants inoculated with PVY developed typical symptoms, veinclearing followed by veinbanding and mottling. The presence or absence of TMV was confirmed by bioassays of new growth from a few of the inoculated plants. Simultaneous transmission of TMV+PVY always occurred. Uninoculated plants which developed disease symptoms were discarded.

Each of the viruses significantly affected some plant characteristics, but the two viruses together had a greater effect, especially in Bu 37. When compared to the controls all virus treatments reduced leaf weight, plant weight and plant height (Table 1). PVY reduced the number of nonabscised leaves of all three cultivars. Leaf abscission was not affected by TMV, and TMV+PVY affected only Bu 21 and Bu 37. TMV+PVY severely reduced the weight of the leaves as well as plant height and weight of all cultivars.

Analysis of the reaction of the cultivars to each virus treatment showed that only TMV+PVY caused a distinct varietal response. The reduction in leaf and plant weight of Bu 37 infected with TMV+PVY was significantly more than for Bu 21 or Bu 49. The height of doubly infected Bu 37 plants was also significantly less than for Bu 21, and the difference from Bu 49 approached significance.

A comparison of the effects of the virus treatments on each cultivar indicated that leaf weight, plant height and plant weight of Bu 37 was affected more by the combination of TMV+PVY than by either of the viruses individually (Table 2). The aboveground weight of Bu 21 was affected more by TMV+PVY than by PVY alone, but this was the only parameter that showed a significant difference in Bu 21 or Bu 49 due to the virus treatments.

DISCUSSION.—Bu 21 and Bu 49 are "resistant" to TMV because both carry the hypersensitive

TABLE 1. Mean values of characteristics of three burley tobacco cultivars infected with potato virus Y (PVY), tobacco mosaic virus (TMV), or TMV+PVY^a

Cultivar ^b	Virus treatment	Leaf		Plant	
		Number	Weight (g)	Height (cm)	Weight (g)
Bu 21	PVY	14	134	42	192
	none	15	160	61	239
	TMV+PVY	16	118	40	169
Bu 37	none	17	150	61	242
	TMV	20 ^c	194	69	316
	none	19 ^c	214	88	367
	PVY	18 ^d	162	43	234
	none	19 ^d	177	73	297
Bu 49	TMV+PVY	15	54	11	63
	none	18	172	43	252
	PVY	16	77	35	119
	none	18	94	54	168
	TMV+PVY	20 ^c	164	25	210
	none	20 ^c	236	44	331

^a When compared with the corresponding uninoculated check using Student's *t*-test, all values were significantly different at the 1% level except as indicated in footnotes c and d. Data for each virus treatment immediately precedes the corresponding check.

^b Bu 21 = 'Burley 21'; Bu 37 = 'Burley 37'; Bu 49 = 'Burley 49'.

^c Not significant.

^d Significant at the 5% level.

reaction from *N. glutinosa* (3, 4). From a combination of TMV+PVY it would be expected that PVY would have the greatest effect on the plant, with little or no effect from TMV since TMV usually does not invade these plants systemically. The results generally confirm this as there was no significant difference between PVY alone and TMV+PVY in Bu 21 and Bu 49 for any of the parameters except the plant weight of Bu 21.

A comparison of the effects of TMV and PVY was possible with Bu 37 since both viruses invaded this cultivar systemically. Infection by TMV+PVY caused significantly lower leaf and plant weight and plant height than either virus alone. Since each virus infects the plant systemically it would be expected that they both contributed to the total effect, unless one virus interfered with the multiplication of the other. The results indicate that there was no interference as the effect on the height of Bu 37 was slightly more than additive, and the effect on leaf and plant weight was synergistic. Plant height was reduced 22% and 41% by TMV and PVY respectively, and together the viruses caused a 74% reduction. The reduction in leaf weight by TMV and PVY was 9% and 8% respectively, but

TABLE 2. Response of three greenhouse-grown burley cultivars to tobacco mosaic virus (TMV), potato virus Y (PVY), and TMV+PVY

Cultivar	Treatment	Percent of control			
		Leaf		Plant	
		Number	Weight	Height	Weight ^a
Burley 21	PVY	93	84	69	80
	TMV+PVY	94	79	66	70
	LSD (.05)	NS ^b	NS	NS	6.5
Burley 37	TMV	105	91	78	86
	PVY	95	92	59	79
	TMV+PVY	83	31	26	25
	LSD (.05)	NS	40.2	28.5	35.3
Burley 49	PVY	89	82	65	71
	TMV+PVY	100	69	57	63
	LSD (.05)	NS	NS	NS	NS

^a Weight of the aboveground portion of the plant.

^b Difference not significant.

TMV+PVY reduced the leaf weight by 69%. Similarly, TMV reduced the plant weight by 14%, and PVY caused a 21% reduction, but together the viruses reduced the weight by 75%. The reason for the synergistic effect of the two viruses is unknown.

There was no appreciable difference between the response of Bu 21, Bu 37, and Bu 49 to PVY, but Bu 37 was affected considerably more than either Bu 21 or Bu 49 when inoculated with both viruses simultaneously, reflecting the susceptibility of that cultivar to both viruses.

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