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TN 86

Burley Tobacco Resistant to TVMV, TEV, and PVY

R. D. Miller

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The University of Tennessee
Agricultural Experiment Station
Knoxville, Tennessee
J.I. Sewell, Acting Dean

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A Burley Tobacco Resistant to TVMV, TEV, and PVY

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Figure 1. Burley 37 plant showing advanced TVMV symptoms.

TN 86

A Burley Tobacco Resistant to TVMV, TEV, and PVY

Introduction

Tobacco vein mottling virus (TVMV) and tobacco etch virus (TEV) have become widespread throughout the burley-producing regions of Tennessee, Kentucky, Virginia, and North Carolina in recent years (Gooding and Sun 1972; Gooding et al. 1980; Pirone et al. 1973; Sievert 1974). TVMV and TEV are transmitted to tobacco from horse nettle (*Solanum carolinense),* dock (*Rumex sp.),* ground cherry (*Physalis* sp.), and possibly other weed hosts by the green peach aphid, *Myzus persicae* (Sulzer) (Pirone et al. 1973; Sun et al. 1974). Because symptoms of TVMV, TEV, and potato virus Y (PVY) are very similar (Gooding and Lapp 1980), it is usually impossible to distinguish these diseases without doing serological assays (Gooding and Sun 1972). Initial symptoms of these diseases, which are often referred to as the PVY complex, may be limited to a slight mottling, yellowing, or other discoloration of the tissue around the veins of the leaves (Pirone et al. 1973). As the diseases progress, leaf specking and necrosis may occur, which can result in leaf deterioration (Figure 1). This often causes infested tobacco to be harvested prematurely, thus resulting in reduced yield and quality (Sievert 1978).

Although several tobacco cultivars have some tolerance to TVMV and TEV, studies have indicated that all commercial cultivars are susceptible to both diseases (Gooding and Ross 1970; Pirone 1974; Pirone and Gooding 1973). In general, cultivars having resistance to the black shank fungus, *Phytophthora parasitica* Dast., are very sensitive to TVMV and TEV (Gupton et al. 1981). In a study conducted by the University of Tennessee and North Carolina State University, yield reductions due to TVMV or TEV infection averaged approximately 200-500 pounds per acre, depending on the tobacco cultivar grown (Rufty et al., North Carolina State University, unpublished data). In addition, virus-infected tobacco was unsound and thin-bodied with undesirable color, resulting in a significant reduction in quality. Although considerable variation was found among the commercial varieties for leaf damage and yield reduction due to virus infection, all black shank-resistant varieties were moderately to severely damaged.

'Tobacco Introduction' (TI) 1406, a breeding line developed in West Germany, has good resistance to TVMV, TEV, and PVY (Koelle 1961). This line, sometimes referred to as 'Virgin A Mutant,' has been the primary source used to incorporate resistance to the PVY complex into tobacco breeding lines (Chaplin et al. 1980; Gupton 1980; Nielsen et al. 1982; Smeeton 1976). However, breeding lines having PVY resistance derived from TI 1406 have

been reported to be unusually susceptible to tobacco budworms, *Heliothis armigera* (Hübner) (Smeeton 1976); tobacco flea beetles, *Epitrix hirtipennis* (Melshimer) (Nielsen et al. 1982); grasshoppers, *Melanoplus* spp, and Japanese beetles, *Popillia japonica* Newman (Gupton 1980); and tarnished plant bugs, *Lygus lineolaris* (Pless and Miller 1986). The high degree of insect susceptibility found in TI 1406 and PVY-resistant breeding lines derived from it has been associated with the lack of trichome exudates that are normally produced in tobacco (Nielsen et al. 1982).

'Tennessee 86' (TN 86) was released by the Tennessee Agricultural Experiment Station as a commercial variety in February 1986 (Miller 1987). It is the first burley tobacco variety having resistance to TVMV, TEV, and PVY (Figure 2). Although resistance to the PVY complex is derived from TI 1406, TN 86 produces normal trichome secretions and does not exhibit the insect susceptibility normally seen in PVY-resistant breeding lines (Miller and Pless, the University of Tennessee, unpublished data). TN 86, which is also resistant to black shank; black root rot, *Theilaviopsis basicola* (Berk. & BR.) Ferr.; and wildfire, *Pseudomonas tabaci* (Wolf and Foster) Stevens, was developed at the Tobacco Experiment Station in Greeneville, Tennessee.

Origin and Development

TN 86, which was tested as Greeneville (GR) 136, was developed from a cross between 'Burley 49' (Hoffbeck et al. 1965) and the breeding line 'PVY-202.' PVY-202, which was derived from a cross between Burley 49 and TI 1406, is a sister line to 'GR 107.' GR 107 is a TVMV-, TEV-, and PVY-resistant breeding line released cooperatively by the Tennessee Agricultural



Figure 2. Burley 49 and TN 86 (GR 136) grown in Madison County, North Carolina, under high levels of TVMV.

Experiment Station and USDA-ARS in 1979 (Gupton 1980). A single plant selection from the F_2 generation of the Burley 49 x PVY-202 population was crossed to 'Burley 21' (Heggestad et al. 1960). In the F_2 generation of the new population, a backcross was made to Burley 21. The original cross and subsequent backcross were made by Dr. Creighton Gupton, former USDA-ARS burley tobacco breeder at the Tobacco Experiment Station in Greeneville.

Selections were made in black shank, TVMV, and TEV nurseries and progeny tested in greenhouse disease screenings. In 1982 a single plant having superior agronomic characteristics and black shank resistance was selected from the F_4 generation following the Burley 21 backcross. All F_5 selections that were determined to be homozygous for resistance to TEV, TVMV, wildfire, and black root rot were bulked and designated as breeding line GR 136 in 1983.

PVY-202 provided the resistance to TVMV, TEV, and PVY, which originated from TI 1406. Burley 49 was the source of resistance to black root rot, wildfire, and black shank. Burley 49 derived its resistance to these diseases from *Nicotiana debneyi, Nicotiana longiflora,* and 'Fla 301,' respectively. GR 136 was in the F_8 generation at the time of its release as TN 86.

Agronomic Characteristics

A comparison of the agronomic characteristics of TN 86 and selected commercial burley varieties is presented in Table 1. TN 86 has a more erect leaf habit, a higher leaf number, and a shorter leaf internode than most other burley varieties (Figure 3). The growth habit and plant size of TN 86 are similar to Burley 21. Under normal growing conditions TN 86 has 4 to 7 more leaves than 'MS KY 14 x L8', but 2 to 4 fewer leaves than 'Burley 64.' The leaf size



Figure 3. TN 86 (GR 136) has more leaves and a more erect growth habit than most other burley tobacco varieties.

and shape of TN 86 are similar to those of 'VA 509' and 'KY 14.' TN 86 has a medium stalk diameter that is larger than MS KY 14 x L8 but is significantly smaller than VA 509.

Because of the upright growth habit of TN 86, breakage and loss of leaves during harvesting is minimized. TN 86 should be topped at about 22 to 26 leaves; higher topping will result in overly large plants that are difficult to manage and harvest. TN 86 is usually ready for harvest approximately 10 days to 2 weeks later than is MS KY 14 x L8; however, it matures about 7 to 10 days earlier than Burley 64. The yield potential of TN 86 is significantly reduced by early harvest.

In comparison to other commercial varieties, TN 86 is lighter green while growing in the field. The cured leaf is generally reddish-tan and has consistently sold for prices comparable to or higher than those for other varieties.

Performance Data

Variety trials

TN 86 appears to be widely adapted. When grown under disease-free conditions, TN 86 is competitive with the highest yielding commercial varieties and is substantially higher yielding than varieties having resistance to Race 1 black shank (Table 2.) It has also performed well in yield and quality in advanced breeding line trials and on-farm trials throughout Tennessee (Tables 3 and 4). TN 86 performs particularly well in areas where heavy outbreaks of TVMV and TEV usually occur each year.

In the 1984 and 1985 Regional Variety Test programs (Tables 5 and 6), TN 86 was the highest yielding line among 22 entries in 1984 and was the second highest yielding line among 19 entries in 1985. It also received the highest ratings in industry evaluations for leaf color, leaf quality, and overall industry usability.

Disease resistance

TN 86 has high resistance to TVMV, black root rot, and wildfire; medium high resistance to TEV; medium resistance to Race 0 and Race 1 black shank; and is resistant to most strains of PVY (Table 7). TN 86 yields were 800 to 2500 pounds per acre higher than those of virus-susceptible varieties when grown in tests artificially inoculated with TVMV or TEV (Table 8). Yields of TN 86 exceeded those of all other black shank-resistant varieties by more than 1000 pounds per acre in these studies. Under moderate to heavy natural infestations of TVMV and/or TEV, yields of TN 86 were 200 to 2000 pounds per acre higher than yields of susceptible varieties (Tables 4 and 8).

Several strains of PVY with different levels of virulence have been identified. Although the level of resistance to these strains varies in TN 86, the resistance is similar to that of TI 1406 and is significantly higher than that of other burley varieties (Table 9).

Recent studies conducted in Mexico and Puerto Rico have indicated that TN 86 is more sensitive to blue mold than are other burley tobacco varieties

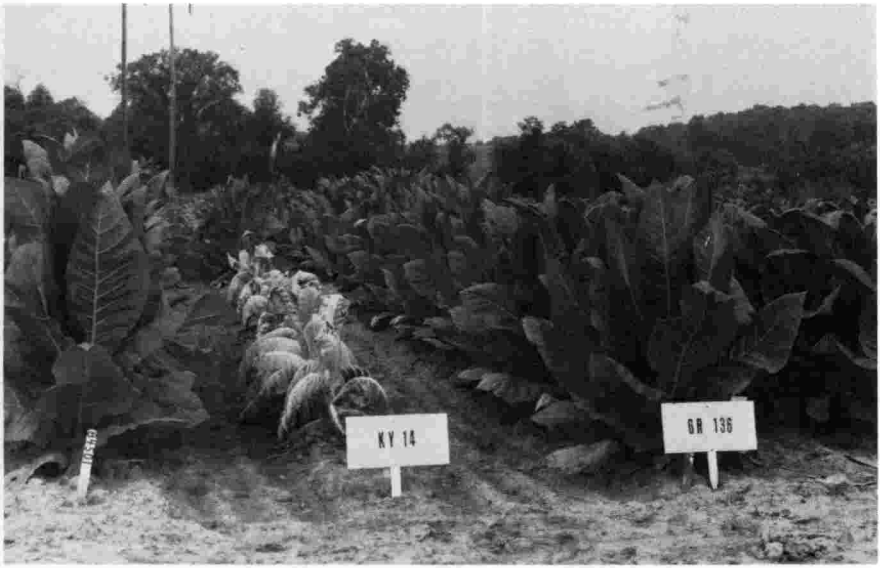


Figure 4. KY 14 and TN 86 (GR 136) in a Greene County, Tennessee, field heavily infested with black shank.

(E. A. Wernsman, 1987, personal communication). Also, TN 86 is susceptible to tobacco mosaic virus. The reaction of TN 86 to alfalfa mosaic virus, tobacco ringspot virus, and tobacco streak virus is similar to that of other burley varieties (Table 10).

The level of black shank resistance in TN 86 is similar to that of VA 509, which is the variety most commonly used for the control of black shank in Tennessee and Virginia (Figure 4). TN 86 is not as resistant to black shank as is 'KY 17,' (the most popular black shank-resistant variety in Kentucky) and some other hybrid burley varieties. However, TN 86 has out-yielded other black shank-resistant varieties in tests grown in black shank-infested soils (Table 11). Limited losses due to black shank may occur when TN 86 is grown in heavily infested fields under normal growing conditions. Under extreme drought and black shank pressure, survival of TN 86 may be significantly lower than that of some other black shank-resistant varieties. However, TN 86 has performed as well as or better than VA 509 in test plots, regardless of the severity of black shank conditions.

Yields of TN 86 have been substantially higher than those of VA 509 in tests grown in black root rot-infested soils (Figure 5 and Table 12).

Chemical composition

The chemical composition of TN 86 has been well within the specifications established for burley tobacco by the Burley Tobacco Quality Committee—Varieties (Tables 13 and 14). The quality of smoke produced from cured leaf



Figure 5. TN 86 (GR 136) and VA 509 produced in a Hamblen County, Tennessee, field that had a high level of black root rot, which stunts growth in nonresistant varieties.

of TN 86 has consistently been judged to be acceptable by industry smoke panels (Table 15).

Summary

TN 86, the first burley tobacco variety having resistance to TVMV and TEV diseases, was released by the University of Tennessee as a commercial cultivar in 1986. The new cultivar, which is also resistant to black shank, black root rot, wildfire, and most strains of potato virus Y, was developed at the Tobacco Experiment Station in Greeneville, Tennessee. Unlike earlier breeding lines having TVMV and PVY resistance derived from TI 1406, TN 86 has normal levels of leaf trichome secretions and is not unusually susceptible to tobacco insect pests. TN 86 is a medium-to-late-maturing cultivar that has more leaves and a more upright growth habit than other burley cultivars. Extensive testing throughout Tennessee and surrounding states has demonstrated that TN 86 is widely adapted. TN 86 has substantially out-yielded other burley cultivars in areas that have heavy infestations of TVMV or TEV diseases. The cured leaf is generally reddish-tan in color and has consistently sold for prices comparable to or higher than those for other cultivars. Because other black shank-resistant cultivars are highly susceptible to TVMV and TEV, burley producers who must grow their crop in black shank-infested ground should benefit greatly by using TN 86.

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Table 1. Agronomic Characteristics by Variety from the 1985 Commercial Burley Variety Test, Tobacco Experiment Station

Entry	Plant Height	Leaf Length	Leaf Width	Leaf No.	Hang Length[1]	Hang Weight[2]	Stalk Circum.
	in.	in.	in.		in.	lb	in
Early maturity							
MS KY 14 x L8	47	33	14	17	68	26	4.2
MS BU 21 x L8	49	32	14	18	68	26	4.2
MS BU 37 x L8	48	31	13	17	66	25	4.3
Medium maturity							
CO-OP 313	49	31	12	19	68	26	4.3
R 7-11	50	33	13	18	70	28	4.4
KY 14	47	30	12	19	67	24	4.2
KY 17	48	31	14	19	67	25	4.5
CO-OP 543	48	30	13	20	66	25	4.5
CLAY 501	50	31	13	20	68	22	4.3
MS BU 21 X KY 10	50	31	13	19	70	27	4.5
Late maturity							
VA 509	52	31	12	22	73	32	4.9
BU 64	51	29	13	26	74	29	4.6
N 77	54	31	13	23	76	30	4.6
TN 86	54	31	13	24	75	32	4.5

[1]Length from butt of stalk to tip of longest leaf when hung on a scaffold.
[2]Weight of a 5-stalk stick of tobacco approximately 3 hours after cutting.

Table 2. 1985 Commercial Burley Variety Test Results

Variety	Yield		Tobacco Experiment Station			
	HRES[1]	TES[2]	Days to Blooming	Days to Topping	Days to Harvest	Black Shank Survival[3]
Early maturity	----lb/A----					%
MS KY 14 x L8	4049	3334	65	65	98	100*
MS BU 21 x L8	3795	3419	65	65	98	100*
MS BU 37 x L8	3614	3213	65	65	98	100*
Medium maturity						
CO-OP 313	3960	3704	68	70	102	41
R 7-11	4159	4024	69	70	102	16
KY 14	3820	3488	70	70	102	0
KY 17	3431	3404	69	70	102	97
CO-OP 543	3713	3413	71	70	102	99
CLAY 501	3487	3284	67	70	102	100
MS BU 21 X KY 10	4012	3816	67	70	102	0
Late maturity						
VA 509	3638	4034	71	74	107	96
BU 64	3292	3821	85	74	107	99
N 77	3688	3890	73	74	107	100
TN 86	3939	4107	72	74	107	97

[1]HRES = Highland Rim Experiment Station. All varieties were topped and harvested on the same dates at HRES.

[2]TES = Tobacco Experiment Station. Varieties were topped and harvested by maturity group at TES.

[3]Average survival of four replications in a field having a high level of Race 0 black shank. Yield data and black shank survival data were obtained in separate tests.

*L8 hybrids have high resistance to Race 0 black shank only; THEY HAVE NO RESISTANCE TO RACE 1 BLACK SHANK.

Table 3. Results of the Advanced Burley Breeding Lines Test, 1984-1985

Entry	Yield		Tobacco Experiment Station		
	HRES[1]	TES[2]	Grade Index	Crop Index	Black Shank Survival[3]
	lb/A				%
			1984		
GR 131	4097	3586	.589	2118	100
GR 132	3715	3699	.531	1972	100
TN 86	4405	4141	.636	2645	100
BU 64	3457	3280	.588	1922	100
R 7-11	—	3660	.635	2329	52
KY 17	3728	3312	.594	1966	100
KY 14	4216	3706	.546	2017	46
VA 509	3946	3432	.592	2030	100
CL 501	—	3708	.641	2372	100
			1985		
GR 131	3629	3935	.582	2284	90
GR 132	3518	4009	.648	2599	100
TN 86	4022	4276	.591	2528	97
BU 64	2975	3630	.594	2158	99
R 7-11	—	4484	.662	2949	0
KY 17	3291	3620	.642	2324	97
KY 14	3763	4029	.635	2557	0
VA 509	2925	4100	.667	2730	96
CL 501	3538	3744	.660	2468	100

[1]Highland Rim Experiment Station, Springfield, Tennessee.

[2]Tobacco Experiment Station, Greeneville, Tennessee.

[3]Average survival of three replications grown in a field having a high level of Race 0 black shank. Disease pressure was moderate in 1984 and high in 1985. Yield data and black shank survival data were obtained in separate tests.

Table 4. Results of the 1985 Burley Tobacco On-farm Variety Trials

County	Average Yield					
	TN 86	VA 509	CL 501	KY 17	KY 14	MS KY 14 X L8
	lb/A					
Macon	2771	3072	2620	2610	2419[1]	3085
Trousdale	2743	2776	2624	2620	3029	2797
Sumner	2867	2750	2517	2100	2428	3133
Robertson	2260	2428	2226	2057	2428	2496
Monroe	3929	4098	2823	3642	3963	4131
Claiborne[2]	4040	3259	3072	3378	3276	3513
Johnson[2]	3019	1636	1973	2049	1788	2631
Hancock	3143	3022	2554	2744	2880	2758
Hawkins	2725	2616	2827	2604	3055	2612
Greene	4480	4294	4014	3827	4014	3827
Robertson	4022	2925[3]	3538	3291	3763	4049
Mean	3273	2989	2800	2811	3004	3185

[1]Approximately 10 percent loss due to black shank.
[2]Heavy incidence of tobacco vein mottling and tobacco etch viruses.
[3]Moderately stunted by black root rot.

Table 5. Yield and Quality Data from the Regional Burley Small Plot Tests

Entry	State					Avg.	Rank[1]
	KY	TN	VA	NC	OH		
				1984 Yield (lb/A)			
VA 509	2952	2934	2997	2095	3130	2822	15
TN 86	3280	3491	3171	2714	3619	3255	1
KY 14	3233	3574	3011	2301	3305	3085	2
				1985 Yield (lb/A)			
VA 509	3079	4325	3222	3037	2788	3290	10
TN 86	3211	4574	3699	3455	2873	3562	2
KY 14	3418	4248	3402	3412	3004	3497	3
				1985 Leaf Color[2]			
VA 509	2.07	1.95	1.80	1.47	1.73	1.80	3
TN 86	1.60	2.25	1.95	1.40	1.60	1.76	1
KY 14	1.33	2.25	2.20	3.53	2.20	2.30	15
				1985 Leaf Quality[3]			
VA 509	2.87	3.05	3.10	2.33	2.40	2.75	2
TN 86	2.67	3.00	3.10	2.47	2.20	2.69	1
KY 14	2.80	3.90	3.15	4.73	3.13	3.54	17
				1985 Percent Usable Leaf[4]			
VA 509	46	31	30	55	58	44	2
TN 86	52	33	33	51	67	47	1
KY 14	49	15	22	0	44	26	14

[1]Rank among the total number of entries in the Regional Small Plot Tests. Twenty-two entries were in the 1984 test and 19 were in the 1985 tests.

[2]Leaf color: 1 = Tan or Buff; 2 = Red; 3 = Variegated; 4 = Greenish, Piebald, or Motley.

[3]Leaf quality: 1 = Good; 2 = Fair; 3 = Poor; 4 = Very Poor.

[4]Percent usability: Average overall industry usability as judged by the six tobacco companies participating in warehouse evaluations.

Table 6. Yield and Quality Data from the 1985 Regional Burley Farm Test

Entry	State					Avg.	Rank[1]
	KY	TN	VA	NC	OH		
				Yield (lb/A)			
VA 509	2953	3308	3081	2834	2850	3054	3
TN 86	3048	3511	3496	3316	2870	3274	2
KY 14	3080	3482	3187	3508	3160	3277	1
GR 131	2947	3046	3226	3270	2784	3044	4
NC 127	2858	2924	2942	3382	2888	2957	5
				Leaf Color[2]			
VA 509	2.09	2.26	1.81	1.74	1.96	2.02	1
TN 86	1.93	2.36	2.08	1.60	2.04	2.04	2
KY 14	1.83	2.26	2.37	2.66	2.70	2.25	5
GR 131	1.89	2.43	2.38	1.60	2.46	2.15	4
NC 127	1.95	2.45	2.01	2.00	2.20	2.12	3
				Leaf Quality[3]			
VA 509	3.33	3.30	3.17	2.63	2.86	3.15	2
TN 86	3.08	3.46	3.19	2.70	2.74	3.11	1
KY 14	3.12	3.54	3.31	3.93	3.53	3.41	5
GR 131	3.16	3.60	3.54	2.90	3.30	3.33	4
NC 127	3.13	3.53	3.24	3.14	3.06	3.24	3
				Percent Usable Leaf[4]			
VA 509	34	25	30	45	47	34	2
TN 86	40	21	29	43	50	35	1
KY 14	40	19	24	14	26	27	5
GR 131	41	18	19	37	36	30	4
NC 127	40	18	27	30	40	31	3

[1]Rank among the total number of entries in the Regional Burley Farm Tests.

[2]Leaf color: 1 = Tan or Buff; 2 = Red; 3 = Variegated; 4 = Greenish, Piebald or Motley.

[3]Leaf quality: 1 = Good; 2 = Fair; 3 = Poor; 4 = Very Poor.

[4]Percent usability: Average overall industry usability as judged by the six tobacco companies participating in warehouse evaluations.

Table 7. Disease Resistance Ratings of Selected Burley Varieties

Entry	Black Shank	Black Root Rot	Wildfire	Viral Diseases			
				TMV	TEV	TVMV	PVY
KY 14	None	Med-high	High	High	None	None	None
MS BU 21 X KY 10	None	Low	High	High	None	None	None
R 7-11	None	Medium	High	High	None	None	None
CO-OP 313	Low	Med-high	High	High	None	None	None
CO-OP 543	Med-high	Medium	High	High	None	None	None
TN 86	Medium	High	High	None	Med-high	High	*
VA 509	Medium	Low	High	None	None	None	None
KY 17	Med-high	High	High	High	None	None	None
CL 501	Med-high	Medium	High	High	None	None	None
N 77	Med-high	Medium	High	Medium	None	None	None
MS KY 14 X L8	**	Medium	High	High	None	None	None
MS BU 37 X L8	**	Low	High	High	None	None	None
MS BU 21 X L8	**	Low	High	High	None	None	None

*TN 86 is resistant to most strains of PVY.

**High resistance to Race 0, no resistance to Race 1 black shank.

Table 8. Results of Tobacco Etch and Tobacco Vein Mottling Virus Inoculation Studies

Variety	Yield		Value		Yield		Value	
	TEV[1]	Check	TEV	Check	TVMV[2]	Check	TVMV	Check
	lb/A		$/A		lb/A		$/A	
Black Shank Susceptible								
KY 10	2975	3600	5373	6490	2824	3175	5095	5818
KY 14	2724	3674	4906	6682	2604	2704	4742	4949
KY 15	2936	3585	5308	6488	2365	2313	4140	4157
BU 21	2662	3845	4886	6964	1763	2478	3104	4492
CO-OP 313	2930	3507	5284	6435	2470	2763	4508	5018
MS BU 21 X KY 10	2958	3336	5366	6030	1685	1964	2974	3585
R 7-11	2986	3422	5394	6189	1919	2161	759	1158
Black Shank Resistant (Race 0)								
MS KY 14 X L8	2535	3301	4532	6021	2511	2927	4582	5372
MS BU 21 X L8	2683	2957	4817	5332	1685	1964	2974	3585
MS BU 37 X L8	1900	3156	3375	5789	966	1894	1550	3425
Black Shank Resistant (Race 0 and Race 1)								
KY 17	2611	3317	4770	5983	1830	1979	3255	3513
BU 37	2048	2943	3698	5327	244	1194	336	2173
BU 49	1968	2864	3568	5163	0	1009	0	1641
CL 501	2530	3037	4582	5539	1968	2360	3589	4376
VA 509	2739	3399	5011	6155	1667	2028	2871	3667
VA 528	2686	3452	4885	6223	2380	2363	4309	4295
Virus Resistant								
TN 86	3932	3721	7156	6704	3643	3173	6830	5972
Mean	2675	3240	4736	5787	2306	2622	3983	4590

[1]Plots were inoculated three weeks after transplanting. Check plots were not inoculated and expressed little or no virus symptoms.

[2]Plots were inoculated three weeks after transplanting. Check plots were not inoculated but expressed moderate to heavy virus symptoms due to infestation from native virus sources.

Table 9. Reaction of Selected Burley Varieties to Four Strains of Potato Virus Y (PVY)[1]

Variety	Percent Necrotic Tissue[2]			
	NC 78	NC 171	NC 187	NC 189
Burley 21	0	20	20	25
Burley 37	100	30	—[3]	30
Burley 49	100	50	—	30
Greeneville 115	0	0	0	15
TN 86	0	0	0	15
Virgin A Mutant	0	0	0	15

[1]The test was conducted in a greenhouse at 26 ± 5°C on plants produced in 2.5 in. diameter clay pots. Plants were inoculated at the 3-4 leaf stage of growth. Symptoms were recorded 4 weeks after inoculation. Three plants were inoculated in each treatment and the experiment was repeated 2 times with essentially identical results; only the results of one trial are reported.

Potato Virus Y Strains	
Designation	Source
NC 78	MN strain from tobacco
NC 171	Necrotic strain from West Germany
NC 187	Necrotic strain from South Africa
NC 189	Necrotic strain from Hungary

[2]Visual estimate of percentage of necrotic tissue on the plant.
[3]Dash (—) = no data recorded.

Table 10. Reaction of Selected Burley Varieties to Alfalfa Mosaic, Tobacco Ringspot, and Tobacco Streak Viruses[1]

	Reaction					
	AMV		TRSV		TSV	
Variety	M[2]	S[3]	M	S	M	S
Burley 21	3	30	3	50	4	60
Burley 49	3	30	3	50	4	60
Kentucky 14	3	30	3	50	4	60
TN 86	3	30	3	50	4	60
Virgin A Mutant	2	20	2	30	2	40

[1]The test was conducted in a greenhouse at 26 ±5°C on plants produced in 2.5 in. diameter clay pots. Plants were inoculated at the 3-4 leaf stage of growth. Symptoms were recorded four weeks after inoculation. Three plants were inoculated in each treatment and the experiment was repeated two times with essentially identical results; only the results of one trial are reported.

[2]M = mottling (1 = mild, 3 = severe).

[3]S = stunting (visual estimate of percent reduction in growth compared with noninoculated check). Number represents mean of the reaction on three plants.

Table 11. Results of Burley Variety Performance Trials under Black Shank Conditions with Three Rates of Ridomil

Variety	Resistance Level	Sumner County Ridomil Rate/Acre[1]			Tobacco Experiment Station Ridomil Rate/Acre		
		2 Quarts	4 Quarts	6 Quarts	2 Quarts	4 Quarts	6 Quarts
TN 86	Medium						
Yield[2]		3170	3504	3576	3501	4004	3912
% Survival		97	100	100	99	100	100
VA 509	Medium						
Yield		2824	2905	2865	3410	3176	3673
% Survival		96	99	100	100	100	100
CL 501	Med-high						
Yield		2965	2934	3264	3260	3138	2976
% Survival		100	100	100	100	100	100
BU 64	Med-high						
Yield		2676	3054	2938	2746	2810	2491
% Survival		98	100	100	100	98	96
CO-OP 313	Low						
Yield		1072	1168	1800	1626	2498	2009
% Survival		28	32	64	49	72	64
KY 14	Susceptible						
Yield		56	35	382	0	101	1202
% Survival		2	2	8	0	3	34

[1]All Ridomil treatments were pre-plant incorporated.
[2]Yields and percent survivals are average values for four replications. Yields are in pounds per acre.

Table 12. Results of Burley Variety Performance Trials under Black Root Rot Conditions

Variety	Resistance Level	Yield	
		Hamblen Co.[1]	Robertson Co.[2]
		lb/A	
VA 509	Low	2230	2925
KY 14	Medium	3694	3763
CL 501	Medium	3635	3538
BU 64	High	3281	2975
TN 86	High	4194	4022

[1]Heavy black root rot infestation.
[2]Moderate black root rot infestation.

Table 13. Results of Chemical Analyses from Regional Burley Small Plot Tests

Entry	Year	State					Avg.
		KY	TN	VA	NC	OH	
Percent Total Alkaloids							
VA 509	1984	4.46	4.03	4.63	4.32	5.70	4.64
TN 86	1984	4.10	3.47	4.25	3.39	5.47	4.14
KY 14	1984	3.43	3.57	4.06	3.74	4.24	3.85
VA 509	1985	4.72	5.61	4.05	4.95	7.06	5.28
TN 86	1985	4.40	5.62	4.06	4.32	6.22	4.92
KY 14	1985	3.54	4.59	3.40	3.44	5.70	4.13
Percent Total Nicotine							
VA 509	1984	3.85	3.77	4.19	4.01	5.21	4.21
TN 86	1984	3.84	3.37	4.03	3.24	5.03	3.90
KY 14	1984	3.16	3.43	3.81	3.60	3.95	3.59
VA 509	1985	4.34	4.89	3.56	4.48	6.29	4.71
TN 86	1985	3.92	4.94	3.55	3.84	5.65	4.38
KY 14	1985	3.24	4.08	3.00	2.94	5.20	3.69
1984 average of controls = 3.90; acceptable range (±15%) = 3.32–4.48.							
1985 average of controls = 4.20; acceptable range (±15%) = 3.57–4.83.							
Percent Total Secondary Alkaloids							
VA 509	1984	0.61	0.27	0.44	0.31	0.49	0.43
TN 86	1984	0.26	0.11	0.22	0.15	0.43	0.24
KY 14	1984	0.27	0.14	0.25	0.14	0.29	0.26
VA 509	1985	0.38	0.72	0.50	0.47	0.77	0.57
TN 86	1985	0.49	0.68	0.51	0.48	0.57	0.55
KY 14	1985	0.30	0.50	0.41	0.51	0.50	0.44

Ratio of Secondary to Total Alkaloids							
VA 509	1984	0.14	0.07	0.10	0.07	0.09	0.09
TN 86	1984	0.06	0.03	0.05	0.04	0.08	0.06
KY 14	1984	0.08	0.04	0.06	0.04	0.07	0.07
VA 509	1985	0.08	0.13	0.12	0.09	0.11	0.11
TN 86	1985	0.11	0.12	0.13	0.11	0.09	0.11
KY 14	1985	0.08	0.11	0.12	0.15	0.09	0.11
Total secondary alkaloids may not exceed 20% of the total alkaloids.							
Percent Total Nitrogen							
VA 509	1984	4.76	3.40	4.81	4.65	4.28	4.38
TN 86	1984	4.22	3.27	4.77	4.21	4.10	4.12
KY 14	1984	4.46	3.24	4.64	4.39	4.20	4.19
VA 509	1985	4.94	4.73	4.75	4.92	5.53	4.97
TN 86	1985	5.00	4.89	4.97	4.49	4.85	4.84
KY 14	1985	5.09	4.77	4.90	4.42	5.04	4.84
1984 average of controls = 4.28; acceptable range (± 10%) = 3.35–4.71.							
1985 average of controls = 4.90; acceptable range (± 10%) = 4.41–5.40.							

Table 14. Results of Chemical Analyses from 1985 Regional Burley Farm Test

Entry	State KY (6)[1]	TN (4)	VA (3)	NC (2)	OH (2)	Avg.
			Percent Total Alkaloids			
VA 509	4.60	4.88	4.39	4.91	7.18	4.97
GR 136	4.59	4.68	4.10	4.18	6.35	4.68
KY 14	4.02	4.20	3.90	3.82	5.58	4.20
GR 131	4.71	4.95	4.87	4.66	6.42	4.99
NC 127	3.95	4.34	3.90	4.80	5.84	4.36
			Percent Nicotine			
VA 509	4.12	4.26	3.83	4.46	6.40	4.41
GR 136	4.00	4.12	3.60	3.68	5.64	4.11
KY 14	3.66	3.71	3.49	3.32	5.02	3.76
GR 131	4.05	3.90	3.66	3.76	5.68	4.10
NC 127	3.56	3.89	3.52	4.34	5.35	3.93
Average of controls = 4.08; acceptable range (±15%) = 3.47–4.69.						
			Percent Secondary Alkaloids			
VA 509	0.49	0.61	0.57	0.46	0.78	0.56
GR 136	0.60	0.57	0.50	0.50	0.72	0.58
KY 14	0.37	0.48	0.41	0.50	0.56	0.44
GR 131	0.66	1.05	1.22	0.90	0.76	0.89
NC 127	0.39	0.46	0.38	0.46	0.50	0.43
			Ratio of Secondary to Total Alkaloids			
VA 509	0.11	0.12	0.13	0.09	0.11	0.11
GR 136	0.13	0.12	0.12	0.12	0.11	0.12
KY 14	0.09	0.11	0.11	0.13	0.10	0.10
GR 131	0.14	0.21	0.25	0.19	0.12	0.18
NC 127	0.10	0.11	0.10	0.10	0.09	0.10
Total secondary alkaloids may not exceed 20% of the total alkaloid fraction.						
			Percent Total Nitrogen			
VA 509	4.83	4.81	4.58	4.84	5.44	4.85
GR 136	4.57	4.82	4.41	4.64	5.02	4.66
KY 14	5.28	4.88	4.66	4.47	5.08	4.96
GR 131	4.84	4.80	4.54	4.62	5.14	4.79
NC 127	4.98	4.92	4.72	4.75	5.08	4.90
Average of controls = 4.90; acceptable range (±10%) = 4.41–5.39.						

[1]Number of locations in each state in parentheses.

Table 15. 1985 Regional Burley Farm Test Smoke Panel Evaluations

Entry	Panel A	Panel B	Panel C	Panel D	Panel E
VA 509	A[1]	A	A	A	A
GR 136	A	A	A	A	A
KY 14	A	A	A	A	A
GR 131	A	U[2]	A	A	A
NC 127	A	U	A	A	A

[1]A = Acceptable burley taste.
[2]U = Unacceptable burley taste.

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