Sensitivity of Burley Tobacco Cultivars to Weather Fleck in Ontario

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ABSTRACT

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Thirteen cultivars of burley tobacco (*Nicotiana tabacum*) were evaluated for sensitivity to weather fleck under local field conditions. Weather fleck damage varied with year, cultivar, and leaf position. Kentucky 17 was least sensitive and Burley 21 was most sensitive during the 2-yr evaluation.

Weather fleck of tobacco (*Nicotiana tabacum* L.) caused by ozone (1) results in moderate damage each year to the burley tobacco crop in southwestern Ontario. Severely flecked leaves tend to shatter during curing and stripping operations, resulting in a direct yield loss. Quality of flecked leaves is affected by an alteration of chemical constituents (4,9). Generally the disorder occurs sporadically from field to field and is considered a minor problem by growers. In Ontario, however, most of the burley tobacco is planted in proximity to Lake Erie, near the flue-cured tobacco area where significant losses from weather fleck have occurred (7). At present, the major proportion of the burley acreage is planted with a single cultivar male-sterile (m.s.) Burley 21 × Kentucky 10. If conditions favoring weather fleck occur and the popular cultivar is susceptible, severe damage to the burley crop will result.

A range of sensitivity to weather fleck among burley tobacco cultivars has been demonstrated in controlled fumigation tests (10) and field experiments (8,10,11); however, the response of cultivars to air pollution in field tests may vary considerably. In testing varietal response in several states, Menser (8) reported variation in weather fleck damage and cited a number of environmental and cultural practices as possible causes. Huang et al (3) concluded that variation in damage to Maryland tobacco was related to genetic and environmental factors. In 1980 and 1981 weather fleck symptoms were evident on 13 cultivars of burley tobacco being evaluated for agronomic suitability in Ontario. This study reports the relative sensitivity of these cultivars to weather fleck damage caused by ambient air pollution.

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MATERIALS AND METHODS

The test site of Fox sandy loam was fumigated with methyl isothiocyanate in a broadcast application at a rate of 56 L/ha, 3 wk before planting. Weeds were controlled by applying pebulate incorporated at 5.6 kg/ha 1 wk before planting. Plots were planted with 7- to 8-wk-old seedlings on 30 May 1980 and 1 June 1981. Transplants were spaced 0.46 m apart in rows 16 m long and 1 m wide. Each cultivar plot consisted of 35 plants per row in a north-south orientation and was replicated four times in a randomized block design.

Fertilizer (5-10-15) was broadcast at a rate of 1,120 kg/ha before transplanting, followed by 1,120 kg/ha side-dressed within 2 wk of planting. An additional sidedressing of fertilizer (34-0-0) was applied 4–5 wk after planting at a rate of 180 kg/ha. Permethrin was applied to each row after planting at 140 ml/ha. Pirimicarb and carbaryl were applied every 10 days until mid-July at 275 L/ha and 3.25 kg/ha, respectively. On 3 August 1980 and 21 July 1981, *n*-decanol at 17 L/ha was applied to control suckers. Plants were topped, retaining 18–20 leaves per plant, beginning on 2 August 1980 and 20 July 1981, depending on the maturity of the cultivar. Weather fleck ratings were made on 21–22 August 1980 and 12–18 August 1981. Rainfall from the date of transplanting to the date ozone ratings were completed totaled 40.8 cm in 1980 and 30.1 cm in 1981; irrigation was not required.

To assess damage, six adjacent plants within a row were removed from the interior of each plot. Leaves at leaf positions 1–12 were stripped from the plants and observed for characteristic weather fleck symptoms. Weather fleck damage was assessed visually on the basis of necrotic tissue evident on the upper leaf surface. Leaf damage was rated on a scale of 0–100% in 5% increments based on photographs of ozone damage presented by Lucas (5). Results were analyzed as a three-factor experiment, with cultivars and leaf position treated as subfactors under years. Subsequently, data for each year were analyzed as a two-factor experiment, with cultivars and positions as the main factors.

RESULTS AND DISCUSSION

Weather fleck damage was evident on all burley tobacco cultivars evaluated in 1980 and 1981. Considerable variation occurred in the extent of weather fleck on individual leaves and plants. Damage on adaxial leaf surfaces ranged from 0 to 40% of the total area. The majority of flecking consisted of circular to slightly irregular necrotic or water-soaked spots 1–2 mm in diameter and resembled type V lesions as described by Menser (8). Occasionally, dark brown spots up to 3 mm in diameter were noted but did not appear to be associated with any particular cultivar. In general, fleck damage was distributed over the entire adaxial surface on lower leaves but was concentrated near the margins of top leaves.

Weather fleck was most severe on leaves in positions 3–7 in both years (Table 1). Mean damage for leaves in positions 1–12 on all cultivars ranged from 2.99 to 7.15% in 1980 and from 0.16 to 9.44% in 1981. Less damage occurred on upper leaves and more on lower leaves in 1981 than in 1980. The general pattern of leaf damage was related to leaf maturity as described previously (2,7).

Analysis of variance as a three-factor experiment (years × cultivars × leaf positions) resulted in significant mean squares for all variables and interactions (Table 2). Considerable variation in weather fleck damage caused by ambient pollutants over locations and years has been reported on flue-cured tobacco (12). Analysis of data for leaf positions 3–5 indicated that a number of interactions were associated with the upper leaf positions; however, the years × cultivars interaction remained significant (Table 2). As a result, differences among cultivars were determined for each year of the evaluation. In 1980, cultivar mean square (412.17) and leaf position mean square (106.04) were significant ($P = 0.01$). The cultivar × position interaction (8.51) was not significant. In 1981, the cultivar × position interaction (19.78) was significant ($P = 0.01$). Cultivar mean square (287.88) and leaf position mean square (622.44) were significant ($P = 0.01$) when tested with the interaction mean square.

Differences in sensitivity to weather fleck among the 13 cultivars evaluated are presented in Table 3. Average damage ranged from 0.33 to 9.64% for Kentucky 17 and Burley 21, respectively, over the 1980–1981 seasons. Fleck damage on Judy's Pride, m.s. Burley 21 × Kentucky 10, and Kentucky 14 × Burley 21 varied considerably between years and probably contributed significantly to the year × cultivar interaction. The reason for this variation is not known, but Huang et al (3) reported a significant genotype × environment interaction with Maryland tobacco and environmental factors that may have contributed to the experiment interactions differed during the 2-yr evaluation. Rainfall in June and July was similar in both years, but rainfall from 1 August until ratings were made was 114.5 mm in 1980 and 21.4 mm in 1981. High soil moisture has been shown to favor symptom expression (6) and may account for the damage on the late-maturing leaves in 1980.

Concentrations of ambient sulfur dioxide monitored at the Research Station during 1980 and 1981 were low. Maximum levels during the growing season were 10.2 and 10.9 pphm in 1980 and 1981, respectively. These concentrations were considerably lower than the 40 pphm sulfur dioxide reported to cause damage to burley tobacco in the presence of 3 pphm ozone (10). Ambient ozone levels at the Research Station were not measured, but ozone concentrations at Windsor, Ontario (32 km from the station), were sufficiently high to cause damage (Table 4). Although ozone concentrations at the test site probably were lower than those at Windsor, the low sulfur dioxide levels recorded at the site suggest ambient ozone as the primary cause of weather fleck damage. No attempt has been made to extrapolate critical fumigation-date information from the Windsor data, but differences in soil moisture and critical fumigation dates might explain the significant year × position interaction. Average days to flowering were 61 in 1980 and 56 in 1981. Flowering dates for cultivars ranged from 56 to 66 days in 1980 and from 50 to 60 days in 1981. Since each cultivar was topped according to flowering period rather than on a specific date, considerable variation could be expected in leaf maturities and consequently variation in weather fleck damage among and within cultivars in both years. Topping has been shown to decrease the susceptibility of flue-cured tobacco, although considerable variation in damage was noted between topped and untopped plants at each fumigation date (6). Topping date and fleck damage were not correlated. It is possible that the effects of topping were masked by other variables such as soil moisture and critical fumigation dates.

In general, results of the evaluation agree with previous reports. Menser (8) reported that Burley 21 was very susceptible to weather fleck at several locations. Burley 21 and Kentucky 16 were found susceptible to fleck in Maryland (10). Reinert et al (11) found that Burley 21 and Kentucky 16 were susceptible, that some hybrids involving Burley 21 as a parent were moderately susceptible, and that Kentucky 10 was

Table 1. Distribution of weather fleck on burley tobacco at Harrow, Ontario, in 1980 and 1981 expressed as percent leaf area damaged

Leaf position	Percent leaf area damaged[a] 1980	1981	1980–1981
1	3.7	2.2	2.95
2	4.2	5.0	4.6
3	6.5	7.8	7.15
4	6.7	9.4	8.05
5	7.2	9.4	8.3
6	7.1	7.9	7.5
7	6.6	5.4	6.0
8	6.4	3.4	4.9
9	6.3	1.9	4.1
10	5.3	0.8	3.05
11	4.6	0.4	2.5
12	3.0	0.2	1.6
$\bar{x}$	5.63	4.48	5.06

[a] Means of 13 cultivars.

Table 2. Mean squares for weather fleck damage on 13 cultivars based on leaf positions 1–12 and 3–5 in 1980–1981

Source of variation	Positions 1-12: Degrees of freedom	Positions 1-12: MS[a]	Positions 3-5: Degrees of freedom	Positions 3-5: MS[a]
Replications	3	211.176**	3	125.878**
Years	1	406.760**	1	342.760**
Cultivars	12	437.260**	12	245.289**
Positions	11	552.523**	2	37.225*
Years × cultivars	12	262.185**	12	180.958**
Years × positions	11	180.596**	2	15.430
Cultivars × positions	132	16.875**	24	6.955
Years × cultivars × positions	132	11.645**	24	5.511
Error	933	7.991	231	11.867

[a] *, ** = Significant at $P = 0.05$ and $P = 0.01$, respectively.

Table 3. Percentage of leaf area damaged by weather fleck on lower 12 leaves of 13 burley tobacco cultivars in 1980 and 1981

Cultivar	1980	1981	1980–1981
Kentucky 17	0.27	0.38	0.33
Kentucky 14 × Line 8	2.86	3.89	3.38
Burley 1	4.89	2.52	3.71
Harwin	5.94	2.62	4.28
Judy's Pride	1.25	7.90	4.57
m.s. Burley 21 × Kentucky 10	7.41	2.03	4.72
Kentucky 10	5.98	3.92	4.95
Kentucky 16	5.36	5.51	5.44
Kentucky 14 × Harwin	4.86	6.20	5.53
Rickard 7-11	5.97	5.43	5.70
Kentucky 14 × Burley 21	9.60	3.35	6.48
Kentucky 14	8.40	5.09	6.75
Burley 21	10.08	9.20	9.64
$\bar{x}$	5.61	4.47	5.04
LSD (0.05)	1.11	1.62	
(0.01)	1.46	2.12	

Table 4. Monthly ozone concentrations recorded at Windsor, Ontario

Year Month	Concentration (pphm) Mean	Maximum 1-hr level	Maximum 24-hr average
1980			
May	3.0	10.3	4.7
June	3.0	10.8	6.7
July	3.8	13.1	6.8
August	3.3	11.2	6.0
1981			
May	2.6	9.9	5.6
June	3.1	9.5	6.1
July	3.6	11.2	6.4
August	3.3	11.1	6.5

among the least-sensitive cultivars evaluated in Ohio. This study suggests that both Kentucky 16 and Kentucky 10 were moderately sensitive compared with the other cultivars evaluated, Burley 21 was sensitive, and Kentucky 17 was highly tolerant to weather fleck under local conditions. Weather fleck damage on m.s. Burley 21 × Kentucky 10 was variable. The stable tolerance of Kentucky 17 should prevent excessive weather fleck damage in the burley tobacco area of southwestern Ontario.

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