Ozone Injury on Tobacco Seedlings can Predict Susceptibility in the Field

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ABSTRACT

Most tobacco plants which were resistant to injury by ozone as seedlings in the four- to six-leaf stage were also resistant as mature plants in the field, and those susceptible as seedlings were susceptible in the field. The correlation coefficient between ozone-sensitivity of seedlings and that of mature plants was .78. Using seedling resistance for screening would err more toward discarding potentially resistant individuals rather than saving susceptible ones. Valuable field space can be saved by screening for resistance at the seedling stage.

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Susceptibility to damage by ozone in polluted air varies widely among individuals for most of the plant species reported to be injured by ozone. Use of these variants to develop resistant cultivars has been successful in a number of crops including alfalfa, onions, petunias, tomatoes, and tobacco.

Resistance in tobacco is multigenic (1, 3), therefore, large numbers of plants are needed to find the few most-resistant individuals in a segregating population. If young plants respond to air pollutants as they do when mature, then use of a small space such as a chamber or greenhouse could substitute for field space. Furthermore, seedlings could be exposed to levels of ozone higher than those normally occurring in the field.

Ozone injury has been reported on cotyledons of cotton (5) and cucumbers (4). Howell and Kremer (2) reported that ozone fumigation injured soybean cotyledons and mature leaves similarly. They also observed ozone injury on cotyledons of radish, cucumber, squash, cabbage, broccoli, and pepper, and suggested that screening seedlings might be used to select crop plants resistant to ozone.

Because polluted air injures cotyledons and primary leaves of tobacco plants in Connecticut, we have tested the feasibility of using seedlings to select tobacco plants resistant to damage by ozone in the field.

Seeds of the following tobacco lines were germinated in vermiculite: commercial cultivars 2238 and Consolidated L, breeding lines Conn. 7264 and Conn. 7272, and cultivar Bel W-3. The first three are considered resistant to ozone as mature plants in the field, and the last two are susceptible. At the four-leaf stage, ten individuals per line in each of four replications were potted in 5-oz paper cups containing a peat perlite mixture (1:1, v/v) amended with lime and calcium sulfate. Ambient ozone levels were monitored with a Mast ozone meter, model 724-1 (modified) fitted with a chromium trioxide scrubber to remove SO_2. Levels over 5 μg ozone/100 liters of air (5 pphm) were recorded in the outside air on 13 June (6 pphm) when plants were in the two-leaf stage, 28 June (8 pphm) after transplanting to cups, and on 2 July (10 pphm).

Before transplanting, the cotyledons and first few leaves of the two susceptible lines were damaged by ambient ozone, while the resistant lines were only slightly injured, or not at all. Further injury occurred while plants were in the paper cups.

On 7 July, when plants were at the four- to six-leaf stage (5 to 10 cm tall), the number of leaves showing some injury was recorded for each plant. On 11 July the plants were set in the field, care was taken to identify each plant for subsequent observations. The field was covered with standard shade cloth and cultivation and cultural procedures were normal for commercial shade-grown tobacco. The mean number of leaves damaged by ozone on each plant was recorded 16 August and 28 August.

The three known resistant lines averaged less than one damaged leaf per plant at the seedling stage and no more than two leaves per plant in the field. The two susceptible lines averaged three to four leaves injured as seedlings and seven to nine as field plants on 16 August. On both lines

TABLE 1. Percentage of individual tobacco plants resistant or susceptible to ozone in the seedling stage and at maturity in the field

Known field history	Seedlings[a]	Mature field plants[b]			
		16 August		28 August	
		Resistant	Susceptible	Resistant	Susceptible
Resistant lines (109 plants)	Resistant (81)	78	3	71	10
	Susceptible (19)	18	1	16	3
Susceptible lines (78 plants)	Resistant (3)	0	3	0	3
	Susceptible (97)	0	97	0	97

[a]Resistant = none to one leaf injured. Susceptible = two to five leaves injured.
[b]Resistant = none to four leaves injured. Susceptible = five to twenty leaves injured.

the number of leaves injured had nearly doubled by 28 August.

When plants were arbitrarily placed into resistant and susceptible classes (Table 1), 97% of the individuals from known susceptible lines were susceptible in both the seedling and mature stages. Only 3% were classed resistant as seedlings but susceptible in the field. This was true for both the 16 August and 28 August dates.

Of the known resistant lines, 81% of the seedlings were classed as resistant. Of these, 96% were classed as resistant mature plants on 16 August, and 90% on 28 August. Thus, selecting for seedling resistance could possibly eliminate about one-fifth of the ozone-resistant plants in a segregating population of tobacco.

Correlation coefficients (all 187 plants in all lines) for seedling vs. field stage plants were .76 and .78 for the 16 August and 28 August dates, respectively. Both were significant, $P = 0.01$, by Student's "*t*" *test*. Thus, overall field reaction matched seedling reaction for these five lines.

Field reaction to ozone of progeny from ozone susceptible lines was accurately predicted by degree of injury on seedlings. Thus, very susceptible individuals can be discovered and eliminated by screening as seedlings. Highly resistant individuals can also be selected by seedling reaction but less reliably so than for the susceptible ones. There were more individuals susceptible as seedlings but resistant in the field, than resistant as seedlings but susceptible in the field. Thus, the chance of discarding germ plasm with some degree of resistance is greater than that of saving worthless germ plasm.

The relative concn of ozone to which plants were exposed at either stage could change the observed degree of correlation. The results reported here suggest that susceptible individuals could be eliminated by exposing a segregating population to ozone at the seedling stage, thus reducing the need for costly field space.

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