Effect of Alternaria Leaf Blight on Soluble Solids Content of Muskmelon

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ABSTRACT

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Soluble solids content (SSC), a measure of fruit quality, was determined from muskmelons sampled periodically from experimental field plots that sustained Alternaria leaf blight epidemics of varying intensity. The relationship between epidemic severity and two quantitative representations of the change in SSC during the sampling period (SSCAREA and SSCINDEX) was investigated. Epidemic severity was represented by the area under the disease progress curve and apparent infection rate. Results show that SSC decreased with increased severity of Alternaria leaf blight epidemics. Interpretation of these results justifies periodic application of protective fungicides to reduce losses caused by the disease.

Epidemics of Alternaria leaf blight occur frequently in commercial muskmelon (*Cucumis melo* L. var. *reticulatus* Naudin) fields in the Midwest. Infection by the pathogen (*Alternaria cucumerina* (Ellis & Everh.) J.A. Elliott) results in characteristic leaf spots that, under favorable conditions, increase in size and number over time (9). Mature lesions bear numerous conidia that are dispersed by wind and splashing water to neighboring plants and fields. Because measurable host resistance is not available in commercially acceptable muskmelon cultivars, and lengthy crop rotations are only partially effective in reducing the disease threat, midwestern farmers rely on repeated applications of protective fungicides for Alternaria leaf blight control.

Unprotected plants are defoliated rapidly by the disease; severe outbreaks can result in fruit damaged by sunscald (11) and significant reduction in melon yield (8,10). It is suspected that fruit from defoliated vines ripen prematurely and therefore have lower quality than fruit harvested from healthy vines (12). Soluble solids content (SSC), defined as the percentage of soluble solids in juice from muskmelon flesh, is a factor traditionally used to assess melon quality (4). According to standards established in the 1920s, muskmelon SSC must be 9% or greater to qualify as USDA No. 1 fruit (1). Research has been conducted on the effects of solar radiation and nutrient status on SSC (2,6), but there are no reports that establish a relationship between infectious disease and factors that determine melon quality. The objective of this research was to investigate the effect of Alternaria leaf blight epidemics on muskmelon quality as defined by the soluble solids content.

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MATERIALS AND METHODS

Research was conducted in experimental field plots in 1990 and 1993 at the Purdue Horticultural Research Center in Lafayette, Indiana. Experimental plots consisted of single 10.67-m rows with 10 plants per row. Plants within rows were spaced 1.07 m apart; rows were spaced 2.44 m apart. Plots were randomized within each of four blocks. All rows were mulched with an agricultural grade black polyethylene plastic (4 mil thickness). The experimental site was prepared and maintained according to standard commercial practices for muskmelon production. Weeds were controlled by incorporation of bensulide (Prefar 4E, 4.5 kg a.i./ha) and naptalam (Alanap L, 1.6 kg a.i./ha) prior to transplanting. Insects were controlled with weekly applications of carbaryl (Sevin 80S, 1.1 kg a.i./ha) or endosulfan (Thiodan 3EC, 0.4 kg a.i./ha) from transplanting through the second week of harvest.

Seeds of the muskmelon cultivar Allstar (Harris Moran Seed Co., Rochester, NY) were planted in a commercially prepared soilless potting medium in plastic growing trays (50 cells per tray with an approximate volume of 65 cm^3 each) approximately 4 wk prior to transplanting in the field. Seedlings with two true leaves were transplanted on 26 May 1990 and 1 June 1993.

Inoculum was prepared from 8-day-old cultures of *A. cucumerina* (isolate 8721) growing on agar containing 20% V8 juice in 9-cm petri dishes using the technique described by Evans et al (5). Conidial suspensions were adjusted to a concentration of 5×10^4 spores per milliliter. Approximately 150 ml of the inoculum suspension was applied over the 10.7-m length of each spreader row with a manually operated pressurized sprayer. Inoculations in both years were performed at dusk (approximately 2000 hr), and a leaf wetness period of at least 12 hr occurred following the application of conidial suspensions to spreader rows. Inoculum was applied on 26 June 1990 and 28 June 1993. At the time of inoculation, plants were beginning to set fruit, and vines within rows were not yet touching.

Epidemics of various intensities were created in the field plots by applying chlorothalonil (Bravo 720) at a rate equivalent to 1.68 kg a.i./ha to treatment rows according to various fungicide application schedules. Fungicides were applied with a hand-held boom sprayer that delivered 187 L/ha through four Tee-Jet hollow cone nozzles with D3-25 components. Nozzle pressure was 2.8 kg/cm^2. Each fungicide treatment row was bordered on one side by an inoculated, unsprayed spreader row. Fungicide applications were initiated after the disease was well established in the spreader rows. Fungicide application schedules are listed in Table 1.

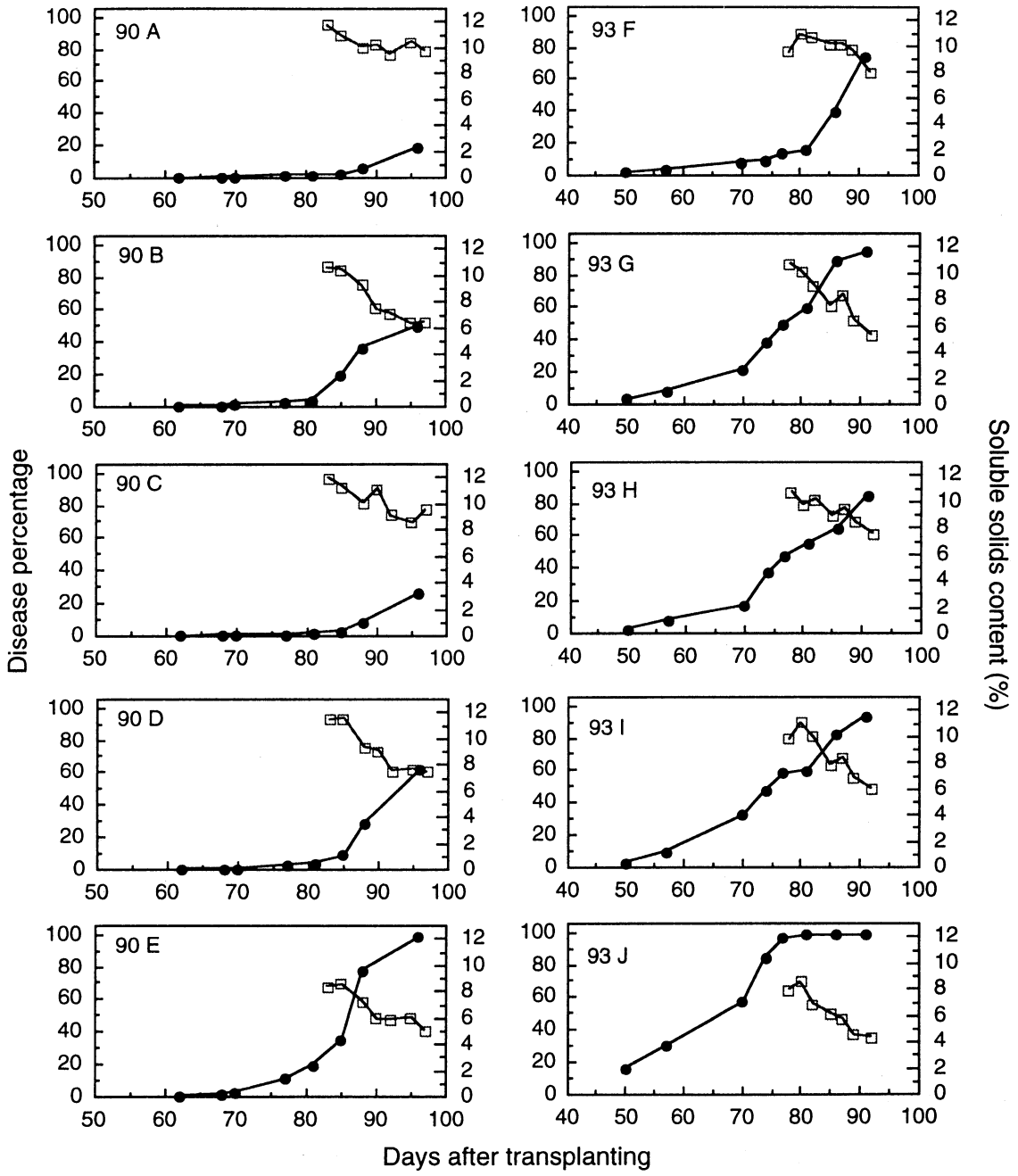

Fig. 1. Disease progress curves (●) for 10 Alternaria leaf blight epidemics and the corresponding soluble solids content determinations (□) from muskmelons sampled during seven harvests in a 2-wk period in 1990 **(A–E)** and 1993 **(F–J)**.

Table 1. Description of treatments, disease characteristics, yield-loss percentages, and soluble solids content (SSC) determinations associated with Alternaria leaf blight epidemics monitored in 1990 and 1993

Treatment identification	Fungicide application dates (days after transplanting)	AUDPC[a]	AIR[b]	YLP[c]	SSCAREA[d]	SSCINDEX[e]
1990.A	56, 62, 70, 77, 84, 91, 98	185.2	0.112	0	144.9	22.6
1990.B	56, 70, 84, 98	580.3	0.117	3.9	115.7	5.9
1990.C	56, 62, 76, 81	246.6	0.128	0	142.0	14.7
1990.D	56, 81	627.8	0.180	8.6	127.8	8.9
1990.E	No fungicide	2,057.9	0.213	27.6	95.3	−0.7
1993.F	38, 44, 52, 59, 66, 72, 81	668.0	0.099	0	140.4	13.8
1993.G	38, 52, 66	1,544.5	0.149	26.6	114.1	5.9
1993.H	38, 50, 64, 79	1,329.5	0.124	21.1	130.1	9.3
1993.I	38, 59, 72	1,667.0	0.140	15.3	119.9	6.5
1993.J	No fungicide	2,648.9	0.172	57.1	87.5	−0.4

[a] Area under the disease progress curve.
[b] Apparent infection rate.
[c] Percentage of yield reduction relative to plots with the least amount of disease.
[d] Area under the curve for change in mean SSC for each of the seven harvest dates.
[e] Days from the beginning of the harvest period that SSC ≥ 9%, the minimum standard for USDA No. 1 melons.

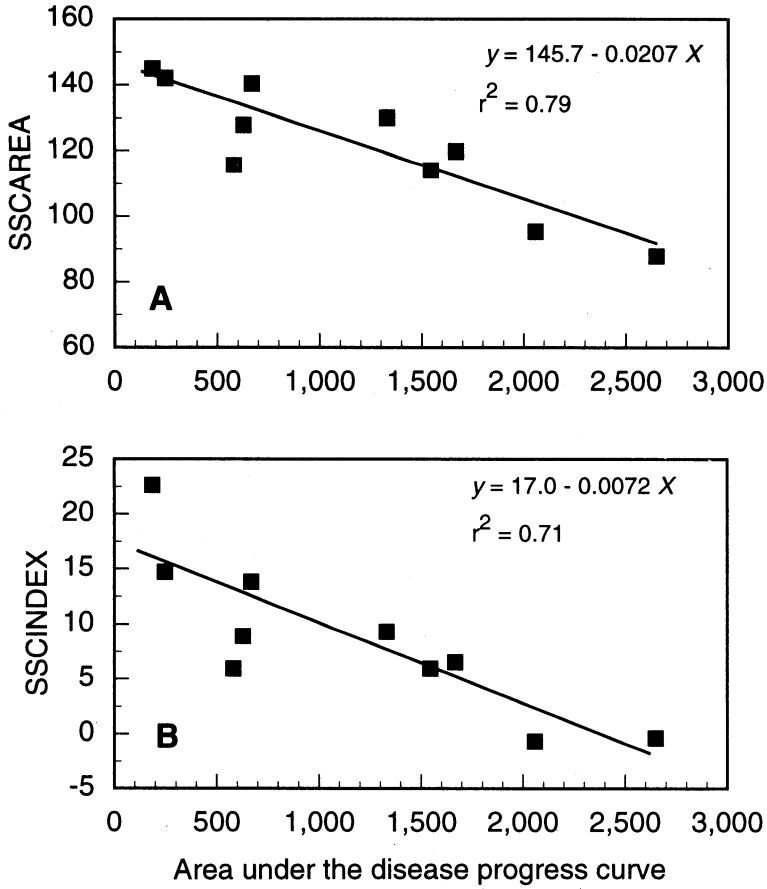

Fig. 2. Scatter diagram showing the relationship between **(A)** area under the disease progress curve (AUDPC) and area under the soluble solids content curve (SSCAREA), and **(B)** AUDPC and a linear regression of SSC against days after transplanting (SSCINDEX).

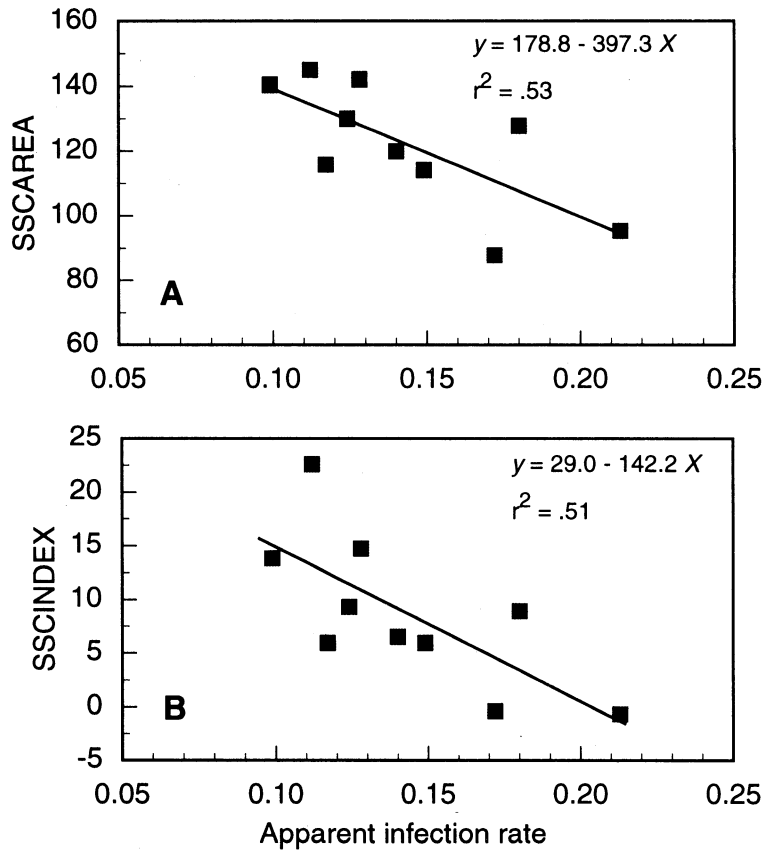

Fig. 3. Scatter diagram showing the relationship between **(A)** apparent infection rate and area under the soluble solids content curve (SSCAREA), and **(B)** apparent infection rate and a linear regression of SSC against days after transplanting (SSCINDEX).

Disease severity was assessed visually at 3–6 day intervals using the Horsfall-Barratt scale (7). A single Horsfall-Barratt value was assigned to each plot on each assessment date. Assessments were recorded from 12 July through 29 August 1990 and from 15 July through 30 August 1993. The Horsfall-Barratt values were converted to disease proportions and transformed to logits for further analysis of epidemics. Apparent infection rates (14) and areas under the disease progress curve (AUDPCs) (3) were determined for epidemics for each treatment.

Mature muskmelons were harvested seven times at 2–3 day intervals from 16 to 30 August 1990 and from 15 to 29 August 1993. Fruit counts and weights were recorded for each harvest. SSC determinations (in percent) were made in the field immediately after recording yield data. In most cases, two mature melons from each replication of each treatment were selected for determination of SSC. In some plots, only one mature melon was available for SSC determination. In a few other plots, no melons were mature; therefore none were harvested. Melons were cut in half so that two SSC determinations could be obtained from each fruit. SSC was measured with a hand refractometer by squeezing juice from a 2.5 cm^3 section of fruit cut from each half melon. SSC values were recorded for each muskmelon harvest.

Changes in SSC during the 2-wk harvest period were defined by two quantitative variables; the area under the SSC curve (SSCAREA) and an index (SSCINDEX) derived from linear regression of SSC against time in days after transplanting. The SSCAREA was determined by trapezoidal integration, the same procedure used to calculate AUDPC. The SSCINDEX represents the number of days after the initial harvest that SSC equaled or exceeded a value of 9%.

RESULTS AND DISCUSSION

Disease progress curves show that the investigation was conducted over a broad range of epidemic intensities (Fig. 1A–J). In general, weather conditions were less favorable for disease development in 1990 than in 1993; therefore epidemic onset occurred later. The data used to generate the disease progress curves provided an acceptable fit to the logistic model based on the r^2 criterion. Also, plots of residuals vs. fitted values did not suggest that the logistic model was inappropriate. Coefficients of determination for regressions of disease logits on time ranged from $r^2 = 0.80$ to 0.95. Apparent infection rates varied from 0.099 to 0.213, and AUDPC values ranged from 185 to 2,649. These values are listed in Table 1 with their corresponding treatment identifications. A

plot of the mean SSC values for muskmelons sampled at each harvest date for each treatment also is displayed in Figure 1. Values for SSCAREA ranged from 87.8 to 144.9, and SSCINDEX values ranged from −0.7 to 22.6 (Table 1.)

As shown in Figure 1, SSC decreased with increasing severity of Alternaria leaf blight epidemics. This relationship was further defined by regressing values for SSCAREA and SSCINDEX against AUDPC (Fig. 2) and the apparent infection rate (Fig. 3). All regressions resulted in slope values that were significantly less than zero ($P = 0.05$), demonstrating the inverse relationship between SSC and disease. Although all regressions were statistically significant ($P = 0.05$), AUDPC appeared to be a better estimator of the decline in SSC due to leaf blight epidemics based on coefficients of determination.

Regardless of the variables used for comparisons between disease severity and SSC, it is evident that increases in Alternaria leaf blight severity resulted in a sustained reduction in SSC over the harvest period. The SSCAREA is a useful variable for treatment comparisons, but it is an awkward term to use outside the scientific community for illustrating the effects of disease on muskmelon quality. The SSCINDEX is valuable in both regards. It appears to be a valid statistic for treatment comparisons and, because of its defining units (days for which SSC $\geq 9\%$), is a suitable term for describing the consequences of Alternaria leaf blight epidemics to farmers and agribusiness personnel. Growers will readily sense that the longer they can produce fruit with SSC values around or above the 9% threshold (as indicated by a high SSCINDEX), the more valuable their crop will be. Likewise, they will understand that if SSC percentages never approach 9 (as in a negative SSCINDEX), they can expect a scarcity of repeat buyers and a substantially devalued crop.

Because data from the 1990 epidemics were used to derive the models described in a prior publication (10), it was not our intention to address bulk yield losses (melons per hectare). However, comparisons among bulk yield losses, SSC determinations, and epidemic descriptions proved noteworthy. As defined in that earlier report, yield losses were represented by percentages based on the yield of field plots with the least amount of defoliation. Regression of yield loss percentages (YLP) (listed in Table 1) on AUDPC resulted in a correlation coefficient of $r = 0.94$ and reinforced previously stated conclusions on the effect of Alternaria leaf blight on melon yields. Regression of YLP on SSC determinations resulted in correlation coefficients of $r = 0.86$ for YLP vs. SSCAREA and $r = 0.76$ for YLP vs. SSCINDEX. These regressions confirm a logical association between reduction in melon yield and decline in fruit quality.

These results are consistent with other reports that document the effects of various noninfectious stresses on muskmelon quality as described by SSC (2,12,13). We recognize that SSC is not the only measurement of muskmelon quality. According to some reports (1,6), supplemental sensory evaluations such as flavor (as determined by a panel of appraisers), color, and shape may help provide a more accurate account of fruit quality than SSC alone. However, other reports (2,4,12,13) include SSC as the only variable representative of melon quality. We concluded that SSC was an appropriate indicator of muskmelon fruit quality for this research because it has the advantage of being quantitatively and objectively determined.

Results presented in Table 1 show that the greatest yields and highest quality fruit were harvested from plots that were protected with fungicides throughout the season. Conversely, the lowest yields and poorest quality fruit were associated with unsprayed plots. Interpretation of these results provides added justification for the use of fungicides for managing Alternaria leaf blight. Previous research described the potential losses in bulk yield (10). This paper shows that a reduction in melon quality and value will occur if the disease is allowed to progress unimpeded by fungicidal sprays.

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