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Dongsheng Zheng
University of Nebraska - Lincoln

James R. Brandle
University of Nebraska - Lincoln, jbrandle1@unl.edu

Laurie Hodges
University of Nebraska - Lincoln, lhodges1@unl.edu

Entin Daningsih
Tanjungpura University

Kenneth G. Hubbard
University of Nebraska - Lincoln, khubbard1@unl.edu

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Dongsheng Zhang[1], James R. Brandle[1], Laurie Hodges[2], Entin Daningsih[2], and Kenneth G. Hubbard[1]
University of Nebraska, Lincoln, NE 68583

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Abstract. The relationships between shelterbelt (tree windbreak)-induced microclimate and muskmelon (*Cucumis melo* L.) growth and development were investigated at the Univ. of Nebraska–Lincoln Agricultural Research and Development Center near Mead, Nebr., during the 1992 and 1993 growing seasons. Wind speed, wind direction, air and soil temperatures, relative humidity, and soil moisture were monitored in both sheltered and nonsheltered areas. Plant growth parameters (plant height, vine length, plant dry weight, and leaf area) were measured at various stages of development. Shelterbelts provided improved growing conditions for muskmelon transplants. Direct wind damage and duration of higher wind speeds were reduced 47% to 56% in sheltered areas. Air temperatures in sheltered areas were slightly higher during daytime and slightly lower at night, and significantly so early in the growing season. Relative humidity was increased significantly in sheltered areas in 1992 and, while higher in 1993, the difference was nonsignificant. Soil moisture content was not affected significantly by wind protection. Sheltered plants exhibited earlier development and faster growth. The first female flower appeared 2 days earlier in sheltered areas in both years. The first fruit set, as indicated by fruit swelling and retention on the vine, occurred 6 days earlier and matured 5 and 6 days earlier in sheltered areas in 1992 and 1993, respectively. Leaf areas and dry-matter accumulation of sheltered plants were greater than those of exposed plants. The shoot relative growth rate of sheltered plants increased earlier in the growing season, but decreased slightly later in the growing season. The earlier development and faster growth of sheltered plants were related mainly to the reduction of wind speed, higher total accumulated air temperatures during the daylight hours (sum of daily average daytime air temperatures based on hourly averages), and higher soil temperature in sheltered areas. Total yields were not affected significantly in either year; however, early yields were significantly greater in sheltered areas in 1993. If earlier maturity and increased yield are possible in large sheltered fields, this practice would provide an economic benefit to producers.

Shelterbelts modify microclimates and thereby affect crop growth and development (Aase and Siddoway, 1974; Baldwin, 1988; Barker et al., 1989; Black and Aase, 1988; Brandle et al., 1984; Frank et al., 1974; Kort, 1988). In general, the beneficial effects of shelterbelts on crop growth, development, and yield have been attributed to the prevention of wind damage because of reduced wind speed and soil abrasion (Grace, 1977; Wei et al., 1987), and to improved soil water regimes and plant water status (Frank et al., 1974; Grace, 1977; Rosenberg et al., 1983). Other effects are attributed to higher daytime air and soil temperatures, as well as lower air temperature at night in the sheltered zone (Marshall, 1967; Rosenberg et al., 1983). Changes in canopy morphology of sheltered plants also may contribute to higher yield (Ogbuehi and Brandle, 1982).

However, the effects of shelterbelts on microclimates and the response of vegetable crops to microclimate modification vary with crop species and from season to season (Bagley and Gowen, 1960; Baldwin, 1988; Harrison and Chrimes, 1988). According to Baldwin (1988), vegetable crops are highly susceptible to wind and wind abrasion. Studies on runner bean (Harrison and Chrimes, 1988) and tomato (Bagley and Gowen, 1960) indicated higher yield, higher quality, and greater economic gain because of reductions in wind speed in sheltered areas.

The objectives of this study were to determine the effects of shelterbelts on muskmelon growth and development, and to relate any such effects to microclimatic factors.

Materials and Methods

Study sites and soil information. The study was conducted at the shelterbelt research area at the Univ. of Nebraska–Lincoln Agricultural Research and Development Center near Mead (lat. 41°29´N; long. 96°25´; 354 m above sea level) during the 1992 and 1993 growing seasons. Two treatments were used: sheltered from wind vs. exposed to wind. Shelter was provided by mature shelterbelt systems established in 1966 (Brandle et al., 1984). Each plot was 225 m² (1992) or 190 m² (1993) and was divided into two subplots by a guard row in both years. There were eight treatment rows and three guard rows in each plot. The sheltered plots were located between one and two shelterbelt heights (H) north of the shelterbelts. For each treatment, three replicated plots were used in 1992 and four in 1993. Separate shelterbelt systems were used for each sheltered treatment plot. Additional details on shelterbelt design are discussed below.

The soil was an Aksarben silty clay loam (Fine, Smectitic, mesic Typic Arguidoll). Soil samples were taken from the top 20 cm of soil before transplanting, and analyzed for available N, P, K, and pH levels. Based on soil test results, N was applied at 89.6 kg·ha⁻¹ in 1992 and 67.2 kg·ha⁻¹ in 1993 to bring all soils to 110 kg·ha⁻¹ (Knott et al., 1988). No potassium or phosphorous was needed. No irrigation was applied after plant establishment.

Shelterbelt characteristics. The prevailing winds in eastern Nebraska during the summer months (May–September) are from the south (Lawson et al., 1977); consequently, east-west–oriented shelterbelts were considered as the primary belts in this study. In 1993, the shelterbelts were composed of two mixed rows of green ash (*Fraxinus pennsylvanica* L.), eastern red cedar (*Juniperus virginiana* L.), and Austrian pine (*Pinus nigra* Arnold). Average height of the shelterbelt systems increased from 11.9 to 12.5 m over the 2-year study. In 1992, a shelterbelt system composed of two rows of alternating eastern red cedar and Scotch pine (*P. sylvestris* L.) with a height of 9.1 m was used in addition to those described for 1993. The width of all shelterbelt systems was 8 m with an approximate summer density of 60%.

Meteorological measurements. All microclimatic data were recorded on CR10 automatic data loggers (Campbell Scientific, Inc., Logan, Utah) located in the center of each plot. Wind speeds were measured with 3-cup anemometers (model 12102; R.M.Young, Traverse City, Mich.) at 50 cm and 2 m aboveground. Wind direction was measured with Gill microvanes (model 12302; R.M. Young) at a height of 2 m. Air temperature and humidity were measured 45 cm aboveground using a temperature and relative humidity probe (model XN217; Campbell Scientific). Soil temperature was measured at a depth of 7.5 cm with averaging soil thermocouple probes (model TCAV; Campbell Scientific) in 1992 and with copper-constantan thermocouples in 1993. All parameters were sampled every minute and hourly averages were recorded.

Daily mean values were calculated from hourly averages. Day/night splits were adjusted through the season to reflect changes in sunrise and sunset. Average wind speed for a given time interval was calculated based on hourly average wind speeds. The percent reduction in average hourly wind speed was calculated by dividing the average hourly value in the exposed areas by that in the sheltered areas. Soil moisture of the top 20 cm was determined weekly by the gravimetric method.

Plant material. Muskmelon, cv. Hiline, seeds coated with captan (*N-N*-trichloromethylthio-4-cyclohexane-1,2-dicarboximide) and thiram (tetramethylthiuram disulfide) were provided by Asgrow Seed Co., Kalamazoo, Mich. 'Hiline' is a nonsutured western shipper melon with an average fruit weight of 1.59 kg. It has good disease resistance and vine vigor.

Plant establishment. Seeds were sown on 28 Apr. in both 1992 and 1993 in 2.54-cm cells (Growing Systems 73 Cell Tray; Growing Systems, Inc., Milwaukee) containing a mixture of 1 peatmoss: 1 vermiculite : 1 perlite (by volume). Fertilizer (540 mg·L⁻¹ N; 2700 mg·L⁻¹ P; 900 mg·L⁻¹ K) was applied once a week. Plants in the single-leaf stage were transferred to a lath house and watered prior to transplanting. Plants were transplanted by hand 30 cm apart into 10-cm-high raised beds oriented perpendicular to the shelterbelts on 20 May 1992 and 3 June 1993. Over the course of the study, plants were thinned to a final spacing of 240 cm. Rows were 2.7 m apart in 1992 and 1.8 m apart in 1993 to allow for subplots within the space available. Beehives were located within 0.4 km of the plots throughout the 2-year study.

Plant growth and development. To maintain relatively consistent spacing between plants and minimize damage to remaining plants during sampling, each subplot was systematically divided into groups from which random samples could be drawn. These removals were part of the thinning process. Spacing was increased to 60 cm between individual plants within the row by flowering and 240 cm by fruit set.

The dates of first open male and female flower, fruit set, and maturity were recorded. For the first 2 weeks following the appearance of flowers, the number of male and female flowers were counted daily in each subplot. In subsequent weeks, they were counted only on those plants sampled for growth measurements. Plant height and vine lengths were measured in the field prior to harvesting for growth measurements. Plants were cut at ground level and taken indoors, where the leaves, stems including petiole, male and female flowers, and fruits were separated and counted. Leaf area was measured with a model Li-3000 area meter (LI-COR, Lincoln, Nebr.) and an accessory transparent belt conveyer. Dry weight of each plant part was determined by drying to a constant weight at 60 °C. Shoot relative growth rate was calculated as (1/w)(dw/dt), where w, dw, and dt were shoot dry weight, shoot dry weight increment, and time increment in days from transplanting, respectively.

Yield. Mature fruit were harvested three times a week. On each harvest date, all fruit at "half slip" or "full slip" were collected, counted, and weighed.

Experimental design and statistical analysis. A randomized complete-block design was used with three replications in 1992 and four replications in 1993. Analysis of variance was performed using the general linear model (GLM) of SAS (SAS Institute, 1985) to test for differences in plant height, vine length, leaf area, and plant dry weight. The analysis of variance showed no significant difference between subplot data, so analyses and interpretations were made on full plot data. Regression equations were calculated on plant growth parameters and microclimate variables to determine the best fit (highest significant R^2).

Results and Discussion

Wind speed. Average wind speed reduction in sheltered areas during the growing seasons (48% reduction in 1992 and 57% reduction in 1993) was dependent on wind direction and exposed wind speed. The reduction was greatest early in the growing season when winds were from the south, southeast, or southwest and wind speeds were higher. From the viewpoint of protecting different agricultural crops, effective protection by shelterbelts

depends not only on the amount of wind speed reduction but also on the frequency of high wind speed. A comparison of wind speeds between sheltered and nonsheltered areas indicated that total hours of wind speeds between 2 and 4 m·s⁻¹ and winds >4 m·s⁻¹ were significantly fewer in sheltered areas (Table 1).

Air temperature and soil temperature. Maximum air and soil temperatures in the sheltered areas were higher early in the growing season during both years. However, differences in daily mean or minimum temperatures between sheltered and exposed areas were not consistently significant (Table 2). The inconsistency of the effects of shelter on air and soil temperatures during the whole growing season may have been due, in part, to the variability in wind direction, radiation load, advective or nonadvective conditions (Rosenberg et al., 1983), soil moisture, and plant cover (Marshall, 1967).

Soil moisture and humidity. Shelters did not affect soil moisture content during either growing season. Seasonal mean soil water content in sheltered and exposed areas was 17.4% and 17.6% ($P = 0.294$) in 1992, and 26.3% and 25.6% ($P = 0.357$) in 1993, respectively. Mean soil water content over the first month after transplanting in 1992 was 16.7% and 17.8% ($P = 0.152$) in sheltered and ex-

Table 1. Effect of shelters on duration of exposure to various wind speeds measured 50 cm aboveground from muskmelon transplanting to first mature fruit harvest in 1992 and 1993.

Average hourly wind speed (*u*) m·s⁻¹	Total time (h)ᶻ			
	1992		1993	
	Exposed	Sheltered	Exposed	Sheltered
0 < *u* ≤ 2	1286 ± 3	1905 ± 6	1389 ± 3	2066 ± 5
2 < *u* ≤ 4	726 ± 2	155 ± 1	674 ± 3	86 ± 2
u > 4	141 ± 1	3 ± 0	92 ± 1	3 ± 0
Total	2063	2063	2155	2115

ᶻMean total hours ±SE for three replications in 1992, and four replications in 1993. Times are accumulated hours based on hourly averages.

Table 2. Average daily maximum, minimum, and mean air and soil temperaturesᶻ during the first 30 d of the growing season and the entire growing season (transplant date to first harvest) in sheltered and exposed areas planted with muskmelon in 1992 and 1993.

	First 30 days of the season		Entire season	
	Exposed	Sheltered	Exposed	Sheltered
	1992			
Air temperature (°C)				
Maximum	25.4 ± 0.1	26.4 ± 0.1ʸ	27.2 ± 0.1	28.4 ± 0.1ʸ
Mean	18.4 ± 0.1	18.6 ± 0.1	20.1 ± 0.1	20.5 ± 0.1
Minimum	12.4 ± 0.0	11.8 ± 0.1	13.9 ± 0.1	13.8 ± 0.1
Soil temperature (°C)				
Maximum	27.9 ± 0.1	29.5 ± 0.2ʸ	29.3 ± 0.2	29.6 ± 0.2
Mean	20.1 ± 0.1	21.0 ± 0.1	21.4 ± 0.1	21.6 ± 0.1
Minimum	12.3 ± 0.0	12.2 ± 0.0	13.8 ± 0.0	13.1 ± 0.0ʸ
	1993			
Air temperature (°C)				
Maximum	26.8 ± 0.2	27.9 ± 0.2ʸ	28.6 ± 0.1	28.7 ± 0.1
Mean	20.4 ± 0.1	20.5 ± 0.1	21.4 ± 0.1	21.0 ± 0.1
Minimum	14.8 ± 0.1	13.4 ± 0.1ʸ	16.8 ± 0.1	15.6 ± 0.1ʸ
Soil temperature (°C)				
Maximum	25.5 ± 0.1	26.2 ± 0.1ʸ	25.5 ± 0.2	26.1 ± 0.1
Mean	21.4 ± 0.1	22.4 ± 0.1	22.3 ± 0.1	23.1 ± 0.2
Minimum	17.2 ± 0.0	18.6 ± 0.1ʸ	19.1 ± 0.1	20.0 ± 0.1

ᶻMean ±SE for three replications in 1992, and four replications in 1993.
ʸSignificantly different from the value for exposed area at $P ≤ 0.05$.

CROP PRODUCTION

Fig. 1. Exposed muskmelon plants following wind stress conditions on 9 July 1993. Note root pulled from the soil (**arrow**).

posed areas, respectively, perhaps reflecting the greater water use by the more vigorous sheltered plants. Mean soil water content over the first month after transplanting in 1993 was 25.5% and 25.1% ($P = 0.786$) in sheltered and exposed areas, respectively. Seasonal mean relative humidity in sheltered and exposed areas was 74.8% and 68.6% ($P = 0.056$) in 1992, and 81.1% and 77.5% ($P = 0.2691$) in 1993, respectively.

Muskmelon growth and development. Sheltered plants exhibited earlier development. The first female flower reached anthesis 2 d earlier ($P = 0.043$) in sheltered areas both years. The results were similar to previous findings for tomato (Baldwin, 1988) and soybean (Ogbuehi and Brandle, 1982). The first fruit set occurred 7 and 6 d earlier ($P \leq 0.001$) and the first fruit matured 5 and 7 d earlier ($P \leq 0.001$) in sheltered areas in 1992 and 1993. Mechanical wind damage was observed in exposed areas on 9 July 1993. Average hourly

Table 3. Effects of wind protection on muskmelon plant height, vine length, leaf area, dry weight, and shoot relative growth rate (RGR) during the 1992 and 1993 growing seasons.

	1992				1993		
DAT[z]	Exposed	Sheltered	P	DAT	Exposed	Sheltered	P
	Plant height (cm)				*Plant height (cm)*		
21	3.8 ± 0.1[y]	5.1 ± 0.2	0.002	7	4.1 ± 0.11[y]	4.9 ± 0.14	0.006
28	4.5 ± 0.2	6.7 ± 0.4	0.001	14	5.0 ± 0.35	6.3 ± 0.28	0.008
33	7.5 ± 0.4	8.6 ± 0.5	0.271	23	10.0 ± 0.28	11.4 ± 0.30	0.039
40	9.7 ± 0.3	11.5 ± 0.5	0.019	33	15.7 ± 0.29	19.6 ± 0.62	0.002
55	18.6 ± 0.8	20.5 ± 0.8	0.126	42	17.9 ± 0.81	22.5 ± 0.61	0.002
				53	21.8 ± 0.59	27.5 ± 0.99	0.004
	Vine length (cm)				*Vine length (cm)*		
40	22 ± 3	28 ± 3	0.098	33	55 ± 5	82 ± 2	0.001
55	100 ± 7	138 ± 7	0.001	42	106 ± 8	143 ± 12	0.014
63	196 ± 7	214 ± 10	0.124	53	174 ± 12	236 ± 4	0.001
71	246 ± 9	275 ± 17	0.016	61	213 ± 13	272 ± 12	0.004
82	285 ± 14	316 ± 10	0.037	69	225 ± 10	289 ± 14	0.02
				177	270 ± 15	318 ± 14	0.021
	Leaf area (cm²/plant)				*Leaf area (cm²/plant)*		
6	8 ± 0.3	7 ± 0.4	0.496	7	21 ± 1	19 ± 1	0.437
12	9 ± 0.1	13 ± 0.3	0.001	14	44 ± 2	59 ± 5	0.011
21	23 ± 2	37 ± 6	0.007	23	290 ± 43	574 ± 21	0.001
28	41 ± 6	112 ± 29	0.005	33	1933 ± 461	3748 ± 592	0.056
33	134 ± 16	278 ± 74	0.084	42	7059 ± 948	13854 ± 948	0.004
40	728 ± 106	1082 ± 213	0.146	53	18662 ± 2632	26239 ± 2653	0.281
55	5516 ± 508	11167 ± 1369	0.001	61	26094 ± 1658	28228 ± 1135	0.429
63	20417 ± 1910	24724 ± 1943	0.139				
	Dry weight (g)				*Dry weight (g)*		
6	0.1 ± 0.3	0.1 ± 0.1	0.886	7	0.2 ± 0.0	0.2 ± 0.0	0.504
12	0.1 ± 0.0	0.2 ± 0.0	0.003	14	0.4 ± 0.0	0.5 ± 0.0	0.020
21	0.2 ± 0.0	0.3 ± 0.0	0.006	23	3.3 ± 0.6	6.0 ± 0.3	0.001
28	0.5 ± 0.1	1.2 ± 0.2	0.003	33	27 ± 5.3	56 ± 4	0.002
33	1.2 ± 0.2	2.4 ± 0.6	0.101	42	73.4 ± 9.9	159 ± 9	0.001
40	6.9 ± 1.0	10.2 ± 2.0	0.144	53	196 ± 30	341 ± 37	0.045
55	77 ± 7.3	125 ± 13	0.003	61	247 ± 25	384 ± 18	0.002
63	239 ± 14	311 ± 32	0.085				
	RGR (g·d⁻¹ per plant)				*RGR (g·d⁻¹ per plant)*		
6	0.0 ± 0.0	0.1 ± 0.0	0.001	7	0.1 ± 0.0	0.1 ± 0.0	0.001
12	0.1 ± 0.0	0.1 ± 0.0	0.001	14	0.1 ± 0.0	0.2 ± 0.0	0.001
21	0.2 ± 0.0	0.4 ± 0.0	0.003	23	0.7 ± 0.1	1.0 ± 0.1	0.006
28	0.2 ± 0.0	0.2 ± 0.1	0.735	33	0.8 ± 0.1	1.0 ± 0.1	0.038
33	0.6 ± 0.2	0.5 ± 0.2	0.080	42	0.2 ± 0.1	0.2 ± 0.1	0.067
40	0.7 ± 0.1	0.8 ± 0.1	0.123	53	0.2 ± 0.1	0.1 ± 0.0	0.139
55	0.3 ± 0.1	0.2 ± 0.1	0.321	61	0.3 ± 0.0	0.0 ± 0.0	0.245
63	0.1 ± 0.0	0.1 ± 0.1	0.083				

[z]Days after transplanting.
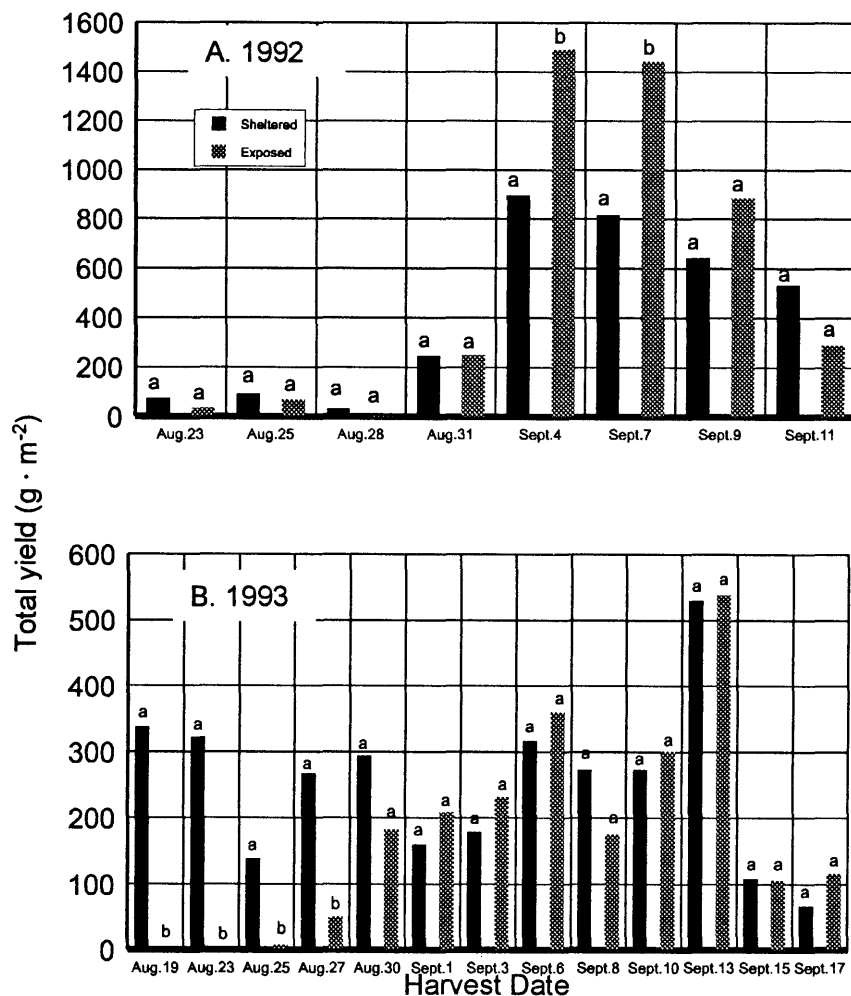[y]Mean ±SE for three replications in 1992 and four replications in 1993.

Fig. 2. The relationship between of accumulated daytime heat units and dry-matter accumulation in sheltered vs. exposed muskmelon plants.

Table 4. Regression of muskmelon relative shoot growth rate (RGR in g·d⁻¹ per plant) on mean daytime air temperature (°C) and mean daytime soil temperature (°C) during the first 30 d after transplanting in sheltered (wind protected) or exposed plots in 1992 and 1993.

Year	Treatment	RGR =	R^2	P
1992	Exposed	$0.00178\ (1.26605^{b\ air})^z$	0.76	0.0056
		$0.00334\ (1.37155^{b\ soil})^y$	0.88	0.0034
	Sheltered	$0.01120\ (1.17016^{b\ air})$	0.52	0.0089
		$0.00347\ (1.23255^{b\ soil})$	0.64	0.0131
1993	Exposed	$0.00003\ (1.52153^{b\ air})$	0.95	0.0001
		$0.00001\ (1.52897^{b\ soil})$	0.92	0.0005
	Sheltered	$0.00006\ (1.50178^{b\ air})$	0.95	0.0001
		$0.00002\ (1.66065^{b\ soil})$	0.79	0.0073

[z]b air = Mean daytime air temperature (°C) for previous 10 d.
[y]b soil = Mean daytime soil temperature °C) for previous 10 d.

winds in exposed areas exceeded 9 m·s⁻¹ for ≈3 h during the night of July 8 but were only ≈3 m·s⁻¹ in sheltered areas. Exposed plants were wind stressed by the bending, shaking, and twisting of the vines, and all exposed plants were blown to one side of the beds. The roots of some plants were almost pulled out of the soil (Fig. 1). In sheltered areas, little or no wind damage was apparent.

Sheltered plants were taller and had longer vines than those from exposed plots (Table 3). Leaf area and dry-matter accumulations of sheltered plants were significantly greater than those of exposed plants on most sampling

dates (Table 3). The shoot relative growth rates of sheltered plants were greater than those of exposed plants at early growth stages, but differences were not significant at later times during both years (Table 3).

The greater dry-matter production of sheltered plants was related to the greater accumulations of daytime air temperatures (Fig. 2). A positive relationship between mean daytime air temperature and shoot relative growth rate was found during early growth stages (the first 30 d after transplanting) in both sheltered and exposed areas (Table 4), but no clear relationship was detected later in the growing season.

Shoot relative growth rate and daytime soil temperatures were positively correlated during the early growing season each year in both sheltered and exposed areas (Table 4), as shown by Dunlap (1986). Although the relationship between shoot relative growth rate and both soil and air temperature accumulated for periods of 3, 10, 14, and 30 d and day/night data prior to sampling was analyzed, the best fit (highest R^2) was with accumulated average hourly daytime air temperatures for 10 d prior to sampling.

Yield. Differences in total yields between sheltered and exposed areas were nonsignificant during the early harvests in 1992; however, the total yields from exposed plants were greater later in the 1992 season (Fig. 3A). This may be due, in part, to an attempt to tag the first early female flowers at anthesis, which resulted in fruit abortion. Since female flowers developed earlier in the sheltered plots, this resulted in more fruit loss in the sheltered areas than in the exposed areas. In 1993, when no flowers were tagged, the earlier and more rapid development of sheltered plants significantly increased the total yields from the early harvests over those of the exposed plants (Fig. 3B). However, when all harvests within sheltered or exposed plots were combined, the analysis of variance indicated no significant increase in the total yields in either year ($P = 0.295$ in 1992 and $P = 0.168$ in 1993). The early marketable yield was significantly greater from sheltered areas in 1993 ($P = 0.008$, Fig. 4B) but not in 1992 ($P = 0.175$, Fig. 4A). The air temperatures early in the season were lower in 1992 than in 1993, especially at night in the sheltered areas, and sheltered plants probably experienced more chilling stress than did the exposed plants. For example, on the night of 28 May 1992, air temperature dropped to a low of 1.2 °C in sheltered areas and 2.5 °C in exposed areas. During this time, air temperatures were <16 °C, the minimum for muskmelon germination (Knott et al., 1988), for 39 consecutive hours in each area. Conversely, during the first 3 weeks after transplanting in 1993, the lowest air temperature was 6.4 and 7.7 °C for the sheltered and exposed areas, respectively. The average daily air temperature during the first 3 weeks after transplanting was <16 °C eight times for both sheltered and exposed plots in 1992. In 1993, this occurred five times in sheltered plots and four times in exposed plots.

Conclusions

Shelterbelts provided improved growing conditions for muskmelon transplants. The duration of wind speeds >4 m·s⁻¹ was reduced between 47% and 56% with a reduction in direct wind damage to the plants during the growing season. Air temperature was higher in sheltered areas during the daytime and lower at night, especially early in the growing season. Also, soil temperature in the sheltered areas was usually higher than in the exposed areas. These changes in air temperature appeared to be a function of the exposed wind velocity and direction, as well as the radiation
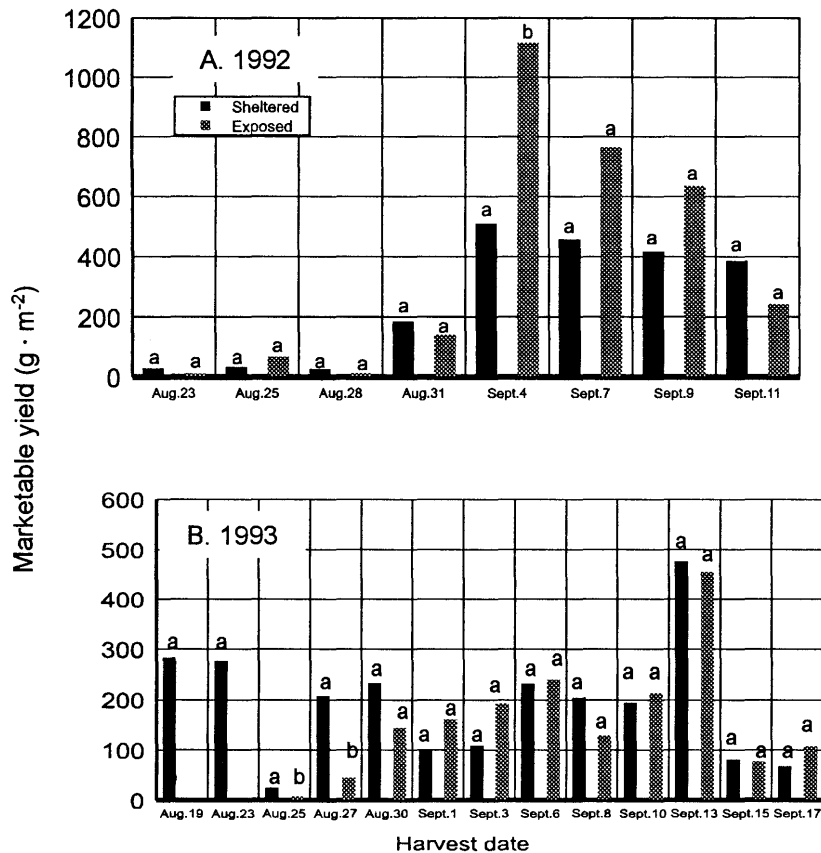
Fig. 3. Effects of shelters on total fruit yields for eight harvests in 1992 (A) and 13 harvests in 1993 (B). Mean separation within sample dates by ANOVA at $P \leq 0.05$.

load (sunny vs. cloudy day), and advective or nonadvective conditions.

Sheltered plants developed earlier and grew more rapidly. They were taller and had longer vines than plants exposed to wind stress. The earlier development and faster growth were related to wind speed reduction, accumulation of daytime air heat units, and higher soil temperature in the sheltered areas. Although differences in total yields between sheltered and exposed muskmelon crops were nonsignificant, the earlier maturity and potentially greater marketable yield in a wind-sheltered area could provide both earlier and greater dollar returns to the grower.

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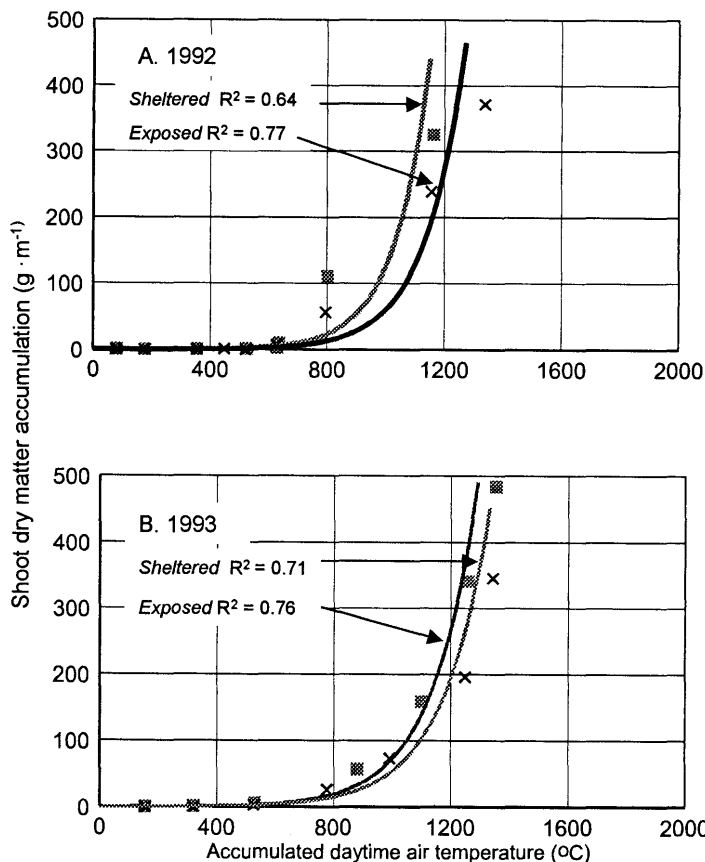
Fig. 4. Effects of shelters on marketable yields for sheltered and exposed areas for eight harvests in 1992 and 13 harvests in 1993. Mean separation within sample dates by ANOVA at $P \leq 0.05$.