Honey Mesquite Seedling Growth and 2,4,5-T Susceptibility as Influenced by Shading

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Highlight: *Honey mesquite seedlings emerged and survived continuous 50% reductions in radiant energy but were reduced in oven-dry weight. General morphological changes in seedlings from shading included increased height, decrease in number of leaves and leaf area, and delay in stem woodiness. Over 70% continuous reduction in radiant energy significantly reduced seedling survival and growth. Continuous reduction in radiant energy of over 90% of full sunlight prevented honey mesquite seedling establishment. More honey mesquite seedlings which developed under shade were killed by 2,4,5-T sprays than seedlings grown under open sunlight.*

The distribution range of honey mesquite (*Prosopis glandulosa* Torr. var. *glandulosa*) has evidently been much the same for the past 150 years (Johnston, 1963; Peacock and McMillan, 1965). However, drastic density increases have evidently occurred in the twentieth century making honey mesquite a management problem on about 56 million acres of grassland in Texas alone. Honey mesquite's distribution has been correlated with temperature, rainfall, and elevation (Bogusch, 1951; Fisher et al., 1959). The undisputed success of honey mesquite in the Southwest has been attributed to the cessation of fire, intensive use of grasslands by man, the plant's xerophytic nature, and the periodic occurrences of drought (Bogusch, 1951).

A myriad of environmental factors interact to regulate ecesis of honey mesquite. Temperature and moisture (Scifres and Brock, 1969, 1971, 1972), seed depth (Scifres and Brock, 1971), susceptibility to top removal (Scifres and Hahn, 1971) and existing vegetation (Scifres et al., 1971) have been studied in relation to germination and seedling establishment. Bogusch (1951) stated that "shading is inimical" to the survival of honey mesquite seedlings. Suppositions and observations (Bogusch, 1951) that shading prevents establishment seem logical, but tolerance of honey mesquite seedlings to reduced levels of radiant energy has not been studied.

The objectives of this study were to investigate the influence of artificial shading on honey mesquite emergence, seedling growth, and tolerance of seed-

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lings to the commonly used herbicide (2,4,5-trichlorophenoxy) acetic acid (2,4,5-T).

Materials and Methods

Shades were constructed by covering frames 1.5 m by 1.5 m and 1.0 m tall with layers of burlap. General construction of shades was similar to those described by Tiedemann et al. (1971). Either zero, one, two, or three layers of burlap were used to simulate a shade gradient.

Thirty 500 cc containers with 10 scarified honey mesquite seeds planted 2.5 cm deep in a sand:clay loam (2:3) mixture were placed under each shade. The shades and pots were set on blocks about 1.5 cm thick to allow air circulation through the system. Laboratory germination of the seeds was over 95% at 28 to 30 C. Three frames of each shade level were arranged in randomized complete block design. Days to first emergence, percentage emergence, plant height, oven-dry weight, leaf area and number of leaves of each plant in each of 10 pots from each shade were recorded after 30 days. Leaf area was calculated using rachis lengths as shown by Wendt et al. (1967).

Immediately after the 30-day growth measurements, seedlings in six pots from each shade were sprayed with the equivalent of either 0, 0.069, 0.14, 0.28 or 0.56 kg/ha of the propylene glycol butyl ether esters of 2,4,5-T in water at 196 liters/ha. Twenty-one days after spraying, the percentage of seedlings killed with 2,4,5-T was recorded.

Honey mesquite seeds were planted periodically throughout the study so that after the 30-day shade period, seedlings of various growth stages developed under no shade were also treated with various rates of 2,4,5-T. Thirty pots each of honey mesquite in the cotyledon, two-leaf, four-leaf and eight-leaf stages were sprayed with 0, 0.069, 0.14 and 0.28 kg/ha of 2,4,5-T. After 21 days, the percentage of seedlings killed with 2,4,5-T was recorded. Reactions of these plants were utilized to assess the influence of growth stage, in the absence of a shading effect, on honey mesquite seedling's susceptibility to 2,3,5-T.

During the study period, incident radiation (cal/cm^2/min) was recorded continuously each day under the shades with solarimeters. The solarimeters sensed about 95% of the light transmitted within the range of 0.36 to 2.0μ wavelengths. Records of daily sky conditions were used to qualitatively describe three primary conditions (bright sunlight, moderately overcast and heavily overcast) during the study period from July through September. Air temperature and relative humidity were continuously monitored under each shade level with recording hygrothermographs.

Each experiment was conducted two or three times and data pooled for presentation. All percentage data were subjected to inverse sine transformation before conducting analyses of variance.

Results and Discussion

Radiant energy reaching the honey mesquite seedlings under the various shades as categorized by three general sky conditions during the study period are discussed as percentages of that on bright days (Table 1). During the experiments, about half the days were bright sunlight with maximum radiant energy available from noon to 2 P.M. On heavily overcast days, which represented about 10% of the study period, little radiant energy reached the honey mesquite seedlings under the artificial shades. Average reductions in radiant energy were weighted by the sky conditions to develop an average, overall figure for radiant energy reductions by the burlap layers. The averages were about 55% for one burlap layer, 75% for two layers and 95% for four layers.

Table 1. Average radiant energy (cal/cm^2/min) as percentage of that on a bright day reaching honey mesquite seedlings under various levels of artificial shade at noon under three sky conditions during the study period at College Station, Texas.[1]

Layers of burlap	Sky condition: Bright	Moderately overcast	Heavily overcast
0	100	75	35
1	55	30	15
2	35	10	5
4	20	2	0

[1]Radiant energy reaching seedlings under no shade on bright day was about 1.2 to 1.5 cal/cm^2/min at noon.

Shading did not reduce the percentage emergence of honey mesquite seedlings. An average of 80% of the seedlings emerged, regardless of reduction in radiant energy, with a trend toward higher emergence under low shade levels. Seedlings first emerged within 2 days under shaded conditions whereas about 4 days were required for first emergence from pots in full sunlight. Maximum emergence was complete after 4 days under the shades and within 6 days under no shade. These differences were attributed to buffering of temperature by the shades. Air temperatures under the shades rarely exceeded 33 C on the hottest days. In full sunlight, air temperatures were often 36 to 38 C for 4 to 5 hours daily at ground level. A constant temperature of about 30 C or a fluctuating temperature not exceeding 37 C or less than about 22 C is optimum for emergence and early seedling growth of honey mesquite (Scifres and Brock, 1969, 1972).

Table 2. Height (cm), leaves per seedling, leaf area (cm^2) per seedling and percent survival 30 days after planting honey mesquite under three levels of reduction (%) in radiant energy.[1]

Reduction in radiant energy[2]	Height	Leaves	Leaf area	Seedling survival
0	9.0*b*	8.6*a*	9.6*a*	65*a*
55	12.8*a*	8.0*a*	10.4*a*	60*a*
75	12.0*a*	5.2*b*	3.8*b*	49*b*
95	3.7*c*	0*c*	0*b*	16*c*

[1]Values followed by the same letter are not significantly different at the 5% level.
[2]Reduction in radiant energy refer to average values across several sky conditions and are related to ambient, open conditions.

Few seedlings survived for 30 days when radiant energy was reduced by 95% (Table 2). Surviving seedlings were chlorotic, etiolated and had developed no true leaves when treated with 2,4,5-T. Percentage survival and leaf development of surviving honey mesquite seedlings were also reduced when radiant energy reaching the seedlings was reduced by 75%. The 75% reduction in radiant energy induced slight foliar chlorosis and total leaf area of seedlings was reduced by 60%. Area per individual leaf was reduced to 0.73 cm^2 as compared to 1.12 cm^2 developed by seedlings in full sunlight. Continuous reduction in radiant energy of 55% did not significantly reduce percentage survival or leaf development of honey mesquite seedlings after 30 days. Seedlings grown under burlap causing the 55% and 75% reductions in radiant energy levels exhibited longer internodes than seedlings grown without shade. Phares (1971) reported that red oak (*Quercus rubra* L.) seedlings developed taller under 30% of full light than under open conditions. Honey mesquite seediings under full sunlight developed shorter, stouter stems than did shaded seedlings after 30 days.

Although a 55% reduction in radiant energy did not affect seedling survival and tended to increase height (Table 2), oven-dry production of roots and tops by honey mesquite seedlings was reduced (Table 3). Decreasing radiant energy progressively decreased root production but caused greater reductions in topgrowth regardless of shade level. Seedlings developed under shades with radiant energy reduced by 55% developed about the same leaf area as seedlings under full

Table 3. Relative oven-dry weights (%) of honey mesquite roots and tops and root: shoot ratios after emerging and growing for 30 days under various levels of reduction (%) in radiant energy.[1]

Reduction in radiant energy[2]	Roots	Tops	Root: shoot
0	100*a*	100*a*	1.7*a*
55	80*b*	57*b*	2.4*b*
75	51*c*	20*c*	4.3*c*
95	24*d*	8*c*	4.9*c*

[1]Values within a column followed by the same letter are not significantly different at the 5% level.
[2]Reductions in radiant energy refer to average values across several sky conditions and are related to ambient, open conditions.

sunlight, but leaves and stems weighed less. Thus, shading caused the foliage to be more fragile. Shaded leaves were thinner than those of seedlings in open sunlight, and stems of shaded seedlings did not appear "woody." Since inhibition of topgrowth was not proportional to losses in root production, root:shoot ratios were increased as radiant energy level was reduced. Although total plant production was greatly reduced, about five times more roots than tops were produced under high shade. Under full sunlight, root production about doubled topgrowth.

Stage of unshaded honey mesquite seedling development when treated with 2,4,5-T influenced the percentage reduction in population (Table 4). Fewer seedlings were killed when treated in the cotyledon and second-leaf stage than after the seedlings had developed four to eight leaves. Evidently, there is a minimal leaf area required for interception and absorption of lethal amounts of 2,4,5-T. Thus, if shading affected response of honey mesquite seedlings to 2,4,5-T only by retarding foliar development, the intermediate level of shading should theoretically have reduced seedling mortality after spraying. However, seedlings developed under the lowest level of shading tended to be more susceptible to 2,4,5-T than those developed under full sunlight

Table 4. Percentage of unshaded honey mesquite seedlings of various growth stages killed by various rates (kg/ha) of 2,4,5-T sprays.[1]

2,4,5-T rate	True leaves/seedling			
	0	2	4	8
0	0*a*	0*a*	0*a*	0*a*
0.069	33*bc*	23*b*	53*de*	60*e*
0.14	27*bc*	23*b*	63*e*	63*e*
0.28	38*bc*	42*cd*	90*f*	90*f*

[1]Values within a column followed by the same letter are not significantly different at the 5% level.

(Table 5). Honey mesquite seedlings grown under continuous 75% reduction in radiant energy had about five leaves when sprayed but were more susceptible to the 2,4,5-T sprays than those with four or eight leaves developed under full sunlight (Tables 4 and 5).

Table 5. Percentage honey mesquite seedling population grown for 30 days under three levels of reduction (%) in radiant energy killed by various rates (kg/ha) of 2,4,5-T.[1]

2,4,5-T rate	Reduction in radiant energy[2]		
	0	55	75
0	0*a*	0*a*	0*a*
0.069	60*b*	64*b*	90*cd*
0.14	70*b*	75*bc*	90*cd*
0.28	87*cd*	96*d*	100*d*
0.56	90*cd*	96*d*	100*d*

[1]Values followed by the same letter are not significantly different at the 5% level.
[2]Reductions in radiant energy refer to average values across several sky conditions and are related to ambient, open conditions.

Also, more seedlings developed under 75% reductions in radiant energy were killed, regardless of 2,4,5-T rate, than were those developed under less intense shade. Thus, changes in seedling metabolism from reduced radiant energy probably account for the differential reaction. No seedlings survived for longer than 45 days when grown under continuous 95% reduction in radiant energy. Therefore, treatment with 2,4,5-T was unnecessary for their control.

These data indicate that honey mesquite seedlings can withstand considerable reductions in radiant energy. Since these studies were conducted with continuous shading as compared to natural communities where intermittent flashes of full radiant energy would undoubtedly reach the seedlings, it would seem that only the most productive grassland communities would attain canopy levels prohibitive to honey mesquite seedling survival. However, the pressure of shading should augment periodic treatment with fairly low rates of 2,4,5-T for preventing establishment of honey mesquite seedlings in grasslands.

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