Sound Abatement with Hedges[1]

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Abstract. **Woody ornamental shrub species with varying leaf size maintained as hedges were found to be effective in attenuating sounds from sources such as a random noise generator, a rotary lawnmower, and an automobile. The nature of the sound and leaf characteristics of the plant appear to be more important than the specific width of the hedge.**

Noise emitted by trucks, automobiles, lawn mowers, air conditioners and other devices have increased to a disturbing level in urban and suburban areas. Most of the studies on sound reduction have dealt with indoor conditions; only recently has work begun on sound reduction outdoors.

Early studies in Panama jungles indicated that the reduction of intensity of sound traveling through vegetation was due primarily to: 1) the physical characteristics of sound (sound intensity decreases with the distance from the source), and 2) attenuation and deflection of sound waves by vegetation (3). Recently, a study of the effects of vegetation on the reduction of highway noises showed a 5 to 8 decibel (dB) reduction of sound from tree plantings 32.9m wide (1, 2). However, a study in Michigan concluded that the practical utility of trees as an urban sound barrier was limited because dense wide plantings were necessary (5). The present study was made to determine if noise could be reduced by various woody ornamentals maintained as hedges in man-made landscapes.

To simulate neighborhood conditions, 3 sound sources were used: 1) a constant noise source obtained from a Scott Random Noise Generator Model #811B, a Knight amplifier, a 20 cm (8-inch) Threau speaker which produced a standard noise at all wave lengths within the audible frequency range; 2) a rotary type lawnmower with a 3.5 hp, 4 cycle gasoline engine run at a fixed speed and 3) a 6-cylinder automobile driven on a paved road at various speeds.

The sound level at a specific height and distance from the source was measured with a General Radio Co., portable sound level meter (Model #1551A) using the A scale. The control level of sound was determined by measuring dB levels 1.2m from the speaker and lawnmower and adjusting each to give 85 dB (Fig. 1). The surface used in setting up dB control levels was centipedegrass turf approx 5.1 cm tall.

Sound level readings were taken at 3.0 and 6.1m (10 and 20 ft) from the control point and 0.9m (3 ft) above the turf (Fig. 1). All measurements were made on a clear, warm day (about 30°C) with no detectable wind. Effectiveness of various hedges in reducing the dB level was calculated by subtracting dB values obtained behind the hedge from those obtained at the same distance over the turf without the hedge. A dB difference is presented since the actual level of noise is not as important as the blocking effect of vegetation; even a slight reduction in noise (i.e., 3 to 5 dB) is helpful in reducing the annoyance factor.

Four high quality hedges varying in leaf size (Fig. 2), configuration, and density were selected in Gainesville, Florida. Sound from the noise generator and lawnmower were tested on all hedges; the automobile noise was tested only with *Illicium*.

Sounds from the noise generator and lawnmower measured at points 3.1 and 6.1m behind the hedge surface were reduced by the shrubs (Table 1). These data suggest that for short distances, *Podocarpus* and *Illicium* are more effective in abating sound created by the random noise generator than *Feijoa* or *Pittosporum*, whereas all hedges were about equally effective in abating sound from the lawnmower. However, *Podocarpus* was particularly ineffective in lawnmower sound attenuation at 6.1m which suggests that broadleaved hedges are more effective in reducing low frequency sounds which are particularly annoying to man. It was of interest to note that the widest 2.4m *(Illicium)* and narrowest 0.9m *(Podocarpus)* hedges showed rather similar dB reductions from the noise generator but contrasting dB reductions from the lawnmower, especially at 6.1m. This suggests that within the limits of this study, the nature of the sound and leaf characteristics of the plant are probably more important than specific width of the hedge. This is similar to Lanphear's conclusion (4) that branch and foliage density appear to be important factors in attenuation.

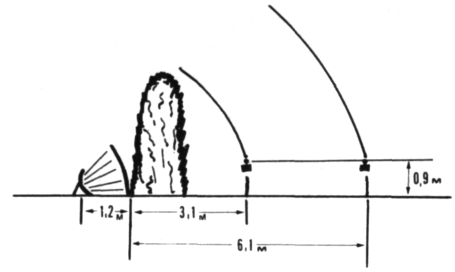

Fig. 1. Schematic arrangement of sound source and sensor with hedge.

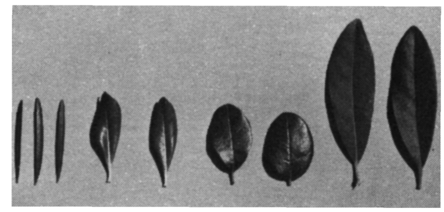

Fig. 2. Relative leaf size and shape of the 4 species, from left to right: *Podocarpus macrophylla* D Don *Pittosporum tobira* Ait, *Feijoa sellowiana* Borg and *Illicium anisatum* L.

With the automobile traveling at speeds of 32.2, 64.4, and 96.5 km per hr (20, 40, and 60 mph) at 5.2m beyond the *Illicium* hedge, and noise measured 3.0m inside the hedge, reductions of 3, 7, and 10 dB's, respectively, were recorded as compared to an adjacent area with similar turf cover and no hedge. These values are similar to those found with the lawnmower sound. This is probably because a major portion of the sound from the automobile was low frequency, primarily from tires and engine exhaust.

While hedges reduced all sound sources tested, a broadleaved evergreen hedge was most efficient giving a 5-7 dB reduction in sound, 3-6m behind the hedge. In this study, the width of the hedge was less important than the leaf

Table 1. Effects of 4 woody ornamental hedges on reduction of sound at various distances from a random noise generator and lawnmower.

			Sound attenuation (dB)			
			Random noise generator		Rotary lawnmower	
	Height	Width	Distance (m)		Distance (m)	
Species	(m)	(m)	3.0	6.1	3.0	6.1
Podocarpus macrophylla	2.1	0.9	6.0	3.0	5.0	1.0
Feijoa sellowiana	0.9	1.8	3.0	3.0	5.0	6.5
Pittosporum tobira	1.5	1.5	3.0	1.0	6.5	4.0
Illicium anisatum	2.4	2.4	6.0	5.0	7.5	6.0

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characteristics, particularly with low frequency sounds. A reduction of 5 dB's amounts to a reduction of about 50% in the apparent loudness of a sound and is thus a considerable improvement.

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Influence of Temperature on the Development of Flower Buds from the Visible Stage to Anthesis of *Lilium longiflorum* Thunb. cv. Ace[1]

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Abstract. **'Ace' lilies were placed in growth chambers at the visible flower bud stage under a 12-hour photoperiod with all possible day and night temperature combinations of 15.6°, 21.1°, 26.7°, and 32.2°C. At a constant day and night temperature of 15.6°, 21.1°, 26.7°, and 32.2° the time to flowering was 50, 28, 25, and 24 days, respectively. At a day temperature of 21.1°, night temperatures above 21.1° had little effect on flowering, but 15.6° greatly retarded flowering.**

Forcing lily bulbs to flower for Easter is particularly difficult when the Pacific Northwest field crop flowers late in the preceding summer. These bulbs are frequently small and, when harvested according to established dates, may be considered immature and dormant. These were the general 1971-72 conditions for forcing lily bulbs for an early Easter. On the other hand, forcing mature and non-dormant bulbs for late Easters also presents problems. This study was undertaken to obtain information on the response of Easter lily to temp applied at visible flower bud stage.

Smith and Langhans (9) reported that the optimum forcing combination for properly cooled lily bulbs from potting to flowering was a 21.1°C day temp (DT)/15.6°C night temp (NT). They found plants at 26.7°/26.7° regime flowered in less than half the time of those plants grown at a 19°/10° sequence. Further, the 16-hr NT had a greater effect on forcing time than the 8-hr DT. They later suggested (5) that the time period when temp was most effective in controlling the rate of flowering was 36 to 96 days after potting with 'Ace' and 30 to 84 days with 'Croft'.

Box (1) found that NT had more influence than DT on days to flower and plant height of lily. He postulated that with a given no. of days to force a plant into flower, the necessary temp can be determined mathematically. To do this, a "threshold" temp is determined. He stated that plant forcing should begin 90 days prior to Easter when grown at 15.6°C (NT), 85 days at 18.3° and 80 days at 21.1°.

For this study, bulbs (20-23 cm in circum) were harvested on Sept. 10, 1971; the controlled temp forcing treatment (2) was started on Oct. 20, 1971. Plants were grown in a commercial greenhouse at a 21.1°C/15.6° regime until March 2, 1972 when 80 plants were selected on the basis of uniform plant height and visible bud development. From 50 to 60 leaves had unfolded at a 45° angle to the stem. For 30 days, 4 temp regimes (15.6°, 21.1°, 26.7°, or 32.2°) with 16 DT/NT treatment combinations were used. Plants were grown in chambers with a 12-hr photoperiod (30.2 klx). On March 31, 1972, those plants that had not flowered and had been grown under 26.7° or 32° DT, regardless of NT, were transfered to 26.7°/21.1°, and those grown under either 21.1° or 15.6° DT, regardless of NT, were transferred to 21°/15.6°. Greenhouse control plants were grown at 23.9°/20° from March 2 to 16 and at 21.1°/18.3° from March 17 to flowering.

The greenhouse grown control plants required 27 days to flower. In growth chamber, with the exception of the 21.1°C/15.6° regime, plants at either 21.1°, 26.7°, or 32.2° DT flowered in 24 to 30 days (Table 1). Hence, rate of

Table 1. Effect of day and night temp on time of flowering, no. of flower buds, plant height, no. of dried leaves at anthesis in 'Ace' lily. (Each mean made up of 5 plants.)

Temp (°C)		Days to	No. of Flower Buds			Plant ht (cm)	No. dry leaves
				Aborted			
Day	Night	flower	Total	≤ 10 mm	> 10 mm	at anthesis[z]	at anthesis
32.2	32.2	24 A[y]	5.0	.92 C	.91 c	22.1 ABCD	22.4 D
32.2	26.7	24 A	4.8	.81 B	.81 b	26.1 D	20.4 C
32.2	21.1	29 AB	4.2	.81 B	.99 c	25.6 CD	17.2 BCD
32.2	15.6	28 AB	5.2	.71 A	.81 b	26.4 D	19.6 CD
26.7	26.7	25 A	4.6	.81 B	.81 b	23.7 BCD	16.6 BCD
26.7	32.2	23 A	5.6	1.20 D	.92 c	23.2 BCD	17.4 BCD
26.7	21.1	26 AB	5.2	.81 B	.81 b	23.5 BCD	15.6 BCD
26.7	15.6	30 AB	5.4	.71 A	.71 a	26.9 D	19.2 CD
21.1	21.1	28 AB	5.0	.71 A	.71 a	22.7 ABCD	13.8 ABCD
21.1	32.2	28 AB	4.6	.81 B	.71 a	20.2 AB	14.6 ABCD
21.1	26.7	26 AB	5.0	.71 A	.71 a	22.1 ABCD	14.2 ABCD
21.1	15.6	40 C	4.6	.71 A	.71 a	21.9 ABCD	13.2 ABCD
15.6	32.2	50 D	4.6	.71 A	.71 a	21.3 ABC	9.4 ABC
15.6	26.7	29 AB	4.6	.71 A	.71 a	17.8 A	7.4 AB
15.6	21.1	36 BC	4.6	.81 B	.71 a	20.5 ABC	5.4 A
15.6	15.6	45 CD	4.4	.71 A	.71 a	19.9 AB	8.6 AB
Greenhouse control		27	4.6	0	0	26.9	12.1
Level of significance[x]							
Day		**	NS	**	*	**	**
Night		**	NS	NS	*	NS	NS
Day x night		**	NS	NS	*	NS	NS

[z]From pot rim to pedicel of 1st flower.

[y]Mean separation in columns by Duncan's multiple range test, 5% level (lower case) or 1 % level (upper case).

[x](**) significant at 1% level; (*) 5% level; (NS) not significant.

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