mite-days between treated and control plants observed in this study indicates that the use of this growth regulator on hibiscus results in significant control of TSM population development. These differences and those noted by Chase et al. (1987) in the reduction of disease severity when plants were treated with CCC suggest that this material would offer significant benefits in an integrated pest management program, the major benefit being the reduced need for applying pesticide.

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Weed Interference in Container-grown 'San Jose' Juniper

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Abstract. Experiments in two consecutive years indicated that barnyardgrass (*Echinochloa crusgalli* L.), large crabgrass (*Digitaria sanguinalis* L.), and giant foxtail (*Setaria faberi* Herm.) reduced growth of container-grown 'San Jose' juniper (*Juniperus chinensis* L. 'San Jose') 83 days after transplanting grass seedlings into the containers. Grass densities of one to six weeds per container reduced 'San Jose' juniper growth. By 83 days of grass interference, juniper shoot dry weight was reduced as much as 43% by six weeds per container.

There has been an increase in the number of ornamental grown in containers (Fretz, 1972; Gwynne, 1985). Along with this increase, weed control in container-grown plants has become a major economic problem (Padgett and Frazier, 1962). Slow crop growth due to weed interference can result in poor-quality plants (Fletcher, 1983) and thus lower prices achieved by growers (Davison, 1971).

Weed interference studies can help nursery operators realize the effect of weed density on plant growth, and such research can improve growers' weed control techniques (Zimdahl, 1980). To date, only a few researchers have evaluated weed interference in container-grown crops (Fretz, 1972; Walker and Williams, 1988). We therefore determined the effects of barnyardgrass, giant

foxtail, and large crabgrass on the growth of container-grown 'San Jose' juniper.

Newly rooted 'San Jose' junipers were planted in 7.6-liter polyethylene nursery containers in a 2 hardwood bark : 1 sand mixture (v/v) in 1985 and 1986. Seeds of barnyardgrass, giant foxtail, and large crabgrass were germinated in a 1 peat : 1 perlite : 1 soil medium (by volume). Two weeks after grass emergence, uniform seedlings (one- to two-leaf stage) of each species were planted into each container at densities of one to six plants per container (10 June 1985 and 2 May 1986). Twenty-one treatments were replicated four times in a randomized complete-block design (one container per treatment). Osmocote (14N-6P-11.6K),

Table 1. 'San Jose' juniper growth index as influenced by densities of annual grasses 83 days after weeds were transplanted into containers.^a

No. of weeds/ container	Juniper growth index ^b (cm)	
	1985	1986
0	27.9	34.2
1	22.2	30.1
2	23.1	30.6
3	22.1	30.2
4	22.3	27.2
5	22.3	28.9
6	21.6	28.4

^aSingle degree of freedom orthogonal comparisons were conducted.

^bMeans of four replicates calculated over three grasses: barnyardgrass, giant foxtail, large crabgrass.

a slow-release fertilizer, was applied at the onset of the experiment. A soluble fertilizer (20N-8.6P-16.6K) at 200 mg-liter⁻¹ was applied at each watering.

Growth indices {growth index = [height + (width + width)/2]/2} were determined three or four times through the growing season to determine when growth reduction might occur. Widths were measured in a north-south and east-west direction. Shoots of grass weeds and junipers were harvested at the termination of the experiments. Plants were dried in a forced-air oven at 60C to constant weight.

'San Jose' juniper growth indices were reduced 23% in 1985 and 21% in 1986 within 83 days after transplanting grass weeds (Table 1). No differences existed between grass species in either year. There was no inter-

Table 2. Orthogonal contrasts for 'San Jose' juniper growth index as influenced by densities of annual grasses 83 days after weeds were transplanted into containers.

Contrast	Densities of grass							F value
	0	1	2	3	4	5	6	
1985								
1	-6	1	1	1	1	1	1	38.59*
2	0	-1	0	0	0	0	1	0.25
1986								
1	-6	1	1	1	1	1	1	30.37*
2	0	-1	0	0	0	0	1	2.11

*F test significant at $P = 0.05$.

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Table 3. Grass and shoot dry weight of 'San Jose' juniper at several densities of annual grasses grown in containers for 83 days, 1985.

No. of weeds/ container	Grass dry wt/ container ^z (g)	Juniper dry wt/ container ^{z,y} (g)
0	---	23
1	77	16
2	93	17
3	92	16
4	81	15
5	97	14
6	97	14

^zMeans of four replicates calculated over three grasses: barnyardgrass, giant foxtail, large crabgrass.

^ySingle degree of freedom orthogonal comparisons were conducted.

action between weed density and grass species, and orthogonal contrasts (Table 2) showed no differences between one weed per

container and six weeds per container in either year, as measured by juniper growth index.

Weed interference was detected earlier in 1985 than in 1986 and may have been due to differences in weed transplanting dates. Weed biomass production was greater and crop biomass was lower in 1985, when the experiment began in June, than in 1986, when the experiment began in May (data not shown). One explanation for these differences may be that the higher soil temperatures at transplanting time in 1985 gave the weeds a better start. Likely, information on when growth index reduction begins could help establish timing of postemergence weed control.

Shoot dry weight of juniper was reduced 39% in 1985 as compared to the control (Tables 3 and 4). No weed reduced shoot dry weight more than another. In 1986, shoot dry weight was reduced 43% by barnyardgrass (Tables 5 and 6). Giant foxtail and crabgrass did not significantly reduce juniper

shoot growth. No differences existed between the increasing densities of weeds per container either year, as measured by juniper dry weights.

Shoot dry weight was positively correlated in 1985 ($r = 0.73$) and in 1986 ($r = 0.60$) with growth index measurements. Correlations were low, however, which suggests the nondestructive method of measuring may not be an accurate alternative to destructive sampling.

According to our data, a single grass plant reduced growth as much as six grass plants, as measured by shoot dry weight or growth indices. As grass densities per container increased, grass shoot dry weight did not increase proportionately, nor did the juniper shoot dry weight decrease proportionately. This relationship suggests that intraspecific interference might have been involved as the number of weeds per container increased. The yield of grasses per unit area was equivalent over a range of densities because the amount of growth by individual plants decreases as density increases (Radosevich, 1984).

Table 4. Orthogonal contrasts for shoot dry weight of 'San Jose' juniper at several densities of annual grasses grown in containers for 83 days, 1985.

Contrast	Densities of grass							F value
	0	1	2	3	4	5	6	
1	-6	1	1	1	1	1	1	16.02*
2	0	-1	0	0	0	0	1	0.81

*F test significant at $P = 0.05$.

Table 5. Grass and shoot dry weight of 'San Jose' juniper at several densities of annual grasses grown in containers for 83 days, 1986.

No. of weeds/ container	Grass dry wt/ container (g)	Juniper dry wt/ container (g)		
		BG ^y	GF	LC
0	---	67	67	58
1	62	51	50	60
2	59	48	62	63
3	68	44	57	57
4	73	40	54	51
5	72	45	45	63
6	73	38	46	48

^ySingle degree of freedom orthogonal comparisons were conducted.

BG = barnyardgrass, GF = giant foxtail, LC = large crabgrass.

Table 6. Orthogonal contrasts for shoot dry weight of 'San Jose' juniper at several densities of annual grasses grown in containers for 83 days, 1986.

Contrast	Densities of grass							F value
	0	1	2	3	4	5	6	
<i>Barnyardgrass</i>								
1	-6	1	1	1	1	1	1	10.46*
2	0	-1	0	0	0	0	1	1.97
<i>Giant foxtail</i>								
1	-6	1	1	1	1	1	1	2.96
2	0	-1	0	0	0	0	1	0.16
<i>Large crabgrass</i>								
1	-6	1	1	1	1	1	1	0.02
2	0	-1	0	0	0	0	1	3.71

*F test significant at $P = 0.05$.

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