

Applying Roundup to the Base of Lemon Tree Canopies: Effects on Leaves, Flowers, Fruitlets, and Yield¹

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Abstract

*The effect of Roundup on lemon trees (*Citrus limon*) was evaluated by repeatedly spraying 0.5, 0.75, 1, 1.25, and 1.5 lb. a.i./acre (corresponding to 0.5, 0.75, 1, 1.25, 1.5 quarts of Roundup Ultra/acre) on the bottom 20 to 24 inches of the tree canopies, over a three year period. The Roundup applications caused significant leaf injury in the sprayed area of the canopies and there was also significant defoliation of branches at the higher Roundup rates in all three years of the study. In 1996 after three Roundup applications, increasing rates of Roundup had no effect on flower or fruitlet production in either the sprayed or unsprayed portions of the tree canopies as judged by the counts collected from branches in each canopy zone. Similarly, in 1997 after five Roundup applications, and in 1998 after nine Roundup applications, increasing rates of Roundup had no effect on flower or fruitlet production in the sprayed or unsprayed portions of the tree canopies. Spraying Roundup on the bottom of the tree canopies did not reduce total lemon yield per tree in 1996, 1997 or 1998 at any of the application rates. In all three years of the study, increasing Roundup rates had no effect on the yield of the first or second ring picks or the percentage of the total crop picked on the first harvest date. Increasing Roundup rates also did not affect fruit size at any harvest date in 1996, 1997 or 1998. Similarly, increasing Roundup application rates did not affect fruit quality at any harvest in 1996, 1997 or 1998. Thus, there was no relationship between the rate of Roundup sprayed on the trees and yield, fruit size or quality in all three years of this study. The three years of data collected in this study indicate that accidental drift or inadvertent application of Roundup onto lemon trees when spraying weeds on the orchard floor has no significant effect on lemon tree productivity.*

Introduction

Weeds in Yuma Mesa lemon groves have been managed using mechanical cultivation and chemical applications. Mechanical cultivation has traditionally been accomplished by frequently disking the orchard floor. Disking orchards occasionally damages tree branches and may damage shallow tree roots. More recently, a type of field

¹ The authors would like to thank the Arizona Citrus Research Council for supporting this work. This is the final report for project 98-03 Effects of foliar applied Roundup on lemon physiology and yield – 1998.

cultivator called the “Perfecta” that is reputed to be less injurious to tree roots has been used for mechanical weed control. Disking also incorporates plant debris into the soil surface creating a breeding habitat for eye gnats (*Liohippelates collusor*) on the Yuma Mesa. Another disadvantage of disking and other forms of mechanical cultivation is that they stir the soil profile bringing weed seeds to the surface causing the release of dormancy and the emergence of more weeds. Due to the disadvantages of mechanical cultivation, the use of both preemergence (i.e., soil applied) and postemergence (i.e., foliar applied) herbicides has increased in recent years. Many preemergence herbicides including Goal, Prowl, Solicam, Surflan, Treflan, and Visor can be used on sandy soils without injuring citrus trees. Postemergence herbicides are then used to control weeds that escape control by preemergence herbicides or mechanical cultivation, or to control all weeds in groves that are not treated with preemergence herbicides. One of the most popular postemergence herbicides in recent years has been Roundup. As a consequence of its widespread use, some Roundup foliar injury symptoms can usually be found on the skirts of citrus trees in groves where it is used.

The use of foliar or postemergence applications of Roundup for weed control in Arizona citrus orchards is a matter of some debate. Proponents of Roundup use cite its lack of soil residual effects on trees and its effectiveness as a weed killer, particularly on difficult-to-control perennials such as bermudagrass and purple nutsedge. Roundup proponents also consider the incidental treatment of citrus foliage with Roundup as inconsequential and frequently use application methods that minimize Roundup spray contact with citrus foliage. Opponents of Roundup use in citrus orchards think that even small amounts of Roundup spray drift or inadvertent application on citrus foliage can have adverse effects on fruit drop and yield, particularly when multiple applications are made in a year. Thus, the objectives of this study were to evaluate the effect of both inadvertent application and simulated drift of Roundup spray on to citrus foliage when multiple Roundup applications per year are made to control weeds.

Materials and Methods

This experiment was initiated in the spring of 1995 in a flood-irrigated lemon grove on the Yuma Mesa (soil series: Superstition Sand). The 6-year-old grove was in full production when the experiment was started and contained trees with scions of ‘Limoneira 8A’ Lisbon lemon on *Citrus volkameriana* rootstock. Weed control in the grove prior to the beginning of the experiment was accomplished using postemergence applications of Roundup. The treatments included an untreated control and five rates of Roundup: 0.5, 0.75, 1.0, 1.25, and 1.5 lb. of active ingredient (a.i.) per acre or 0.5, 0.75, 1.0, 1.25, and 1.5 quarts of Roundup or Roundup Ultra per acre. The six treatments were arranged in the orchard using a randomized complete block experimental design with nine blocks. Each plot consisted of a single tree. Trees were not skirted so the canopies extended down to the ground. The experiment began with the first set of Roundup applications on 6/6/95. Subsequent applications were made on 9/1/95, 3/6/96, 7/31/96, 11/22/96, 5/14/97, 8/15/97, 11/19/97, 3/20/98 and 8/26/98. Roundup was applied with a CO₂ pressurized backpack sprayer at about 20-psi using a single TeeJet 8002EVS nozzle with the nozzle orifice pointing at the tree canopy (i.e., oriented 90 degrees from the horizontal). The nozzle was held 10 inches above the ground at about the edge of the canopy and the applicator paced around the perimeter of the tree, at a speed of 3 miles per hour. This method of application resulted in about a 20 to 24-inch spray band extending upward from the ground around the perimeter of the canopy at the base of the tree.

The data collected included visual estimates of leaf and canopy injury symptoms, counts of blooms and fruitlets (fruit with a diameter less than 1-cm) per unit branch length, and lemon yield per tree. Visual estimates of canopy injury symptoms were made on 4/26/96, 5/14/97 and 4/18/98 in all treatments and blocks. On each evaluation date, two separate ratings were made, one for the sprayed canopy zone (0 to 2 feet above the ground) and one for the portion of the canopy that was not directly sprayed (greater than 3 feet above the ground). Similarly, bloom and fruitlet counts were made in both the sprayed and non-sprayed canopy zones in February to May of 1996, 1997 and 1998. In both the sprayed and non-sprayed canopy zones in each tree (i.e., plot) in blocks one to six, one branch between 20 and 160 inches in length was selected. The branch lengths averaged across Roundup rate and canopy portions for each year were (mean \pm std. dev., n=12) 27.8 \pm 6.4, 24.4 \pm 5.0, and 51.2 \pm 9.8 in 1996, 1997, and 1998 respectively. Beginning at early bloom (i.e., flowers evident but not yet open), the length of the shoot and number of flowers and fruitlets were counted every two weeks until no more flowers were produced. Flower and fruitlet counts were made on (month/day) 2/29, 3/12, 3/26, 4/9, 4/23, 5/7, and 5/21 in 1996; on 2/28, 3/14, 3/28, 4/11, 4/25, and 5/9 in 1997; and on 3/25, 4/3, 4/22, and 5/8 in 1998.

Trees were harvested individually in all treatments and blocks. In 1996, there was one ring harvest (11/4/96) followed by a “strip” or complete harvest (12/2/96). In 1997, there were two ring harvests (10/20/97 and 11/21/97) followed by a complete harvest. Unfortunately, the experiment was mistakenly harvested and we did not obtain yield data from the final harvest. We estimate that about 20% of the total yield was not collected in 1997. In 1998, there was one ring harvest on 9/23/98 followed by a complete harvest on 11/24/98. The fruit from each tree was placed in one to four 100-lb. field boxes. Five full field boxes were each weighed to obtain the average weight of fruit in a full box. For the rest of the field boxes, the portion of a full box was visually estimated and the weight calculated based on the average weight of a full box. Sub-samples of 25 to 35 lbs of fruit were collected from each tree and individually sized using standard rings (0 to 12) whose diameter correspond to industry fruit size categories. For example, a number 10 ring selects a fruit size that results in 95 fruit per industry standard 37.5 lb. carton. After sizing, each fruit was visually graded into three industry standard grades, Fancy, Choice, and juice or cull. Grading was based on the presence or absence of blemishes, the number of blemishes, and the size of blemishes. Blemishes resulted primarily from thrips damage, damage from wind-borne soil, puncture wounds, rubbing against branches, and bumps.

Results and Discussion

Roundup applications to the bottom 20 to 24 inches of the tree canopies caused visible injury in the sprayed zone 1, 2, and 3 years after Roundup applications were initiated but had little effect on leaves in the upper portion of the tree canopies (Table 1). The injury symptoms were primarily narrow “strapped leaves” and branch defoliation but there was also some discoloration or bleaching of sprayed leaves immediately after some applications. The degree of injury at the base of the tree canopies increased with increasing rates of Roundup (Table 1). The degree of Roundup induced defoliation observed at the higher application rates was severe at certain times of the year and probably limited the uptake and subsequent translocation of Roundup in the trees. The lack of significant injury symptoms in the upper portion of the canopy suggests that there was not enough translocation or movement of Roundup from the sprayed zone to unsprayed portion of the tree canopies to cause foliar injury symptoms. The injury observed in the control trees on 4/26/96 was due to Roundup applied prior to the start of the experiment. This injury declined in 1997 but an inadvertent application of Roundup in the entire experimental area in 1997 caused the increased injury observed on 4/18/98 in the untreated plots.

The effect of Roundup on flower and fruitlet (fruit with a diameter less than 1-cm) production was variable as indicated by the coefficients of variation listed in Tables 2 to 7. On evaluation dates where few blooms or fruitlets were counted, the coefficients of variation tended to be well in excess of 100% indicating that the data collected on these dates were of little value in assessing the effect of Roundup on flower or fruitlet production. However, on several evaluation dates sufficient blooms or fruitlets were counted to determine the effect of increasing Roundup rate on flower and fruitlet production. In 1996 after three Roundup applications, increasing rates of Roundup had no effect on flower production in either the sprayed or unsprayed portions of the tree canopies as judged by the counts collected from single branches in each canopy zone on 2/29/96, 3/12/96 and 3/26/96 (Table 2). Similarly, in 1997 after five Roundup applications, increasing rates of Roundup had no effect on flower production in the sprayed or unsprayed portions of the tree canopies as judged from the data collected on 2/28/97 and 3/14/97 (Table 3). The data collected in 1998 after nine Roundup applications were consistent with the previous two years of data and showed that increasing rates of Roundup had no effect on flower production as judged from the data collected on 3/25/98 and 4/3/98 (Table 4). (There was some flowering prior to 3/25/98 but no data was collected before this date.) Fruitlet production in 1996 in the sprayed and unsprayed zones was low, however like flower production, was not affected by the Roundup applications (Table 5). There was more fruitlet production in 1997 and 1998 than in 1996 (Tables 5, 6, and 7). Similar to the 1996 data, the data collected in 1997 and 1998 indicated that increasing rates of Roundup had no effect on fruitlet production in either the sprayed or unsprayed portions of the tree canopies (Table 6 and 7). In summary, despite the obvious foliar effects, Roundup at the rates used in this study had no effect on flower or fruitlet production in all three years of this study.

Yield data were not collected in 1995 because Roundup had been applied only twice before harvest and it seemed unlikely that there would be a yield effect. However, spraying Roundup on the bottom 20 to 24 inches of the tree canopies did not reduce total lemon yield per tree in 1996 at any of the application rates (Table 8). Although the final strip harvest in 1997 was not measured, spraying Roundup on the base of the tree canopies also did not appear to reduce lemon tree yields in 1997 (Table 9). Similarly, the 1998 tree yields were unaffected by increasing rates of

Roundup (0 to 1.5 lb. a.i./A) applied to the base of the canopies (Table 10). In all three years of the study, increasing Roundup rate had no effect on the yield of the first or second ring picks or the percentages of the total crop (partial total in 1997) picked on the first harvest date (Tables 8, 9 and 10). Increasing Roundup rates also did not affect fruit size at any harvest date in 1996 (Tables 11 and 12), 1997 (Tables 13 and 14) or in 1998 (Tables 15 and 16). Similarly, increasing Roundup application rates did not affect fruit quality at any harvest in 1996 (Tables 17 and 18), 1997 (Tables 19 and 20) or in 1998 (Tables 21 and 22). Thus, there was no relationship between the rate of Roundup sprayed on the trees and yield, fruit size or quality in all three years of this study.

The lack of Roundup effects on flower and fruitlet production, yield, or fruit size and quality contrasts with the obvious foliar symptoms caused by Roundup in the sprayed portion of the tree canopies in all three years of the study (Table 1). The flower and fruitlet production, yield, and fruit size and quality data suggest that significant amounts of Roundup did not translocate out of the sprayed portion of the tree canopies to affect other visible parts of the tree. Alternatively, the Roundup applied to the trees may have been diluted to concentrations too small to have an affect on unsprayed portions of the trees due to the large size of the trees. It is also possible that the lower portion of the tree canopies primarily translocated Roundup to the roots where symptoms would not be visible but the lack above ground affects on flower and fruitlet production, yield, and fruit size and quality suggests that affects on roots were not significant. These data may suggest that the bottom portion of the tree canopy may not contribute significantly to yield or more likely that any loss of fruit in the sprayed portion of the canopy was compensated for by the unsprayed portion of the canopy. It is noteworthy in regard to the yield data, that the defoliation and narrow strapped leaves on the lower branches caused by the higher Roundup rates may have limited the amount of Roundup absorbed. Defoliation might also be expected to reduce flower and fruitlet production because less leaf area was available to feed developing flowers and fruits. This effect was not seen in this study because there were always some branches producing flowers and fruitlets in the sprayed portion of the tree canopies and it was these branches that were selected for measurement. The amounts of Roundup absorbed by the lemon trees in this study were far greater than occurs during normal commercial applications on the Yuma Mesa because of the greater extent and severity of the foliar injury symptoms exhibited by trees in this study compared to other groves where Roundup was used. This study indicates that current weed control practices involving the use of Roundup in lemon groves on the Yuma Mesa do not have a significant effect on tree yields. However, it is always prudent to use shielded spray booms and other techniques in order to minimize spray drift and the inadvertent application of Roundup on lemon tree foliage.

Table 1. Visual injury symptoms caused by application of Roundup to the bottom 20 to 24 inches of lemon tree canopies. The bottom or sprayed zone was the portion of the canopy from the ground up to 2 feet above the ground while the top or unsprayed portion of the canopy extended from 3 feet above the ground to the top of the tree. Data are means \pm standard deviations (SD); means within a column and portion of the tree canopy followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Portion of Canopy	Roundup Rate	Evaluation Date		
		4/26/96	5/14/97	4/18/98
	<i>(lb. a.i./acre)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>
Bottom	0	11 \pm 5 c	1 \pm 2 d	7 \pm 4 e
	0.5	36 \pm 13 b	10 \pm 6 c	31 \pm 12 d
	0.75	48 \pm 15 ab	15 \pm 9 bc	33 \pm 12 cd
	1.0	47 \pm 20 ab	29 \pm 18 bc	52 \pm 19 bc
	1.25	56 \pm 15 ab	46 \pm 16 ab	59 \pm 9 ab
	1.5	59 \pm 17 a	48 \pm 19 a	75 \pm 9 a
Top	0	0 \pm 0 b	0 \pm 0 c	0 \pm 0 b
	0.5	0.1 \pm 0.3 ab	0 \pm 0 c	0.2 \pm 0.3 b
	0.75	0.1 \pm 0.3 ab	0.1 \pm 0.3 bc	0.8 \pm 1.0 b
	1.0	0 \pm 0 b	0.1 \pm 0.3 bc	1.0 \pm 0.8 b
	1.25	0.1 \pm 0.3 ab	1.7 \pm 1.5 a	1.1 \pm 0.7 b
	1.5	0.4 \pm 0.5 a	1.3 \pm 1.7 ab	2.3 \pm 1.4 a

Table 2. Effect of Roundup on flower production in 1996. Flower counts were normalized by calculating the number of blooms per meter of branch. The bottom or sprayed zone was the portion of the canopy from the ground up to 2 feet above the ground while the top or unsprayed portion of the canopy extended from 3 feet above the ground to the top of the tree. Data are means \pm standard deviations (SD); means within a column and portion of the tree canopy followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Portion of Canopy	Roundup Rate	Blooms/Meter of Branch at Various Dates				
		2/29/96	3/12/96	3/26/96	4/9/96	4/23/96
	(lb. a.i./acre)	(mean \pm SD)	(mean \pm SD)	(mean \pm SD)	(mean \pm SD)	(mean \pm SD)
Bottom	0	35 \pm 23 a	11 \pm 6 a	0 \pm 0 a	0 \pm 0 a	3.3 \pm 8.0 a
	0.5	46 \pm 25 a	16 \pm 22 a	0.9 \pm 1.6 a	0 \pm 0 a	0.9 \pm 1.5 a
	0.75	39 \pm 17 a	14 \pm 14 a	0.9 \pm 2.2 a	0 \pm 0 a	0.4 \pm 1.0 a
	1.0	47 \pm 35 a	17 \pm 14 a	1.3 \pm 2.4 a	0.8 \pm 1.5 a	1.1 \pm 1.8 a
	1.25	29 \pm 19 a	16 \pm 18 a	4.1 \pm 8.8 a	0 \pm 0 a	0 \pm 0 a
	1.5	37 \pm 24 a	10 \pm 9 a	0 \pm 0 a	0 \pm 0 a	0.5 \pm 1.2 a
	CV (%)		62	107	332	480
Top	0	42 \pm 22 a	34 \pm 17 a	7.1 \pm 2.4 a	0 \pm 0 a	0 \pm 0 a
	0.5	31 \pm 15 a	26 \pm 14 a	4.7 \pm 4.8 a	0.1 \pm 0.3 a	1.6 \pm 3.9 a
	0.75	53 \pm 17 a	34 \pm 15 a	3.8 \pm 3.4 a	0 \pm 0 a	0 \pm 0 a
	1.0	41 \pm 31 a	30 \pm 22 a	8.5 \pm 10.5 a	0 \pm 0 a	0 \pm 0 a
	1.25	57 \pm 40 a	37 \pm 30 a	8.0 \pm 7.7 a	2.0 \pm 4.8 a	0.8 \pm 1.9 a
	1.5	48 \pm 24 a	38 \pm 18 a	5.4 \pm 4.3 a	0.1 \pm 0.4 a	1.4 \pm 2.8 a
	CV (%)		55	61	101	513

Table 3. Effect of Roundup on flower production in 1997. Flower counts were normalized by calculating the number of blooms per meter of branch. The bottom or sprayed zone was the portion of the canopy from the ground up to 2 feet above the ground while the top or unsprayed portion of the canopy extended from 3 feet above the ground to the top of the tree. Data are means \pm standard deviations (SD); means within a column and portion of the tree canopy followed by the same letter are not significantly different at $P=0.05$ according to Tukey's HSD. The coefficient of variation (CV) for the data is listed for each evaluation date and canopy portion.

Portion of Canopy	Roundup Rate	Blooms/Meter of Branch at Various Dates				
		2/28/97	3/14/97	3/28/97	4/11/97	4/25/97
	(<i>lb. a.i./acre</i>)	(<i>mean \pm SD</i>)	(<i>mean \pm SD</i>)	(<i>mean \pm SD</i>)	(<i>mean \pm SD</i>)	(<i>mean \pm SD</i>)
Bottom	0	45 \pm 6 a	37 \pm 7 a	0.9 \pm 1.6 a	0 \pm 0 a	0.3 \pm 0.7 a
	0.5	41 \pm 18 a	43 \pm 16 a	4.8 \pm 4.5 a	0.3 \pm 0.8 a	0.2 \pm 0.4 a
	0.75	47 \pm 15 a	42 \pm 14 a	2.6 \pm 3.3 a	0 \pm 0 a	0 \pm 0 a
	1.0	31 \pm 6 a	28 \pm 5 a	7.0 \pm 8.3 a	2.6 \pm 5.0 a	1.8 \pm 2.9 a
	1.25	52 \pm 13 a	43 \pm 14 a	0.8 \pm 1.4 a	0 \pm 0 a	1.8 \pm 4.5 a
	1.5	33 \pm 11 a	27 \pm 21 a	7.6 \pm 14 a	1.4 \pm 2.2 a	0.7 \pm 1.7 a
	CV (%)		30	37	188	328
Top	0	55 \pm 21 a	51 \pm 19 a	1.3 \pm 1.7 a	0 \pm 0 a	0.1 \pm 0.3 a
	0.5	50 \pm 23 a	45 \pm 19 a	3.0 \pm 4.0 a	0.4 \pm 1.0 a	1.7 \pm 3.0 a
	0.75	50 \pm 11 a	45 \pm 11 a	3.8 \pm 6.8 a	1.5 \pm 3.6 a	0 \pm 0 a
	1.0	60 \pm 23 a	59 \pm 22 a	0 \pm 0 a	0 \pm 0 a	0.5 \pm 0.9 a
	1.25	50 \pm 24 a	42 \pm 14 a	1.9 \pm 2.9 a	0.7 \pm 1.7 a	0.5 \pm 1.2 a
	1.5	45 \pm 11 a	43 \pm 15 a	4.0 \pm 3.7 a	1.1 \pm 2.1 a	0.5 \pm 0.8 a
	CV (%)	1.5	38	33	169	313

Table 4. Effect of Roundup on flower production in 1998. Flower counts were normalized by calculating the number of blooms per meter of branch. The bottom or sprayed zone was the portion of the canopy from the ground up to 2 feet above the ground while the top or unsprayed portion of the canopy extended from 3 feet above the ground to the top of the tree. Data are means \pm standard deviations (SD); means within a column and portion of the tree canopy followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD. The coefficient of variation (CV) for the data is listed for each evaluation date and canopy portion.

Portion of Canopy	Roundup Rate	Blooms/Meter of Branch at Various Dates			
		3/25/98	4/3/98	4/22/98	5/8/98
	<i>(lb. a.i./acre)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>
Bottom	0	25 \pm 13 a	8.9 \pm 2.1 a	0.2 \pm 0.4 a	1.0 \pm 1.7 a
	0.5	18 \pm 10 a	6.6 \pm 16 a	0.2 \pm 0.4 a	0.9 \pm 0.9 a
	0.75	24 \pm 14 a	11.3 \pm 6.7 a	0.3 \pm 0.8 a	2.8 \pm 4.1 a
	1.0	22 \pm 12 a	8.4 \pm 7.1 a	0.2 \pm 0.4 a	1.1 \pm 1.8 a
	1.25	16 \pm 8 a	7.7 \pm 4.2 a	0.5 \pm 0.6 a	1.8 \pm 2.0 a
	1.5	29 \pm 12 a	11.1 \pm 3.2 a	0 \pm 0 a	1.4 \pm 1.4 a
	CV (%)		44	54	156
Top	0	18 \pm 6 a	7.8 \pm 5.0 a	0 \pm 0 a	0.5 \pm 1.2 a
	0.5	21 \pm 7 a	5.3 \pm 6.2 ab	0.2 \pm 0.6 a	3.2 \pm 5.6 a
	0.75	15 \pm 9 a	3.6 \pm 2.3 ab	0 \pm 0 a	3.0 \pm 5.3 a
	1.0	10 \pm 5 a	1.6 \pm 1.3 b	0 \pm 0 a	2.4 \pm 2.5 a
	1.25	14 \pm 11 a	1.6 \pm 2.9 b	0 \pm 0 a	2.8 \pm 4.9 a
	1.5	14 \pm 4 a	1.6 \pm 1.4 b	0.3 \pm 0.8 a	3.9 \pm 3.7 a
	CV (%)		51	90	436

Table 5. Effect of Roundup on fruitlet production in 1996. Fruitlet (fruit with a diameter less than 1 cm) counts were normalized by calculating the number of fruitlets per meter of branch. The bottom or sprayed zone was the portion of the canopy from the ground up to 2 feet above the ground while the top or unsprayed portion of the canopy extended from 3 feet above the ground to the top of the tree. Data are means \pm standard deviations (SD); means within a column and portion of the tree canopy followed by the same letter are not significantly different at $P=0.05$ according to Tukey's HSD. The coefficient of variation (CV) for the data is listed for each evaluation date and canopy portion.

Portion of Canopy	Roundup Rate	Fruitlets/Meter of Branch at Various Dates				
		3/26/96	4/9/96	4/23/96	5/7/96	5/21/96
	<i>(lb. a.i./acre)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>
Bottom	0	1.6 \pm 2.1 a	1.6 \pm 2.1 a	0.9 \pm 2.1 a	2.9 \pm 5.9 a	0.4 \pm 1.1 a
	0.5	5.0 \pm 9.3 a	3.6 \pm 6.2 a	0.8 \pm 1.6 a	0.4 \pm 1.0 a	0 \pm 0 a
	0.75	4.2 \pm 10 a	3.0 \pm 7.3 a	0.9 \pm 2.2 a	0.6 \pm 1.5 a	0.6 \pm 1.5 a
	1.0	5.0 \pm 12 a	0.2 \pm 0.4 a	0.6 \pm 1.0 a	1.6 \pm 1.4 a	0.5 \pm 0.9 a
	1.25	5.6 \pm 8.1 a	3.1 \pm 4.8 a	0.2 \pm 0.6 a	0.8 \pm 1.3 a	0 \pm 0 a
	1.5	0.9 \pm 1.4 a	0.7 \pm 1.2 a	0.3 \pm 0.6 a	0.3 \pm 0.6 a	0.3 \pm 0.6 a
	CV (%)		226	213	248	216
Top	0	0.6 \pm 0.3 a	0.3 \pm 0.2 a	0.2 \pm 0.1 a	0.1 \pm 0.1 a	0.08 \pm 0.07 a
	0.5	0.3 \pm 0.2 a	0.2 \pm 0.1 a	0.2 \pm 0.1 a	0.1 \pm 0.1 a	0.06 \pm 0.05 a
	0.75	0.5 \pm 0.3 a	0.3 \pm 0.2 a	0.1 \pm 0.1 a	0.1 \pm 0.1 a	0.05 \pm 0.07 a
	1.0	0.5 \pm 0.3 a	0.3 \pm 0.2 a	0.2 \pm 0.2 a	0.1 \pm 0.1 a	0.11 \pm 0.09 a
	1.25	0.4 \pm 0.2 a	0.3 \pm 0.2 a	0.2 \pm 0.1 a	0.2 \pm 0.1 a	0.06 \pm 0.04 a
	1.5	0.5 \pm 0.3 a	0.3 \pm 0.2 a	0.2 \pm 0.1 a	0.1 \pm 0.1 a	0.05 \pm 0.04 a
	CV (%)		54	60	77	64

Table 6. Effect of Roundup on fruitlet production in 1997. Fruitlet (fruit with a diameter less than 1 cm) counts were normalized by calculating the number of fruitlets per meter of branch. The bottom or sprayed zone was the portion of the canopy from the ground up to 2 feet above the ground while the top or unsprayed portion of the canopy extended from 3 feet above the ground to the top of the tree. Data are means \pm standard deviations (SD); means within a column and portion of the tree canopy followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD. The coefficient of variation (CV) for the data is listed for each evaluation date and canopy portion.

Portion of Canopy	Roundup Rate	Fruitlets/Meter of Branch at Various Dates				
		3/14/97	3/28/97	4/11/97	4/25/97	5/9/97
	<i>(lb. a.i./acre)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>
Bottom	0	3.0 \pm 3.2 a	14 \pm 4 a	7.9 \pm 7.0 a	3.9 \pm 2.8 a	2.6 \pm 2.6 a
	0.5	1.3 \pm 3.2 a	17 \pm 8 a	11 \pm 3 a	5.4 \pm 2.7 a	4.2 \pm 1.5 a
	0.75	2.6 \pm 4.9 a	19 \pm 14 a	8.6 \pm 7.1 a	5.9 \pm 3.7 a	4.9 \pm 3.5 a
	1.0	3.5 \pm 3.0 a	9 \pm 3 a	4.6 \pm 4.3 a	1.2 \pm 1.0 a	2.8 \pm 3.1 a
	1.25	3.6 \pm 2.6 a	13 \pm 5 a	2.5 \pm 2.0 a	0.8 \pm 1.3 a	1.4 \pm 2.2 a
	1.5	4.5 \pm 8.0 a	7 \pm 7	5.0 \pm 5.8 a	2.0 \pm 2.6 a	1.2 \pm 1.9 a
CV (%)		142	60	83	79	94
Top	0	1.4 \pm 1.8 a	16 \pm 13 a	10 \pm 10 a	5.6 \pm 8.1 a	5.3 \pm 5.4 a
	0.5	1.3 \pm 1.2 a	21 \pm 7 a	15 \pm 8 a	7.4 \pm 4.2 a	4.1 \pm 2.5 a
	0.75	1.8 \pm 2.2 a	19 \pm 8 a	12 \pm 9 a	11.1 \pm 6.9 a	6.3 \pm 5.4 a
	1.0	1.5 \pm 2.5 a	23 \pm 12 a	15 \pm 20 a	8.4 \pm 6.0 a	5.6 \pm 4.7 a
	1.25	4.0 \pm 8.8 a	16 \pm 5 a	10 \pm 7 a	8.8 \pm 5.8 a	6.9 \pm 5.4 a
	1.5	2.0 \pm 2.3 a	16 \pm 7 a	9.5 \pm 5.3 a	6.3 \pm 5.5 a	3.6 \pm 2.8 a
CV (%)		195	51	92	80	82

Table 7. Effect of Roundup on fruitlet production in 1998. Fruitlet (fruit with a diameter less than 1 cm) counts were normalized by calculating the number of fruitlets per meter of branch. The bottom or sprayed zone was the portion of the canopy from the ground up to 2 feet above the ground while the top or unsprayed portion of the canopy extended from 3 feet above the ground to the top of the tree. Data are means \pm standard deviations (SD); means within a column and portion of the tree canopy followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD. The coefficient of variation (CV) for the data is listed for each evaluation date and canopy portion.

Portion of Canopy	Roundup Rate	Fruitlets/Meter of Branch at Various Dates			
		3/25/98	4/3/98	4/22/98	5/8/98
	<i>(lb. a.i./acre)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>	<i>(mean \pm SD)</i>
Bottom	0	3.3 \pm 3.4 a	12.6 \pm 8.7 a	7.9 \pm 4.5 a	2.7 \pm 1.9 a
	0.5	2.0 \pm 1.1 a	7.9 \pm 3.1 a	4.2 \pm 2.4 a	0.2 \pm 0.3 a
	0.75	2.3 \pm 1.8 a	8.5 \pm 4.2 a	9.8 \pm 3.8 a	3.5 \pm 2.9 a
	1.0	1.2 \pm 0.9 a	8.1 \pm 4.3 a	9.2 \pm 5.9 a	2.5 \pm 2.0 a
	1.25	3.1 \pm 2.9 a	7.7 \pm 4.0 a	6.5 \pm 3.9 a	1.1 \pm 1.1 a
	1.5	4.2 \pm 1.0 a	11.1 \pm 6.6 a	9.4 \pm 5.1	2.8 \pm 1.7 a
CV (%)		83	54	56	91
Top	0	4.4 \pm 4.0 a	9.3 \pm 6.0 a	8.2 \pm 4.6 a	1.8 \pm 1.8 a
	0.5	3.2 \pm 6.0 a	6.3 \pm 6.7 a	4.9 \pm 5.7 a	1.0 \pm 1.6 a
	0.75	3.4 \pm 4.5 a	6.4 \pm 5.4 a	5.9 \pm 5.4 a	1.3 \pm 1.2 a
	1.0	3.9 \pm 2.5 a	4.5 \pm 3.1 a	3.7 \pm 2.7 a	1.0 \pm 1.2 a
	1.25	5.7 \pm 6.1 a	8.0 \pm 8.8 a	3.5 \pm 5.2 a	0.9 \pm 0.7 a
	1.5	3.1 \pm 4.1 a	2.4 \pm 2.9 a	1.9 \pm 3.0 a	0.8 \pm 1.1 a
CV (%)		123	102	106	120

Table 8. Effect of Roundup on the 1996-97 yield of lemon trees when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate (<i>lb. a.i./acre</i>)	Lemon Tree Yield			
	11/4/96 (<i>lb./tree</i>)	12/2/96 (<i>lb./tree</i>)	Total Yield (<i>lb./tree</i>)	First Harvest (% of total)
0	89 \pm 22 a	44 \pm 16 a	133 \pm 27 a	67 \pm 10 a
0.5	82 \pm 23 a	44 \pm 17 a	125 \pm 31 a	65 \pm 9 a
0.75	79 \pm 19 a	50 \pm 18 a	129 \pm 21 a	62 \pm 12 a
1.0	80 \pm 21 a	57 \pm 21 a	137 \pm 20 a	58 \pm 13 a
1.25	81 \pm 32 a	48 \pm 18 a	128 \pm 45 a	62 \pm 9 a
1.5	82 \pm 28 a	42 \pm 14 a	124 \pm 36 a	65 \pm 10 a

Table 9. Effect of Roundup on the 1997-98 yield of lemon trees when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data for a third and final harvest were not collected. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate (<i>lb. a.i./acre</i>)	Lemon Tree Yield			
	10/20/97 (<i>lb./tree</i>)	11/21/97 (<i>lb./tree</i>)	Partial Total Yield (<i>lb./tree</i>)	Percent Early Fruit (% of total)
0	121 \pm 64 a	95 \pm 63 a	216 \pm 122 a	57 \pm 7 a
0.5	111 \pm 34 a	109 \pm 47 a	220 \pm 63 a	52 \pm 12 a
0.75	128 \pm 37 a	95 \pm 37 a	223 \pm 62 a	59 \pm 10 a
1.0	122 \pm 74 a	90 \pm 49 a	213 \pm 87 a	57 \pm 19 a
1.25	97 \pm 43 a	86 \pm 31 a	183 \pm 44 a	52 \pm 14 a
1.5	131 \pm 41 a	94 \pm 36 a	225 \pm 54 a	59 \pm 12 a

Table 10. Effect of Roundup on the 1998-99 yield of lemon trees when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate (<i>lb. a.i./acre</i>)	Lemon Tree Yield			
	9/23/98 (<i>lb./tree</i>)	11/24/98 (<i>lb./tree</i>)	Total Yield (<i>lb./tree</i>)	First Harvest (% of total)
0	35 \pm 19 a	222 \pm 54 a	256 \pm 66 a	13.1 \pm 5.4 a
0.5	42 \pm 17 a	200 \pm 56 a	242 \pm 62 a	17.6 \pm 6.7 a
0.75	46 \pm 10 a	236 \pm 58 a	282 \pm 60 a	16.7 \pm 4.3 a
1.0	36 \pm 18 a	216 \pm 66 a	252 \pm 74 a	14.2 \pm 5.6 a
1.25	43 \pm 23 a	200 \pm 40 a	244 \pm 55 a	17.1 \pm 6.2 a
1.5	52 \pm 26 a	208 \pm 53 a	260 \pm 56 a	19.9 \pm 9.6 a

Table 11. Effect of Roundup on lemon fruit size (fruit/box) as a percentage of all fruit harvested on November 4, 1996 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate (<i>lb. a.i./acre</i>)	Tree yield (<i>lb./tree</i>)	Fruit size (fruit/box) as a percentage of all fruit harvested			
		11/4/96 %	165 or smaller %	140 %	115 %
0	89 \pm 22 a	15.1 \pm 9.7 a	6.0 \pm 3.4 a	7.1 \pm 2.3 a	72 \pm 12 a
0.5	82 \pm 23 a	11.7 \pm 5.9 a	5.3 \pm 2.2 a	6.9 \pm 2.1 a	76 \pm 9 a
0.75	79 \pm 19 a	11.2 \pm 5.7 a	4.9 \pm 1.7 a	6.0 \pm 2.8 a	78 \pm 6 a
1.0	80 \pm 21 a	11.4 \pm 6.3 a	6.7 \pm 5.7 a	6.5 \pm 2.0 a	75 \pm 7 a
1.25	81 \pm 32 a	16.1 \pm 6.9 a	6.5 \pm 2.0 a	6.4 \pm 2.8 a	71 \pm 10 a
1.5	82 \pm 28 a	12.8 \pm 6.6 a	6.4 \pm 2.8 a	7.2 \pm 4.6 a	74 \pm 9 a

Table 12. Effect of Roundup on lemon fruit size (fruit/box) as a percentage of all fruit harvested on December 2, 1996 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit size (fruit/box) as a percentage of all fruit harvested			
		12/2/96	165 or smaller	140	115
<i>(lb. a.i./acre)</i>	<i>(lb./tree)</i>	%	%	%	%
0	44 \pm 16 a	21.8 \pm 10.1 a	8.7 \pm 5.4 a	6.6 \pm 2.4 a	63 \pm 14 a
0.5	44 \pm 17 a	17.2 \pm 5.9 a	8.8 \pm 2.8 a	6.3 \pm 3.6 a	68 \pm 9 a
0.75	50 \pm 18 a	14.9 \pm 7.8 a	6.3 \pm 2.5 a	4.6 \pm 2.2 a	74 \pm 10 a
1.0	57 \pm 21 a	17.6 \pm 11.3 a	8.2 \pm 5.1 a	5.0 \pm 2.5 a	69 \pm 16 a
1.25	48 \pm 18 a	18.1 \pm 7.4 a	9.8 \pm 3.2 a	5.4 \pm 2.6 a	67 \pm 11 a
1.5	42 \pm 14 a	13.6 \pm 5.7 a	8.2 \pm 4.2 a	3.3 \pm 2.1 a	75 \pm 10 a

Table 13. Effect of Roundup on lemon fruit size (fruit/box) as a percentage of all fruit harvested on October 20, 1997 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit size (fruit/box) as a percentage of all fruit harvested			
		10/20/97	165 or smaller	140	115
<i>(lb. a.i./acre)</i>	<i>(lb./tree)</i>	%	%	%	%
0	121 \pm 64 a	7.4 \pm 7.0 a	6.3 \pm 4.1 a	6.7 \pm 4.0 a	80 \pm 13 a
0.5	111 \pm 34 a	6.6 \pm 4.5 a	4.9 \pm 3.2 a	6.6 \pm 3.0 a	82 \pm 8 a
0.75	128 \pm 37 a	4.8 \pm 2.7 a	5.5 \pm 1.4 a	6.9 \pm 4.3 a	83 \pm 5 a
1.0	122 \pm 74 a	9.6 \pm 7.6 a	6.3 \pm 4.1 a	6.0 \pm 3.5 a	78 \pm 14 a
1.25	97 \pm 43 a	6.9 \pm 5.4 a	6.9 \pm 2.7 a	6.3 \pm 3.5 a	80 \pm 9 a
1.5	131 \pm 41 a	4.7 \pm 3.7 a	5.3 \pm 3.2 a	6.8 \pm 3.5 a	83 \pm 8 a

Table 14. Effect of Roundup on lemon fruit size (fruit/box) as a percentage of all fruit harvested on November 21, 1997 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate (lb. a.i./acre)	Tree yield (lb./tree)	Fruit size (fruit/box) as a percentage of all fruit harvested			
		11/21/97 %	165 or smaller %	140 %	115 %
0	95 \pm 63 a	11.1 \pm 8.3 ab	7.0 \pm 4.6 a	7.4 \pm 4.9 a	74 \pm 15 a
0.5	109 \pm 47 a	15.8 \pm 7.6 ab	8.2 \pm 4.8 a	6.9 \pm 3.1 a	69 \pm 12 a
0.75	95 \pm 37 a	9.9 \pm 3.8 b	7.9 \pm 3.9 a	7.1 \pm 2.0 a	75 \pm 7 a
1.0	90 \pm 49 a	14.7 \pm 7.9 ab	9.0 \pm 3.7 a	8.5 \pm 4.2 a	68 \pm 12 a
1.25	86 \pm 31 a	16.6 \pm 6.5 a	9.4 \pm 2.8 a	6.9 \pm 2.1 a	67 \pm 9 a
1.5	94 \pm 36 a	12.1 \pm 5.1 ab	7.6 \pm 4.3 a	6.4 \pm 2.5 a	74 \pm 10 a

Table 15. Effect of Roundup on lemon fruit size (fruit/box) as a percentage of all fruit harvested on September 23, 1998 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate (lb. ai/acre)	Fruit size (fruit/box) as a percentage of all fruit harvested						
	235 or smaller %	200 %	165 %	140 %	115 %	95 %	75 or larger %
0	11 \pm 8 a	14 \pm 5 a	6 \pm 4 a	13 \pm 5 a	11 \pm 5 a	23 \pm 8 a	22 \pm 9 b
0.5	18 \pm 19 a	14 \pm 5 a	5 \pm 4 a	9 \pm 3 a	8 \pm 3 a	22 \pm 9 a	24 \pm 14 ab
0.75	7 \pm 6 a	11 \pm 4 a	5 \pm 3 a	11 \pm 5 a	12 \pm 4 a	25 \pm 6 a	30 \pm 13 ab
1.0	12 \pm 11 a	11 \pm 7 a	9 \pm 5 a	10 \pm 4 a	9 \pm 5 a	21 \pm 9 a	29 \pm 12 ab
1.25	8 \pm 7 a	8 \pm 5 a	7 \pm 7 a	13 \pm 4 a	12 \pm 6 a	21 \pm 9 a	30 \pm 13 ab
1.5	5 \pm 6 a	8 \pm 4 a	5 \pm 3 a	10 \pm 6 a	10 \pm 4 a	25 \pm 8 a	38 \pm 14 a

Table 16. Effect of Roundup on lemon fruit size (fruit/box) as a percentage of all fruit harvested on November 24, 1998 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at $P=0.05$ according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit size (fruit/box) as a percentage of all fruit harvested				
		11/24/98	165 or smaller	140	115	95
(lb. a.i./acre)	(lb./tree)	%	%	%	%	%
0	221 \pm 54 a	9.8 \pm 5.4 a	6.9 \pm 4.4 a	8.0 \pm 4.3 a	31 \pm 4 a	44 \pm 12 a
0.5	200 \pm 55 a	14.8 \pm 10.7 a	9.5 \pm 4.9 a	6.7 \pm 5.0 a	27 \pm 8 a	42 \pm 15 a
0.75	236 \pm 58 a	9.2 \pm 6.6 a	7.2 \pm 3.3 a	7.9 \pm 5.0 a	29 \pm 5 a	47 \pm 9 a
1.0	216 \pm 66 a	7.6 \pm 2.8 a	6.4 \pm 3.7 a	6.2 \pm 3.3 a	30 \pm 4 a	50 \pm 9 a
1.25	200 \pm 40 a	11.3 \pm 10.8 a	8.0 \pm 2.9 a	8.3 \pm 7.4 a	30 \pm 7 a	42 \pm 10 a
1.5	208 \pm 53 a	7.4 \pm 3.5 a	6.7 \pm 4.2 a	8.2 \pm 5.5 a	27 \pm 4 a	51 \pm 10 a

Table 17. Effect of Roundup on lemon fruit grade as a percentage of all fruit harvested on November 4, 1996 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at $P=0.05$ according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit quality as a percentage of all fruit harvested		
		11/4/96	Fancy #1	Choice #2
(lb. a.i./acre)	(lb./tree)	%	%	%
0	89 \pm 22 a	67 \pm 3 a	15.3 \pm 3.6 a	17.3 \pm 4.0 a
0.5	82 \pm 23 a	69 \pm 6 a	13.6 \pm 4.1 a	17.7 \pm 6.1 a
0.75	79 \pm 19 a	69 \pm 5 a	12.7 \pm 2.4 a	18.1 \pm 4.0 a
1.0	80 \pm 22 a	68 \pm 7 a	12.6 \pm 5.0 a	19.7 \pm 5.7 a
1.25	81 \pm 32 a	67 \pm 8 a	14.8 \pm 5.4 a	18.3 \pm 3.9 a
1.5	82 \pm 28 a	69 \pm 5 a	15.8 \pm 3.0 a	15.7 \pm 3.3 a

Table 18. Effect of Roundup on lemon fruit grade as a percentage of all fruit harvested on December 2, 1996 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit quality as a percentage of all fruit harvested		
		12/2/96	Fancy #1	Choice #2
<i>(lb. a.i./acre)</i>	<i>(lb./tree)</i>	%	%	%
0	44 \pm 16 a	41 \pm 10 a	12.9 \pm 6.1 a	47 \pm 9 a
0.5	44 \pm 17 a	39 \pm 11 a	15.3 \pm 4.6 a	46 \pm 11 a
0.75	50 \pm 18 a	42 \pm 8 a	11.0 \pm 3.9 a	47 \pm 7 a
1.0	57 \pm 21 a	43 \pm 9 a	11.6 \pm 1.8 a	45 \pm 8 a
1.25	48 \pm 18 a	40 \pm 6 a	10.9 \pm 3.4 a	49 \pm 5 a
1.5	42 \pm 14 a	38 \pm 13 a	15.3 \pm 5.9 a	47 \pm 13 a

Table 19. Effect of Roundup on lemon fruit grade as a percentage of all fruit harvested on October 20, 1997 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit quality as a percentage of all fruit harvested		
		10/20/97	Fancy #1	Choice #2
<i>(lb. a.i./acre)</i>	<i>(lb./tree)</i>	%	%	%
0	121 \pm 64 a	75 \pm 14 a	9.4 \pm 4.9 b	15.5 \pm 10.6 a
0.5	111 \pm 34 a	65 \pm 10 a	16.7 \pm 6.6 a	17.9 \pm 4.1 a
0.75	128 \pm 37 a	75 \pm 9 a	10.2 \pm 4.3 b	14.9 \pm 6.2 a
1.0	122 \pm 74 a	73 \pm 7 a	12.0 \pm 3.1 ab	14.6 \pm 4.8 a
1.25	97 \pm 43 a	73 \pm 10 a	13.6 \pm 4.4 ab	13.4 \pm 6.0 a
1.5	131 \pm 41 a	74 \pm 13 a	11.2 \pm 6.2 ab	15.2 \pm 8.3 a

Table 20. Effect of Roundup on lemon fruit grade as a percentage of all fruit harvested on November 21, 1997 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit quality as a percentage of all fruit harvested		
	11/21/97	Fancy #1	Choice #2	Juice #3
<i>(lb. a.i./acre)</i>	<i>(lb./tree)</i>	%	%	%
0	95 \pm 63 a	52 \pm 12 a	21 \pm 6 a	27 \pm 8 a
0.5	109 \pm 47 a	44 \pm 12 ab	23 \pm 5 a	33 \pm 12 a
0.75	95 \pm 37 a	40 \pm 10 b	22 \pm 7 a	38 \pm 10 a
1.0	90 \pm 49 a	48 \pm 14 ab	22 \pm 5 a	30 \pm 11 a
1.25	86 \pm 31 a	52 \pm 8 ab	21 \pm 7 a	27 \pm 6 a
1.5	94 \pm 36 a	47 \pm 15 ab	22 \pm 5 a	31 \pm 12 a

Table 21. Effect of Roundup on lemon fruit grade as a percentage of all fruit harvested on September 23, 1998 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit quality as a percentage of all fruit harvested		
	9/23/98	Fancy #1	Choice #2	Juice #3
<i>(lb. a.i./acre)</i>	<i>(lb./tree)</i>	%	%	%
0	35 \pm 19 a	93 \pm 3 a	6.2 \pm 3.1 a	0.4 \pm 1.0 a
0.5	42 \pm 17 a	91 \pm 2 a	8.1 \pm 2.5 a	0.6 \pm 0.8 a
0.75	46 \pm 10 a	92 \pm 5 a	7.2 \pm 4.9 a	0.4 \pm 0.8 a
1.0	36 \pm 18 a	94 \pm 3 a	4.8 \pm 2.6 a	1.0 \pm 1.5 a
1.25	43 \pm 23 a	93 \pm 4 a	5.8 \pm 3.3 a	0.9 \pm 1.5 a
1.5	52 \pm 26 a	89 \pm 4 a	9.0 \pm 3.7 a	1.8 \pm 2.0 a

Table 22. Effect of Roundup on lemon fruit grade as a percentage of all fruit harvested on November 24, 1998 when Roundup was sprayed on the bottom 20 to 24 inches of the tree canopies. Data are means \pm standard deviations; means within a column followed by the same letter are not significantly different at P=0.05 according to Tukey's HSD.

Roundup Rate	Tree yield	Fruit quality as a percentage of all fruit harvested		
		11/24/98	Fancy #1	Choice #2
<i>(lb. a.i./acre)</i>	<i>(lb./tree)</i>	%	%	%
0	221 \pm 54 a	46 \pm 12 a	51 \pm 10 a	3.4 \pm 3.4 a
0.5	200 \pm 55 a	46 \pm 10 a	50 \pm 8 a	3.6 \pm 2.4 a
0.75	236 \pm 58 a	56 \pm 13 a	42 \pm 12 a	2.3 \pm 2.5 a
1.0	216 \pm 66 a	44 \pm 13 a	53 \pm 11 a	3.4 \pm 3.6 a
1.25	200 \pm 40 a	44 \pm 18 a	52 \pm 18 a	3.9 \pm 2.7 a
1.5	208 \pm 53 a	45 \pm 15 a	51 \pm 13 a	3.8 \pm 3.1 a