Completed

A. Project title:

Citrus Growers can Reduce Nitrate Groundwater Pollution and Increase Profits by Using Foliar Urea Fertilization in the Spring to Increase Fruit Set and Yield and Reduce Citrus Thrips Populations and Fruit Scarring

CDFA contract number: 93-0530

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B. STATEMENT OF OBJECTIVE: Our objective is to test the hypothesis that a single application of low-biuret urea to the foliage of the 'Washington' navel orange between April 1 to June 1 can do triple duty: (*i*) as a "non-pesticide" to control citrus thrips and reduce fruit scarring; (*ii*) as a "growth regulator" to improve fruit set and increase yield without reducing fruit size or quality; and (*iii*) as a nitrogen fertilizer by supplying a portion of the nitrogen to be applied in a given year thus reducing the amount applied to the soil. The goal of our research is to provide citrus growers with the optimal time and rate of foliar-urea application needed to successfully improve fruit set and yield and control citrus thrips to reduce fruit scarring. If our research is successful in improving yield and/or reducing the economic loss due to fruit scarring caused by citrus thrips, our research will provide an economic incentive for citrus growers to reduce their use of soil-applied nitrogen in favor of a spring foliar application of urea. Thus if successful, the results of our research will not only improve citrus productivity and grower profits, but will also reduce pollution to the groundwater from nitrate and reduce the amount of chemical pesticides currently used to control citrus thrips, which would result in less potential for pesticide pollution of the soil and groundwater. The project is a success if a spring foliar-application of urea increases yield, and/or fruit size, and/or reduces economic losses due to fruit scarring by citrus thrips.

C. EXECUTIVE SUMMARY: The research employed 17-yr-old 'Frost nucellar' navel orange trees on Trifoliate orange rootstock under commercial production by Paramount Citrus in the Ivanhoe area of the San Joaquin Valley. The research was replicated for 2 years with CDFA FREP funds and for a final third year with funds from the Citrus Research Board.

There were 5 treatments each replicated as 8 randomized blocks (6 rows wide by 15 trees long). Data were collected from 6 individual trees per block for a total of 48 data trees per treatment. Low-biuret urea was applied to the foliage on April 7, April 21, May 5 or May 20 in year 1 and on April 13, April 27, May 11 and May 25 in year 2 for treatments 1 through 4, respectively in each year. Treatment 5, the control, was Paramount Citrus' best management practice.

In both years of the study, spring foliar applications of low-biuret urea had no statistically significant effect on fruit scarring caused by *Scirtothrips citri* determined as either on-tree evaluations of fruit on the outside of the tree during the first week of September 1992 and 1993 or evaluation of total fruit per tree at harvest in March 1993 and 1994 (Table I and IV). While not significant at the 5% level, it is interesting to note that for both years of the study the late May (May 20, 1992 and May 25, 1993)

foliar application of low-biuret urea resulted in the lowest degree of fruit scarring, especially severe scarring (Tables I and IV). This trend can be seen in both the on-tree and harvest evaluations for both years of the study. Although not significant at the 5% level, it is also worth noting that for both years of the study, the second date of foliar application of urea (April 21,1992 and April 27, 1993) had the highest percent scarring, especially severe scarring (Tables I and IV).

The results of the study provided clear evidence that a spring foliar application of low-biuret urea had no negative effect on the population densities of beneficial predatory mite, *Euseius tularensis* (hibisci). There was no significant difference in the number of *E. tularensis* mites per leaf for trees on which 500 mites had been released on March 19, 1992, independent of whether these trees were left as controls or subsequently sprayed with low-biuret urea on the date indicated (Table II). The number of mites per leaf was not due to a natural increase in the population during the course of the study, since the control trees on which no mites were released had significantly lower numbers of mites per leaf on both sampling dates (Table II).

In the both years of the study, there were statistically significant effects on yield between dates of urea application to the foliage and the control trees receiving only soil-applied nitrogen. In addition, for both years of the study, the late May (May 20, 1992 and May 25, 1993) foliar urea application had the greatest kg and number of larger-sized fruit (packinghouse carton size 56 or larger) (Tables III, V and VI).

In the first year of the study, which was an "on" year, there were statistically significant differences at the 5% level between dates of urea application to the foliage in terms of total weight of fruit per tree and the number of fruit of packinghouse carton size 56 (fruit with diameters between 8.1 and 8.8 cm) (Table III). The date of foliar urea application had no statistically significant effect on other sizes of fruit. The May 20, 1992 foliar application of low-biuret urea had the highest total fruit weight and the highest number of fruit of packinghouse carton size 56. In both cases, the May 20, 1992 low-biuret urea application was statistically better at the 5% level than the April 7 and May 5 spray dates. However, the April 7, April 21, and May 5 treatments were not statistically different from the control at the 5% level. At the 10% level, the May 20, 1992 foliar application of urea resulted in significantly more total weight of fruit per tree and more fruit per tree of packinghouse carton size 56 than the control and all other treatments, except the April 21, 1992 urea application.

In the second year of the study, which was an "off" year, there was no significant effect at the 5% level on the kg and number of fruit per tree. There was, however, a statistically significant increase in the kg of fruit of packinghouse carton size 56 (fruit with diameters between 8.1 and 8.8 cm) and greater than 56 (fruit with diameters greater than 8.8 cm) for trees receiving the May 25, 1993 foliar application of low-biuret urea compared to the control trees receiving soil-applied nitrogen ($p<0.05$). In the second year of the study, the increase in kg of larger-sized fruit for trees receiving a foliar application of urea on May 25, 1993 was at the expense of fruit of size 72, 88, and 113 with no significant effect on total yield.

Our results demonstrate that a late May (20-25) application of low-biuret urea to the foliage is a cost effective means to N fertilize the "Washington' navel orange. The performance of urea in reducing the percentage of fruit scarred by citrus thrips was consistent for two years. While not significant at the 5% level, our results clearly showed that some dates for foliar application of N fertilizer may be more efficacious than others, i. e. late May (20-25; less severe scarring) versus late April (21-27; more scarring). The increase in yield of larger-sized fruit (packinghouse carton size 56) observed in both years of the study for the late May foliar application of low-biuret urea resulted in a net increase in return revenue to the grower each year ($740 for 1993; $302 for 1994). Since the grower will most likely fertilize with N some time during the year anyway, foliar application of urea in late May (20-25) would seem to afford many benefits over soil-applied nitrogen.

D. WORK DESCRIPTION:

Task 1: Determination of the Effect of a Spring Foliar Application of Low-Biuret Urea on Leaf Levels of NH_3-NH_4^+ and Total N.

The purpose of this task is to determine if a spring application of foliar urea will increase the NH_3-NH_4^+ content of the foliage to a level sufficient to increase yield without reducing fruit size, to reduce *S. citri* population levels without reducing the population of *E. tularensis*, and supply the tree with 1/3 to 1/4 of its annual N requirement. This task will be accomplished in two parts. The first part is collecting samples of mature and young developing leaves from control trees and trees to be treated with a foliar application of urea one day before the foliar application of urea and on day 1, 8, and 15 after foliar application and analyzing the leaves for their content of ammonia. Urea will be applied to the foliage on April 7, April 21, May 5 and May 20, 1992 and April 13, April 27, May 11, and May 25, 1993. The second part is to collect samples of mature spring flush leaves from non-fruiting terminals for commercial analysis of total N content.

The task products are: (*i*) an average maximum level of NH_3-NH_4^+ per gram dry weight leaf tissue that accumulates in leaves in response to low-biuret foliar fertilization at each spray date; (*ii*) quantification of the impact of the foliar application of low-biuret urea spray date on the total N content of the tree; and (*iii*) evaluation of the contribution of the application of low-biuret urea at each spray date to the annual N requirement.

Subtask 1.1.1: Review results of the first year and modify the experimental plan as necessary for year two.

Subtask 1.1.2: Meet with Carol Adams, Cooperative Extension Statistics Specialist, to discuss research results, statistical analyses of data, and any needed revisions of the experimental plan for year two.

Subtask 1.1.3: Lay out experiment in the orchard: block treatments; tag data trees.

Subtask 1.2.1: Apply low-biuret urea to the foliage on April 7, April 21, May 5, and May 20.

Subtask 1.2.2: Collect leaves for day -1, +1, +8, and +15 for April 7 treatment (treatment #1) and control. Wash leaves, dry leaves.

Subtask 1.2.3: Collect leaves for day -1, +1, +8, and +15 for April 21 treatment (treatment #2) and control. Wash leaves, dry leaves.

Subtask 1.2.4: Collect leaves for day -1, +1, +8, and +15 for May 5 treatment (treatment #3) and control. Wash leaves, dry leaves.

Subtask 1.2.5: Collect leaves for day -1, +1, +8, and +15 for May 20 treatment (treatment #4) and control. Wash leaves, dry leaves.

Subtask 1.2.6: Grind dried leaf samples to a size fine enough to pass through a 40 mesh screen.

Subtask 1.2.7: Extract 50 mg dried leaf sample in 10% TCA for 30 minutes, filter, and determine NH_3-NH_4^+ content of the filtrate using a Wescan Ammonia Analyzer.

Subtask 1.2.8: Statistically analyze leaf NH_3-NH_4^+ content data. Report average maximum level of NH_3-NH_4^+ resulting from each application of foliar urea.

Subtask 1.2.9: Collect leaves from each data tree for leaf analysis for total N, prepare and send for analysis.

Subtask 1.3.0: Statistically analyze leaf total N content data from results. Report effect of each foliar application of urea on tree total N status.

Subtask 1.3.1: Calculate contribution of each foliar urea application to the annual N requirement of the tree.

TASK 2: Determination of the Effect of a Spring Foliar Application of Low-Biuret Urea on the Population Density of *Scirtothrips citri* and on the Degree of Fruit Scarring by *S. citri*.

The purpose of this task is to determine if a spring application of foliar urea will reduce *S. citri* population levels sufficiently to reduce the economic loss due to the fruit scarring by *S. citri*. This task will be accomplished in two parts. The first part is collecting samples of *S. citri* by D-Vac from control trees and trees to be treated with a foliar application of low-biuret urea one day before the application of urea and on days 1, 3, 8, and 15 after application of urea to the foliage. Urea will be applied to the foliage on April 7, April 21, May 5, and May 20, 1993 and April 13, April 27, May 11 and May 5, 1993. The second part is to evaluate the degree of citrus thrips scarring on the fruit at harvest.

The are four products resulting from this task: (1) a coefficient of linear correlation (with its statistical significance) for *S. citri* population level as a function of the average maximum leaf NH_3-NH_4^+ content for each treatment date; (2) a coefficient of linear correlation (with its statistical significance) for fruit scar counts as a function of the average maximum leaf NH_3-NH_4^+ content for each treatment date; (3) a coefficient of linear correlation (with its statistical significance) for fruit scar counts as a function of *S. citri* population level for each treatment date; and (4) an assessment of economic benefit of the use of foliar-applied urea to reduce the number of fruit downgraded from first to second grade or culled due to scarring by *S. citri*.

Subtask 2.1.1: Collect *S. citri* samples for day -1, +1, +3, +8, and +15 for April 7 treatment and control by D-Vac.

Subtask 2.2.1: Collect *S. citri* samples for day -1, +1, +3, +8, and +15 for April 21 treatment and control by D-Vac.

Subtask 2.3.1: Collect *S. citri* samples for day -1, +1, +3, +8, and +15 for May 5 treatment and control by D-Vac.

Subtask 2.4.1: Collect *S. citri* samples for day -1, +1, +3, +8, and +15 for May 20 treatment and control by D-Vac.

Subtask 2.5.1: Samples of *S. citri* are examined under the dissecting scope . *S. citri* at various stages of development are identified and counted.

Subtask 2.5.2: *S. citri* population densities for each treatment date are calculated.

Subtask 2.6.1: At harvest all fruit from the data trees are evaluated for levels of citrus thrips scarring using a 0 to 4 rating scale [0=no citrus thrips scarring; 1 and 2=slight scarring with no grade reduction; 3=severe scarring equivalent to a level normally causing a grade reduction from first to second grade; and 4=severe scarring with ring scarring extending down the shoulder of the fruit normally resulting in culled (for juice) fruit].

Subtask 2.6.2: Statistical analyses of the degree of fruit scarring, *S. citri* population data, and average maximum leaf NH_3-NH_4^+ content. Development of coefficients of linear correlation.

Subtask 2.6.3: Cost/benefit analysis of the use of foliar-applied urea to control citrus thrips and to reduce citrus fruit scarring.

TASK 3: Determination of the Effect of a Spring Foliar Application of Low-Biuret Urea on the Population Densities of the Beneficial Predacious Mite *Euseius tularensis*.

The task product is the answer that foliar applications of low-biuret urea are not toxic to *E. tularensis*.

TASK 4: Determination of the Effect of a Spring Foliar Application of Low-Biuret Urea on Yield and Fruit Size.

The purpose of this task is to determine if a spring application of low-biuret urea to the foliage will increase yield and/or fruit size. At harvest, number of kg (lbs) of fruit per tree, number of fruit per tree and number of fruit of each size for commercial packout will be determined. Cost/benefit analysis of the effect of a spring application of foliar urea on yield, including fruit size, will be conducted.

The task products are: (1) a direct answer as to whether a spring application of foliar-applied urea increases yield; (2) assessment of the impact of a spring foliar-application of urea on fruit size; and (3) an economic evaluation of the efficacy of using a spring foliar-application of urea to increase yield and/or fruit size.

Subtask 4.1: Pickers harvest fruit and place it in field boxes, which are taken to the commercial sizer. Fruit from each data tree, one tree at a time, are loaded onto a conveyor that feeds the fruit onto the sizer, which sorts the fruit by size. The total weight of fruit of each size per tree is recorded for packout and the total weight of fruit is summed for each data tree and recorded as total yield.

Subtask 4.2: Fruit for each data tree are sized.

Subtask 4.3: Yield data analyzed and the commercial packout for each treatment computed.

Subtask 4.4: Cost/benefit analysis of the use of a spring application of foliar-urea on yield and fruit size is conducted.

TASK 5: Prepare the Progress Report for the Second Year of the Study.

The purpose of this task is to integrate the results of each task carried out during the each year of the study.

The product of this task is a written report integrating the results of each task and the cost/benefit analyses of the efficacy of using a spring foliar application of low-biuret urea to increase yield and fruit size, and to reduce fruit scarring by citrus thrips.

Subtask 5.1: Written interim report.

Subtask 5.2: Write final report. Integrate the results of each task and the cost/benefit analysis into this report.

E. RESULTS, DISCUSSION AND CONCLUSIONS: In early April, young developing spring flush leaves averaged 150 ± 30 μg NH_3-NH_4^+ per g dry weight. These values were two times the concentration of NH_3-NH_4^+ in mature leaves from the previous year's spring flush. The level of NH_3-NH_4^+ in young and mature leaves decreased from April through May. By mid-May, both young and mature leaves had similar levels of NH_3-NH_4^+, approximately 35 μg per g dry weight. Foliar applications of low-biuret urea consistently raised the NH_3-NH_4^+ content of both young and mature leaves by 100 to 150 μg per g dry weight leaf tissue, but this increase was only evident for sampling dates 1 or 2 days after the foliar urea application. Eight days after the foliar application of urea, the levels of NH_3-NH_4^+ in either young or mature leaves were not significantly different from the control leaves sampled on the same date or the time zero leaves collected the day before the foliar urea application.

Total nitrogen content of the leaves for all trees used in the research increased from 2.5% to 2.9%. The spring application of low-biuret urea is known to contribute to the annual nitrogen requirement of the tree, but it was not possible to tell the effect of the urea sprays versus that of the soil-applied N from the leaf analyses provided to us by Paramount citrus.

Spring foliar applications of low-biuret urea had no statistically significant effect on the population densities of *Scirtothrips citri.* The high degree of variability in the number of thrips in each of the replicate samples made it impossible to detect statistically significant differences in thrips numbers attributable to any of the treatments. Thus, there were no statistically significant correlations at the 5% level between leaf NH_3-NH_4^+ concentrations, population densities of *S. citri* and the degree of fruit scarring.

In the second year of the study, as in the first year, spring foliar applications of low-biuret urea had no statistically significant effect at the 5% level on the degree of fruit scarring by *Scirtothrips citri* determined as either on-tree evaluations of fruit on the outside of the tree during the first week of September 1992 and 1993 or evaluation of total fruit per tree at harvest in March 1993 and 1994 (Tables I and IV). This is likely due to the high degree of variability in the number of thrips in each of the replicate samples. While not significant at the 5% level, it is interesting to note that for both years of the study the late May (May 20, 1992 and May 25, 1993) foliar application of low-biuret urea resulted in the lowest degree of fruit scarring, especially severe scarring (Tables I and IV). This trend can be seen in both the on-tree and harvest evaluations for both years of the study. Although not significant at the 5% level, it is also worth noting that for both years of the study, the second date of foliar application of urea (April 21, 1992 and April 27, 1993) had the highest percent scarring, especially severe scarring (Tables I and IV).

The results of the study provided clear evidence that a spring foliar application of low-biuret urea had no negative effect on the population densities of beneficial predatory mite, *Euseius tularensis* (hibisci) (Table II). There was no significant difference in the number of *E. tularensis* mites per leaf for trees on which 500 mites had been released on March 19, 1992, independent of whether these trees were left as controls or subsequently sprayed with low-biuret urea on the date indicated. The number of mites per leaf was not due to a natural increase in the population during the course of the study, since the control trees on which no mites were released had significantly lower numbers of mites per leaf on both sampling dates (Table II).

In the both years of the study, there were statistically significant effects on yield between dates of urea application to the foliage and the control trees receiving only soil-applied nitrogen. In addition, for both years of the study , the late May (May 20, 1992 and May 25, 1993) foliar urea application had the greatest kg and number of larger-sized fruit (packinghouse carton size 56 or larger) (Tables III, IV and V).

In the first year of the study, which was an "on" year, there were statistically significant differences at the 5% level between dates of urea application to the foliage in terms of total weight of fruit per tree and the number of fruit of packinghouse carton size 56 (fruit with diameters between 8.1 and 8.8 cm) (Table III). The date of foliar urea application had no statistically significant effect on other sizes of fruit. The May 20, 1992 foliar application of low-biuret urea had the highest total fruit weight and the highest number of fruit of packinghouse carton size 56. In both cases, the May 20, 1992 low-biuret urea application was statistically better at the 5% level than the April 7 and May 5 spray dates. However, the April 7, April 21, and May 5 treatments were not statistically different from the control at the 5% level. At the 10% level, the May 20, 1992 foliar application of urea resulted in significantly more total weight of fruit per tree and more fruit per tree of packinghouse carton size 56 than the control and all other treatments, except the April 21, 1992 urea application.

Trees receiving the May 20, 1992 foliar application of low-biuret urea yielded 54 lbs more fruit than the control trees receiving soil-applied nitrogen (Table III). This represents an additional 1.35 40-lb carton of fruit per tree or a 9% increase in yield. At a typical planting density of 96 trees per acre, the May 20, 1992 foliar application of low-biuret urea would yield 130 additional cartons per acre. For the cost/benefit analysis, we used the following values: (*i*) The May 20, 1992 foliar application of urea increased the number of fruit per tree of packinghouse size 56 and had no effect on any other fruit size, thus, we used the price of $8.00 per 40-lb carton which was the low value in effect at the time of our harvest (March-April 1992), for fruit of size 56, 72, and 88 and subtracted $2.29 per carton for packinghouse handling of the extra cartons (per Connelly Melling; Dole) to calculate profit; (*ii*) 15 gallons Unocal PLUS, per acre at $1.10 per gallon; and (*iii*) spray rig at $25.00 per acre to calculate expenses with all other expenses being the same, although there really is the expense of a soil application of nitrogen to the control trees which we did not include. Thus, a conservative estimated minimum net return to the grower for the May 20, 1992 foliar application of low-biuret urea was $740 per acre.

In the second year of the study, which was an "off" year, there was no significant effect at the 5% level on the kg and number of fruit per tree. There was, however, a statistically significant increase in the kg of fruit of packinghouse carton size 56 (fruit with diameters between 8.1 and 8.8 cm) and greater than 56 (fruit with diameters greater than 8.8 cm) for trees receiving the May 25, 1993 foliar application of low-biuert urea compared to the control trees receiving soil-applied nitrogen ($p<0.05$). In the second year of the study, the increase in kg of large-sized fruit for trees receiving a foliar application of urea on May 25, 1993 was at the expense of fruit of size 72, 88, and 113 with no significant effect on total yield.

Trees receiving the May 25, 1993 foliar application of low-biuret urea yielded 10 kg (22 lbs) more fruit of size 56 or larger than the control trees receiving soil-applied nitrogen (Table V). This represents an additional half of a 40-lb carton of larger-sized fruit per tree. At a typical planting density of 96 trees per acre, the May 25, 1993 foliar application of low-biuret urea yielded 53 additional cartons of fruit of packinghouse carton size 56 or larger per acre. Using the same factors used above for the cost/benefit analysis of year one, which does not take in to account that the extra cartons of fruit are 56s, the conservative minimum estimated net return to the grower for the May 25, 1993 foliar application of low-biuret urea was $302 per acre.

Our results demonstrate that a late May (20-25) application of low-biuret urea to the foliage is a cost effective means to N fertilize the 'Washington' orange. The performance of urea in reducing the percentage of fruit scarred by thrips was consistent for two years. While not significant at the 5% level, our results clearly showed that some dates for foliar application of N fertilizer may be more efficacious than others, i. e. late May (20-25; less severe scarring) versus late April (21-27, more scarring). The ability of urea to reduce thrips scarring in light thrips year remains to be determined. The increase in yield of larger-sized fruit (packinghouse carton size 56) observed in both years of the study for the late May (May 20-25) foliar application of low-biuret urea resulted in a net increase in revenue to the grower each year ($740 for 1993; $302 for 1994). Since the grower will most likely fertilize with N some time during the year anyway, foliar application of urea in late May (20-25) would seem to afford many benefits over soil-applied nitrogen.

Table I. Effect of Foliar Applications of Low-Biuret Urea to 'Frost Nucellar' Navel Orange Trees in Ivanhoe, CA, on Fruit Scarring by Citrus Thrips

Urea application date	On-tree outside fruit September 2, 1992					Whole tree harvested fruit March-April 1993					Correlation between on-tree and harvest data			
			% scarred fruit					% scarred fruit						
	no. of trees	no. of fruit	slight (a)	severe (b)	total (c)	no. of trees	no. of fruit	slight (d)	severe (e)	total (f)	(d)/(a)	(e)/(b)	(f)/(c)	
April 7	48	3284	23.3 a[z]	25.4 a	48.7 a	19	20,794	16.6 a	20.7 a	37.2 a	0.71	0.81	0.76	
April 21	48	3543	22.2 a	25.5 a	47.6 a	18	20,993	15.6 a	22.0 a	37.6 a	0.71	0.86	0.79	
May 5	48	3174	24.8 a	24.1 a	48.9 a	18	20,483	15.7 a	20.9 a	36.6 a	0.64	0.87	0.75	
May 20	48	3476	20.9 a	19.8 a	40.7 a	18	20,765	14.9 a	16.1 a	31.0 a	0.71	0.81	0.76	
Control	48	3147	23.5 a	22.2 a	45.7 a	18	19,491	14.7 a	18.9 a	33.7 a	0.63	0.85	0.74	
											Means			Grand Mean
											0.68	0.84	0.76	0.76

[z] Means in a vertical column followed by the same letter are not statistically different at the 5% level.

Table II. Effect of Foliar-Applied Urea on the Predatory Mite, *Euseius tularensis* (hibisci)

Urea application date	Mite release on March 19 (500 mites/tree)	Cumulative number of mites/leaf[z]	
		through May 28	through July 9
April 7	Yes	0.92 b	2.08 a
April 21	Yes	1.23 ab	2.21 a
May 5	Yes	1.11 ab	1.81 a
May 20	Yes	1.59 a	2.41 a
Control	Yes	1.33 ab	2.43 a
Control	No	0.48 c	1.06 b

[z] Data are the mean of analyses of one tree per block x eight blocks, means in a vertical column followed by different letters are statistically different at the 5% level.

Table III. Effect of Spring Foliar Application of Low-Biuret Urea on the Yield of 'Frost Nucellar' Navel Orange.[z]

Urea application date	Pounds of fruit per tree	$P \leq 0.05$	$P \leq 0.10$	Number of fruit per tree of packinghouse carton size 56	$P \leq 0.05$	$P \leq 0.10$
April 7	570	b	b	135	b	b
April 21	601	ab	ab	148	ab	ab
May 5	572	b	b	136	b	b
May 20	639	a	a	166	a	a
Control	585	ab	b	153	ab	b

[z] Data are the means of 48 data trees per treatment. Means in a vertical column followed by a different letter are statistically different at the P value indicated.

Table IV. Effect of Foliar Applications of Low-Biuret to 'Frost Nucellar' Navel Orange Trees in Ivanhoe, CA on Fruit Scarring by Citrus Thrips

		On-tree outside fruit September 1993				Whole tree harvested fruit March-April 1994				
			% scarred fruit					% scarred fruit		
Urea application date	# of trees	# of fruit	slight	severe	total	# of trees	# of fruit	slight	severe	total
April 13	48	4,282	14.02a[z]	12.37a	26.39a	24	18,877	15.95a	11.93a	27.88a
April 27	48	4,945	16.25a	14.50a	30.75a	24	21,175	18.88a	14.03a	32.91a
May 11	48	4,663	13.71a	10.82a	24.53a	24	20,130	15.62a	11.09a	26.72a
May 25	48	4,252	13.67a	10.24a	23.92a	24	18,628	16.21a	9.67a	25.88a
Control	48	4,539	13.71a	11.72a	25.43a	24	21,300	15.96a	11.08a	27.04a

zMeans in a vertical column followed by the same letter are not statistically different at the 5% level.

Table V. Effect of Spring Foliar Application of Low-Biuret Urea on the Yield (Kg) of 'Frost Nucellar' Navel Orange[z]

Urea application date	Kg fruit per tree	Kg fruit of packinghouse carton size >56	56	72	88	113	138
April 13	135a	20ab	45b	41b	10ab	19a	0.6a
April 27	146a	18ab	52ab	47a	11a	17ab	0.6a
May 11	142a	19ab	50ab	43ab	11a	20a	0.7a
May 25	139a	23a	54a	39b	9b	14b	0.4a
Control	143a	17b	50ab	45ab	11a	20a	0.7a

[z]Data are the means of 48 data trees per treatment. Means in a vertical column followed by a different letter are stastically different at P≤0.05.

Table VI. Effect of Spring Foliar Application of Low-Biuret Urea on the Yield (Number of Fruit/Tree) of 'Frost Nucellar' Navel Orange[z]

Urea application date	# of fruit per tree	# of fruit of packinghouse carton size >56	56	72	88	113	138
April 13	1040a	119ab	301b	314b	96ab	205ab	11a
April 27	1111a	108ab	350ab	362a	101a	182ab	9a
May 11	1092a	111ab	326ab	330ab	100a	215ab	11a
May 25	1034a	135a	360a	296b	82b	154b	7a
Control	1107a	102b	334ab	342ab	105a	219a	11a

[z]Data are the means of 48 data trees per treatment. Means in a vertical column followed by a different letter are stastically different at P≤0.05.