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Citrus Growers Can Reduce Nitrate Groundwater Pollution And Increase Profits By Using Foliar Urea Fertilization

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Project Objectives

Our objective is to test the hypothesis that foliar urea applied April 1 to June 1 can do triple duty: 1) as a "non-pesticide" to control citrus thrips and reduce fruit scarring; 2) as a "growth regulator" to improve fruit set and increase yield without reducing fruit size or quality; and 3) 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 results in less potential pesticide pollution of the soil and groundwater.

Project Description

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 the young and mature le aves by 100 to 150 µg per g dry weight leaf tissue, but this increase was only evident for the 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 on the same date or the time-zero leaves collected the day before the foliar urea application.

Results and Conclusions

Total nitrogen content of the leaves increased from 2.5% in September 1991 to 2.9% in September 1992. Thus, a spring application of low-biuret urea appears to contribute to the annual nitrogen requirement of the tree.

In the first year of the study, spring foliar applications of low-biuret urea had no statistically significant effect on the population densities of *Scirtothrips cirti*. The high degree of variability in the number of thrips in each of the replicate samples made it impossible to detect statistically significant differences due to any of the treatments. In the first year of the study, spring foliar applications of low-biuret urea had no statistically significant effect on fruit scarring determined

as either on-tree evaluations of fruit on the outside of the tree on September 2, 1992, or evaluation of total fruit per tree at harvest March-April 1993 (Table 1). While not significant at the 5% level, it is interesting to note that the May 20, 1992 foliar application resulted in the lowest degree of fruit scarring, especially severe scarring. This trend can be seen in both the on-tree and harvest evaluations. The correlation between the on-tree counts and whole tree harvest data are given in Table 1. Note that there is much variability in this correlation. For that reason, the data from all 48 data trees per treatment were subsequently analyzed as follows: whole tree harvest data were used as is, whereas the on-tree outside fruit data were transformed to a whole tree harvest evaluation using the correlation given in Table 1. The transformed data did not yield statistically significant separation between treatments, except in two cases. The May 20, application of low-biuret urea had significantly lower fruit scarring than the May 5 application of low-biuret urea, as determined by the on-tree counts and whole tree harvest data with transformed on-tree counts. Numerically, but not significantly, this trend was consistent. The May 20 application of urea resulted in slightly reduced scarring than the control trees.

Table 1. Effect of Foliar Applications of Low-Biuret Urea to 'Frost Nucellar' Navel Orange Trees in Ivanhoe, CA on Fruit Scarring by Citrus Thrips

	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						
Urea application date	# of trees	# of fruit	slight (a)	severe (b)	total (c)	# of trees	# 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	20,974	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 2. Effect of Foliar-Applied Urea on the Predatory Mite, *Euseius tularensis* (hibisci)

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

[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.

There were no statistically significant correlations at the 5% level between the degree of fruit scarring, *S. citri* population data, and maximum leaf NH_3-NH_4^+ concentrations.
The results of the first year 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). In Table 2, it can be seen that 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, whether or not 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 3. Effect of Spring Foliar Application of Low-Biuret Urea on the Yields of 'Frost Nucellar" Navel Orange[z], 1992

Urea Application Date	Pounds of fruit/tree	P≤0.05	P≥0.10	# of fruit/tree of packinghouse carton size 56	P≤0.05	P≥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	ab	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.

In the first year of the study, 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). The date of foliar urea application had no statistically significant effect on other sizes of fruit (Table 3). The May 20 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 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 application 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, ex cept the April 21 application.

It can be seen in Table 3 that the trees receiving the May 20 foliar application of low-biuret urea yielded 54 lbs more fruit than the control trees receiving soil-applied nitrogen. 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: 1) The May 20 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 56's, 72's, and 88's and subtracted $2.29 per carton for packinghouse handling of the extra cartons (per Connelly Melling; Dole) to calculate profit; 2) 15 gallons low biuret urea per acre at $1.10 per gallon; and 3) 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. Despite this, the net return to the grower for the May 20, 1992 foliar application of low-biuret urea was $740 per acre.
The first year of the study was a very heavy thrips year. Our results suggest that urea will not have much impact in preventing thrips scarring of fruit when thrips pressure is great. The performance of urea in reducing the percentage of fruit scarred by thrips in a light thrips year or in combination with sabadilla treatments remains to be determined. The increase in yield without a reduction in fruit size observed for the May 20 foliar application of low-biuret urea is encouraging, but awaits confirmation by a second and third year field trial. No conclusions can be drawn until this field trial is replicated for at least a second year.

A copy of the latest annual report titled "Citrus Growers Can Reduce Nitrate Groundwater Pollution and Increase Profits: Annual Report " is available from FREP. Please see Section X for ordering information.