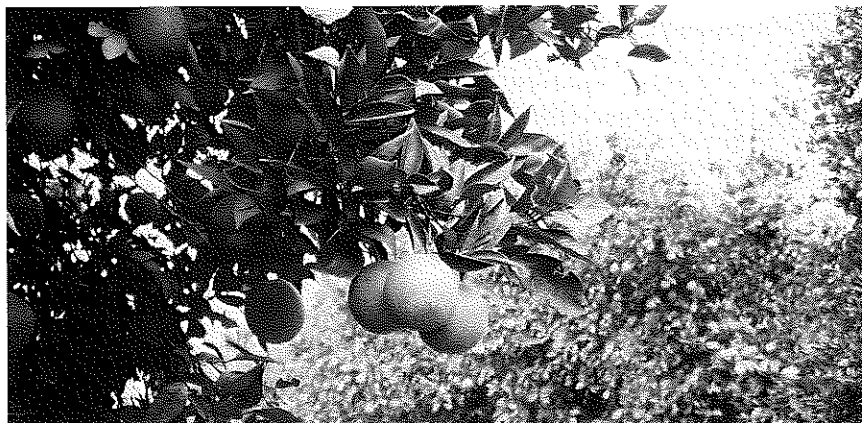


California Farmer®



Amid-winter application of low-biuret urea to citrus foliage can provide up to 30 percent of a tree's nitrogen requirement while increasing yields. Low biuret prevents phytotoxicity.

Leaf Ahead

Citrus growers want to reduce soil applied nitrogen in response to groundwater contamination charges. Foliar fertilization is the answer. But the real payoff is increased yields.

BY LEN RICHARDSON

Citrus growers are facing a dilemma. Charges of groundwater contamination from nitrogenous leaching are forcing them to reduce or eliminate soil applications of nitrogen. But field experience has shown that the three-to-six foliar applications it would take to provide an annual citrus nitrogen rate just aren't cost-effective.

Now, new studies are demonstrating that under certain conditions, not only can foliar applications provide an economical way to provide nitrogen, but they can also boost yields.

The trick is winter (mid-January) foliar application of a low-biuret urea (Unocal Plus was used in the experiments) applied to the foliage at the rate of 28 pounds of nitrogen per acre (0.15 kg N per tree).

Three years of research at UC Riverside shows that such an application can increase yields of navel oranges by one to 2.5 cartons per tree. The research was directed by Anwar G. Ali and Carol J. Lovatt with support from the UC Water Resources Center, by matching

funds from the Citrus Research Board and the Citrus Research Center. Paramount Citrus was a cooperator in the project.

Winter application is crucial because citrus trees flower in response to low temperatures and research has shown that flower number is consistently correlated with the duration of the low temperatures. UC

researchers found that the ammonia content of the leaves increases during the period of low temperatures. Thus, it was reasoned, a winter foliar application of low-biuret urea (LBU) could increase flowering and increased flowering would lead to higher yields.

The emphasis is on low biuret because biuret can be phytotoxic when foliar-applied to sensitive perennial crops like citrus.

Unocal Plus (20-0-0) is formulated to reduce the potential for phytotoxicity from biuret and free ammonia.

Lovatt explains, "To determine whether or not the ammonia accumulating in the leaves of citrus trees subjected to low temperature was physiologically related to floral intensity, five-year-old rooted cuttings of the "Washington" navel orange were subject to short periods of low temperature which do not result in significant flower production. At the end of the treatment period, the ammonia status of the trees was artificially increased with a foliar-application of LBU." As Table 1 indicates, after four weeks of low-temperature treatments, leaf ammonia increased 166 percent and flowering by 194 percent. These

Table 1. Effect of LBU (1.5 g per tree) applied to the foliage of 5-year-old rooted cuttings of the 'Washington' navel orange at the end of the low-temperature treatment.

Weeks of low-temperature treatment at 15-18° C for 8 h/day and 10-13° C for 16 h/night	Increase in leaf ammonia content during the first week after transfer to warm temperature as a percent of the control without urea for each treatment	Increase in flower number as a percent of the control without urea for each treatment
4	166%	194%
6	215%	230%

From: Lovatt *et al.*, 1988a.

numbers jumped to 215 percent and 230 percent following six weeks of treatment.

It is important to note that only the ammonia level of the leaves could be correlated with low temperatures and floral intensity. "There was no correlation between the leaf concentration of total nitrogen or nitrate; the effect on flowering is specifically related to the increased ammonia concentration," Lovatt observes.

In addition, foliar LBU increased the proportion of the total flower population borne on shoots bearing leaves and flowers (leafy inflorescence). For example, when five-year-old rooted cuttings of the "Washington" navel orange induced to flower by six weeks of low-temperature treatment were also given foliar application of LBU, the number of "leafless" inflorescence doubled, but the number of leafy inflorescence increased four-fold. This increased the number of flowers borne on leafy inflorescence from 25 to 40 percent of the total flower population. Furthermore, foliar LBU increased the average number of leaves per inflorescence three-fold. "It is well documented for citrus that leafy inflorescence set more fruit that persist to harvest than 'leafless' inflorescence," says Lovatt.

Ali and Lovatt preceded to confirm these research results under field conditions. Lovatt explains, "We used commercially producing 30-year-old Washington navel orange trees. LBU was foliar-applied at the equivalent of 28 pounds of nitrogen per acre on either Nov. 14, Dec. 14, Jan. 14, or Feb. 14.

All trees also received 110 pounds of nitrogen per acre as LBU applied to the soil each year in either November or December to ensure that adequate nitrogen was available.

For three consecutive years, a winter foliar application in January or February of LBU increased both the fruit weight per tree and the number of fruit per tree. These applications of LBU increased yield by just over one carton (37.5 pounds) per tree in 1989-90, just under one carton per tree in 1990-91 (remember, yields were reduced in the 1990-

91 season due to the freeze in December of 1990), and by 2.5 cartons per tree in 1991-92. January or February applications are preferred because they have consistently increased yields. Smaller and less consistent yield increase resulted from test applications made in November or December.

Lovatt stresses that there was no reduction in fruit size as a result of these yield increases. For 1989-90 and 1990-91, the application LBU had the greatest effect on fruit in carton sizes 88 and 72. There was an additional carton per tree in 1989-90 and an additional half carton per tree in 1990-91.

Nor could the yield increases be traced to the improved nitrogen status of the trees. At the end of the three-year experiment, leaf total nitrogen content of the 1991 spring flush leaves collected in September was not significantly different at the 5 percent level for control trees receiving soil LBU vs. trees receiving foliar LBU. Leaf total nitrogen content was between 2.5 to 2.6 percent. There was no significant correlation between total nitrogen and yield.

So what is the potential bottom line? The researchers conducted a cost-benefit analysis using these values:

- The 1989-90 average price of \$3.20 per carton.
- An average cost of 15 gallons of LBU (Unocal Plus) per acre.
- Spray rig at \$25 per acre for the highest cost of application;

• An airplane at \$10 per acre as the lowest cost of application to give a lower and upper end of the range reported as net return.

The three year cumulative increased net return for winter application was between \$1,341 and \$1,372. It adds up to an average increase per acre in net dollars of \$447 to \$457 (see Table 2). Who would turn that down these days?

The researchers emphasize that their analysis underestimates total and net return because it does not take into account the increased fruit in carton sizes 72 and 88, which have a higher dollar value.

In conclusion, the researchers say such foliar applications will allow citrus growers to become proactive regarding charges the industry is contributing to nitrate contamination of groundwater. By using low-biuret urea (LBU) as a nitrogen source and shifting one application to winter you can provide 15 percent to 30 percent of annual nitrogen requirements while increasing yields and economic returns. That adds up to a profitable trade-off.

And there may be more good news ahead. The UC researchers are testing the idea that foliar urea applied during a spring window (April 1 to May 15) could act as a non-pesticide control for thrips and to reduce fruit scarring in addition to "growth regulator" and fertilizer advantages. Results won't be available for another month or so, but Lovatt says there has been no negative impact on beneficial predator mites. Stand by. □

Table 2. Three-year net cumulative increase in packing cartons and in total and net dollar return per acre for trees receiving foliar LBU vs. soil LBU.

	Month LBU applied to the foliage			
	November	December	January	February
Packing cartons	288	319	452	400
Total return	\$924	\$1,024	\$1,451	\$1,284
Net return	\$814-845	\$914-945	\$1,341-1,372	\$1,174-1,205
Average net dollar return per acre per year for trees receiving foliar LBU vs. soil LBU.				
	\$271-282	\$305-315	\$447-457	\$391-402