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What about Foliar NPK On Citrus?

Florida researchers are finding that these sprays at bloom and post-bloom enhance fruit set and yields.

Summary: *Urea applied as a foliar is a very efficient source of N for citrus growth. Leaf age is of little consequence to good uptake. The biuret levels in urea should be less than 0.8 percent and, if applications are repeated, biuret contamination should be less than 0.4 percent. Potassium uptake is less efficient than urea, but in young leaves uptake was still good, particularly in K deficient plants. Phosphorus uptake was much less compared to K or urea uptake, but a P spray raised leaf P the same percentage as an equal spray of K raised leaf K. Little uptake of P and K by leaves with high levels of these elements occurred. Further work on the effect of different rates of NPK, timing of these sprays, and spraying without P is planned for the coming years. Field experience still indicates that sprays of N and K at bloom and post-bloom enhance fruit set and yields.*

Earlier work in California (Ali and Lovatt, 1988) and in Florida (Albrigo, 1999) found that winter urea sprays enhanced flowering and fruit yields. Bloom and post-bloom sprays of N as urea with P and K sources increased fruit set in Florida (Albrigo, 1997). These results led to several questions about best sources of these nutrients for citrus foliar applications.

Year one

During the first year of this project supported by the FFF, emphasis was placed on citrus leaf reaction to biuret levels as urea was applied to old and young citrus leaves. Biuret levels of 0.2, 0.5, 0.8, and 1.05 percent were used with applications of 10, 20, or 30 lbs/A of N as urea. At least 0.5 percent biuret was necessary to cause leaf tip yellowing and only the two higher rates/A of N with 5 percent biuret resulted in an average 5 percent of leaf area with a light yellowing. At 0.8 percent biuret, the same level of injury occurred at the 10-lb/A N rate in half the treatments and at the 30-lb/A rate about 10 percent of the leaf surface showed a moderate yellowing in half the treatment leaves. With the 1.05 percent level of biuret, all three N levels developed some tip yellowing (biuret symptoms). The leaf area affected was still in the 5 to 10 percent range but the yellowing was more pronounced as the biuret level increased. The leaf yellowing appears to persist indefinitely without recovery of chlorophyll.

A second goal was to evaluate sources of P for foliar uptake. Three products—ammonium polyphosphate (APP), mono-potassium phosphate (MKP), and a PK humate (PKH)—were evaluated at two rates, with and without urea as a booster. Applications on limb units were equivalent to 5 or 10 lbs/A of P, with or without urea at 5 lbs/A of N. APP increased P levels about 10 percent in young leaves three days after applications with the 10-lb/A rate. If urea was added, the increase was the same at either the 5- or 10-lb/A rate. Levels of P in young leaves were not different from the controls six days after treatment, suggesting that redistribution to other plant parts may have taken place.

Leaf K level increases for mature leaves were inconsistent after application of K-containing products. Some treatments caused increases of up to 17 percent. These tests suggested that better methodology was needed to detect any foliar uptake of P and K. Major problems appeared to be movement of nutrients away from sprayed limb units, and leaf to leaf variation in original nutrient level from one shoot to another. These problems led to 1) reduced values for detecting increases the longer time went by before subsequent sampling and 2) variability because the same shoots and leaf position were not sampled each time.

Year two

In year two, these problems were partially controlled by spraying whole trees to minimize nutrient loss from treated leaves to nearby areas of lower nutrient levels, by using adjacent leaves for sequential sampling, and by doing follow-up sampling within 3 to 6 days of application, before applied nutrients could be translocated from treated leaves. Using these techniques and repeating the APP and MKP applications, we determined that both sources were equal for P and K uptake three to six days after application. Young leaf nutrient uptake values increased 60 to 100 percent when trees were in the deficient nutrient range (0.6 percent P and 0.59 percent K). Old leaves did not take up P well even if deficient (11 percent increase), but K uptake was still high (135 to 254 percent increase). In less deficient leaves (P and K, 0.12 and 1.20 percent, respectively), uptake was more modest with P increasing 15 to 22 percent in young leaves and 10 to 13 percent in older leaves (more than five months old). K increases were only 5 to 10 percent when leaf K values were 1.2 percent before spraying. Uptake of P was only one-eighth to one-tenth that of K uptake or proportional to the internal leaf levels of the elements (.14 percent P versus 1.4 percent K recommended for citrus). But this smaller uptake raised P in the leaves as much, proportionately, as did the K uptake. Uptake needs to be evaluated for possible beneficial effect on plant yield and other responses.

Year three

The third year studies were commercial field tests to see if various NPK sprays, when applied by commercial sprayer, resulted in increased leaf N, P, and K levels and increased yields if applied at bloom and post-bloom. Moreover, the relative effects of APP versus MKP were evaluated further. Urea biuret levels of 0.4 and 0.8 percent were compared to see if severe toxicity symptoms occurred when the 0.8 percent biuret level was used twice per season.

A mature Valencia block was selected in Central Florida on a deep sandy soil, and plots were single rows (0.9 acres) replicated four times. Urea was applied at 14 lbs/A of N with either 0.4 or 0.8 percent biuret. P was supplied as either APP or MKP at 7 lbs P_2O_5/A. K at 7 lbs K_2O/A was either in the nitrate form applied with APP or part of the MKP form. Sprays were applied at 5 percent open flowers and again five weeks later. Leaf samples for mineral analysis were taken from 20 tagged shoots at three locations before spraying in each plot, and five days after application. The center leaf of each of the 20 shoots was selected before spraying, and an adjacent leaf to this position was selected five days later. This sampling procedure was used each spray time. An additional sample was take 180 days after the last spray.

Results

Leaf values of N, P, and K were not different between treatment plots at the beginning of the experiment. Five days after the first treatment, leaf N was higher in the treatments receiving APP and K nitrate, along with either the 0.4 or 0.8 percent biuret urea (Table 1). No difference was detected in P or K levels after this first spray (Tables 2 and 3, respectively). Five weeks later, before the second spray, the two treatments using APP were different in N (0.8 percent biuret urea + APP was highest and 0.4 percent + APP was lowest). The leaf K level of trees receiving the APP and urea with 0.8 percent biuret was higher at this time. Five days after the second spray, all treatments had higher N levels than the non-sprayed, but P and K levels were not different between treatments.

No significant changes in P occurred after either spray, but the natural decline

Table 1. Leaf nitrogen levels at various times of sampling before or after sprays of 14-7-7 lbs/A on Valencia oranges.

Treatment	% nitrogen				
	Pre-spray1	Spray+ 5 days	Pre-spray2	Spray2 +5 days	Spray2+ 180 days
Control	3.43	3.32	3.19	3.23	2.71
Urea 0.4% with APP	3.59	3.57	2.97	3.39	2.83
Urea 0.8% with APP	3.49	3.55	3.42	3.40	2.91
Urea 0.4% with MKP	3.51	3.50	3.17	3.45	2.75
Urea 0.8% with MKP	3.42	3.45	3.26	3.43	2.69

Table 2. Leaf phosphorus levels at various times of sampling before or after sprays of 14-7-7 lbs/A on Valencia oranges.

Treatment	% phosphorus				
	Pre-spray1	Spray+ 5 days	Pre-spray2	Spray2 +5 days	Spray2+ 180 days
Control	0.26	0.23	0.43	0.20	0.17
Urea 0.4% with APP	0.28	0.25	0.19	0.20	0.17
Urea 0.8% with APP	0.28	0.24	0.21	0.20	0.18
Urea 0.4% with MKP	0.27	0.24	0.18	0.20	0.17
Urea 0.8% with MKP	0.26	0.24	0.19	0.20	0.17

in leaf P was numerically less than the control after the second spray. K levels were increased after the first spray while the control decreased over the five-day period. None of these changes was significant from one another. The K level of leaves of the treatment receiving MKP with 0.4 percent biuret urea was significantly higher after the second spray, but the K level of the 0.8 percent biuret urea with APP treatment leaves was significantly lower.

By fall, the two sprays using urea with 0.8 percent biuret resulted in tip leaf yellowing toxicity symptoms in about 5 percent of the leaves. This injury level should not alter tree growth or yields, but possible effects will be evaluated in subsequent years.

Another approach to evaluation of the data is to look at the difference between the leaf nutrient values just before spraying and the values five days after spraying (Table 4). After the first spray at bloom time, there was no significant rise of leaf N, but the natural decline with leaf age was numerically reduced. There was a significant increase in leaf N after the second spray for one of the 0.4 percent biuret urea sources. Three of the four treatments with urea were positive numerically.

Table 3. Leaf potassium levels at various times of sampling before or after sprays of 14-7-7 lbs/A on Valencia oranges.

Treatment	Pre-spray1	Spray+ 5 days	Pre-spray2	Spray2+ 5 days	Spray2+ 180 days
	———	———	% potassium	———	———
Control	2.13	2.33	2.02	1.98	1.39
Urea 0.4% with APP	2.21	2.42	2.01	2.02	1.43
Urea 0.8% with APP	2.17	2.35	2.33	2.09	1.46
Urea 0.4% with MKP	2.22	2.41	2.00	2.09	1.36
Urea 0.8% with MKP	2.04	2.30	1.93	1.89	1.36

Table 4. Difference in leaf nutrient values five days after spraying an NPK combination and the values just before spraying. Two spray cycles are represented (a bloom and a post-bloom spray).

Treatment	Leaf N % Spray1 +5 days pre-spray	Leaf N % Spray2 +5 days pre-spray	Leaf P % Spray1 +5 days pre-spray	Leaf P % Spray2 +5 days pre-spray	Leaf K % Spray1 +5 days pre-spray	Leaf K % Spray2 +5 days pre-spray
Control	-0.15	+0.04	-0.03	-0.23	-0.16	-0.04
Urea 0.4% with APP	-0.02	+0.42	-0.03	+0.01	+0.20	+0.01
Urea 0.8% with APP	+0.05	-0.02	-0.04	-0.01	+0.19	-0.23
Urea 0.4% with MKP	-0.01	+0.28	-0.03	+0.01	+0.20	+0.10
Urea 0.8% with MKP	-0.01	+0.17	-0.03	+0.01	+0.18	-0.06

These data do not indicate a strong response of either source of P and K on increasing leaf nutrient levels when leaf nutrient levels were already high. This is contrary to earlier work, but these trees had luxuriant levels of N, P, and K before treatments started (.26 to .28 P versus 0.6 to 0.9 percent P in the previous year's studies, and 2.04 to 2.22 K versus .59 to 1.2 percent K in the previous year's studies). These third-year data further support the earlier observations that nutrient uptake from foliar applications is less if the pretreatment nutrient levels are higher.

A spring foliar N, P, K spray appears to be a good, quick method to get these nutrients into the leaf tissues, particularly if leaf values are below optimum levels. Growth and yield responses from foliar nutrient sprays in the spring have been demonstrated, but if tissue values are above optimum, there may be little uptake and benefits may be small. Further work on this aspect is still required.

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