Foliar applications of Lo-Biuret Urea and Potassium Phosphite to Navel Orange trees

Glenn C. Wright and Marco Peña[1]

Abstract

This experiment was established in January 2000 in a block of 'Washington' navel orange trees at Verde Growers, Stanfield, AZ. Treatments included: normal grower practice, winter low biuret (LB) urea application, summer LB urea application, winter LB urea application plus winter and spring potassium phosphite, winter LB urea application plus summer potassium phosphite, and normal grower practice plus spring potassium phosphite. Each treatment was applied to approximately four acres of trees. For 2000-01, yields ranged from 40 to 45 lbs. per tree, and there was no effect of treatments upon total yield, and only slight effect upon fruit size, grade and quality. For 2001-02, there was a slight effect of treatment upon yield as LB urea led to improved yield, while potassium phosphite led to reduced yield. Normal grower practice was intermediate between these two extremes. For 2002-03, we noted a large increase in yield, however the yield data was lost when the block was inadvertently harvested. For 2005, there was no effect of treatments upon total yield.

Introduction

Arizona citrus growers face increasing economic and political pressure to adapt best management practices for nitrogen fertilization. Foliar N fertilization offers an opportunity to apply a significant portion of the total tree N needs in a more efficient manner than traditional flood or ground applications.

Navel oranges typically do not bear in great abundance in the desert. Water stress during fruit set, and/or high temperatures during bloom or fruit set can cause yield reductions.[2] Recent research by Lovatt suggests that pre-harvest applications of foliar urea and potassium phosphite can increase yield and fruit set on 'Washington' navel oranges in the San Joaquin Valley[3]

Although relatively uncommon in Arizona, foliar macronutrient application to citrus is an increasingly common practice in California citrus groves. Research by Jones and Parker found that foliar urea application was a practical

[1] The authors would like to than the Arizona Citrus Research Council for ongoing financial support necessary to complete this study. This is the final report for Project 2004-07 "Foliar applications of Lo-Biuret Urea and Potassium Phosphite to Navel Orange trees".

[2] Davies, F.S. 1986. The Navel orange. In: Janick, J. (ed.) Horticultural Reviews. AVI Publishing, Co., Westport, CT Pp. 79-99.

[3] Lovatt, C.J. 1998. Managing yield with foliar fertilization. Calif. Citrograph 84:1.

method of applying N as early as 1949[4]. Foliar N fertilization did not find widespread commercial acceptance because of the fact that a minimum of three applications per year would be needed to supply the tree's N requirements. However, Sharples and Hilgeman[5] suggested that a single application of urea applied to 'Valencia' orange foliage at the phenologically appropriate time might improve yield in Arizona trees. This idea was tested further by Ali and Lovatt, who found that a single application of urea in either mid-January or mid-February led to significantly improved navel orange yields compared to the untreated control. Winter pre-bloom foliar applications of urea have been universally adapted in South Africa, and are being tested by Dr. Gene Albrigo in Florida. Lovatt has also found that a July application of urea led to improved fruit size in navels. We have not yet tested either of these practices in Arizona.

Another compound that is of recent interest because of the work of Lovatt is potassium phosphite, known commercially as Nutri-Phite (Biagro Western Sales, Inc., Visalia, CA). In the navel orange study mentioned above, applications of potassium phosphite in May and July led to improved fruit number and fruit size. Research by Dr. Albrigo at the University of Florida suggests that applications of the material lead to improved fruit number, although there is no indication that the results are significant. Subsequent research reported by Dr. Albrigo at the recent Florida State Horticulture Society meeting suggests that application of potassium phosphite sprays in the winter and spring led to a significant yield increase of 18%. There was no increase in flowering or fruitlet number. This work has not yet been replicated under Arizona conditions.

Therefore, with this information in mind, we proposed to apply foliar applications of urea and potassium phosphite to reduce the need for soil applied N on navel oranges while maintaining appropriate leaf N concentration, and to improve fruit yield and fruit size.

Materials and Methods

This project was initiated in the 'Washington' navel orange groves of Verde Growers, Stanfield, AZ. All the trees were on Carrizo rootstock. Treatment units are double rows of trees, 86 to 97 trees total, approximately 1 acre each. There are four replications, and the experimental design is randomized complete block. The following treatments were initiated:

1. **Normal grower practice** – Foliar LB urea applications in March and September at a rate of 7 lb. N per acre. 120 units of N applied as UN 32-0-0 or Calcium Ammonium Nitrate in three split applications, mid to late January, April and September. Potassium sulfate applied in mid January and micronutrients applied in the spring as needed.

2. **Winter LB urea application** - Foliar LB urea applications in January at 28 lb. N per acre and in September at a rate of 7 lb. N per acre. 120 units of N applied as UN 32-0-0 or Calcium Ammonium Nitrate in three split applications, mid to late January, April and September. Potassium sulfate applied in mid January and micronutrients applied in the spring as needed. Winter LB urea was applied on 2-2-00 and 1-24-01, and again in 2-11-02.

3. **Summer LB urea application** - Foliar LB urea applications in March at 7 lb. N per acre and in July at a rate of 28 lb. N per acre. 120 units of N applied as UN 32-0-0 or Calcium Ammonium Nitrate in three split applications, mid to late January, April and September. Potassium sulfate applied in mid January and micronutrients applied in the spring as needed. Summer LB urea applications occurred on 7-14-00 and 7-18-01, and again on 7-31-02.

4. **Winter LB urea application plus spring potassium phosphite** - Foliar LB urea applications in January at 28 lb. N per acre and in September at a rate of 7 lb. N per acre. 120 units of N applied as UN 32-0-0 or Calcium Ammonium Nitrate in three split applications, mid to late January, April and September.

---

[4] Jones, W.W. and E.R. Parker. 1949. Application of urea to foliage of orange trees. Calif. Citrograph 34:463.
[5] Sharples, G.C. and R.H. Hilgeman. 1969. Influence of differential nitrogen fertilization on production, trunk growth, fruit size, quality and foliage composition of 'Valencia' orange trees in central Arizona. Proc. First Intl. Citrus Symposium 3: 1569-1578.

Potassium phosphite applied six weeks after bloom at a rate of 4 pts. Nutriphite per acre. Micronutrients applied in the spring as needed. Winter LB urea was applied on 2-2-00, 1-24-01 and 2-11-02. The spring application of potassium phosphite was not applied in 2000, because we were unable to get the product. For 2001, potassium phosphite was applied on 5-24-01. For 2002, the application was 5-14-02.

5. **Winter LB urea application plus summer potassium phosphite** - Foliar LB urea applications in January at 28 lb. N per acre and in September at a rate of 7 lb. N per acre. 120 units of N applied as UN 32-0-0 or Calcium Ammonium Nitrate in three split applications, mid to late January, April and September. Potassium phosphite applied in May and again in July at a rate of 4 pts Nutriphite per acre. Micronutrients applied in the spring as needed. Winter LB urea was applied on 2-2-00, 1-24-01 and 2-11-02, and summer potassium phosphite on 7-14-00, on 7-18-01 and on 7-31-02.
6. **Normal grower practice plus spring potassium phosphite** - Foliar LB urea applications in March and September at a rate of 7 lb. N per acre. 120 units of N applied as UN 32-0-0 or Calcium Ammonium Nitrate in three split applications, mid to late January, April and September. Potassium phosphite applied at bloom and again six weeks later at a rate of 4 pts Nutriphite per acre. Micronutrients applied in the spring as needed. The spring application of potassium phosphite was not applied in 2000, because we were unable to get the product. For 2001, potassium phosphite was applied on 5-24-01. For 2002, the application was on 5-14-02.

All treatments were applied with a commercial air-blast sprayer during the day. All treatments were applied in 150 gallons of water per acre. In 2002, leaf samples for N and P analysis were collected. (See Figure 1). Trees were harvested at the appropriate time, and yield and packout data was collected. Fruit samples were collected for fruit quality analysis.

For 2002, we noted a large increase in yield, yet the block was mistakenly harvested without our knowledge, and thus the yield data was lost.

For 2005, part of the block was inadvertently harvested again, but we were able to collect yield data, but not packout.

Results and Discussion

For 2000-01, there was no effect of the fertilizer treatments upon total yield (Table 1), all treatments led to yields between 40.0 and 47.0 lbs. per tree. There was also no effect of the treatments on fruit sizes 40 to 72. LB urea treatments led to significantly fewer fruit of size 88, compared with normal grower practice, however these differences were slight. There was no effect of treatment on fruit smaller than size 88. Summer LB urea treatments also led to slightly more choice grade fruit as compared to other treatments, but this difference was less than 2%. There was virtually no effect of treatment upon packout.

Treatment had virtually no effect upon percent juice, pH, peel thickness or total soluble solids of fruit harvested in 2000-01 (Table 2).

For the 2001-02 harvest season, total yield was reduced by about 60% compared to 2000-01, but there were some significant differences in total fruit yield and fruit size (Table 3). Winter and summer LB urea applications led to the greatest total yield, about 18% greater than control, yet not statistically significant due to variability within the field. Trees treated with spring potassium phosphite had a 60% yield drop compared to the LB urea treatments, and had a 52% drop compared to normal grower practice. Both LB urea potassium phosphite combination treatments had intermediate yields, not significantly different than the normal grower practice.

Treatments had no effect upon fruit size except in the size 48 and 72 categories. For size 48, spring potassium phosphite treatments had significantly more fruit than did the combination treatment of winter LB urea and spring potassium phosphite. More fruit in this comparatively large size category may be a result of the lower yield of these trees. For size 72, the winter LB urea and spring potassium phosphite led to significantly more

fruit in this category than did winter LB urea applications alone. As in 2000-01, there was no effect of treatment upon packout.

There was very little effect of treatment upon fruit quality in 2001-02 (Table 4). Spring potassium phosphite application in combination with winter LB urea resulted in fruit with greater total soluble solids concentration than a summer potassium phosphite application and winter LB urea. Considering only these two treatments, there was no difference in total acids or in solid to acid ratio.

Leaf sampling fro 2001-02 shows little difference in leaf N or P concentrations due to treatments (Figure 1).

For 2005, although there were differences in yield, we saw no significant effects of the treatment, because of high variability within the block.

Conclusions

It has been somewhat surprising that after 3 years of data, there has been little significant effect of treatment upon any of the parameters measured, except for yield in 2001-02. This work suggests that application of LB urea and potassium phosphite has very little effect upon yield of navel oranges in the desert.

Table 1. Effect of foliar low biuret urea and potassium phosphite application regimes on 2000-01 yield, fruit size and packout of 'Washington' navel orange trees.

		Fruit Size (%)								Packout		
	Yield (lb./tree)	**40**	**48**	**56**	**72**	**88**	**113**	**138**	**163**	**Fancy**	**Choice**	**Juice**
Normal grower practice	45.7 a	12.5 a	16.4 a	15.6 a	28.7 a	15.7 a	8.3 a	1.3 a	1.6 a	97.8 b	2.2 a	0.0 a
Winter LB urea	44.3 a	12.4 a	18.4 a	15.0 a	28.3 a	12.8 bc	8.4 a	1.5 a	3.1 a	99.7 a	0.2 b	0.1 a
Summer LB urea	46.2 a	12.6 a	17.9 a	17.1 a	26.9 a	11.9 c	8.3 a	2.0 a	2.7 a	98.0 b	1.9 a	0.1 a
Winter LB urea plus spring potassium phosphite	43.3 a	10.1 a	16.6 a	16.0 a	30.2 a	14.8 ab	8.4 a	2.0 a	1.9 a	99.7 a	0.2 b	0.1 a
Winter LB urea plus summer potassium phosphite	42.6 a	11.6 a	16.9 a	14.6 a	28.6 a	14.0 abc	9.7 a	2.3 a	2.2 a	99.7 a	0.3 b	0.0 a
Normal grower practice plus spring potassium phosphite	40.4 a	12.9 a	18.5 a	13.9 a	27.6 a	14.2 abc	9.0 a	1.7 a	2.2 a	99.7 a	0.2 b	0.1 a

[z]Means separation within columns by the Waller-Duncan t test, with a Type I to Type II error ratio of 75%.

Table 2. Effect of foliar low biuret urea and potassium phosphite application regimes on fruit quality of 'Washington' navel orange trees harvested in the 2000-01 season.

	Percent Juice	Total Soluble Solids	Total Acids	TSS:TA	pH	Peel Thickness
Normal grower practice	41.4 a	10.9 a	0.65 ab	17.0 a	3.89 a	5.7 a
Winter LB urea	38.6 a	11.1 a	0.63 ab	17.7 a	3.92 a	6.3 a
Summer LB urea	36.6 a	10.6 a	0.59 b	17.8 a	4.06 a	6.2 a
Winter LB urea plus spring potassium phosphite	38.6 a	10.6 a	0.62 ab	17.2 a	3.87 a	5.7 a
Winter LB urea plus summer potassium phosphite	39.4 a	11.0 a	0.62 ab	17.9 a	3.87 a	5.6 a
Normal grower practice plus spring potassium phosphite	39.3 a	11.7 a	0.68 a	17.2 a	3.95 a	5.5 a

[z]Means separation within columns by the Waller-Duncan t test, with a Type I to Type II error ratio of 75%.

Table 3. Effect of foliar low biuret urea and potassium phosphite application regimes on 2001-02 yield, fruit size and packout of 'Washington' navel orange trees.

		Fruit Size (%)									Packout		
	Yield (lb/tree)	**36**	**40**	**48**	**56**	**72**	**88**	**113**	**138**	**163**	**Fancy**	**Choice**	**Juice**
Normal grower practice	14.5 ab	16.0 a	11.2 a	19.9 ab	28.2 a	18.6 ab	5.0 a	0.9 a	0.2 ab	0.1 a	92.4 a	3.7 a	3.9 a
Winter LB urea	17.1 a	20.8 a	10.6 a	23.4 ab	27.0 a	12.7 b	4.4 a	1.0 a	0.1 b	0.0 a	87.7 a	5.1 a	7.2 a
Summer LB urea	17.1 a	20.1 a	10.4 a	21.6 ab	27.5 a	14.0 ab	4.9 a	1.2 a	0.4 a	0.0 a	89.8 a	4.4 a	5.8 a
Winter LB urea plus spring potassium phosphite	11.2 ab	14.0 a	9.1 a	18.4 b	32.2 a	19.5 a	5.9 a	0.6 a	0.1 b	0.1 a	90.9 a	4.8 a	4.3 a
Winter LB urea plus summer potassium phosphite	12.4 ab	22.0 a	11.6 a	19.2 ab	29.2 a	12.4 b	4.2 a	1.0 a	0.2 ab	0.0 a	90.9 a	4.0 a	5.1 a
Normal grower practice plus spring potassium phosphite	6.9 b	20.2 a	10.5 a	24.3 a	26.1 a	14.3 ab	4.0 a	0.5 a	0.0 b	0.1 a	89.6 a	4.1 a	6.3 a

[z]Means separation within columns by the Waller-Duncan t test, with a Type I to Type II error ratio of 75%.

Table 4. Effect of foliar low biuret urea and potassium phosphite application regimes on fruit quality of 'Washington' navel orange trees harvested in the 2001-02 season.

	Percent Juice	Total Soluble Solids (%)	Total Acids (%)	TSS:TA	pH	Peel Thickness (mm)
Normal grower practice	30.0 a	11.3 ab	0.62 a	18.3 a	4.06 a	6.6 a
Winter LB urea	28.8 a	11.2 ab	0.57 a	20.0 a	4.02 a	5.7 b
Summer LB urea	30.8 a	11.2 ab	0.63 a	18.0 a	3.91 a	7.0 a
Winter LB urea plus spring potassium phosphite	30.8 a	11.5 a	0.59 a	19.6 a	4.16 a	6.6 a
Winter LB urea plus summer potassium phosphite	30.3 a	10.9 b	0.55 a	20.1 a	4.17 a	6.5 a
Normal grower practice plus spring potassium phosphite	28.8 a	11.0 ab	0.56 a	19.9 a	4.18 a	6.6 a

[z]Means separation within columns by the Waller-Duncan t test, with a Type I to Type II error ratio of 75%.

Table 5. Effect of foliar low biuret urea and potassium phosphite application regimes on 2005 yield of 'Washington' navel orange trees.

	Yield (lb/tree)
Normal grower practice	77.6 a
Winter LB urea	96.9 a
Summer LB urea	112.08 a
Winter LB urea plus spring potassium phosphite	81.25 a
Winter LB urea plus summer potassium phosphite	84.9 a
Normal grower practice plus spring potassium phosphite	89.1 a

[z]Means separation within columns by the Waller-Duncan t test, with a Type I to Type II error ratio of 75%.
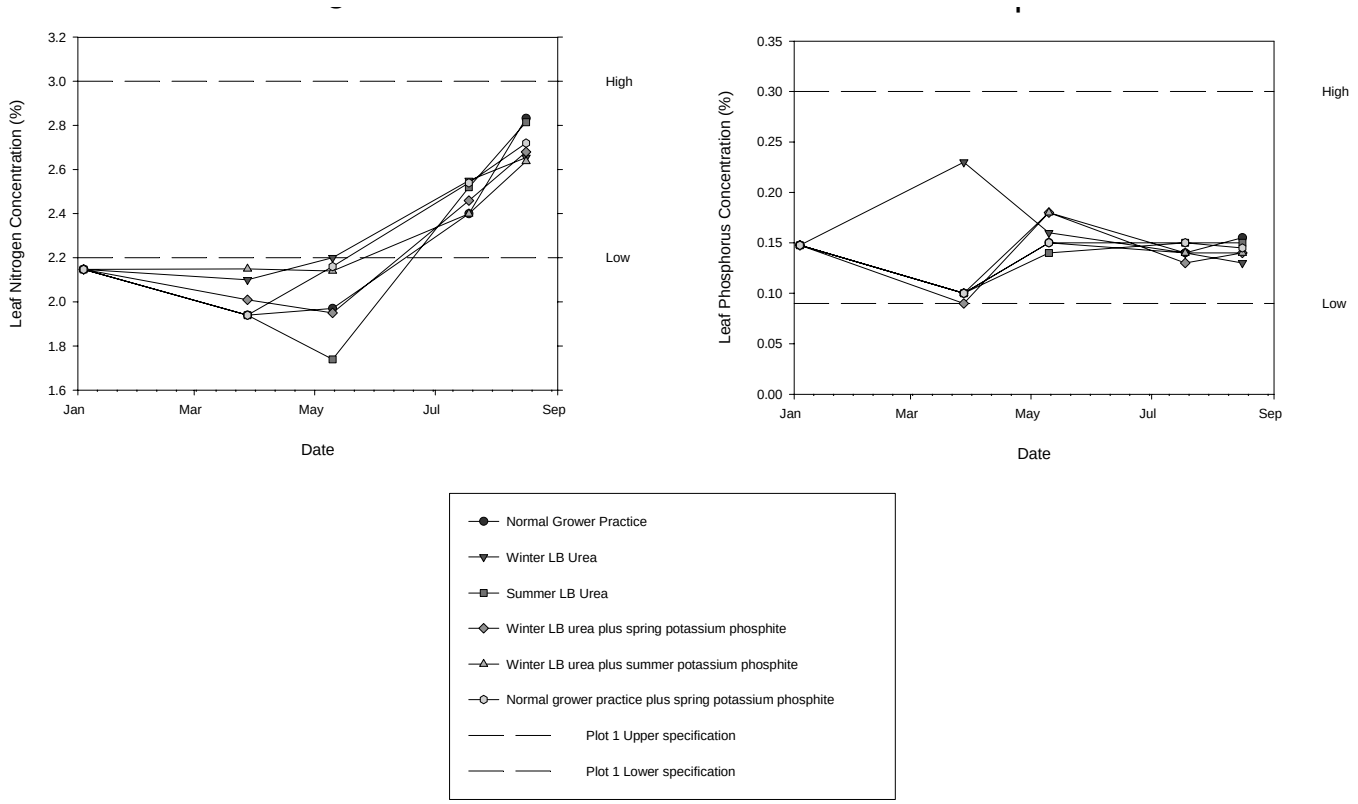
Figure 1. Leaf nitrogen and phosphorus concentrations of trees treated with foliar LB urea and potassium phosphite.