

Irrigation, Nutrition, and Citrus Fruit Quality¹

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Introduction

This publication targets agricultural and horticultural producers, homeowners, Extension agents, industry or governmental staff, land managers, other professionals, youth and interested citizens.

Florida has the highest citrus fruit quality standards in the world. The most important quality factors for Florida citrus growers, production managers, processors, and packers include fruit juice content, soluble solids and acid concentrations, soluble solids-acid ratio, fruit size, and color. Florida citrus growers discern between quality factors for the fresh and processing markets. For example, fruit size, shape, color, and maturity date are most important for fresh fruit, but high juice content and soluble solids are desired for processing fruit. However, in the case of fresh fruit, emphasis must be made on the importance of internal quality as well in order to ensure returning customers and market fidelization. Fruit quality is affected by several factors, including cultivar, rootstock, climate, soil, pests, irrigation, and nutrition.

The effects of irrigation and nutrition on fruit quality are important and should be understood and taken into consideration by citrus growers and production managers to increase profitability and enhance sustainability and worldwide competitiveness. It is interesting to note that preharvest conditions in the grove will have an effect during postharvest in terms of quality, and that these effects may

only be noticed after several weeks, when the fruit is already at the final destination. In general, excessive irrigation and fertilization reduce fruit quality. Therefore, supplying sufficient nutrition and using sound irrigation scheduling techniques should be high-priority management practices for every grower. Citrus trees require a properly designed, operated, and maintained water management system and a balanced nutrition program formulated to provide specific needs for maintenance and for expected yield and fruit quality.

Irrigation contributes to the efficiency of fertilizer programs. Citrus trees with sufficient water and nutrients grow stronger, better tolerate pests and stresses, yield more consistently, and produce good quality fruit. On the other hand, excessive or deficient irrigation or fertilization may result in poor fruit quality. In general, fertigation programs should take into consideration the need of minimizing environmental stresses, especially closer to the harvesting window.

The most important management practices influencing fruit quality are irrigation and nitrogen, phosphorus, potassium, and magnesium nutrition. Some micronutrients like boron and copper can also affect fruit quality, but only if they are deficient in the tree. In general, when any nutrient element is severely deficient, fruit yield and fruit quality will be negatively affected.

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Effects of Specific Elements

Trends in fruit quality response to increasing nutrient and water availability are described and summarized below:

Nitrogen (N)

- Increases juice content and color, total soluble solids (TSS), and acid concentration.
- Increases TSS per box and per acre. However, excessive N, particularly with inadequate irrigation, can result in lower yields with lower TSS per acre.
- Decreases fruit size and weight.
- Increases peel thickness and green fruit at harvest.
- Increases incidence of creasing and scab but decreases incidence of peel blemishes like wind scar, mite russetting, and rind plugging.
- Reduces stem-end rot incidence and green mold of fruit in storage.
- On the other hand, an excess of N produces thicker peel and albedo gets separated from the carpelar segments of the fruit, leading to puffiness. The fruit becomes more misshapen and prone to deformation and wounds, making them more susceptible to infection. This is more common in mandarin; hence, these fruit should be packed carefully without overcrowding the crates.

Phosphorus (P)

- Reduces acid concentration, which increases TSS-acid ratio. Phosphorus rates have no effect on TSS per box but may increase TSS per acre due to increase in fruit production in soils that are low in plant-available P.
- Increases number of green fruit but reduces peel thickness.
- Increases expression of wind scar but reduces that of russeted fruit.
- P deficiency may result in lower yield per tree, thicker albedo, and open central axis.

Potassium (K)

- Potassium produces mostly negative effects on juice quality except for TSS per acre. Potassium increases fruit production, therefore producing more TSS per acre.
- Decreases juice content, TSS, TSS-acid ratio, and juice color.
- Increases acid content.
- Increases fruit size, weight, green fruit, and peel thickness.

- Reduces incidence of creasing and fruit plugging. In storage, reduces stem-end rot.
- On the other hand, K deficiency may induce smaller but better-colored fruit and thin skin. It has been related to the alteration known as creasing, with weaker albedo that gets less dense, resulting in long depressions in the peel. This alteration appears in the fruit still on the tree.

Magnesium (Mg)

- Slightly increases TSS per box and per acre, and TSS-acid ratio.
- Slightly increases fruit size and weight, but decreases rind thickness.

Irrigation

- Increases juice content and TSS-acid ratio.
- Reduces TSS and acid concentration. TSS per box decreases, but TSS per acre may increase due to yield increase.
- Increases fruit size and weight, increases green fruit at harvest but decreases rind thickness.
- Increases incidence of blemish from wind scar, scab and *Alternaria* brown spot, but reduces rind plugging.
- Reduces stem-end rot incidence but increases incidence of green mold in storage.
- An excess of irrigation, especially in periods of higher rainfall, may result in an excess of peel breakdown. In some varieties, like sugarbelle, this may have special incidence at the end of the fruit developing phase prior to change in color (August–September) in which rainfall is abundant, especially in Florida.

Summary

Specific effects on juice and external fruit qualities are summarized in Table 1. This summary is based on numerous field experiments conducted over many years that evaluated the response of oranges to irrigation and fertilization practices. Most of these effects were consistently observed, but some of them appeared to depend on local conditions and growing regions. These observations are useful in developing a strategy to improve fruit quality for a particular variety or location.

For more information on nutrition and irrigation effects on citrus, see http://edis.ifas.ufl.edu/TOPIC_Citrus_Nutrition_and_Fertilization and http://edis.ifas.ufl.edu/TOPIC_Citrus_Irrigation.

Table 1. Effects of mineral nutrition and irrigation on citrus fruit quality.

Variable	N	P	K	Mg	Irrigation
Juice Quality					
Juice Content	+	0	-	0	+
Soluble Solids (SS)	+	0	-	+	-
Acid (A)	+	-	+	0	-
SS/A Ratio	-	+	-	+	+
Juice Color	+	0	-	?	0
Solids/Box	+	0	-	+	-
Solids/Acre	+	+	+	+	+
External Fruit Quality					
Size	-	0	+	+	+
Weight	-	0	+	+	+
Green Fruit	+	+	+	0	+
Peel Thickness	+	-	+	-	-
Increase (+), Decrease (-), No change (0), No information (?)					