Proper Nectarine Nutrition Improves Fruit Quality

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Successful stone fruit production requires attention to both fruit yield and fruit quality. Mineral nutrient shortages will result in a greater degree of fruit browning during storage. Excessive N fertilization stimulates vegetative growth, delays fruit ripening, and increases the severity of brown rot.

Fruit tree nutrition research has primarily focused on optimizing growth and yield, with less attention paid to its effect on fruit quality. The link between tree fruit nutrition and fruit quality cannot be overlooked. For example, studies on apples and plums have shown an influence of nutrient deficiencies on internal fruit breakdown. Other work has demonstrated a link between plant nutrition and fruit color. But additional research is needed on the influence of mineral nutrition on stone fruit postharvest quality and cold storage performance.

A major problem with stone fruits is their tendency to become brown during storage. Browning of fruits and vegetables occurs when a naturally occurring enzyme (polyphenol oxidase, PPO) degrades phenolic compounds to form quinones, which rapidly form brown-colored compounds (melanin) (**Figure 1**).

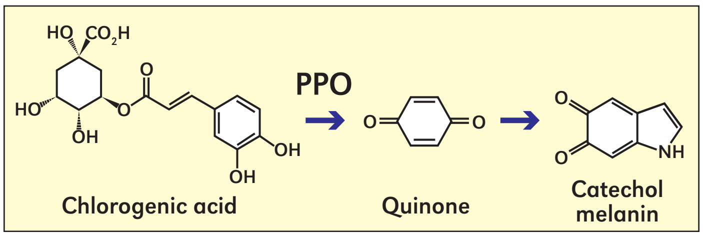

Figure 1. Generalized example of the production of melanin from polyphenolic compounds following the breakdown of fruit by the naturally occurring polyphenol oxidase (PPO) enzyme. Melanin is the cause of fruit browning.

The concentration of phenolic compounds, the activity of PPO, and the presence of oxygen are strongly related to enzymatic browning. However, the composition of the phenolic compounds and their concentration are important contributors to fruit antioxidant capacity, which is desirable because they provide benefits to human health. In addition, certain phenolic compounds can assist in enhancing resistance to brown rot (*Monilinia fructicola*) in peaches by acting directly on cutinase and preventing the penetration of this fungal infection within the fruit flesh.

It would be preferable to have fruit with high concentrations of phenolic compounds, but low postharvest fruit browning during and after cold storage. Two studies were conducted to measure the influence of nutrient supply on fruit yield and quality.

Experimental Details

1. N-P-K Study

In 2000, 60 large (10,000 L) tanks were buried in the ground at the University of California Kearney Agricultural Research Center in Parlier, CA to study the nutrition of stone fruit. Each tank was filled with sand to enable accurate control of the nutrient supply and specific mineral deficiencies.

Abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; Ca = calcium.

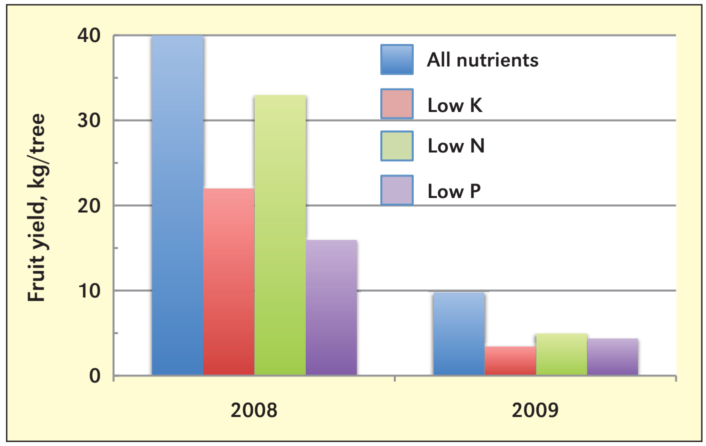

Figure 2. Nectarine yield during 2008 and 2009 for trees fertilized with low K, low N, low P, or supplied with all nutrients.

A 'Grand Pearl' nectarine tree was placed in each tank and trained to a perpendicular V system to ensure uniform shape. Four different fertilization treatments were imposed for 8 years using a drip irrigation system with two emitters per tank. The treatments were a fully fertilized control, low N, low P, or low K with four replications per treatment.

In 2008 and 2009, fruit were collected from each tree as they reached commercial maturity based on color and firmness. Fruit size, soluble solids concentration, and titratable acidity were determined at harvest. In 2009 only, fruit was stored for 11 days at 5°C for quality evaluation. After storage, fruit was evaluated for internal breakdown symptoms and other disorders.

2. Nitrogen Rate and Brown Rot Study

'Fantasia' nectarines were grown in a 2-acre field at the Kearney Center in Parlier, CA and received 0, 100, 175, 250, or 325 lb N/A/yr since the 8^{th} year after planting. Mature fruit was harvested in the 16^{th} and 17^{th} year and evaluated for various parameters of quality. The effect of N fertilization on brown rot was studied by inoculating the blossoms or green fruit with three rates of brown rot spores. The number of lesions on the mature fruit was counted at harvest.

Results

1. N-P-K Study

Fruit yield and quality. In 2008, only low K and P reduced fruit yield, whereas in 2009, low N also reduced fruit yield compared with the fully fertilized control. Individual fruit weight was especially reduced in the low K and P treatments in 2008, but not in the low N treatment, compared with the fully fertilized control (**Figure 2**). All treatments had lower yields in 2009.

Fruit nutrient concentration. The N, K and Ca concentrations measured in fruit tissues were within the ranges

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Fruit browning (left) was most significantly related to low P supply; while the development of brown rot in fruit (right) was related to excessive N supply—which promotes vegetative growth but also increases the risk to fungal infections.

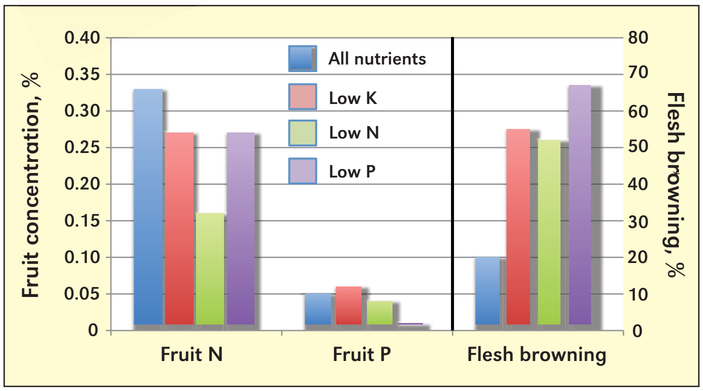

Figure 3. Effect of low K, N or P in the nutrient solution on N and P concentrations in nectarines compared with a no-deficiency control. The effect of K, N or P deficiency on flesh browning after 11 days storage at 5°C compared with a no-deficiency control.

previously published. Only fruit from the low P treatment had concentrations below those obtained from a survey of typical fruit populations. Fruit from fully fertilized trees had the highest N concentrations, followed by fruit from the low P and K treatments, whereas fruit from the low N treatment had the lowest N concentration. Phosphorus concentrations in fruit were affected significantly by the nutrient deficit treatments, with the low P treatment having the lowest concentration of P (**Figure 3**).

Potassium and Ca concentrations in fruit were unaffected by any treatment. The low K treatment did not reduce fruit K, P or Ca concentrations but reduced the N concentration (but still within the normal range). The low N treatment significantly reduced fruit N to 50% of control fruit, without affecting fruit K, P or Ca concentrations. The low P treatment reduced fruit P (~80%) and N (~20%) concentrations without reducing the K or Ca concentrations.

Fruit Browning. Fruit browning was higher in the low-P treatment than in fruit from the other treatments. The low-P fruit had 67% flesh browning in 2009 compared with only 20% in the control treatment (**Figure 3**). Fruit from all the deficient treatments had significantly more browning than fruit from the fully fertilized treatment after 11 days of storage.

Fruit with low P concentrations had increased phenolics concentrations (620 µg/g), compared with the fully fertilized treatment (388 µg/g). The phenolic compounds act as substrates for the PPO enzyme, which produces quinones that turn fruit tissues brown.

The low N treatment also had reduced concentrations of P in the fruit, which commonly leads to increased fruit browning.

Our work demonstrated that a restricted nutrient supply (N, P or K) affects the intensity and incidence of fruit browning during cold storage, independent of which of these nutrients were deficient. However there appear to be other complex nutrient interactions, where a limited supply of two or more nutrients produced imbalances that affected the total fruit nutrient status and quality.

Only low P concentration in the fruit had a consistent effect on browning potential and its precursors during both seasons. A low fruit P concentration may have a role in excessive cell membrane permeability, allowing the phenolic substrates to be more accessible for reaction with PPO.

Contrary to what we expected, low-P fruit also had the most antioxidants, which were supposed to counteract oxidation and retard browning.

Results

2. Nitrogen Rate and Brown Rot

Although it is common for stone fruit growers to annually apply over 100 lb N/A, it is not unusual for some individuals to apply additional N in the hope of increased crop yields. However, excess N fertilization may result in overly vigorous vegetative growth, leading to a negative effect on fruit quality and also a deleterious effect on the tree's susceptibility to attack by disease and insect pests.

In this experiment, total fruit yield was not affected by the N fertilization above 100 lb N/A/yr, but the time to fruit maturity was delayed by 4 to 5 days with additional N. The lower application rates of N induced more red color on the nectarine skin. The added vegetative growth from excess N increased shade both inside and beneath the tree canopy, extending the length of the harvest period. Vegetative growth was positively correlated with N application rate.

Mature stone fruit trees in sand tanks for nutrition experiments (University of California).

Blossoms from unfertilized trees showed the lowest occurrence of brown rot infection following inoculation. When the data were combined for all infection dates, significantly more stamens were infected on blossoms from the high N treatments than on blossoms from the unfertilized and 175 lb N/A/yr treatments. The green fruit inoculation also showed a positive correlation between the incidence of infected fruit and N fertilization (**Figure 4**).

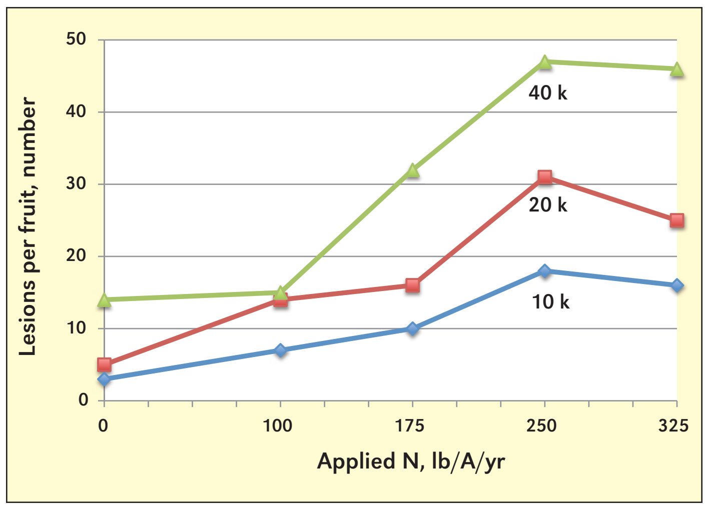

Figure 4. Effect of N fertilizer application rate and spore inoculation rate (10,000, 20,000 or 40,000 spores/ml) on brown rot infection of mature nectarines.

Summary

Nectarine tree fertilization practices have significant effects on fruit quality. Low fruit P consistently increased fruit browning during storage. Excessive N fertilization stimulated excessive vegetative growth and caused fruit to be more susceptible to brown rot. BC

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Additional details are available in these publications

Andres Olivos, A., R.S. Johnson, Q. Xiaoqiong, and C.H. Crisosto. 2012. HortSci. 47:391-394.

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