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"Interaction effects of nitrogen and potassium fertilization on anthocyanin composition and chromatic features of Tempranillo grapes"

By: R. Delgado, M. González, and P. Martín

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Adequate nitrogen and potassium fertilization are essential for grape production. But how do the levels of these nutrients affect phenolic composition and color, two critical quality parameters in red grapes?

• Previous authors had shown that moderate nitrogen application before bloom enhances anthocyanin accumulation. But **excessive nitrogen** can delay ripening, promote excessive vegetation, and result in reduced polyphenol concentration and color. Similarly, potassium enhances sugar translocation into the berry, which is important for polyphenol synthesis. But **excessive potassium** may decrease tartaric acid, resulting in an increase in pH that can affect color stability.

• The authors study the effect of three levels of nitrogen (0, 50, and 200 g of N per vine) combined with three levels of potassium (0, 60, and 129 g of K per vine) (3 x 3 factorial design) on the anthocyanin composition and visible color of Tempranillo grapes (110R) grown in the appellation of origin *Ribera del Duero*, Spain. The design was a randomized complete block with 4 replications of 5 10-year-old vines each. N and K fertilization was applied as ammonium nitrate and potassium sulfate, respectively, right before budbreak (end of March, 2000).

• Besides anthocyanins (measured by HPLC), and visible color (CIELAB coordinates), the authors also measured yield, cluster number and weight, berry weight, leaf area index, pruning weights, and juice composition for each of the treatments.

CIELAB coordinates	*Scale measured*
L*(Lightness)	Dark-Bright (0=black, 100=white)
a*	Green-Red (negative value=more green, positive value=more red)
b*	Blue-Yellow (negative value=more blue, positive value=more yellow)
h (Hue angle)	Degree of brownness (the higher the more brown)
C* (Chroma)	Color intensity (the higher the more intense)

• **Effect of N and K on agronomic parameters and fruit composition**.
1- The highest application rate of N and K increased the levels of these nutrients in the *leaf tissue*, but the lower rates had no effect.
2- K enhanced N content in the petioles, showing that K improves N assimilation; their effects are synergistic.
3- N and K did not significantly affect vigor (as measured by *pruning weights*) or berry size.
4- The lower application rate of N significantly increased *yield*, but the higher rate didn't increase it further.

5- The failure to further increase yield with the highest rate of N was not due to compacted foliage or other changes in canopy, as *leaf area index* was not changed.
6- The fruit from vines with the highest N rate had lower *Brix*. However, when both N and K were applied at a high rate, Brix was similar to the control. Balanced K supply appears to lessen the negative effects of excessive N.
7- Both rates of K (60 and 129 g/vine) caused reduced total acidity. The mechanism seems to be that excessive K+ migrates to the fruit, enhancing the formation of potassium bitartrate, which precipitates, lowering total acidity.
8- N and K fertilization did not significantly affect pH. So N and K could be modifying color directly by affecting anthocyanin and phenol synthesis, rather than through shifts in pH.

- **Effect of N and K on total polyphenols and total anthocyanins.**

1- *Polyphenols*. An increase in N caused a significant decrease in total polyphenols. This agrees with two previous studies, which found that excessive N reduces polyphenol synthesis in the berry skins. However, when K was also high, the treatments with maximum N had higher polyphenols. In the fruit with the highest polyphenol levels, the N:K ratio was 3.6-4.3. This is much higher than previously reported.

- 2- *Anthocyanins*. The same trend observed with polyphenols was found with anthocyanins . When there was no K or medium levels of K, increasing rates of N decreased the content of total anthocyanins. But when K was high, the anthocyanin levels in the fruit receiving the highest N rates were not different from those of the control. Previous authors observed that moderate nitrogen levels favor the formation of all classes of flavonoids in grapes. As for K, the highest K application rate reduced anthocyanins, but when the high K was balanced with sufficient N, no reductions in anthocyanin content were detected. Once again, a balance between N and K seems to be the key. Sound familiar?

- **Effect of N and K on chromatic characteristics**.

1- *N*. Low application rates of N caused a major increase in hue (h*) and yellow component (more b*), but did not modify color intensity (C*). But the highest rate of N increased color intensity, as well as the red (higher a*) and blue (lower b*) hues. The authors speculate that the high N might have predisposed more formation of copigmentation complexes, thus contributing to the hyperchromic (more red) and bathochromic (more blue) effects observed.
2- *K*. Potassium, by itself, reduced red hue (less a*) and increased the yellow component (more b*). Nevertheless, these chromatic shifts were not observed when high potassium was balanced with sufficient N supply.

So we've seen that nitrogen and potassium fertilization can modify total polyphenols and anthocyanin composition of Tempranillo grapes. The authors observed a strong nitrogen x potassium interaction, so an optimal N:K fertilization ratio may enhance formation of polyphenols. For the conditions observed in this study, the optimal N:K ratio was shown to be 3.6 to 4.3.

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