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EXCESSIVE POTASSIUM FERTILIZATION DESTROYS GRAPE JUICE QUALITY

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In warm production regions high pH of grapes at harvest can be a problem for both the juice and wine industries. High pH values in grapes reduce color and stability of processed products. This condition can be exaggerated by high cation uptake from the soil, and excessive potassium (K) can contribute to the problems. The substitution of K+ cations for H+ in the grape tissue can increase the pH despite a high acidity. Additional information on this subject is needed. The objective of this study was to investigate the effects of three levels of excessive K fertilization on the K content of the plant and fruit and on the subsequent quality and stability of the fresh and stored juice.

One-year-old 'Concord' grapevines were planted in 1980 in commercial potting sail (Pro-Mix) in 19-L containers. They were grown for one year, pruned, and trained to a short bilateral cordon system with 1.5 m between plants and 1.8 m between rows. For the first year, vines were uniformly fertilized weekly with nitrogen, phosphorus, and potassium. Drip-irrigation was used as required to maintain adequate soil moisture.

In 1981, three excessive rates of potassium fertilization (3,6, and 12 g per plant in the form of K_2O_4) were applied at weekly intervals to the containers from May 1 through Sept. 1 (harvest). The potassium was spread evenly over the surface of each container and incorporated by flooding the containers with water. To these treatments and a control, nitrogen was applied weekly during the growing season to maintain vine growth, and water was applied with drip-irrigation as needed. All vines were thinned to 4 clusters (2 on each cordon). The experiment was designed as a randomized complete block with 20 replications of single vine plots.

At harvest, the four clusters were destemmed, and the berries were frozen in polyethylene bags for analysis. The samples were thawed, blended, heated for one hour at 85^{o}C, allowed to cool to 25^{o}C, and strained through two layers of coarse cheesecloth to remove the pulp. A portion of this juice was collected for immediate analysis, and the other portion was placed in 50-ml plastic tubes, capped, frozen and stored for 3 days to crystallize potassium bitartrate.

The % soluble solids, tristimulus color (Gardner Color and Color Difference Meter), pH, acidity, absorbance at 520 nm, potassium and magnesium content were determined.

For stored juice analysis, the frozen samples were thawed overnight at l0^{o}C. Quality determinations were identical to those used for fresh juice.

Increasing the K fertilization resulted in an accumulation of K in the fresh and stored juice (See table). Previous reports on K fertilization present similar results. Excessive levels of K fertilization increased the pH and lowered the acid content of fresh and stored juice. These increases in pH due to excessive K were probably due to the direct exchange of K cations for protons derived from the organic acids, and probably due to the activity of adenosine triphosphatase.

These high rates of K fertilization also resulted in a reduction in CDM "b" values and an increase in CDM hue (a/b) values of the fresh and stored juices. Consequently, juice color was more blue and less desirable. This change in color was probably due to the increases in pH due to high K fertilization. High pH values have been shown to alter the color of anthocyanin solutions by changing the structure of the anthocyanin molecule. These color changes occurred even though the excessive levels of K in the juice had little or no effect on the anthocyanin content (as determined by the acidified absorbance at 520 nm).

Little change occurred in the pH of the juice during storage if excessive potassium had not been applied, but excessive K fertilization resulted in greater pH increases during storage (See table). This change in pH occurred even though excessive K fertilization had no effect on acid and little influence on potassium loss during juice storage. Excessive K fertilization resulted in a greater change in CDM "b" and hue (a/b) values during storage. Although these undesirable color changes occurred, there were no differences in the changes of the anthocyanin content (acidified absorbance at 520 nm) during storage as a result of high K fertilization.

In summary, fresh and stored juice K levels and pH were increased when excessive K fertilization was applied. The color quality and acidity of the fresh and stored juice were lowered by excessive K fertilization. Excessive K fertilization also resulted in a greater increase of juice pH and a greater loss in color quality during storage.

Effects of potassium fertilization and storage on the quality and changes of grape juice.

Potassium fertilization (g/plant)[z]	Juice K (ppm)	pH	Acidity (% tartaric)	CDM b	Color a/b	Acidified absorbance @ 520 nm
			Fresh			
0	2730c[y]	3.43c	0.58a	3.7a	5.76	0.629a
3	2977bc	3.52b	0.56ab	3.8a	5.66	0.5396
6	3266ab	3.58b	0.54b	3.4ab	6.0ab	0.574ab
12	3343a	3.67a	0.54b	3.0b	6.5a	0.620ab
			Stored			
0	1504c	3.44c	0.42a	3.1a	6.2c	0.528a
3	1642c	3.596	0.38b	2.8ab	6.66c	0.459a
6	1891b	3.706	0.37b	2.41bc	7.2ab	0.503a
12	2378a	3.82a	0.38b	2.1c	8.0a	0.506a
			Change in Storage			
0	-1226ab	-0.01c	-0.17a	-0.6a	+0.5a	-0.101a
3	-1335ab	+0.076	-0.18a	-1.16	+1.1b	-0.080a
6	-1375a	+0.11a	-0.16a	-l.0b	+1.2b	-0.071a
12	- 965b	+0.15a	-0.16a	-1.0b	+1.5b	-0.114a

[z]K fertilizer was applied weekly from May 1 through Sept. 1 (harvest).
[y]Means separated within columns and storages by Duncan's Multiple Range Test at the 5% level.