Anthocyanin Development in Mango Fruit in Response to a Preharvest Antitranspirant Spray[1]

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Abstract. **Preharvest development of external red color of 'Irwin' and 'Keitt' mango (*Mangifera indica* L.) was enhanced with an application of the antitranspirant poly-1-p-menthen-8-9 diyl (Vapor Gard) prior to commercial fruit maturity. Both the percentage of fruit surface area showing red color and intensity of the red color was increased. Red color development in storage at 21°C was not affected by Vapor Gard. This effect was specific for the anthocyanin pigment(s). Colorimetric measurements in both yellow and green areas indicated that Vapor Gard did not affect disappearance of chlorophyll and development of yellow color at time of or following harvest.**

External color of Florida mangos ranges from yellow to red or purple. Marketability of most cultivars is enhanced when mangos are harvested well colored. Commercially, time of harvest is based on maturity and not color. Postharvest color development of most yellow cultivars is usually complete. However, postharvest red color development on some red cultivars is reduced, since the amount of red color at full ripeness is generally comparable to that which had developed at time of harvest. Use of Vapor Gard[5] (VG) to enhance preharvest red color development has been investigated for 2 years and is now being used commercially.

Tests were made on 'Irwin', 'Keitt', and 'Lippens' in a commercial planting in south Dade County, Florida. VG was applied at either 5 or 6% at the time of the last fungicide application, 1 to 3 weeks prior to harvest, VG replacing the sticker-extender, Nu-Film-17. Preliminary trials had indicated that the addition of fungicidal materials to VG had no effect on its red color inducing properties. All spray applications were made with a speed sprayer at 837 liters/ha (100 gal/acre). Three trees of each cultivar were sprayed and 15-25 fruit from each treatment were analyzed for color.

Color measurements were made with a Hunterlab D25 Color Difference Meter and expressed as a/b ratio, a value used to express a scale of red to yellow to green. Measurements were made in an area of max red color on each fruit at harvest. An additional 2 areas of yellow and green were measured on 'Keitt' at harvest and during storage at 21°C. Percentage surface area showing red pigmentation was estimated visually. Effects of VG on maturity and ripening were determined from respiration patterns as CO_2 evolved, ethylene production, and the time required to soften. CO_2 and ethylene concn were determined with a Beckman Infrared Analyzer–IR 215 and a Varian Series 1800 gas chromatograph equipped with an H flame ionization detector and an activated alumina (hydrated) column, respectively.

Effect on preharvest color development. Effect of VG on color was specific for preharvest development of red pigmentation. These pigments were identified as anthocyanins by the technique of Fuleki and Francis (1). Colorimetric measurements of both green and yellow areas on 'Keitt' fruit indicated no difference between treated and nontreated fruits in the loss of green or development of yellow color (Fig. 1). Fruit receiving full sunlight exposure gave a greater color response than shaded fruit.

'Irwin', when tree ripened, develop a deep red color over most of the fruit surface. These fruit are usually harvested commercially with considerably less red color development with the remaining portion of the surface green in color. Further anthocyanin development is reduced during postharvest storage (21°C), and the remaining green area becomes yellow, not red. Preharvest applications of 5% VG resulted in a marked increase in intensity (a/b) of red color and a moderate increase in percentage of red

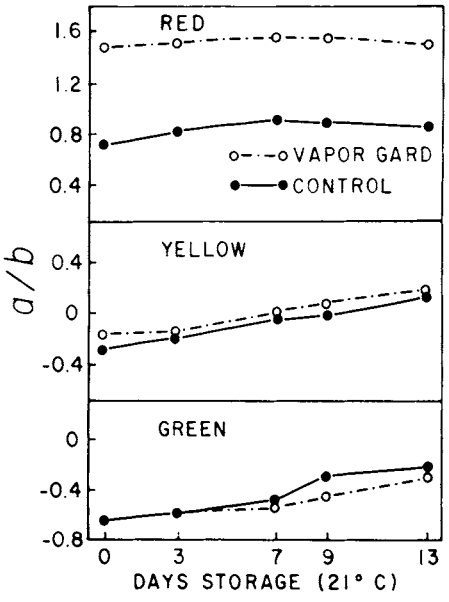

Fig. 1. Hunter a/b values in red, yellow, and green areas at harvest and during storage at 21°C of 'Keitt' mangos harvested 7 days after 6% VG application.

Table 1. Effect of VG on percentage area showing anthocyanin pigmentation and a/b value (intensity) in the area of maximum redness on 3 mango cultivars.

Cultivar	Treatment	Avg red surface color (%)	Intensity (a/b value)
Irwin[z]	Fungicide	75	2.846
	Fungicide + 5% VG	87	3.550
Keitt[y]	Fungicide	20	0.735
	Fungicide + 6% VG	31	1.501
Lippens[x]	Fungicide	34	0.975
	Fungicide + 5% VG	38	1.106

[z]Measurements made 17 days after spraying.
[y]Measurements made 7 days after spraying.
[x]Measurements made 21 days after spraying.

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[5]Trade names are used for convenience in identification and do not constitute endorsement.

Fig. 2. Color response of 'Keitt' mangos to 6% VG applied 7 days prior to harvest. A. VG treated. B. Control.

surface area (Table 1).

'Keitt' fruit are light green in color with a light red-yellow color mixture on the portion exposed to sunlight at commercial maturity. Fruit were harvested 7 days after spraying with 6% VG. Color measurements showed both an increase in the red color intensity and percentage surface area with red color in response to VG (Table 1, Fig. 2).

'Lippens' mangos are light yellow-green in color at commercial maturity with a small amount of red color on the upper portion exposed to sunlight. Color of ripe fruit is primarily yellow. VG had only a slight effect on red color development (Table 1).

Effects on postharvest color development and ripening. Preharvest VG applications had no obvious effect on postharvest development of red color or on loss of chlorophyll and development of yellow color (Fig. 1). Respiration and ethylene production of treated and nontreated fruit were similar and time to reach an edible condition was comparable.

Red color response to VG can be observed as soon as 7 days after spraying, even with lower concn of 2 to 3% (C. R. Barmore, unpublished). High concn, >6%, has been observed to retard chlorophyll degradation in storage. The mode of action of VG on red pigmentation is not understood but appears related to sunlight. Treated fruit receiving full exposure to sunlight respond better than do shaded fruit. Red color development, however, is not enhanced on fruit treated with VG and held after picking under continuous fluorescent light. Color response obtained with VG under grove conditions is under further investigation.

Literature Cited

1. Fuleki, T., and F. J. Francis. 1968. Quantitative methods for anthocyanins. I. Extraction and determination of total anthocyanin in cranberries. *J. Food Sci.* 33:72-77.

Cytokinin-induced Axillary Bud Sprouting in Macadamia[1]

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Abstract. **Sprays of a synthetic cytokinin, 6-(benzylamino)-9-(2-tetrahydropyranyl)-9H-purine (PBA), applied to seedlings of *Macadamia tetraphylla* L. in the greenhouse resulted in sprouting of axillary buds, and reduced growth of the terminal shoot. Terminal removal caused lateral shoot development in more seedlings than PBA.**

Macadamia cultivars with predominantly upright growth may be topped mechanically to reduce tree height in developing a spreading scaffold branch system and to facilitate harvesting. Pruning of large limbs significantly increases new shoot growth (8), providing for latitude in shaping the tree. However, pruning is expensive and may reduce yields on mature trees. Growth retardants may be of economical value in reducing terminal growth (1); they did not stimulate lateral shoot growth. Terminal dominance in plants has been overcome with cytokinins (6, 7) and other growth regulators specifically stimulate lateral bud growth in apple and avocado (2, 3, 4, 5, 9). Cytokinins also increased crotch angles of young 'Delicious' apple trees (2), thus allowing a greater limb choice for a permanent scaffold structure.

The stem of 'Johnson' Macadamia has a whorl of 4 sessile leaves at a node and 3 dormant buds in the axil of each leaf. Potentially, it is possible for 12 branches to appear at a single node. The objective of this research was to investigate the use of PBA[3] as an aid in changing the undesirable growth habits in macadamia trees.

Macadamia seeds were planted in 4 liter containers in June 1972. Prior to treatment with PBA, 312 seedlings were selected for uniformity in height and girth. Treatments were started April 6, 1973 when plants averaged 70 cm tall with a circumference of 2.9 cm at 15 cm above soil level.

Aqueous PBA solutions at 250, 500 and 1000 ppm and containing 0.1% of X-77[4] wetting agent were sprayed to run-off at weekly intervals (April 6 to 27). The 26 treatments were 2 controls and 3 concn of PBA, at 4 dates in which the apex was either removed or left intact. There were 12 single-seedling replicates in randomized complete blocks in the greenhouse. Terminal shoots of seedlings in which the apex was removed were cut off 5 days before spraying.

Applications of PBA to seedlings with the apex intact induced sprouting of axillary buds (Fig. 1, 2). Terminal shoots were not killed, but grew at a reduced rate. Lateral bud growth was initiated on 50% of plants treated with 4 foliar sprays of PBA at 500 and 1000 ppm, and 42% with 250 ppm. The fewer the frequency of applications, the

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[3]Shell Development Company kindly supplied PBA (experimental compound SD 8339).

[4]Colloidal Products Corporation of Sausalito, California produces X-77. The principal functioning agents of X-77 are alkylarylpolyoxyethylene glycols, free fatty acids, and isopropanol.