Proc. Fla. State Hort. Soc. 134:88. 2021.

—Scientific Note—

Using Colored Mesh Bags to Induce Early Color Development in Fresh Market Citrus Varieties

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Additional index words. fruit color, shade cloth.

Citrus under protective screen (CUPS) growing systems are only successful when the quality of fruit meets the standards to fetch high prices in the market. One aspect of high fruit quality is the color of the fruit peel. Many popular varieties in CUPS systems reach internal maturity standards before the color break is complete. Finding a method for hastening color development so fruit can be harvested as soon as internal fruit maturity is reached is essential. Research has shown that factors such as cool temperatures, nutrient concentrations (nitrogen, phosphorus, and potassium) and light intensity can cause the breakdown of chlorophyll and the development of carotenoids. These experiments aim to take advantage of the latter mentioned factor by using various colored light filtering bags to shade fruit.

At the Citrus Research and Education Center (CREC) CUPS facility, three experiments were done over two seasons (2019–20 and 2020–21). Fruit from three varieties 'UF914', 'Ray Ruby' and 'W. Murcott' were covered with colored knitted shade cloth mesh bags (Fig. 1a and 1b). In the first experiment, fruit from 'UF914', a hybrid of grapefruit (*Citrus × paradisi*) and pomelo (*C. maxima*) were covered with black, blue, green, and red mesh bags. In the second and third experiments using 'Ray Ruby' grapefruit (*C.× paradisi*) and 'W. Murcott' tangerines (*C. reticulata*), pink and white bags were added. Unbagged fruit were also sampled as a control comparison. Fruit was tested for both internal and external quality. External fruit color was analyzed using digital images of the fruit at a fixed white balance. Images were then analyzed using ImageJ software to calculate CIE L* a* b* color coordinates. Internal fruit quality was measured using standard brix and acid juice analysis, as well as internal color analyzed using the same methods employed for the external color analysis.

Fig. 1. Mesh bags deployed in the research field **(a)** and mesh shade cloth colors used to make bags **(b)**.

Results (Table 1), of the 2019 'UF914' experiment found that covering fruit with green mesh bags significantly increased the a* (redness) value. Results from the 'Ray Ruby' experiment (harvested Nov. 2020) agree and show fruit within the green bags had significantly higher redness (a*) values. The 'W. Murcott' experiment (harvested Dec. 2020) failed to show any significant differences between colored bags and unbagged controls. While there were no significant differences in the a* values, all treatments evenly developed orange peel color. We believe this is due to a reduced nitrogen fertilizer program that was put in place in the CUPS research block for the 2020 harvest season. Ongoing research in the 2021–22 season is attempting to test this hypothesis. Across all three variety experiments and all colored bag treatments, there were no significant differences in internal fruit color or juice quality between bagged treatments and unbagged controls.

This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture award number 2018-70016-27387.

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Table 1. External color analysis using the CIE color mapping system. L* represents lightness from 0–100 black to white, a* represents green-red color from –100 to +100, and b* represents blue-yellow color from –100 to +100. 'UF914' is a hybrid of grapefruit (*Citrus ×paradisi*) and pomelo (*C. maxima*). 'Ray Ruby' is grapefruit (*C. ×paradisi*) and 'W. Murcott' is a tangerine (*C. reticulata*)

	UF914 (2019)			Ray Ruby (2020)			W. Murcott (2020)		
Bag color	L* (ns)	a* ($P < 0.001$)	b* (ns)	L* ($P < 0.001$)	a* ($P < 0.001$)	b* ($P < 0.001$)	L* (ns)	a* (ns)	b* (ns)
Unbagged	48.52	–3.43 a	43.35	49.3 ab	1.8 a	40.9 a	38.9	19.4	41.1
White	--	--	--	51.5 b	2.7 a	43.7 b	39.2	24.5	41.4
Black	47.74	1.34 ab	41.43	47.4 a	9.6 bc	39.9 a	38.9	28.4	42.6
Red	48.64	2.06 b	43.48	48.2 a	7.9 b	41.3 a	39.9	16.3	41.1
Green	47.95	5.07 b	42.25	48.2 a	13.1 c	41.1 a	44.3	18.0	44.5
Blue	48.8	2.16 b	42.47	48.0 a	9.1 bc	40.7 a	42.1	14.7	41.4
Pink	--	--	--	46.6 a	5.3 ab	40.2 a	43.8	21.5	46.7