HortScience. 13(5):577–578. 1978.

Tomato Fruit Color Measured with an Agtron E5-W Reflectance Spectrophotometer[1]

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Additional index words. Lycopersicon esculentum, ripeness.

Abstract. **A reflectance spectrophotometer (Agtron E5-W) was found to be a useful laboratory tool for nondestructive determination of tomato fruit color as an indicator of ripeness classes and changes in ripeness in postharvest studies. Values obtained represent the average green and red color hues of the whole fruit which is rotated dueing the measurement.**

Tomatoes generally are sorted visually into their ripeness classes with the help of a color chart. The accuracy of such visual evaluations is limited by several factors including: 1) inspector's ability to differentiate colors, training, experience, and fatigue; 2) light intensity of the inspection environment; and 3) optical characteristics of color. Consequently, research workers have tested and used alternative objective methods for color determination, which have been primarily instruments that measure light reflectance nondestructively (1, 2, 3, 4, 5, 6, 7). These include several commercially available tristimulus colorimeters and reflectance spectrophotometers. Because of fruit shape, measurements are usually limited to a small area (circle of 1-2 cm in diam) of the fruit surface, and this is repeated on several locations on the fruit to obtain a mean value representing its overall color. In general, such measurements have been highly correlated with visual color ratings, and have been more sensitive than subjective methods to small color differences.

The Agtron E5-W reflectance spectrophotometer[3] is designed to measure green (546 nm) and red (640 nm) reflectance of a rotating object and display the true mathematical ratios of the 2 color modes in percentage. It has mercury and neon light sources and a long wavelength trimmer filter. The instrument is equipped with a device to rotate the fruit and a lens focuses the reflected light onto a sensor. This feature makes it possible to determine average external color of a whole fruit in less than 30 sec. In this report, we present data of several tests carried out in 1976 and 1977 to evaluate the Agtron E5-W for determination of tomato fruit color.

Fruits of various tomato cultivars grown at Davis, Calif. were picked at 6 different stages of ripeness or were sorted out of commercially-packed boxes. Visual sorting into ripeness classes was done by 1 person under the same light conditions for all tests. Ripeness classes used were those of the USDA standards for grades of fresh tomatoes (8). Reflectance measurements were made on individual fruits in each ripeness class, and the means and standard deviations were calculated for each lot. The repeatability of reflectance readings for any given fruit was excellent.

Fruit orientation during rotation for measurement had a small effect on reflectance readings for all ripeness classes except breaker and turning (Table 1). Fruits of these 2 classes exhibited a higher reflectance reading when rotated around an equatorial axis than when rotated around the stem-blossom and axis. This is related to the fact that red color development begins at the blossom end which was more exposed to the sensor when the fruit was rotated around an equatorial axis. All subsequent measurements were taken on fruits rotated around their stem-blossom end axis to avoid

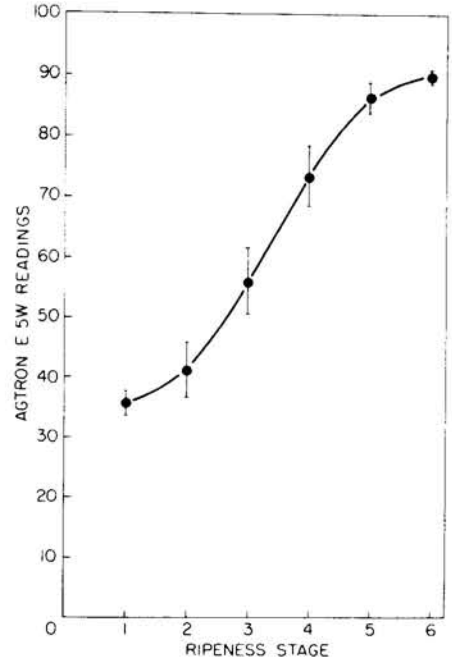

Fig. 1. Agtron E5-W reflectance readings vs ripeness classes of 'Ace 55' fruits. Each point represents a mean for 50 fruits and vertical lines indicate standard deviation.

Table 1. Influence of fruit orientation during rotation on measurements by an Agtron E5-W reflectance spectrophotometer; 'Ace 55' fruits sorted subjectively into 6 ripeness classes (50 fruits per class).

	Mean reflectance readings[z] and SD (%)	
Ripeness class	Fruits rotated around stem-blossom end axis	Fruits rotated around equatorial axis
1 – Mature-green	35.1 ± 2.2	35.7 ± 2.2
2 – Breaker	39.0 ± 5.8	41.2 ± 4.8
3 – Turning	51.2 ± 6.6	56.0 ± 5.6
4 – Pink	70.6 ± 5.8	73.3 ± 5.3
5 – Light-red	85.9 ± 3.0	86.3 ± 2.6
6 – Red	89.8 ± 0.9	89.9 ± 0.8

[z]Mathematical ratio of reflectance in the red and green modes.

Table 2. Comparison of Agtron E5-W reflectance readings vs. ripeness classes selected subjectively for fruits of 5 cultivars (20 fruits per class for each cultivar).

	Mean reflectance readings and SD (%)				
Ripeness class	Cal Ace	6718 VF	VFN Bush	Walters	Florida MH-1
1 – Mature-green	37.9 ± 3.8	39.0 ± 2.1	36.2 ± 2.1	36.3 ± 1.9	33.3 ± 1.8
2 – Breaker	47.0 ± 4.8	44.5 ± 1.9	44.9 ± 3.7	48.4 ± 2.9	44.2 ± 5.0
3 – Turning	59.8 ± 6.6	55.3 ± 4.3	61.2 ± 6.5	58.7 ± 4.9	60.3 ± 5.1
4 – Pink	73.6 ± 4.2	70.0 ± 6.8	75.4 ± 5.1	74.6 ± 4.3	77.1 ± 4.3
5 – Light-red	86.1 ± 2.6	84.2 ± 6.4	83.8 ± 3.4	84.9 ± 3.0	86.8 ± 2.7
6 – Red	92.4 ± 1.1	90.5 ± 2.2	91.8 ± 1.1	91.5 ± 1.0	92.5 ± 0.8

[1]Received for publication April 17, 1978. Research supported in part by the California Fresh Market Tomato Advisory Board.
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[3]Manufactured by: Magnuson Engineers, Inc., P.O. Box 5846, San Jose, CA 95150.

Reprinted from HORTSCIENCE, Vol. 13(5), October 1978
A publication of the American Society for Horticultural Science, Mt. Vernon, Virginia

possible variability due to stem scar color and size, and because the stem scar area provided a good holding point for rotation.

There was a good correlation between reflectance readings and visual color ratings for 'Ace 55' fruits (Fig. 1) and for 5 other cultivars tested (Table 2). Small variations among cultivars were noted and may be related to genotypic differences in red color development pattern and green color intensity and uniformity

We have used this instrument for 2 seasons to measure color (ripeness) changes of tomato fruits subjected to various postharvest treatments. It has proven to be a useful, nondestructive, objective and quick method, and can also be used for other fruits where green and red are the dominant colors.

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