evidence of an inhibitor[3]. Thus based on these data it could be hypothesized that the seed tissue contained 1 acidic promoter and 1 neutral inhibitor.

To verify this hypothesis, the neutral ether fraction was chromatographed in solvent B. The results (Fig. 1C) resembled those obtained when both fractions were co-chromatographed in solvent A (Fig. 1A), except for the absence of the promoter at R_f 0.0-0.1. It could now be argued that the seed tissue contained 1 neutral inhibitor and 2 promoters, 1 acidic and 1 neutral. However, on further chromatography in a solvent system of markedly different polarity (solvent C) 2 well-separated zones of growth promotion (R_f 0.0-0.1 and at R_f 0.5-0.7) were found in the neutral ether fraction (Fig. 1D).

Subsequently, we found that each of the 2 neutral promoters was chromatographically homogeneous, and that the zone of promotion at R_f 0.0-0.1 (Fig. 1D) was not an artifact caused by overloading[3]. Furthermore, the 2 neutral promoters overlapped on chromatograms developed in solvents A and B such that the promoter concn at R_f 0.9 (Fig. 1A, 1C) was supraoptimal in the *Avena* first internode bioassay, resulting in inhibition of internode elongation.

The minor zone of growth promotion located at R_f 0.0-0.1 (Fig. 1A) was not found when either the acidic or neutral fractions were chromatographed alone (Fig. 1B, 1C). In view of the large amount of material chromatographed (1.9 g equivalents) this zone of promotion may be attributed to overloading.

Our data illustrate the need to critically insure that complete chromatographic separation is achieved before attempting bioassay and interpretation. We have illustrated that with varying degrees of separation considerably different conclusions can be drawn. The overloading problem can be reduced by first bioassaying serial dilutions of the crude extract and determining the optimum concentration for chromatography. The problem of promoters and inhibitors moving to the same zone, however, can only be resolved by repeated chromatography of the active zone in solvents of markedly different polarity (Fig. 1C, 1D) to ensure that the growth substance under investigation is satisfactorily separated from other promoters and inhibitors that may be present in the original extract.

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New Portable Colorimeter to Evaluate External Fruit Color of Tomato and Peach[1]

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Abstract. **A new portable colorimeter appears promising as a tool for evaluating color of horticultural products. G(green) reflectance values (546 nm) for external fruit color of tomato (*Lycopersicon esculentum* Mill.) correlated highly with visual scores and Hunter a/b ratios. For ground color of peach [*Prunus persica* (L.) Batsch], G values decreased as fruits matured and softened.**

External color is an accepted indicator of maturity and/or ripeness of fruits of tomato and peach. In tomato-ripening studies, some researchers visually evaluate external color, assigning numerical scores on a predetermined scale from green to red (1, 3). The most frequently reported instrumental indicator of external tomato color is the a/b ratio calculated from readings on the Hunter or Gardner Color Difference Meter (7). A combination of redness and yellowness, a typical a/b ratio may change from -0.5 to +2.0 as color changes from green to red.

Ground color of peaches is reported to be a reliable maturity index, especially when combined with Magness-Taylor firmness measurements (4, 5). Printed paper color charts and the a/b ratio are used most often for visual and instrumental ground color evaluation.

Current methods have several disadvantages for many horticulturists. Visual scores may be affected by the skill of the observer, scoring system used, lighting conditions, and physical fatigue after many samples. A color-difference meter (2) is a non-portable laboratory instrument that costs several thousand dollars.

A new colorimeter (Tri-Colorphot)[3,4] is portable, simple to use, and relatively low in cost (about $750). Its readings are expressed as percentage reflectance of the 3 basic or tristimulus colors, blue (B, 436 nm), green (G, 546 nm), and red (R, 640 nm).

The colorimeter consists of 2 units joined by a cable (Fig. 1). The probe unit, which touches the sample, contains the light source, 3 colored glass filters, and 3 photocells, 1 for each filter. Light reflected from the sample is detected by the photocells and signals are transmitted to the second unit, containing the power supply and meter. Any of the 3 values (B, G, and R) may be read on the meter by moving the selector switch. White and gray cards are provided by the manufacturer for standardization.

This report describes the evaluation of the new colorimeter's usefulness in measuring external color of tomatoes and peaches.

Tomato. 'Homestead' tomatoes were sorted by a light-transmittance technique (6) into 3 similar groups, each containing a known range of maturities, from immature green to breaker. External color was evaluated after 2 weeks storage at 10°, 13°, or 16°C ± 1° (50°, 55°, or 60°F).

B, G, and R values were measured with the colorimeter at the blossom end of each tomato. Preliminary tests showed that blossom-end measurements were more indicative of ripeness and easier to duplicate than measurements

Fig. 1. New colorimeter, consisting of probe and power supply with meter.

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[2]Agricultural Marketing Research Institute, Agricultural Research Service.

[3]Manufactured by Phototronic, Inc., Jenkintown, Pa., 19046.

[4]The mention of specific instruments, trade names, or manufacturers is made for the purpose of identification and does not imply any endorsement by the U. S. Government.

at other points on the tomato. Color of the blossom end on each fruit also was measured on a Gardner Automatic Color Difference Meter (No. 57), and a/b ratios were calculated. A white ceramic tile (L = 93.3, a = 0.0, b = 2.3) was used for standardizing the instrument. A horticulturist with 20 years experience in tomato research visually scored the blossom-end color of each tomato on a scale from 1 = green to 10 = red. He viewed the tomatoes under incandescent light, which intensified small differences in tomato color, especially around the breaker stage. Color photographs from a commercial tomato color chart were used as references for several points on the scale.

G values on the colorimeter decreased as external color changed from green to red. G values correlated extremely well with visual scores and a/b ratios (beyond 1% level of significance) (Table 1). Although the R/G (red/green) ratio should be sensitive to changes in both red and green, the correlation coefficients of R/G with visual scores were lower than those obtained with G alone. G values can be read directly from the instrument, requiring no further calculations. R values were not related to tomato color change. The scoring ability of the horticulturist was confirmed by the high correlation between his visual scores and the a/b ratios.

Change in G values on the colorimeter appears promising as an indicator of external color change during ripening. Color can be evaluated rapidly under ambient lighting by workers having no previous experience with tomatoes. For studies involving ripening on the plant, tomato color could be evaluated easily in the greenhouse or field.

Peaches, single harvests, 1971. Ground color of 'Redhaven', 'Loring', and 'Blake' peaches was evaluated with the colorimeter as part of a study on maturity indices. Peaches of a given cultivar were harvested on one date, when most of the fruit were still firm. Measurements were made on the flat part of the cheek of each peach, most representative of overall ground color.

The percentage distributions of G values at harvest indicate variation in external color and maturity within harvest dates (Fig. 2). Patterns of the distributions were different for each cultivar, indicating overall differences in ground color. In developing maturity standards based on ground color, desirable G values for each cultivar would have to be determined. Because the new colorimeter is portable, percentage distributions could be calculated from measurements of peaches still on the tree. Harvests could be scheduled when a high percentage of peaches have developed the ground color desired. In studies on growth regulators and mechanical harvesting, G values might be used as a rapid estimate of uniformity of maturity.

Peaches, series of harvests, 1972. Ground color of 'Earlired' and 'Redhaven' peaches was evaluated over a series of harvests to determine effect of harvest date on G values. The diam of the colorimeter probe opening (4.1 cm) was too large to use with small, immature peaches from early harvests. If the curved surface of a peach extends into the probe opening, reflectance values are erroneous. A plastic ring 2.8 cm thick with a 2.7-cm opening was attached to the probe for all 1972 measurements. Reflectance values measured with the smaller opening were expected to be lower than those measured with the larger opening. To be sure that values were reduced equally for all colors, a series of colored book covers was measured. B, G, and R values measured with and without the plastic ring were very highly correlated (+0.98 to +0.99, beyond 1% significance level) (Fig. 3). The regression equation could be used for converting values obtained with one opening size to those obtained with the other.

Average G values for both cultivars in 1972 decreased over the series of harvests, as peaches matured on the trees (Fig. 4). From 20 to 100 peaches were harvested on each date. Firmness of a separate group of peaches from each of the harvest dates was measured with a Magness-Taylor probe mounted on an Instron Universal Tester. Average G vs. average firmness correlations were high for both 'Earlired' (+0.94, significant beyond 1% level) and 'Redhaven' (+0.88, significant at 5% level) peaches. For example, average G values for 'Redhaven' declined from 12 to 6 as peaches softened from 4.5 kg (10 lb.) to 0.9 kg (2 lb.). G value on the colorimeter appears promising as an indicator of peach ground color. Additional correlations of G vs. firmness could be used to establish new ground color maturity standards for individual cultivars.

The new portable colorimeter described in this report appears to be a useful tool for color evaluation of horticultural crops, especially in field or

Table 1. Correlation coefficients for 3 methods of evaluating external color of 'Homestead' tomatoes.

Ripening temp[z] (°C)	Correlations: G^y vs. visual score	G vs. a/b ratio	a/b ratio vs. visual score
10	−.93	−.92	.98
13	−.86	–	–
16	−.90	–	–

[z]Color evaluated after 2 weeks ripening; 42 or 43 fruits per temp.

[y]G = Green reflectance value on new colorimeter.

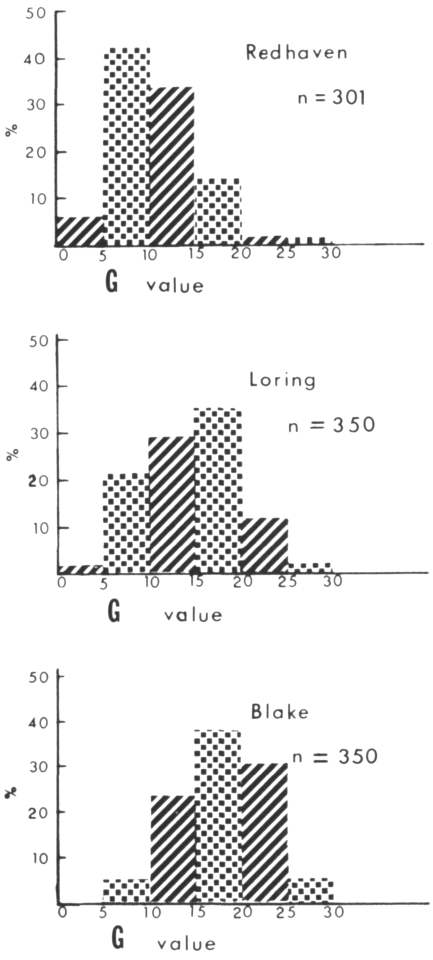

Fig. 2. Percentage distributions of G values for ground color of 3 peach cultivars, 1 harvest per cultivar, 1971.

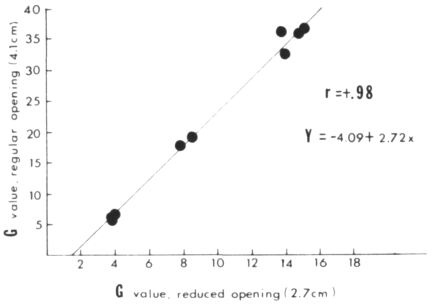

Fig. 3. Relationship of G values measured with regular (4.1 cm) and reduced (2.7 cm) light source openings on 9 colored book covers.

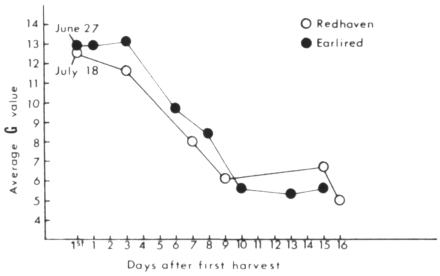

Fig. 4. Effect of harvest date on average G values for ground color of 'Earlired' and 'Redhaven' peaches, 1972.

greenhouse situations. Preliminary measurements of each product are required to select the instrument reading (B, G, or R) that is most closely related to visual color.

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A Simplified Soil Temperature Regulation System[1]

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Abstract. **A flexible, inexpensive system for experimental control of soil temperature independent of "above ground" temperature is described. The system is based on the control of air temperature around soil containers in an insulated sealed chamber.**

One difficulty in studying the influence of temp on plant growth is the limited ability to control soil temp independent of air temp. Use of water baths is limited by the no. and size of soil containers that can be used and in equipment costs. The system described by Woltz (1) is quite satisfactory for some purposes but the contiguous nature of the tanks makes randomization of treatments impossible and the equipment lacks flexibility from one study to the next. Because of these limitations we developed and are using a system based on the control of air temp surrounding soil containers in a sealed chamber (Fig. 1).

Our chambers, 61 cm wide, 122 cm long and 41 cm high, were constructed from 0.6 cm (¼ inch) plywood with 2.5 cm (1 inch) styrofoam insulation on the bottom and sides. Pots are held in place by a 1.9 cm (¾ inch) plywood cover with holes cut to fit. Pots are supported by wooden strips on the lower side of the lid. Fiberglass insulation sheets with slits cut around the plant stem cover the pots to reduce temp fluctuations. The 61 cm x 122 cm chambers will accommodate 28 closely spaced 12.7 cm (5 inch) pots.

A refrigerated liquid bath serves as a common source of cooling for all treatments that are to be maintained at low soil temp. A ½ hp portable cooling unit and a 80 liter (20 gal) plastic container insulated with fiberglass have been satisfactory. For the cool soil treatments the air inside the chamber is cooled by pumping refrigerated ethylene glycol-water solution from the refrigerated bath through a 15.2 m (50 ft) long 6 mm (¼ inch) ID copper coil inside the chamber with a submersible pump. Tygon tubing is used to supply cold solution to the coil and return it to the bath. A thermostat controls the pump. Connection of the sensing element of the thermostat to the cooling coil near the feeder end of the coil results in very little fluctuation of air temp inside the chamber. The thermostat setting needs to be slightly lower than the desired soil temp to achieve optimum results when equilibrium is reached. The exact setting is determined by trial and error. Circulating fans inside the chamber help maintain uniform temp.

Several different soil temp regimes can be maintained lower than air temp "above ground" by use of the one refrigerated bath. Each unit would be controlled by its own circulating system and thermostat. Thus for example, a liquid bath maintained at 0°C could be used to control one unit at +5°, another at 10°, and another at 15°. However, fluctuations increase as soil temp varies from that of the cooling bath.

For the warm soil treatments a similar insulated chamber is used and air temp inside the chamber is maintained by use of thermostatically controlled electric heating cables.

Soil temp fluctuations in the center of 12.7 cm (5 inch) pots does not exceed ± 1°C when thermostats with a differential of 2° are used to control the cooling or heating.

Plastic bags placed over the bottom of the pots help to keep them from drying out and moisture from collecting on the cooling coils.

Since the temp level of each chamber is controlled independently great flexibility is possible. Any number or size chambers can be included as long as the cooling capacity of the refrigeration unit is sufficient. Thus the number of replications and soil temp treatments can be easily varied. Some units can be maintained at a given soil temp throughout the experiment and others changed at given intervals to coincide with different developmental stages of the plants.

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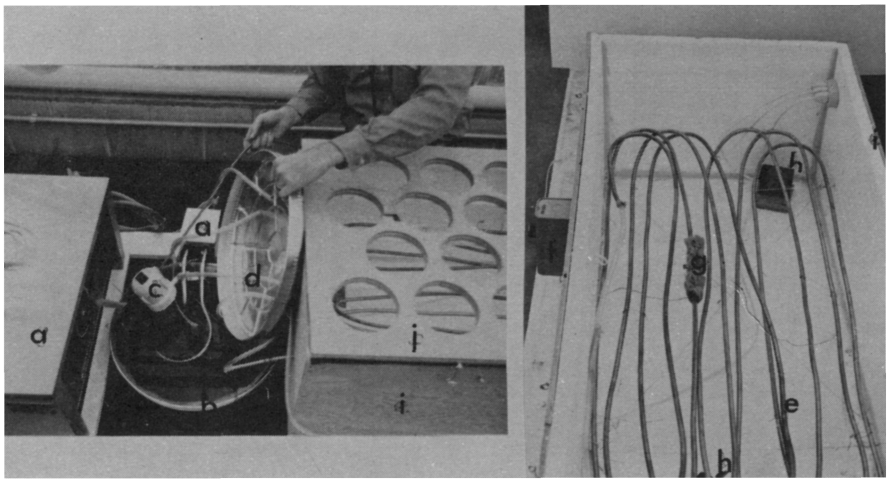

Fig. 1. Equipment for maintaining low soil temp; (a) portable cooling unit, (b) insulated water bath, (c) submersible pump for circulating coolant, (d) coolant supply line, (e) copper tubing cooling coil, (f) thermostat, (g) thermostat sensing element (connected to cooling coil), (h) fan, (i) plywood chamber insulated with styrofoam, and (j) lid for supporting pots.

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