

Orchard and vegetable fruit crop maturity determination using handheld NIR analyzers.



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A five-second analysis of fruit ripeness is possible using the PHAZIR. The PHAZIR is unique in that it is sensitive to the taste (organoleptic chemicals) and structure of the fruit. As a handheld non-invasive device, it can be used to rapidly determine the ripeness of an individual fruit by applying the analyzer to the fruit surface. The fruit is not damaged in any way. The analyzer is fast and reliable enough to allow a minimally-trained user to profile an entire field.

Maturity in Orchard and Vegetable Fruit Crops

Maturity of climacteric (apple, pear, grape, squash, melon) and many tropical fruits (including mango and citrus) is difficult to judge. Climacteric fruits for market are often harvested for market before full color develops. Certain varieties of pears, do not develop full color and flavor without harvesting. Citrus fruits do not develop color without suitable seasonal stress. Citrus fruits are occasionally stored "on-tree." During on-tree storage, the fruit slowly metabolizes stored nutrients leading to reduced warehouse storage life.

It is also well known that simple methods for determining maturity, *e.g.* days since inflorescence are inadequate.¹ Local climate conditions can promote or delay maturity of fruit on each individual plant. Color is a useful, but unreliable, indicator of fruit qualities. Loss of chlorophyll and an increase in anthocyanins progresses before or after sugar, acidity and flavors are at their peak. A suitable method for large-scale crop evaluation is sensitive to the taste and quality of the fruit and is rapid and usable by a minimally-trained operator.

Operating Principle

In the "long-wave" region of the spectrum, between 1000 and 2400 nm the colors arise primarily from water, cellulose, simple sugars, proteins and fats. These attributes are measured within a few millimeters of the skin surface. These attributes correlate directly with maturity.²

In fruits, the two most important measures of maturity are sugar content (usually in units of °Brix) and in acidity (pH or titratable/total acidity). These parameters are readily measured in the long-wave NIR.³ In some types of fruits, such as peaches, apples and melons total soluble solids and flesh firmness can be measured as well.⁴

PHAZIR Features

The PHAZIR is designed as an *analyzer*. An analyzer presents a simple to interpret result for a non-technical user. NIR instruments acquire a spectrum and require an expert user system to prepare samples, present and interpret the resulting spectrum. The PHAZIR was designed for the non-expert. An expert system interprets the spectrum and displays a phrase, like "ripe" or "unripe" or numerical results like "18 Brix, 5 pH" or "15 days until harvest". The results from all analyses are stored in an internal database that can be downloaded into any portable computer for analysis.



An example PHAZIR screen showing the result of a Brix measurement on a grape.

The PHAZIR is an effective tool for the rapid or more complete profiling of field maturity, allowing hundreds of measurements to be taken by a single operator. Decisions to harvest a field can then be rapidly made using the data displayed or with computerized analysis of the database. The expertise needed to interpret crop data can be captured in an expert system.

The PHAZIR is designed for long-term use. It weighs only 1.8 kg and the battery is designed to last for 10 hours of continuous operation. The optical engine is stable in typical temperature and humidity conditions. The PHAZIR has been proven in the field, providing millions of measurements per unit each year.

The PHAZIR is a general purpose tool, used in many industries. While Polychromix does not have ready-to-go calibrations for fruits, calibrations can be rapidly developed and maintained. We, and others, have also successfully transferred calibrations from other NIR instruments.

Conclusions

The PHAZIR is an analyzer that is ideal for the maturity determination of orchard and vegetable fruit. The long-wave NIR region is sensitive to the properties of fruit that contribute to taste and mouth-feel. The analysis that converts the measurement to a result is transparent to the user, allowing non-experts to use the device successfully. It is lightweight, rugged and long-lasting enough for all-day use day after day.

¹ Wm. Grierson, "Fruit Development, Maturation, and Ripening" in *Handbook of Crop and Fruit Physiology*. Ed. M. Pessarakli, Marcel Dekker, Inc., p.155 (2002).

² D. Pérez-Marín, M.T. Sánchez, P. Paz, J.E. Guerrero, A. Garrido-Varo, M.A. Soriano *Postharvest Biology and Technology*. Accepted Oct, 2008

³ D. Cozzolino, R.G. Damberg, L. Janik, W.U. Cynkar, M. Gishen, *J. Near Infrared Spectrosc.* **14**, 278 (2008).

⁴ K. Flores, M.T. Sánchez, D.C. Pérez-Marín, M.D. López, J.E. Guerrero, A. Garrido-Varo, *J. Near Infrared Spectrosc.* **16**, 91 (2008).