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Digital Imaging; A Useful Technique for Analysing Fruit Shape in Pears

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Abstract

Ratios of fruit height to width parameters are useful in describing the characteristic fruit shapes of cultivars and the genetic variability within pear breeding populations. The use of digital imaging provides a quick and accurate method of describing fruit shape in pears. Ratios for fruit height to width at 7 different positions were calculated for 8 pear cultivars.

Introduction

Fruit shape in pears varies widely between cultivars. There are the calabash shapes of 'Conference' and 'Beurre Bosc,' the ovate-pyriform shapes of 'Doyenne du Comice' and 'Ya Li,' the conical shapes of 'Shinsei' and 'Hong Li' and the rounded form of 'Hosui.'

Measurement of fruit shape has traditionally been based on comparisons with silhouettes of existing cultivars. Some descriptors incorporate ratios calculated from measurements of length and width (2, 3). These ratios are intended to give an indication of the fruit shape irrespective of size. Thus a perfectly round fruit would have a height:width ratio of 1 and a height:height of maximum width of 2, a pyriform fruit would have figures for the same ratios tending to be greater than 1 and greater than 2 and a conical fruit greater than 1 and less than 2 respectively. These two ratios are not always sufficient to fully differentiate between cultivars as they do not allow for the differing rates of taper that may occur from the widest point on the fruit to its extremities, for example, a fruit may be as wide as it is high, but need not be round. Width measurements at other points on the fruit give ratios with fruit height that reflect the fruit's shape at those points. These ratios collectively can provide an objective distinction between fruit shapes useful in cultivar description and in describing variability in breeding populations. In this study ratios were calculated for seven height and width relationships of eight pear cultivars.

Digital image analysis provides a quick and accurate means of measuring a range of parameters related to fruit shape. In the system we have developed, the fruit images are captured with an Ikegami model ICD-840P CCD video camera linked to a PCVISION-plus Frame Grabber installed in an IBM compatible personal computer (PC). The PC host computer performs the numeric computation and storage of data using the VIPS (1) image processing software package.

Materials and Method

Measurements were made on fruits of the pear cultivars 'Hosui,' 'Doyenne du Comice,' 'Williams bon Chretien,' 'Packhams Triumph,' 'Ya Li,' 'Beurre Hardy,' 'Beurre Bosc' and 'Conference' using the equipment described in the introduction. Each fruit to be measured was placed on a spike, calyx end down, backlit to give good contrast and snapped with the video camera (Figure 1a). The profile of the image was enhanced electronically to produce a profile of the fruit against the background and the spike and stem detected and removed from the image (Figure 1b). The host computer then calculated the height, the maximum width, the height of maximum width from the base of the fruit, and the

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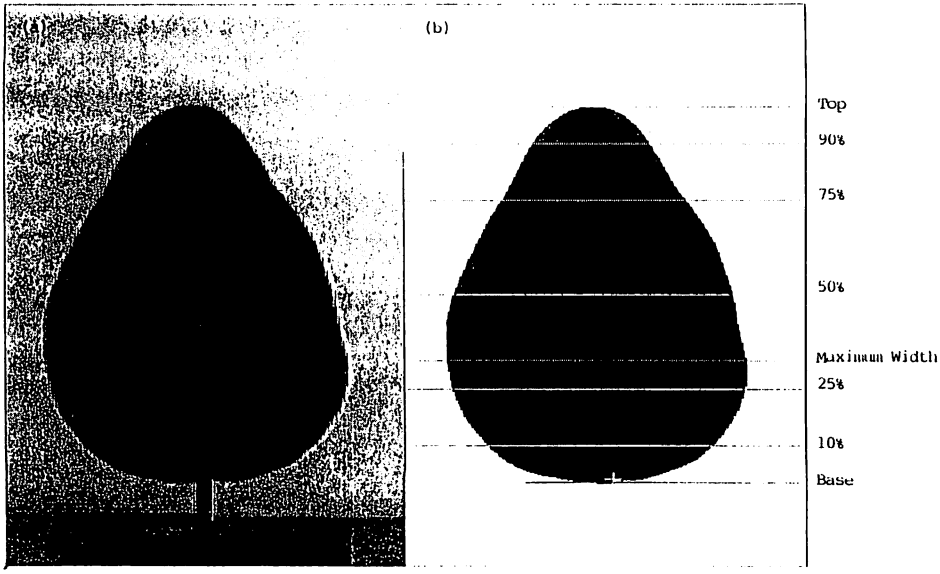

Figure 1. (a) Image and (b) Silhouette of 'Doyenne du Comice' and points of height and width at which measurements are taken.

The measurements taken were used to calculate ratios between fruit height and maximum width, height of maximum width and maximum width, and height to width ratios at 10, 25, 50, 75 and 90% of the height of the fruit (Table 1). They were also used to sketch an outline of the fruit graphically (Figure 2).

Results and Discussion

The 'Hosui' is a relatively symmetrical fruit and this is reflected in the ratios calculated for this cultivar. The ratios for fruit height to height of maximum width, 2.05, fruit height to maximum width, 0.90, and fruit height and widths at 50% fruit height, 0.92, are close, as are the ratios of fruit height to width at 10%, 1.31, and 90%, 1.41, and at 25%, 1.01, and 75%, 1.03. By comparison, for 'Conference' which has an elongated oblong-pyriform shape, the ratio between fruit height and, height of maximum width, 3.41, is consistent with an elongated fruit and the greater difference between the ratios for fruit height to maximum width, 1.57, and fruit height to width at 50% fruit height, 2.01 with a pyriform shape. The large differences between the ratios of fruit height and width at 10%, 2.02, and 90%, 5.31, and at 25%, 1.60, and 75%, 3.57, are expected for a fruit which has elongated oblong-pyriform shape.

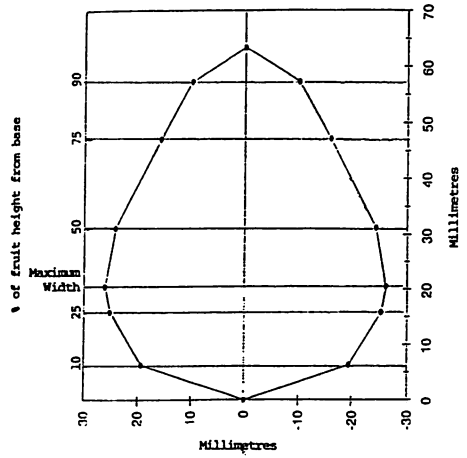

Figure 2. Graphical reproduction of fruit shape from measurements taken on fruit in Figure 1.

Table 1. Ratios calculated from height and width dimensions from fruit of 8 cultivars of pear.

	Height of fruit: Height of: maximum width	Height of fruit: Maximum width	Height fruit: Width at 10% height	Height of fruit: Width at 25% height	Height of fruit: Width at 50% height	Height of fruit: Width at 75% height	Height of fruit: Width at 90% height
Housi	2.05	0.90	1.31	1.01	0.92	1.03	1.41
Doyenne du Comice	2.69	1.14	1.52	1.20	1.20	1.83	2.86
WBC	2.55	1.19	1.66	1.27	1.24	1.93	3.17
Packhams Triumph	2.95	1.20	1.56	1.24	1.32	2.15	3.03
Ya Li	2.40	1.24	1.78	1.34	1.26	1.72	2.80
Beurre Hardy	2.81	1.25	1.71	1.31	1.35	2.26	3.94
Beurre Bosc	3.62	1.52	1.87	1.54	2.00	3.42	5.67
Conference	3.41	1.57	2.02	1.60	2.01	3.57	5.31

The measurements taken enable the distinction between cultivars which have similar shapes. 'Beurre Bosc' is elongated similarly to 'Conference,' but has a more accentuated pyriform shape. This is reflected in the difference between the ratio of fruit height to height of maximum width for 'Beurre Bosc,' 3.62, being greater than for 'Conference,' 3.41 showing that the point of maximum width for 'Beurre Bosc' is relatively closer to the base of the fruit than for 'Conference.'

The measurement of fruit at 10, 25, 50, 75 and 90% of fruit height besides fruit height and maximum width provides a more sensitive measure of fruit shape and better distinction between cultivars than just taking fruit height and width. The extra measurements were not sufficient to describe the concavity at the neck of the fruit, however, as demonstrated with 'Doyenne du Comice' where the obvious concavity at the neck in the fruit's image (Figures 1a and 1b) is not reproduced in the graphical representation (Figure 2). Increasing the number of points at which width measurements are taken on the fruit would increase the sensitivity of the ratios to any variations in fruit shape, particularly in the areas of the neck and base of the fruit, also providing a more accurate graphical reproduction of the fruit shape.

Accurate objective descriptions of fruit shape are important in providing measurable distinctions between fruit and cultivars for use in studies of the genetics of fruit shape and the development of fruit descriptors. Digital imaging provides a useful technique in achieving this.

References

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