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Tree Trunk Measuring Device

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Abstract

An apparatus designed to measure the trunk circumference of fruit trees is described herein. It has been invented to replace the traditional measuring tape method commonly used by pomologists. Field tests were conducted with both methods in order to compare their respective results. In terms of mean circumference and accuracy no significant difference could be found between them. Using the apparatus made the work easier but the weight of the apparatus should be decreased.

Introduction

It has been widely recognized that trunk size is the most reliable indicator of tree vigor in apple and other tree-fruits. Westwood (7) has stated that the usual method of obtaining plant efficiency is to calculate grams or kilograms of fruit per square centimeter of cross-sectional area of the trunk. In order to calculate the production efficiency of fruit trees, a new common practice used by pomologists is to express the yielding capacity of a stion on a per trunk cross-sectional area basis (1, 2, 3). This method has been accepted and adapted by the members of the NC-140 working group (5, 6). The traditional way of obtaining the trunk cross sectional area is to measure its circumference at 15 cm above the graft union with a measuring tape (4) and to calculate the area from this measurement. A somewhat quicker way was to measure the trunk diameter with a caliper and to calculate the cross sectional area. This latter method was not accurate enough since most tree trunks are not round and the measured diameter depends on the relative position of the caliper around the tree.

The trunk of a fruit tree, especially that of a tree trained in a high density system does not lend itself to easy measuring on account of its low profile branch canopy. In many cases, kneeling down is necessary to achieve this operation. Whenever this is executed in the fall or early winter, wet soils, wet grass or snow make it a tedious job. Measuring may also be obstructed by large perennial weeds. The purposes of the present study were to develop an instrument that would improve the working conditions during measurements of tree circumference and to compare the measurements obtained by the new instrument with those obtained by the traditional method.

Materials and Method

As seen in Figure 1 the instrument consists of an aluminum tube bolted at one extremity to an acrylic half-ring. A second acrylic half-ring is attached at one end to the first one through a spring loaded strap hinge in order to wrap around the trunk of a tree. A metallic wire is attached to a handle controlling the opening and closing of the ring. Two eyelets are placed at the free tips of the two half-rings. A nylon cord is attached to the eyelet of the moving half-ring and passes through the eyelet of the bolted half-ring and along the stem of the instrument. The other end of the nylon cord is attached to a self winding metallic measuring tape. The tape is pulled to measure the circumference of the tree trunk when the nylon cord encircles it. The moving half-ring is properly positioned when the two eyelets meet together against the tree trunk. The self winding measuring tape is set to zero with an adjustable zero set point indicator.

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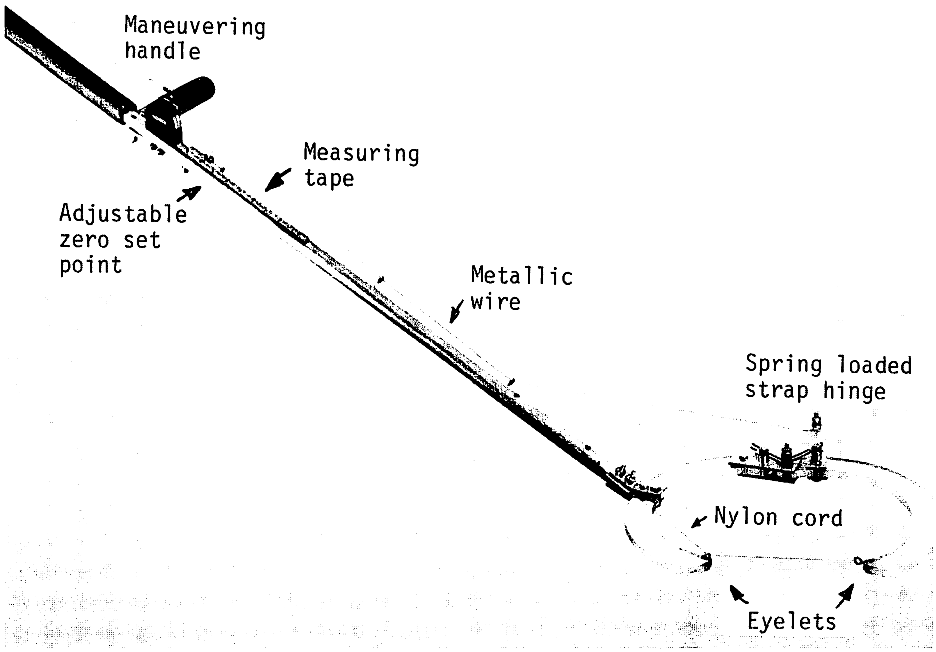

Figure 1: View of the tree trunk measuring device for circumference measurement.

Experimental trials were performed with three different persons using both the traditional method and the new instrument. The measurements were taken on a set of eight trees for the first and second person and on another set of eight trees for the third person. For both measuring methods, and for all users, three sets of measures were taken on each tree to permit a better study of the variation in the manipulations. The first and second persons were novices in the use of both methods whereas the third person had used the traditional method.

An F-test statistical analysis was performed to determine if a difference in the results obtained with both methods could be attributed to the skills of the user. An analysis of the variation coefficient of the measurements of each tree, method and experimenter was used to evaluate the effect of different users and methods.

A third method consisting of using the trunk measuring device equipped with a chain height gauge was also tested. It merely consisted of adding a 15 cm long chain to the eyelet of the bolted half-ring of the instrument. The attached end of the chain gave the height at which the tree trunk should be measured. An F-test was performed on the data collected by the second person on the same set of eight trees. When a significant difference was found with the F-test statistical analysis at a 0.05 level of significance, a Duncan multiple range test was used to differentiate the means of the parameters.

Results and Discussion

In using the new tree trunk measuring device, the users did not have to bend or kneel down to measure the circumference of the tree since the measurement was successfully made standing straight while reading the tape. The new instrument was found as easy to use as the traditional method although not any faster since care had to be taken to ensure the proper closing of the acrylic ring at the time of measurement.

The three experimenters found that the new instrument, weighing 1.47 kg. was tiring for the wrist, thus some changes could be recommended to lighten the apparatus. The thickness of the aluminum tube and of the acrylic neck could be reduced. The handle of the instrument could be redesigned with an angle to match the angle of the arm holding the apparatus to decrease the tension on the wrist of the user.

The instrument was designed to measure tree trunks up to 20 cm in diameter. If the instrument was to be rebuilt the acrylic neck dimensions could be either decreased or increased to satisfy the needs of the user which will affect the total weight of the instrument.

No significant differences between coefficient of variations were obtained for small or large tree diameter ($F_{1,30}$ = 2.36, P = 0.14). The results obtained showed no significant difference between the three experimenters ($F_{2,37}$ = 0.13, p = 0.88) and between the methods ($F_{1,37}$ = 0.10, p = 0.75). Another statistical analysis was run on the circumferences obtained for each tree by each of the experimenters, to determine the effect of both methods on the accuracy of the results. The F-test showed no significant difference between the traditional and new method for measuring tree trunk circumference and that for each experimenter (EXP1: $F_{1,7}$ = 1.57, P = 0.25; EXP2: $F_{1,7}$ = 5.10, P = 0.06; EXP3: $F_{1,7}$ = 0.64, P = 0.45).

It has been postulated that when using the method of a rubberized fabric measuring ribbon, the estimation of a 15 cm distance from the graft union should be rather accurate since the experimenter is close to the tree trunk. When a non experienced person uses the new instrument it should be harder to estimate the 15 cm height from the graft union because the experimenter has to stand some distance away from the tree. With a height guage, the variability between measures should be decreased. An F-test statistical analysis demonstrated that there was a significant difference between the chain method and the other two previously described methods ($F_{2,21}$ = 5.51, P = 0.01). As can be seen in Table 1, the mean circumference measurements obtained with the chain method was significantly lower than those obtained with the two other methods. This lower diameter could be due to a greater distance between the graft union and the height of measurement; likely caused by a parallax problem when using the chain as a reference. The mean coefficient of variation obtained with the chain method was significantly higher than the two other methods. Hence this method was less accurate and was rejected.

Table 1. Comparisons of three methods for experimenter n⁰ 2 using the Duncan multiple-range test.

Method	Mean of circumference(1) (cm)	Mean of coefficient of variation(1)(2) (%)
Ribbon	22.9 a	1.11 a
Instrument	22.7 a	0.93 a
Chain	22.2 b	3.75 b

(1) Means followed by the same letter are not significantly different at the 0.05 level of significance.
(2) The coefficients of variation were obtained from the three replicates of each method for each tree.

Conclusions

The instrument designed for measuring tree trunk circumference has proven to be useful and as accurate as the conventional method. Some improvement could be made to lighten its weight, but the objective of simplifying the manipulation has been achieved. The mechanical measuring tape could be replaced by an electronic device which could be linked to a portable data logger to automate the data acquisition further.

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Heritability of Flowering and Harvest Dates in *Vaccinium corymbosum* L.

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Abstract

Six highbush cultivars with varying flowering dates and fruit development periods were crossed in a diallel fashion to measure the heritability of flowering and harvest dates. Significant levels of general combining ability were observed for both of the traits, along with high levels of heritability. 'Bluejay' and 'Spartan' show promise as parents which can both delay flowering and hasten harvest.

Introduction

Spring frost damage is of major concern in the highbush blueberry production regions of North America. It is an unusual year when there is not at least some damage across the region and the degree of crop loss in the leading producing state, Michigan, has ranged from a few percentage points to as much as 30% over the last decade (6, 8).

From a breeding perspective, there are two solutions to this problem: 1) blossom tolerance to frost can be increased, or 2) flowering date can be delayed until the chance of frost is minimal. Several studies have shown that there is little variation among cultivars in blossom tolerance *per se*, but there is a large amount of variation in the developmental rate of buds and their subsequent flowering date (8, 9, 10). This makes breeding for a delay in bloom the most feasible strategy.

Unfortunately, most of our early ripening cultivars are also early flowering, making them highly subject to frost damage. To avoid this problem, breeders will have to reduce the strong positive association between flowering and harvest date. This has already been done in a few instances, as 'Spartan' is one of the earliest ripening cultivars in Michigan, but also has a later than average bloom date (8). Similar claims have been made for the recently released 'Duke' (Draper, pers. com.). It appears that there are no physiological barriers to combining late flowering with early ripening.

In this study, we measured the heritability of flowering and harvest dates among six northern highbush types as a prelude to developing a new generation of late flowering/early ripening cultivars. Lyrene (9) had conducted a similar study on rabbiteye types and

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