The USDA Pear Breeding Program[1] III. Fruit Evaluation

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Abstract

In the USDA pear breeding program, fruits are harvested between mid-July and November because of wide variation in maturation time among seedling trees. Six-fruit samples are picked when mature as determined by color of skin and lenticels, ease of separation from the fruit spur, darkening of the seeds, change in sugar content of the fruit, or a combination of these characteristics. The fruits are stored at 0°C from 1 week to 3 months before ripening for about 7 days at 18°-20°C.

Each sample is evaluated and all fruit characteristics are recorded on machine-readable forms for processing by computer. All fruit data are compiled and stored in a computer master file for future use. Printouts of these data that also shows the lowest fire blight rating for each seedling, are very useful in selecting trees to be harvested, planning genetic studies, and choosing new selections in the field.

The two previous reports in this series on the pear breeding program of the U. S. Department of Agriculture covered spring pollination and seedling tree evaluation (1, 2).

All phases of the pear breeding program are carried out at Beltsville, Maryland, and at Wooster, Ohio. Investigators at both locations work together to standardize the fruit evaluations so that data are comparable. Differences in season between the two locations are compensated for by using the Bartlett pear as a standard for comparison.

Picking and Storage

Fruit samples from seedling trees, named cultivars, and selections are collected each year for evaluation. Selected cultivars and selections are picked weekly for as many as 4 weeks and a pressure test is made at each picking. Data accumulated over a period of years should permit the determination of the optimum picking time for these cultivars and selections.

Seedling trees to be picked for the first time are flagged with white plastic tape in July for easier detection during the harvest season. Up to six fruit that best represent the tree are picked as a sample. When possible, each seedling is evaluated a 2nd year. A yellow flag is attached to seedlings fruiting for the second time and to seedlings that have had high evaluation scores. Since the seedlings are maintained for only 10 years, some of them do not fruit or fruit only once during this time. Seedlings with superior fruit quality ratings, as shown on computer records, are picked annually to maximize the volume of data on those with cultivar potential. When possible, promising seedlings are picked up to four times per season to increase the probability of picking a given seedling at the best time. On seedlings to be sampled more than once, a red flag for each sample picked

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is added to the white or yellow flag. As the harvest of a given seedling is completed, all flags are removed.

The seedlings vary greatly in fruit-ripening characteristics, which makes it difficult to determine the proper picking date for each seedling. Some fruit are found that are tree ripened and have to be evaluated on the day they are picked. Others are picked too early and do not ripen properly. During the harvest season, fruit on all seedlings to be sampled, are observed at least once a week for the following maturity indicators:

1. Color change from green to greenish yellow.
2. Softening of the fruit as determined by applying pressure to stem end of the fruit with the thumb.
3. Change of lenticel color from white or a light color to tan or a darker shade.
4. Ease in separating the fruit stem from the spur with a simple upward twist.

If maturity is still in question after these observations, a fruit can be cut and tested for sugar content, which usually rises with advancing maturity. Also, the seeds can be observed for darkening of the seed coat.

The picked fruit samples are placed in perforated bags with a slip of paper showing the Julian picking date and the tree identification. The samples are moved quickly to cold storage at 0°C and 90% relative humidity for future evaluation.

For storage at Beltsville, the bagged samples are placed in slotted fruit boxes with one layer in each box. The fruit boxes are stacked on pallets away from the wall to allow maximum circulation of air. At Wooster the samples are stored on shelves. The samples are screened in October and November to identify those that need to be evaluated out of sequence because of short storage life.

Fruit Evaluation

Fruit evaluation starts as soon as the rush of harvest slows down so that personnel are available, usually about October 1. About 80 samples per day, in the order in which they were picked, are moved from storage to ripening rooms maintained at 18° to 20°C. Most samples are ripened for 7 days. Extra ripening time is given to those needing it. The ripened fruit is evaluated in a laboratory and the data are recorded on a machine-readable form (Fig. 1). This same form is used for seedling, cultivars, and selections. Data on the completed forms are mechanically punched on ADP cards. The data are edited by the computer to eliminate detectable errors and then transferred to tapes for long-term storage and retrieval.

Most of the codes used on the recording form are shown on the form (Fig. 1) and are self-explanatory. Following is an explanation of codes that are not self-explanatory:

Cultivar/Seedling — Seedling fruit are designated as 1. Cultivar and selection fruit are designated as 2.

Progeny Number/Cultivar Code — The seedling progeny of each cross is assigned a unique five-digit number. The first two digits are the last two digits of the year the progeny was planted. The last three digits designate a given cross.

Location — Locations are coded as previously described (2). Additional location codes are used for the evaluation of fruit obtained from sources outside the USDA.

Harvest Date, Date from Storage and Evaluation Date — All dates are Julian dates to facilitate computation of the harvest date in relationship to the harvest date of Bartlett and com-

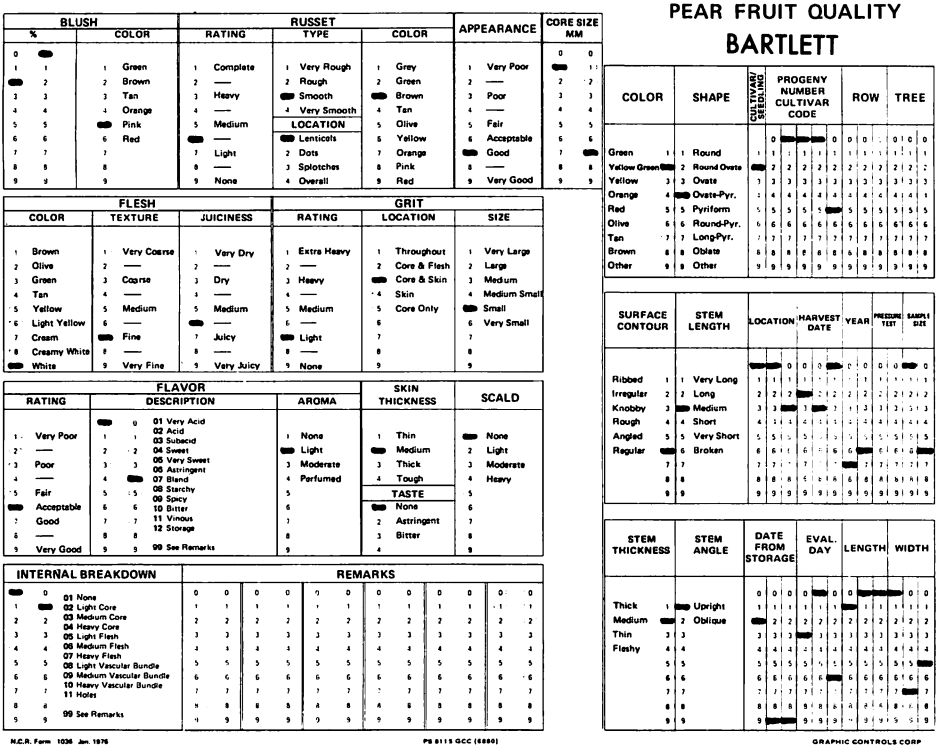

Figure 1. Machine Readable form for data on various characteristics of pear fruit

putation of the length of storage and ripening periods.

Pressure Test — Pressure tests are made on cultivars and selections only to establish a criterion for picking. A Magness-Taylor pressure tester with a $\frac{5}{16}$-inch (8-mm) diameter plunger is used on pared flesh and the data recorded in 1 pounds.

Sample Size — When possible, six representative fruits are picked as a sample. Some samples comprise only a single fruit, but any evaluation based on fewer than four fruits is considered of questionable value, except as an indication that the juvenile period of the seedling has ended.

Length and Width — Fruit length and width are measured in millimeters. A width of 63 mm (2½ inches) is the minimum acceptable size for fruit for commercial purposes. Smaller diameter fruit may be used in the breeding program.

Remarks — Each remark is assigned a number as the need arises to note exceptions to the ripening routine and to add additional information that

could affect the evaluation of a given seedling, cultivar, or selection.

A quality index is calculated on the computer from the data on each evaluation form and made a part of the permanent record. Data on russet, appearance, grit, flavor, and texture enter into the calculation of the quality index. The five characteristics are each rated on a scale of 1 to 9 and weighted according to their relative importance. The quality index of Bartlett is calculated in Table 1, as an example. Bartlett, with a quality index of 72, is the standard of comparison for all fruit. The Bartlett ratings have been established over many years of fruit testing and it allows ratings for superior qualities to remain within the established range of 1 to 9.

Fruit data for the current season are added to the master data files and a listing for seedlings (Fig. 2) is printed. A similar list is made for selections and cultivars. The listing includes the lowest twig fire blight reading obtained on each seedling, selection, or cultivar which has had fruit evaluated. The listings are used just before harvest to select seedlings to be flagged for harvest as previously mentioned. The computer listing of seedling with a quality index above 68 greatly reduces the work required in selecting seedlings for retention in the program.

Discussion

Pear fruit evaluation is more than the elimination of seedlings with inferior fruit. Studies on the inheritance of specific characteristics (3, 4) can aid in the judicious recombining of various characteristics into more desirable pear cultivars. In the USDA program detailed data are taken on 32 fruit characteristics. These data are prepared as computer input and are stored on tape until enough have been accumulated to make inheritance studies possible. These data are also used in deciding on the retention of given seedlings in the breeding program and as evidence to support the introduction of new cultivars and selections. Seedlings are frequently selected for retention in the breeding program as parental stock because of specific characteristics although the seedlings have no potential as new cultivars.

The Bartlett cultivar has been established as the standard for fruit quality evaluation. Each year by use of the maturity factors listed in the section on picking and storage along with a 16 to 18 pound pressure test reading, a specific ripening date for Bartlett is determined at Beltsville and Wooster. Records show that over the years this date has varied as much as 20 days at each location. The Beltsville season is usually about 2 weeks ahead of the Wooster season.

The decision to harvest a given seedling two to four times in a single season may be made at harvest time

Table 1. Example of calculation of pear fruit quality index with data of Bartlett.

Characteristic	Bartlett rating*		Multiplier	Quality index score
Flavor	6	x	4	24
Grit	7	x	3	21
Texture	7	x	2	14
Appearance	7	x	1	7
Russet	6	x	1	6
		Total quality index		72

*Rating scale: 1 (worst) to 9 (best).

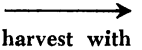

Fig. 2. Sample of pear fruit data print out. Heading HARVREFBART = harvest with reference to Bartlett.

PROGENY	TREE NO	LOCATION	YEAR DATA	HARVEST BART	PRESSURE	DSATYO SR AIGNE	DRAI YPSE NTO	SIZE (MM) LENGTH	SIZE (MM) WIDTH	SAMPLE SIZE	SHAPE FORM	SHAPE SURFACE	STEM LENGTH	STEM THICKNESS	STEM ANGLE	COLOR	BLUSH PERCENT	BLUSH COLOR	RUSSET RATING *	RUSSET TYPE	RUSSET LOCATION	RUSSET COLOR	APPEAR *	FLESH COLOR	FLESH TEXTURE *	FLESH JUICINESS	GRIT RATING *	GRIT LOCATION	GRIT SIZE	FLAVOR RATING *	FLAVOR ACIDITY	FLAVOR AROMA	SKIN THICKNESS	SKIN TASTE	CORE SIZE	INTER BREAK	SCALD	REMARKS	QUALITY *	TWIG BLIGHT
US 56112-146 *		EWART																																						
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if the fruit shows exceptional characteristics. If a seedling is bearing for the first time, a single fruit may be taken as a record that the juvenile period of that seedling has ended. Samples of cultivars and selections are pressure tested at harvest and handled much the same as the samples of seedlings. Several samples of some cultivars may be taken as a check on the best harvest date and the optimum length of storage life.

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Yield and Its Components in the Strawberry Cultivar Olympus

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Abstract

Shoot and fruit development in the strawberry cultivar Olympus were examined at 2 sites, one in Washington and the other in Oregon. It differed from conventional cultivars in its marked crown-branching habit, and showed early and vigorous vegetative growth and a high number of flowers per inflorescence. Analysis of yield components indicated a yield potential of about 44+ ot/ha (19 t/a) but there was a tendency for flower failure or fruit malformation in the primary and secondary ranks of the inflorescence. Plants at the Oregon site exhibited a much greater development of secondary inflorescences than those in Washington.

Experiments at the North Willamette Experiment Station (NWES), Oregon (3) have shown that the new cultivar Olympus has the greatest yield potential of any cultivar so far released in the Pacific Northwest. The aims of the present work were to investigate the form of the development of the cultivar in the field, and to assess the relative importance of its various yield components.

Materials and Methods

Olympus shows a high degree of crown branching and only limited runnering (1). The cultivar Totem (2) was selected as a standard because of its more conventional runnering habit.

Plants for dissection were lifted from a field near Puyallup, Wa, at approximately 2 week intervals from March until May. The plants were in the first full fruiting year, i.e., in their second year after (spring) planting, and were grown on the hill system at about 40 cm (18″) spacing in the row. On each sampling date 2 plants of each cultivar were divided into individual crowns and these were further

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