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An Interactive Microcomputer Program for Development and Calculation of a Plant Breeding Selection Index

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Abstract. **A microcomputer program was written to enable the development and calculation of a selection index appropriate for the objectives of any plant breeding program. Other features of the computer program include the capability to accept numerical character rating scores and statistically analyzed objective measurements, estimate missing data, average multiple year data, and storage of breeding line data with output capability.**

Plant breeding programs are designed to achieve continuous genetic improvement of populations with regard to several important characters, each of which contributes to the overall merit of an individual. Superior cultivars are developed by selection from an improved population. There are 3 general methods for multicharacter population improvement; tandem selection, independent culling levels, and index selection (4). Index selection is expected to give the most rapid improvement of economic value (2, 3, 4, 7, 13).

The use of a selection index in plant breeding was proposed by Smith (9), who applied Fisher's (5) concept of discriminant functions to determine the net value of an individual. The general formula for a selection index using n characters is $I = \sum_{a=1}^{n} b_a X_a$, where b_a is a weight value assigned to or calculated for character a, and X_a is the phenotypic value of character a. Smith (9) and others (1, 2, 3, 10) have used genotypic and phenotypic variances and covariances and relative economic value to determine the appropriate weight for each character.

Williams (11) described a potential bias in Smith's weighting method arising from errors in population parameter estimates, and proposed a simplified selection index (the base index) in which characters are weighted directly by their relative economic value. In a 5-cycle multicharacter selection experiment with alfalfa, the base index and Smith's selection index were demonstrated to be superior to tandem selection and independent culling levels (3). The base index was at least as effective as the selection index and was preferred for its consistent response and simplicity of application.

Although fruit breeding programs typically are concerned with multicharacter selection, index selection rarely has been used. Morrow et al. (8) noted that most fruit breeding programs are aimed at solving specific problems and therefore do not require overall merit scores. A further criticism of index selection was the difficulty in determining the relative importance of characters. Watkins and Spangelo (10), however, were encouraged by the genetic progress achieved with a selection index for 7 characters in strawberry. Genetic progress in improving overall merit using the index was only slightly less than selection for yield alone, suggesting that improvements in yield could be made without sacrificing other desirable characters. Fogle (6) used weighted progeny data to obtain cumulative scores for identifying prepotent peach and nectarine parents. He concluded that percentage of selections from combined progenies did not necessarily delineate the most prepotent parents. Yadava et al. (12) recently proposed a type of selection index called a desirability index for predicting the commercial potential of fruit tree breeding lines. Phenotypic values are converted into LSD units, multiplied by a weighting factor, and the cumulative score of each breeding line is compared to that of a standard commercial cultivar.

Because of the demonstrated effectiveness of index selection using the general formula of Smith (9), this selection method was chosen for use in the grape breeding program at Florida A&M Univ. In order to facilitate the calculation of the selection index, a computer program, designated SELECTION INDEX, was written in BASIC for the Commodore 64 microcomputer. The program is designed to be highly interactive, enabling the user to develop a selection index for the specific objectives of any plant breeding program. The computer program also has been rewritten in BASIC for use with Apple microcomputers.

An outline of the computer program's functions is given by the Master Menu (Fig. 1). The selection index is developed by the user, who creates the list of characters evaluated and assigns weight values to each character. A maximum of 30 characters can be evaluated and weight values have no limitations. Since the computer program uses the general formula for a selection index ($I = \sum_{a=1}^{n} b_a x_a$), any method may be used for determining weight values. Calculations using population parameter estimates to determine appropriate weight values are not done by this program, so these should be done prior to assignment of weight values. The selection index can readily be modified at any time by changing the character list or weight values.

Characters and weight values to be included in the selection index should be chosen judiciously to avoid a biased index. Inclusion of several intercorrelated characters, such as components of yield, could result in an index biased for the composite character (yield) if weight values for all characters are not appropriately adjusted.

Breeding line data entry is conducted in part 2 of the program. A maximum of 500 breeding lines can be evaluated. Two types of data are accepted by the program; subjective rating scores on a scale of 1–10 (10 best), and objective measured data analyzed by Duncan's multiple range test. Means analyzed by Duncan's test are converted to a 1–10 scale based on the letters assigned by the analysis (i.e., a = 10, b = 9, etc.). Letters from k through z are given a value of one. This system could result in slightly inflated values for the poorest performing lines, but it is not expected to influence the total index score seriously. In the case of multiple let-

Master Menu

Key	Operation
1	Develop Selection Index
2	Enter Breeding Line Data
3	Selection of Superior Lines
4	Selection for Specified Characters
5	Data for Specified Breeding Line
6	Complete List of Breeding Line Data
7	Quit Program

Fig. 1. Master menu for the SELECTION INDEX computer program.

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The Top 5% of 200 Breeding Lines

Breeding Line	Score
1013	164
1095	159
1148	157.5
1024	157
1162	156.5
1027	155.5
1088	154
1018	150.5
1076	150
1122	149
Mean selection index = 155.25	
Mean Character Scores	
Yield	8.85
Berry wt.	7.60
Cluster wt.	7.70
Flavor	8.35
sugars (%)	7.90
Acid (%)	7.95
Pierces R.	8.00
Blk Rot R.	8.70
Anthrac R.	7.90

Fig. 2. An example of SELECTION INDEX output with hypothetical grape breeding line data.

determined for each breeding line. The data can be accessed by parts 5 and 6 of the program. Part 5 allows the user to see data of a specific breeding line, whereas part 6 provides a complete listing.

The SELECTION INDEX computer program provides quick and convenient development and calculation of a selection index for a plant breeding program. A listing of the program or a disk copy are available from the author.

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ters, an average score is calculated (e.g., ab = 9.5).

Any number of years of data may be included in the data base. The program calculates mean character scores for each breeding line based on the number of years of determined data. Breeding lines do not have to have the same number of years of data.

Missing data are handled individually for each character of a breeding line in one of 2 ways. If no previous data are available, the population mean score for the character is used as an estimate of a breeding line's missing score. When data are present for a breeding line, its mean score for a character is used as the missing year's score.

Calculation of the selection index is performed in part 3 of the program. Character scores are multiplied by weight values and the products are summed to produce the cumulative index score. Breeding lines then are sorted from high to low by their index scores. The user specifies the percentage of breeding lines to select, and the top specified percentage of breeding lines and their index scores are displayed as output (Fig. 2). The program then provides data for the selected population. The mean selection index score and mean character scores are given (Fig. 2).

The selection index can be modified in part 4 to include only certain characters in the index calculation. The user then can select for only one character or any combination of characters from the original list. This option can be useful in identifying outstanding individuals for specific characters.

Breeding line data are stored by the program as unweighted scores. Multiple-year data are stored as mean scores, and the number of years of data represented by the means is

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Rewetting Characteristics of Container Media Composed of Gasifier Residue in Combination with Pine Bark or Peat Moss

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Abstract. **Rewetting of gasifier residue (GR) at 0% of container capacity was greater than milled pine bark (B) or Canadian sphagnum peat moss (P). The percentage of container capacity necessary to obtain 80% rewetting of GR was substantially lower than for either P or B (5%, 23%, and 25%, respectively). Neither the rewetting of B, P, or GR at 0% of container capacity, nor the percentage of container capacity necessary to produce 80% rewetting of these media were affected by Aqua-Gro wetting agent (WA). Addition of GR in excess of 75% substantially increased the percentage of rewetting of both B and P.**

Milled pine bark and Canadian sphagnum peat moss are major container medium components used by many growers of woody ornamentals. These materials have a number of positive characteristics which make them ideal for the production of plants. (3, 4). Bark and peat are both hot-air dried during processing; subsequently, a problem with both materials is the difficulty of rewetting after they have been dried (1).

Rewetting characteristics of a substrate can be important in reducing moisture stress during the early growth of short term crops (1). Beardsell (2) suggested that a medium should rewet easily to 80% of container capacity. Wetting agents have been recommended for incorporation during mixing of bark- or peat-based media or for periodic use in the irrigation water to increase rewetting (5). Gasifier residue was found to have superior physical and horticultural characteristics as a container medium component for woody ornamentals (7, 8). The objectives of this study were to determine the rewetting prop-

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