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.

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

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Additional index words. wetting agent, percentage of container capacity

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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Table 1. Regression equations of percentage of rewettability on the percentage of container capacity.

Medium[z]	Equation	R^2 [y]
B	y = − 3.61 + 3.41x	0.83**[x]
B + WA	y = − 1.71 + 3.54x	0.89**
3B:1GR	y = − 1.40 + 3.38x	0.94**
1B:1GR	y = 20.70 + 2.91x	0.92**
1B:3GR	y = 53.26 + 4.38x − 0.01x²	0.95**
P	y = − 10.68 + 3.89x	0.87**
P + WA	y = 6.05 + 4.05x	0.82*
3P:1GR	y = 4.10 + 3.38x	0.82**
1P:1GR	y = 16.12 + 3.24x	0.88**
1P:3GR	y = 61.28 + 3.05x − 0.06x²	0.83**
GR	y = 66.30 + 3.09x − 0.07x²	0.89**
GR + WA	y = 66.30 + 2.82x − 0.06x²	0.96**

[z]B = pine bark, P = Canadian sphagnum peat moss, GR = gasifier residue, and WA = wetting agent.
[y]R^2 = coefficient of determination.
[x]Significant at the 5% (*) or 1% (**) level.

erties of gasifier residue, and the effect of this material on the rewetting of bark and peat relative to a wetting agent.

Treatments consisted of GR:B or GR:P in 100%:0%, 75%:25%, 50%:50%, 25%:75%, or 0%:100% ratios (v/v), and GR, P, or B alone with wetting agent (WA). The wetting agent, Aqua-Gro (Aquatrols Corp.), was incorporated into the media in granular form (40% a.i.) at the rate of 884 g/m³. Medium combinations were mixed in a 0.09 m³ rotating cement mixer. Particle size distributions of GR, B, and P were similar to those previously described (8).

Each medium was placed in six 19 liter containers to a depth of 7.5 cm and saturated with water. Complete saturation had occurred by the end of 2 weeks. After stirring, 6 medium samples from one of the 19 liter containers per medium were placed in 6 × 6 × 9 cm pots to a depth of 7.5 cm, and bottom holes of pots were sealed. After 24 hr of saturation, pots were drained for 24 hr to determine container capacity according to White and Mastalerz (9).

The remaining five 19 liter containers of each medium were air-dried at 32° ± 6°C to predetermined wet weights to establish a series of media moisture contents based on the percentage of container capacity for each medium at a 7.5 cm depth. Samples of each medium were removed at 0%, 5%, 10%, 15%, 20%, and 30% of container capacity. Seven equal-weight subsamples of each medium were placed into 6 × 6 × 9 cm pots and settled to a depth of 7.5 cm by tapping the container bottom. Three subsamples were used to determine the exact percentage of container capacity for each medium at the time of testing. The remaining 4 subsamples were sprinkled over a 30 min period with 100 ml of water, which exceeded total pore space of all media. Subsamples were allowed to drain for 3 hr, and then weighed to determine the percentage of rewetting based on the exact percentage of container capacity.

Stepwise regression analyses of the percentage of rewetting on the percentage of container capacity were performed for each medium. The addition of terms to the regression equation was evaluated by an F test. Values of the percentage of container capacity for 80% rewetting were predicted inversely from the regression equations (Table 1). One-way analysis of variance was performed on the percentage of rewetting at 0% of container capacity, and means were separated by the Tukey procedure (HSD) at the 5% level.

Relationship of the percentage of rewetting to the percentage of container capacity of GR and GR + WA was curvelinear, indicating that they rewetted more rapidly at the lower media moisture contents (Figs. 1 and 2) than at the high. Wetting agent had little effect on the rewetting characteristics of GR. In contrast, the rewetting response of P or B was directly related to the percentage of container capacity, and the addition of wetting agent increased rewetting of P equally at all moisture levels while having little effect on the rewetting of B (Fig. 2). Addition of GR to both P and B also resulted in linear relationships between percentage of rewetting and percentage of container capacity until a concentration of 75% GR was reached. Rewetting responses of 1P:3GR or 1B:3GR were similar to GR alone and were substantially greater at lower media moisture contents than that of P or B alone.

Beardsell suggests the degree of dryness which permits rewetting of a medium to 80% of its container capacity is an important point for comparing the rewetting characteristics of media (2). The 80% rewetting points for B and P occurred at a relatively high percentage of container capacity, 25% and 23%, respectively, compared to 5% for GR (Table 2). Addition of wetting agent did not sub-

Table 2. Percentage of container capacity necessary to obtain 80% rewetting of a medium, and percentage of rewetting of media at 0% of container capacity.[z]

Medium[y]	Container capacity (%)	Rewetting (%)
B	24.6[x]	5.8 bc[w]
B + WA	22.2	5.2 bc
3B:1GR	24.1	7.8 c
1B:1GR	20.5	15.2 d
1B:3GR	7.5	48.5 e
P	23.3	0.0 a
P + WA	18.3	0.0 a
3P:1GR	22.5	3.5 b
1P:1GR	19.7	7.0 c
1P:3GR	7.1	65.2 f
GR	4.9	62.8 f
GR + WA	5.5	63.5 f

[z]Percentage of rewetting =
$$\left(\frac{\text{total water (ml) after wetting}}{\text{water (ml) held after container capacity}}\right) \times 100.$$

[y]B = pine bark, P = Canadian sphagnum peatmoss, GR = gasifier residue, and WA = wetting agent (granular Aqua-Gro).
[x]Values calculated using media regression equations Table 1.
[w]Mean separation by HSD, 5% level.

FIG. 1

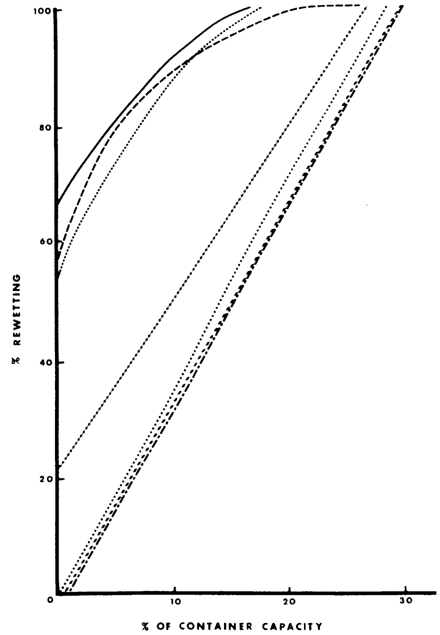

Fig. 1. Regression of percentage of rewettability on percentage of container capacity of bark and gasifier residue. Medium components are pine bark (B), gasifier residue (GR), and wetting agent (WA). Medium combinations are B (–·–·–), B + WA (··········), GR (————), GR + WA (– – – – –), 3B:1GR (- - - - - -), 1B:1GR (-·-·-·-·-·-) and 1B:3GR (·············).

FIG. 2

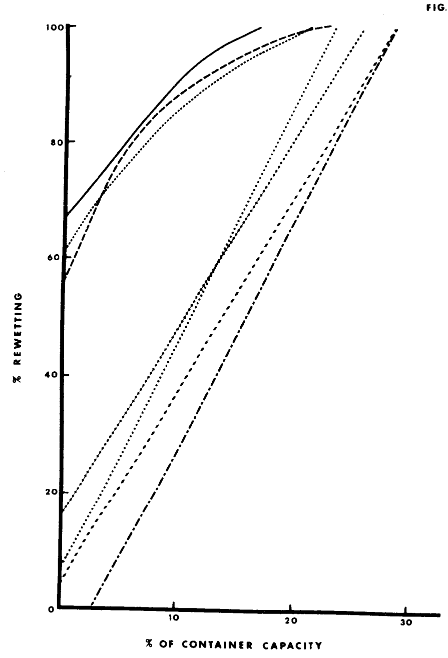

Fig. 2. Regression of percentage of rewettability on percentage of container capacity of peat and gasifier residue. Medium components are Canadian sphagnum peat moss (P), gasifier residue (GR), and wetting agent (WA). Medium combinations are P (–·–·–), P + WA (··········), GR (————), GR + WA (– – – – –), 3P:1GR (- - - - - -), 1P:1GR (-·-·-·-·-·-) and 1P:3GR (·············).

stantially decrease the percentage of container capacity necessary for 80% rewetting of P, B, or GR. GR in excess of 75% reduced the percentage of container capacity necessary for satisfactory rewetting of both P and B.

Neither B nor P substantially reabsorbed water at 0% of container capacity; however, 63% rewetting of GR was achieved at 0% of container capacity (Table 2). While use of wetting agent did not improve rewetting of B, P, or GR, addition of GR in excess of 75% substantially increased the percentage of rewetting of both B and P at 0% of container capacity.

Gasifier residue alone or in combination with bark or peat demonstrated a greater rewetting capability at lower moisture contents than bark or peat alone. Peat and bark behave hydrophobically when they are at low moisture contents, however, their wettability increases over extended periods of water contact (1). This change is possibly due to a rotation of the surface organic molecules to increase the hydrophilic surface (6). This mechanism of wetting is probably not operative with gasifier residue, since most of the organic compounds of bark have been destroyed during the high temperature combustion processes of gasification. Because these hydrophobic compounds are destroyed, water might more easily enter the material itself. In addition, the physical structure of bark has probably changed during combustion, possibly enlarging the pores and increasing water absorption. The rewetting effects of gasifier residue, when added to either bark or peat, is only effective at high concentrations, indicating that gasifier residue is itself rewetting and retaining increased water and not directly influencing the rewettability of bark or peat as do some wetting agents.

Medium combinations containing at least 75% gasifier residue, which would rewet rapidly even when completely dry, could eliminate the use of wetting agent on both bark- and peat-based media. These characteristics would not only be important at propagation or initial potting time, but also would enable a medium to recover quickly from a period of desiccation, possibly reducing water stress on the plants.

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Simulated Pest Injury Effects Photosynthesis and Transpiration of Apple Leaves

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Abstract. **Simulated pest injury to expanding or fully expanded apple leaves (*Malus domestica* Borkh. 'McIntosh') by midrib cutting, lamina pricking, or heat injury from ironing reduced net photosynthesis (Pn). Only cutting of the basal half of the midrib of fully expanded leaves reduced transpiration (Tr). Application of gibberellic acid (GA_3), and particularly of 6 benzylamino purine (BA), to lamina lesions damaged by pricking, stimulated Pn. This Pn compensation of injured apple leaves mediated by phytohormones may overcome otherwise damaging levels of some pests.**

Photosynthesis (Pn) and transpiration (Tr) of apple leaves are influenced by insects, diseases, growth regulators, and many environmental factors (3, 4, 7, 14, 16, 18). Artificially inducing leaf injury can be used to study the effect of these factors on Pn and Tr of apple leaves (6, 11). For instance, Heinicke (12) mimicked petiole girdling damage by the red-humped apple caterpillar and found that injury on older leaves resulted in reduced Pn, but young expanding leaves were unaffected.

More recently, Hall and Ferree (10) found that feeding injury of the 2-spotted spider mite [*Tetranychus urticae* (Koch)] reduced Pn 9 days after treatment. Parallel insect feeding simulation studies by Hall and Ferree (11) showed that many small holes resulted in a greater decrease in Pn than the same amount of leaf area removed by several larger holes. Ten percent or greater leaf area had to be removed to cause a reduction in Pn, and injury by severing main lateral veins in the leaf blade resulted in lower Pn than did interveinal injury. In addition, leaf injury by cuts or breaks in the leaf lamina, without the loss of tissue, showed that 6 or more one cm cuts per leaf reduced Pn, but had no effect on Tr (6). These studies did not, however, investigate the influence of cuts through different parts of the midrib, or small hole damage (pricking), mimicking that caused by the spotted tentiform leafminer (STLM), *Phyllonorycter blancardella*. The STLM is a major insect pest of apple for which we are seeking an economic threshold (16).

A visible symptom of fruit trees which have been injured by aphids and some fungi is the wrinkling of young expanding leaves. Previous studies in our laboratory have indicated that this phenomenon can be simulated by touching the adaxial surface of these leaves with an electric iron heated to 250°C.

Growth regulator effects on Pn, respiration and Tr of apple leaves also have been evaluated (5, 8, 9). For instance, Grochowska and Lubinska (8) reported that sprays of gibberellic acid (GA_3) increased the respiration of leaves of nonbearing spurs by about 25%. Conversely, Ferree and Hall (5) found no influence of daminozide or ethephon on Pn or Tr of container-grown 'Golden Delicious' apple. The current study includes comparisons of the effects of applying 6-benzylamino purine (BA) and GA_3 after simulated pest injury on Pn and Tr of apple leaves. These treatments were included because of our unreported observations that tissue injury by the STLM often is surrounded by increased tissue chlorophyll content par-

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