A Clustering Technique Applied to Sweetpotato Incompatibility Classification[1]

Franklin W. Martin[2]
U. S. Department of Agriculture, Mayaguez, Puerto Rico

Abstract. **Sweetpotato cultivars both as males and as females were classified into groups of related individuals on the basis of an index of similarity (correlation coefficients based on pollen tubes per stigma data). By gradually lowering the criterion of similarity the majority of the varieties were classified into one large group. At no stage of the process were inter-compatible, intra-incompatible groups found. A few cultivars, either as male or female, did not fit into the large group, and were also not clearly related to each other. Thus, this technique, as well as previous techniques, demonstrates the difficulty of incompatibility classification in sweetpotato, and the resultant lack of predictability of crossing ability.**

The system of self-incompatibility of the sweetpotato, *Ipomoea batatas* (L.) Lam. is extremely difficult to analyse by traditional techniques because sterility barriers occurring at various stages of the reproductive process also reduce seed production (2). In a previous study by Martin and Cabanillas (3) indices of fertility were found to be distributed in a continuous fashion making it impossible to judge many crosses as either sterile or fertile. Some resolution of the classification problem would be useful, however, in order to be able to predict the results of controlled crosses. I have therefore restudied this data and have tried another technique of classification.

The Martin and Cabanillas data (3) consist of the counts of pollen tubes in the stigmas after controlled pollinations among 29 sweetpotato stocks or cultivars (see legend for Fig. 1). From the pollen tube counts, correlation coefficients were calculated between each pair of cultivars on the basis of results of crosses in common with others. Such coefficients had to be calculated separately for cultivars acting as males. Thus, objective indices of similarity were obtained.

A clustering technique using an index of similarity described by Wirth et al. (4) was used as a classification aid. Using graphical methods, groups of related individuals were progressively delimited at successively lower levels of similarity. A series of 5 drawings was made in which cultivars (as females) were represented as numbered points. In the first drawing points were connected by lines when the cultivars were significantly correlated (as previously described) with coefficient of .90-1.00. In subsequent drawings lines were made to represent correlation coefficients of .80-1.00, .70-1.00, .60-1.00, and .50-1.00. Correlations among males were treated similarly.

Some cultivars as females were very similar to each other and thus grouped together even at the r = .90-1.00 level (Fig. 1 top left). As the criterion of similarity was lowered, all cultivars but 3 were included in a single large group. Although subgroups appeared at various stages of the graphing process (*10, 17* and *16; 2* and *23)* these were eventually tied into the large group by one or more relationships.

The cultivars *10, 16, 17* and *19* constituted a subgroup only weakly associated with the main group (Fig. 1, bottom). Cultivars *1* and *28* were weakly correlated (r = .53), and may

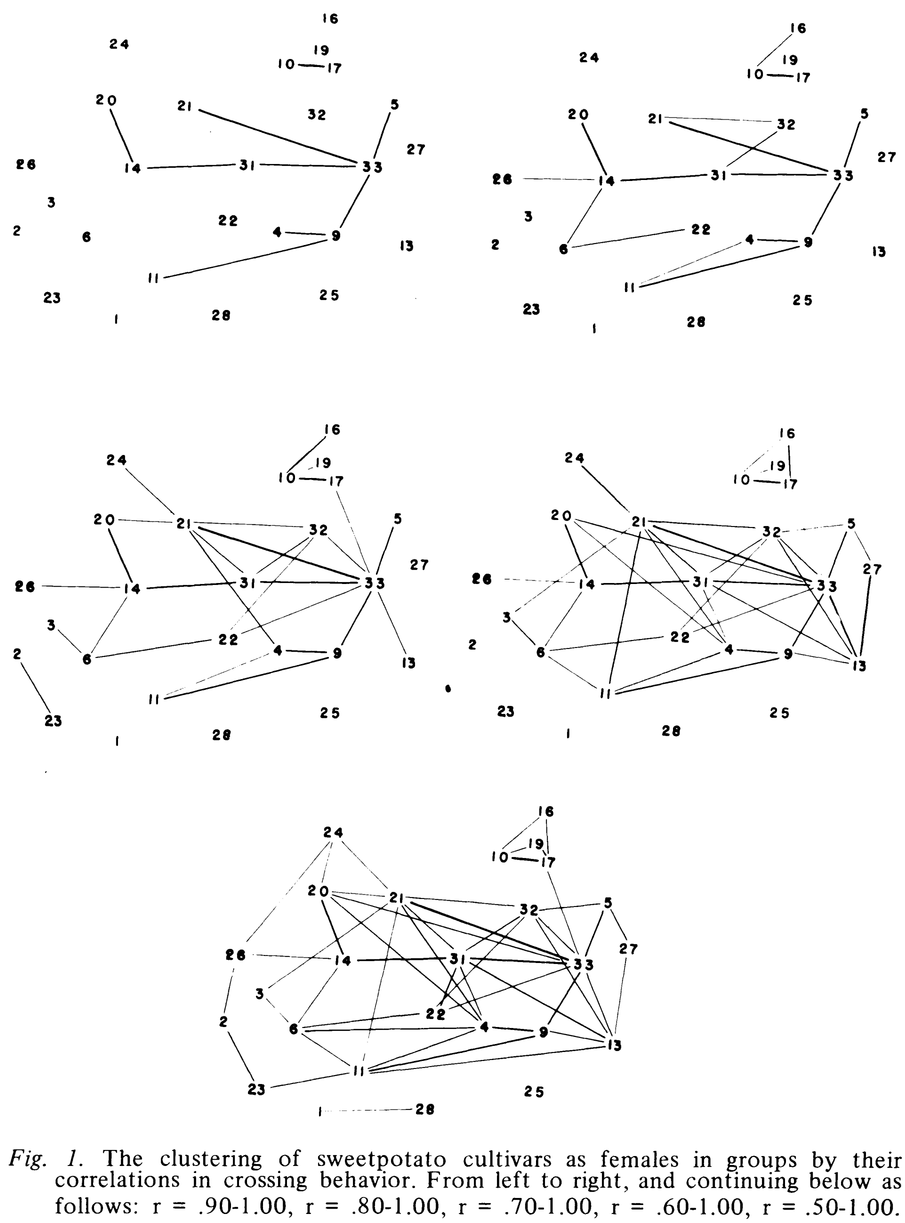

Fig. 1. The clustering of sweetpotato cultivars as females in groups by their correlations in crossing behavior. From left to right, and continuing below as follows: r = .90-1.00, r = .80-1.00, r = .70-1.00, r = .60-1.00, r = .50-1.00. Cultivar and stock identifications: 1. C461, 2. Apache, 3. Australian canner, 4. Blanquita, 5. Canela, 6. Centennial, 7. Cobre, 9. Goldrush, 10. Heartogold, 11. Julian, 12. Kandee, 13. Nemagold, 14. Nugget, 16. BNAS 51, 17. Sunnyside, 19. 57, 20. Unit 1PR, 21. UPR 3, 22. L 3-7, 23. L 1-171, 24. L 130, 25. L 21, 26. L 7-142, 27. L 131, 28. L 3-80, 30. Cal 134, 31. Cal 143, 32. Cal 247, 33. Cal 257.

[1]Received for publication August 6, 1970.
[2]Plant Geneticist, Federal Experiment Station, Crops Research Division, Agricultural Research Service.

constitute a small group. Cultivar *25*, not correlated as female with any other, constitutes a one-member incompatibility class.

As males, correlations were somewhat weaker, and first relationships were not evident until the level r = .80-.90 (Fig. 2 top left). All but 7 cultivars were clustered into one large group in the 5th level of clustering (Fig. 2 bottom right). Only one subgroup (*24* and *14)* could be distinguished. The 5 cultivars that did not fit into the main group *(17, 19, 20, 28, 31)* also were not correlated with each other. Thus, each constituted an incompatibility class by itself. Small groups obtained from clustering of males were completely different from groups obtained by clustering of females.

Thus, objective methods in a previous study (3) and in the present study have not permitted a classification of cultivars into incompatibility classes. Cultivars show a wide spectrum of crossing relationships from complete sterility (frequent) to complete fertility (rare). Any criterion of fertility is distributed hyperbolically with mode at 0 (2). The failure of objective methods of classification suggests that the crossability of particular sweetpotato cultivars cannot be predicted in advance. From observations of the stigma a few hr after pollination, pollen germination can be detected, however (1). The use of this technique is recommended when large no. of crosses must be rapidly screened for fertility.

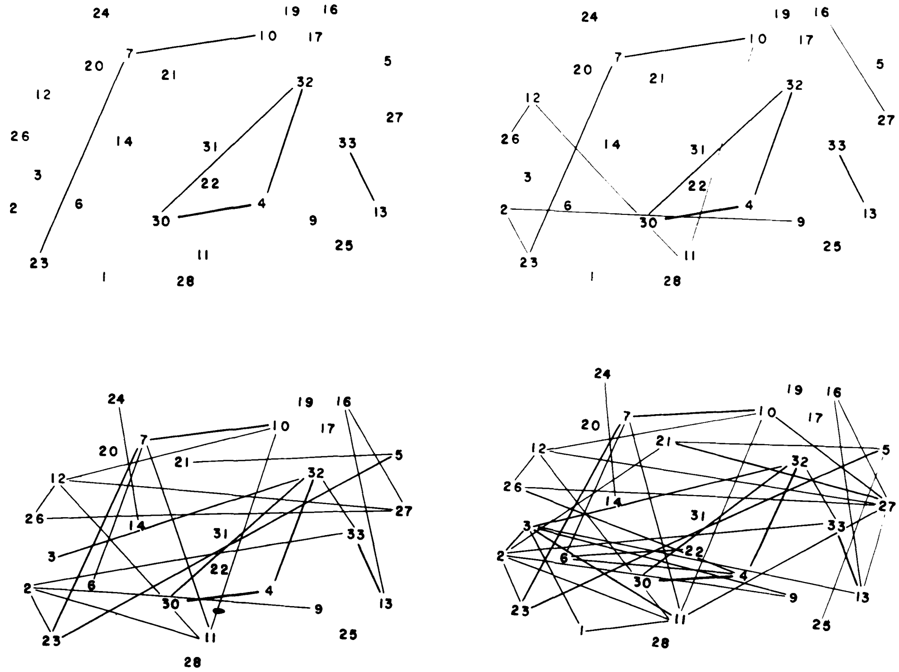

Fig. 2. The clustering of sweetpotato cultivars in groups as males by their correlations in crossing behavior. From left to right and continuing below as follows: r = .80-1.00, r = .70-1.00, r = .60-1.00, r = .50-1.00.

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Large Volume Generator of Stable Foam for Freeze Protection[1]

J. F. Bartholic, M. D. Heilman, and B. M. Farris[2]

U. S. Department of Agriculture, Weslaco, Texas

Abstract. **A large volume generator with a foam-producing rate of 130 ft^3/min is described. The generator is based on a simple principle and could be easily adapted to a variety of field foam application requirements. A combination of 3 materials has been found that will form an economical, stable, nontoxic foam for insulating crops during freezing conditions. Field tests showed that the foaming materials and foam generator have the necessary characteristics for covering large acreages of temperature-sensitive crops.**

Foams have been used for such varied purposes as fire fighting, frost protection, and as media for dispensing herbicides. Research on the agricultural use of stable foams has been conducted mainly to evaluate their potential as insulation for protecting plants against freeze injury.

Foam is made up of pockets of gas separated from one another by a liquid film. The liquid film is composed of 2 outer layers consisting of soap, detergent, or surfactant, and an inner layer of water. Stable foams have thick walls and small bubble size. The foaming of a substance depends on its surface activity; hence, substances which lower the surface tension of liquids are used. Foams may be formed by passing gases through soap or other hydrophilic substances, or by creaming such substances. When the liquid is lost from the bubbles, foams decay as a result of gravitational attraction and evaporation. These 2 forces cause the bubble walls to become too thin, and they break (5).

In 1953, Shear and Barrows (6) reported results of some small-scale experiments on using foam for frost protection. In 1967 Siminovitch, et al. (7) presented results using a protein-based foam to protect plants against freezing. The generator he developed for laboratory use was shaped like a fire extinguisher with air forced into a solution and bubbles formed at the surface forced out a small tube. He found that the foam could be a very effective insulator; however, no large-scale apparatus was proposed at that time. Braud and Chesness (2) and Chesness, et al. (3) recently investigated materials that could be used as foaming agents, and developed and tested a foamer that could be used in the field. Their foamer had a small volume output and was mainly for test purposes. In 1968, Eggert (4) reported the use of liquid foam to prevent freeze injury to strawberry blossoms and the performance of a number of foam-forming agents. Bartholic, et al. (1) showed that under a radiational freeze in a semi-tropical area, foam-insulated plants could be kept 3 to 5°F warmer than in a nonfoamed adjacent check area.

Siminovitch, et al. (8) recently published results using a 400-gal capacity field foam applicator. This is one of the first large-scale application rigs. The apparatus requires a chamber in which the liquid forming agents and

[1]Received for publication August 24, 1970.

[2]Soil and Water Conservation Research Division, Agricultural Research Service.