Agronomic and Chemical Characteristics of Male-Sterile Flue-Cured Tobacco as Influenced by Cytoplasms of Different Nicotiana Species

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I N SEXUAL propagation it is generally agreed that genes carried in chromosomes are relatively stable units which are transferred from generation to generation and are responsible for similarities between parents and offspring. Evidence has also accumulated over the years that extranuclear constituents of the cell have a certain degree of stability which may be transmitted to succeeding generations. When the extranuclear constituents influence the phenotype of the offspring, the phenomenon is called cytoplasmic inheritance. However, if certain characteristics are known to be genic inherited and are modified or changed by the cytoplasm, this represents an interaction of the cytoplasm with certain genes.

Significant cytoplasmic effects on corn were demonstrated by Fleming et al. (4) for silking, ear height, plant height, erect plants, yield, and budworm damage. Mann et al. (5) showed the effects of N. megalocephalon Heuch & Mill. on certain quantitatively inherited characters of male-sterile N. tabacum L.

Several types of cytoplasmic male-sterile tobaccos have been derived from the transfer of N. tabacum chromosomes into cytoplasts of different Nicotiana species. Clayton (3) described the male-steriles with modification of the stamens and corolla as being associated with a displacement of the maternal genome by chromosomes of the recurrent parent in the presence of maternal cytoplasm. Burk (1) described two cytoplasmic male-sterile tobaccos produced through interspecific hybridization of N. plumaginifolia Viv. and N. glatios L. with N. tabacum but in N. tabacum cytoplasm. He postulated that such sterility may be brought about by a plasmagene which has evolved from or has been activated by an interaction of non-specific nuclear components.

The production of F₁ hybrid tobacco (N. tabacum) has developed in recent years in burley and cigar types in the United States as well as flue-cured in Australia and European countries. The production of hybrid seed can be greatly facilitated by the use of cytoplasmic male sterility. Floral anomalies of male-steriles differ and some lend themselves more readily to the production of hybrid seed (2).

All Nicotiana species cytoplasts may not interact with the genotype in the same manner. Therefore, information should be obtained as to the influence of the cytoplasts from different Nicotiana species on male-sterile tobaccos. The objective of this investigation was to develop isogenic male-sterile lines of two flue-cured tobacco varieties using cytoplasts from different Nicotiana species and to determine the influence of the cytoplasts on agronomic and chemical characteristics of flue-cured tobacco.

MATERIALS AND METHODS

Cytoplasmic male-sterility from nine sources, representing cytoplasts of six different Nicotiana species, was transferred to the flue-cured tobacco varieties cv. Hicks and cv. 'Coker-187' by the backcross method. Sterility in seven of the male-steriles was produced by transferring N. tabacum chromosomes into cytoplasts of other Nicotiana species. Three of these were in the cytoplasm of the same species (megalocephalon) but their genomes were derived from different tabacum types. The following are the Nicotiana species from which the cytoplasts were derived and the tabacum genome of the original male-steriles: Suavenolens Lehm., —consolida, bigelovii (Torr.) Wats. —burley, plumaginifolia—purpurea, undulata R.&P.—purpurea, megalocephalon (p)—purpurea, megalocephalon (b)—burley, and megalosiphon (f)—flue-cured. In addition, two male-steriles in tabacum cytoplasts were supplied by Burk (1). They were discovered as single plants in interspecific populations by tabacum by plumaginifolia and glatiosa and will be referred to as tabacum (p) and tabacum (g).

The male-steriles will be designated by the maternal species involved in the original interspecific hybridization.

In the beginning of the experiment a single plant representing each of the male-sterile types was crossed with the flue-cured varieties Hicks and Coker-187. Parallel series of hybridization were then continued until the BC₃ generation. The male-fertile plants used for crossing were self-pollinated and advanced a generation after each cross. The same pollen plant from each variety was used to cross all of the male-steriles in each generation. In the BC₃ generation two sister plants were selected from random among each male-sterile line and advanced to the BC₄. The sister plants from each line were compared to obtain information on adequacy of backcrossing.

In 1963 and 1964 nine male-sterile (2 selections each) in the BC₃ generation with Hicks and Coker-187 were compared with their respective recurrent parents and with each other for yield and other agronomic characteristics as listed in Table 1. The experiment was conducted at the Pee Dee Experiment Station, Florence, S. C. Chemical analysis including total alkaloids, total nitrogen, reducing sugars, petroleum-ether-extract, total volatile bases, and ash were also determined. In 1964 growth measurements were taken on plants in the plant bed at time of transplanting and in the field at weekly intervals during June.

A split-plot design was used where whole-plots were the recurrent parent variety with all the male-steriles involving that variety. Two sister selections from each male-sterile along with the recurrent parents constituted the subplots. Split-plot consisted of 20 competitive plants spaced at 22-inch intervals in a single row. Transplants were made directly to the field in 1963 and banded plants were used in 1964.

RESULTS

Character differences were not significant between sister selections; therefore, it was assumed that backcrossing was adequate and the data from both sister selections were averaged. In statistical comparisons the variety (recurrent parent) X male-sterile interactions were not significant for most characters. Also there was very little year by male-sterile interaction. Therefore, the data will be presented as an average of the two varieties for both years.

Agronomic characteristics. The data on yield and other agronomic characteristics are presented in Table 1.

Reductions in yields for bigelovii, plumaginifolia, and both tabacum male-steriles below the fertiles were obtained.