Morphological Variations in Normal, Cytoplasmic Male-Sterile, and Restored Counterparts in Maize, *Zea mays* L.\(^1\)

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**M**ale sterility is a phenomenon widely distributed in the plant kingdom. It may be caused by mechanical, morphological, or environmental factors and may be implemented by genetic or cytoplasmic means. Male sterility in nature may lead to the elimination of a strain or even a species or may be instrumental in maintaining hybrid vigor for the perpetuation of certain organisms. Male sterility is characterized by the failure of the plant to produce viable or functional pollen.

Morphological differences have been observed between normal and male-sterile plants. Male-sterile millet plants, unlike the normal, branched profusely and had numerous heads and a low bushy appearance, according to Ayyangar and Krishnaswamy (1). Clayton (2) found that the flowers of male-sterile tobacco plants were split and devoid of anthers, but produced seed when fertilized. The petals of sterile Japanese radish were observed by Tokumansu (10) to be smaller than those of fertile radish. Peterson and Foskett (7) found no morphological differences associated with sterility in onions. Stephens and Quinby (9) found that male-sterile sorghum plants had longer rachises but shorter rachis branches toward the tip of the head than the normal ones. Sarvella (8) observed that the vegetative and fruiting branches of normal cotton were longer than those of male sterile. Jones (4) found a slight shortening of plant height in sterile corn. A shortening of the stalk above the ear in some lines of corn was found by Jones and Mangelsdorf (5). Josephson and Kincer (6) indicated that shortening was confined to the upper 2 or 3 internodes. However, Grogan and Sarvella (3) indicated shortening could involve several internodes.

Information is lacking on the details of shortening of the maize plant, especially where shortening occurs. A study was initiated in 1960 to determine where morphological differences exist between normal, male-sterile, and restored counterparts of several inbred lines.

**MATERIALS AND METHODS**

Six inbred maize lines (CI21, Mp305, Mp313, Mp317, Mp335, and Mp464) having normal, cytoplasmic male-sterile, and restored (in sterile cytoplasm) counterparts (versions) were studied in 1960 at State College, Mississippi. To ascertain differences under an entirely different environment, the 3 counterparts of CI21, Mp313, Mp317, and Mp466 were studied in the 1960-1 Florida winter nursery. The 4 lines studied in the Florida 1960-1 nursery were grown again in 1961 at State College with the addition of line Mp444. The sterile counterparts in Texas cytoplasm previously had been backcrossed 8 to 12 generations. The restored counterparts (Mp307 as restorer source) in Texas cytoplasm were backcrossed 6 to 8 generations and selfed to homoyogosity. The same seed source from individual ears was used for those lines tested more than one season. The 3 counterparts of each line during each season were grown as a group with each counterpart in individual blocks from which approximately 15 randomly-selected plants were studied.

After the plants grown in 1960 had attained maximum height, the number of internodes above the ear, the stalk length above the ear (excluding the tassel culm or peduncle), tassel culm and sheath lengths, and lengths of individual internodes and sheaths above the upper ear, starting at the second internode, were determined. The measurements of the 1960-1 Florida winter nursery material were similar with additional ones on the number of internodes from the ground to the ear and the stalk length to the ear. The individual internode and sheath measurements started at the first internode above the upper ear rather than the second. Measurements included the first 3 below the upper ear in 1961 at State College. All other data were the same as in the 1960-1 Florida study.

Seasonal and combined (seasons) analyses of variance were made to compare the normal with the male-sterile and restored counterparts for the attributes studied.

**EXPERIMENTAL RESULTS**

Shortening of some plant parts was the general pattern in the male-sterile and sometimes in the restored counterparts of the lines during one or more seasons and locations. In some cases the male-sterile or restored version had certain parts that were longer than the normal. The data are given in Tables 1 through 3. Significant sterility (counterparts) X environment interactions are indicated by the symbol a in Tables 1 and 2.

**Internodes from ground to ear.** The three versions of Mp313 and Mp466 did not differ significantly in the number of internodes from the ground to the ear during the two seasons this characteristic was studied. Significant differences were observed in CI21 and Mp317. Sterile and restored CI21 and Mp317 had significantly more internodes than the normal in 1961 but not in Florida.

**Stalk length to ear.** Compared with the normal, the decrease in stalk length to the ear was associated with the restored version more frequently than with the cytoplasmic male sterile. The stalk lengths of restored CI21 and Mp466 were significantly less than the normal counterparts in the Florida planting but were not significant in 1961 at State College. Sterile and restored Mp313 were significantly

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