# Relationship Between the B Genes of Two Cucurbita Species

Shifriss, O., Department of Horticulture and Forestry, Rutgers-The State University, New Brunswick, NJ 08903.

Gene B conditions precocious depletion of chlorophyll in fruits of Cucrubita pepo L. And chlorophyll depletion is followed by precocious yellow pigmentation. In addition, B can affect leaf blades depending upon the genetic background and the environment. A gene of similar expression, tentatively designated by the same symbol, exists in Cucurbita maxima Duch. It is difficult to study the relationship between the 2 B genes by direct breeding tests because the 2 species are isolated from one another by strong genetic barriers. This difficulty was overcome by transferring the B of C. pepo and the B of C. maxima to C. moschata Poir (3).

A.M. Rhodes made the above transfers, and in the fall of 1980 he generously sent me a few $BC_6$ seed (6 backcrosses to C. moschata) of each transfer. The source of B in C. pepo was a 'Bicolor Spoon' inbred which presumably carries $B^W$ (2). The source of B in C. maxima was P.I. 165558 (1, 3). The recurrent parents used in backcrossing were of somewhat complex lineage and will be described elsewhere.

The BB inbred of C. moschata in which B was derived from C. maxima is designated IL-B. I failed to obtain from Rhodes' material a fertile BB ($B^WB^W$ ?) inbred in which B was derived from C. pepo. However, such a BB inbred of C. moschata was developed in our department from a cross of C. pepo, 'Jersey Golden Acorn', BB, as seed parent, and C. moschata, 'Burpee Butterbush', $B^+B^+$. For this transfer we used the pedigree method of breeding in which BB segregates were selected on the basis of taxonomic features and compability with C. moschata as seed parent. Our BB inbred of C. moschata is designated NJ-B. The parents, the $F_1$ and the $F_2$ are described as follows.

$P_1$, IL-B (n = 35). Under field conditions, the stems and portions of the petioles are precociously yellow, becoming golden with the passage of time. The leaf blades are uniformly green, and the fruits are precociously yellow, becoming golden later. Under greenhouse conditions (fall sowing), the lower leaf blades are partially yellow precociously, but otherwise the phenotype is similar to that observed under field conditions. Precocious stem pigmentation in IL-B is a highly stable trait, a distinguishing feature of this inbred. By contrast, it is a highly unstable phenotype in P.I. 165558 (1).

$P_2$, NJ-B (n = 28). This inbred is green in potentially photosynthetic organs except fruits which are precociously yellow at the bud stage.

$F_1$ (n = 25). The hybrids ($P_1$ x $P_2$) of reciprocal crosses are indistinguishable phenotypically. With respect to precocious pigmentation, they are similar to IL-B ($P_1$) except for one deviation. The leaf blades of some $F_1$ plants exhibit a unique pattern of variegation in which precocious yellowing is confined to a stripe along the midrib (Fig. 1). For the past 4 years, 2 perennially grown $F_1$ plants exhibited this pattern regularly in newly differentiated leaves which appear in the fall (November). The leaf blades of the same plants are uniformly green in summer. This cyclic and precise

pattern may be regulated by the phytochrome system in the presence of a particular genotype. There is considerable variation in the expressivity of this midrib pattern among the $F_1$ plants.

$F_2$ (n = 217). This generation is extremely variable and difficult to classify. The difficulty is due to the fact that precocious pigmentation is subject to developmental changes which are different in different $F_2$ segregates. These changes are related to the stage in which they occur, the tissue or group of tissues affected, the extent and intensity of expression, and the environment. The following is a preliminary classification of the $F_2$ into 7 phenotypic groups.

Group #1 (n = 9). All potentially photosynthetic organs, including fruits at the bud stage, are green. -- Group #2 (n = 21). Stems, petioles, and leaf blades are green. Fruits on the same plant are variable: green and bicolor (partial precocious pigmentation). -- Group #3 (n = 19). Stems, petioles, and leaf blades are green. Fruits are precociously yellow (uniformly pigmented). -- Group #4 (n = 23). Stems and petioles are precociously yellow or variably so. Leaf blades and fruits are green. -- Group #5 (n = 82) Stems and petioles are precociously yellow or variably so. Leaf blades are green. Fruits on the same plant are either variable, green and bicolor, or precociously yellow. -- Group #6 (n = 49). Stems and petioles are precociously yellow. Leaf blades are precociously yellow at an early stage of plant development, but later turn to variegated patterns of different kinds. Differences between plants are largely in extent of leaf yellowing. -- Group #7 (n = 14). Lethal and semi-lethal. Seedlings grow very slowly. Cotyledonary leaves are green. Stems and true leaves are either uniformly albino or yellow early in development. Most plants die at the seedling stage. Two plants were rescued by shifting them to a less stressful environment in which they gradually (after several weeks) turned from yellow to variegated leaf blades.

In plants which produce both green and bicolor fruits, the green fruits often appear first during development. Therefore, there is uncertainty about the phenotypes of plants which bore only 1 or 2 green fruits at the time of classification. This uncertainty applies to a few plants of Group #1, but particularly to plants of Group #4.

No firm conclusions can be made about the relationship between the B genes in this cross considering the small size of the $F_2$, the element of uncertainty in classification, and the absence of backcross data. Nevertheless, the data suggest the following ideas which may be tested in future investigations. 1). The 2 B genes which condition precocious chlorophyll depletion in fruits, but which can also affect leaf blades, reside at different loci. Are these genes independent? 2). There exists another gene which conditions precocious depletion of chlorophyll primarily in stems. Is this gene linked to B of C. maxima? 3). The genetic system governing precocious pigmentation is affected occasionally by instability, perhaps through the activity of mobile elements.

The phenomenon of precocious pigmentation in Cucurbita is useful for studies of differential gene expression as related to the fate of chlorophyll during plant development. Potentially, this phenomenon represents a wide range of genetic variations. The great majority is detrimental. But a small minority can be utilized for breeding new edible, ornamental and edible-ornamental cultivars.

## Literature Cited


1. Shifriss, O. 1965. The unpredictable gourds. Amer. Hort. Mag. 44:184-201.

2. Shifriss, O. 1981. Origin, expression, and significance of gene B in Cucurbita pepo L. J. Amer. Soc. Hort. Sci. 106:220-232.

3. Shifriss, O. 1985. Developmental aspects of gene B in three cultivated species of Cucurbita. In: R.W. Robinson, C. Jeffrey, and D.M. Bates (eds). Biology and chemistry of the Cucurbitaceae. Cornell Univ. Press (in press).


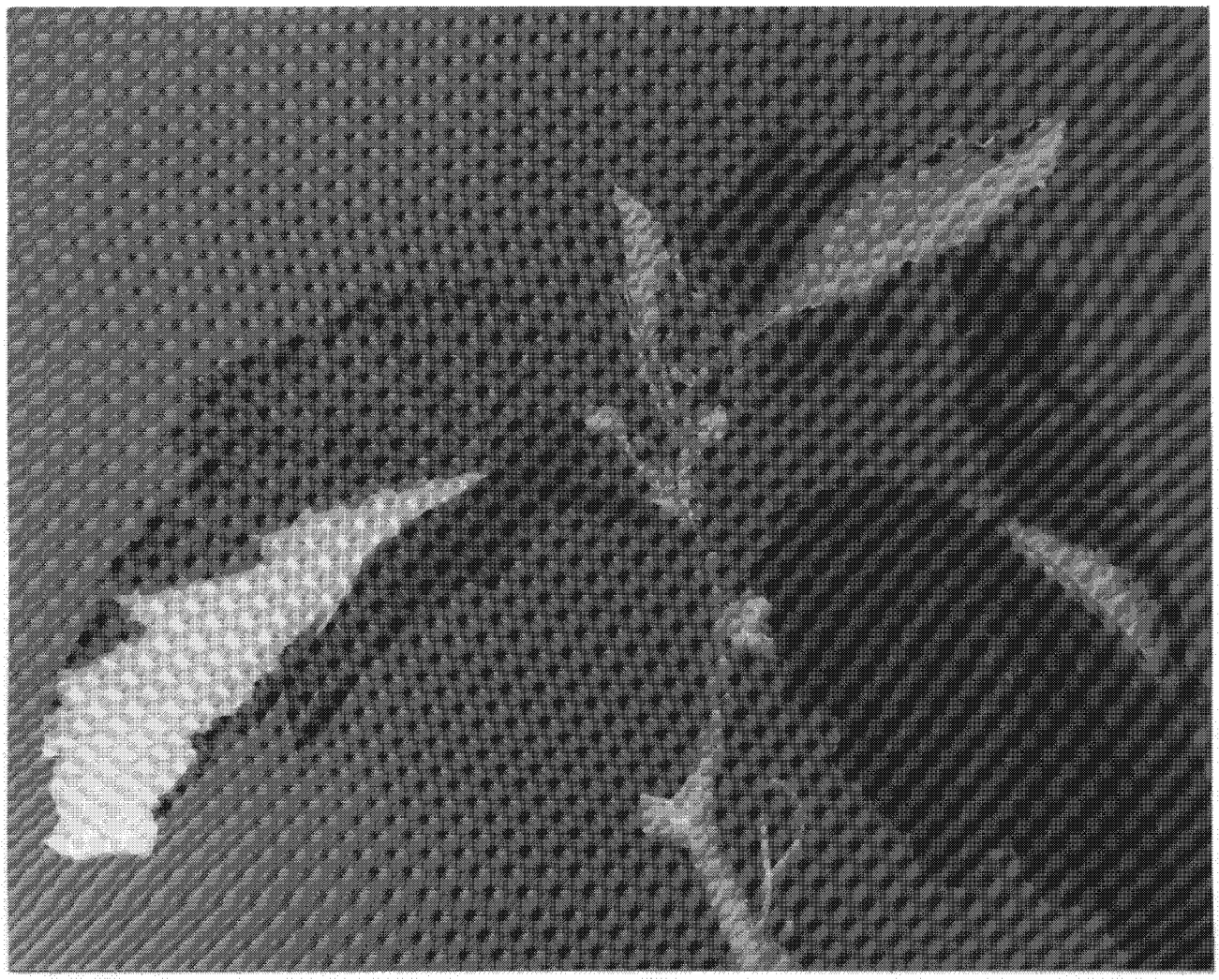

Figure 1. The "midrib pattern" in a hybrid obtained from crossing 2 "precocious" inbreds of C. moschata. Neither inbred exhibits this pattern.