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Brief Articles

A DOMINANT GENE FOR MALE-STERILITY IN UPLAND COTTON[1]

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MALE-STERILITY is a useful plant characteristic for the production of hybrids in various crops. The search for male-sterility has been extended to many other crops including those normally self-pollinated. Workers in cotton have been active in the search, but to date an economically usable sterile type has not been found. Justus and Leinweber (1) reported a partially male-sterile line, ms-1, and Justus et al. (2) reported a second partially male-sterile line, ms-3, in Upland cotton. Richmond and Kohel (4) reported a completely male-sterile line, ms_2, in Upland cotton. Kohel and Richmond (3) expended considerable effort in searching for a cytoplasm that would interact with the ms_2 gene. This effort was not successful, and they concluded that the economic possibilities of the ms_2 line are limited without the gene-cytoplasm interaction to restore fertility. This paper reports another completely male-sterile type which also has obvious economic limitations.

The male-sterile plant whose description and inheritance is described herein was found late in the growing season in 1960 while roguing a pure-seed increase field of 'Acala 44' (*Gossypium hirsutum* L.). It had few bolls and thus was erect and standing above normal plants which had produced a heavy boll load and were lodged. The flowers on the male-sterile plant had either rudimentary or no anthers. A range in anther development of three male-sterile flowers compared with a normal flower is illustrated in Figure 1. The original plant and 4 grafts from it have shown no male-fertility in over 3 years.

Cytological examination of young anthers disclosed no chromatin material other than that present in tapetal cells. Examination of more mature rudimentary anthers showed no development of sporogenous tissue indicating that meiosis was abnormal or absent, thus preventing the development of pollen. The original male-sterile plant as well as male-sterile derivatives appear to be normal in gross morphology. Fertilization of male-sterile flowers is readily accomplished when pollen is supplied from a normal flower. F_1 populations from these crosses have been grown in the greenhouse and in the field. Male-sterile and male-fertile plants were produced in approximately equal numbers. Chi-square values shown in Table 1 indicate a good fit to a 1:1 ratio. In addition a small F_1 population produced from a cross between the male-sterile line (*G. hirsutum*) and 'Pima S-2' (*G. barbadense* L.) gave a 1:1 ratio of male-sterile to male-fertile plants. An F_2 population of 350 plants from male-fertile F_1 plants produced all normal plants, and these in turn gave all normal F_3 plants. Cytological analyses of root tips of sterile plants revealed a normal complement of 52 chromosomes.

These results coupled with the absence of gross morphological abnormalities and consistent 1:1 segregation in the

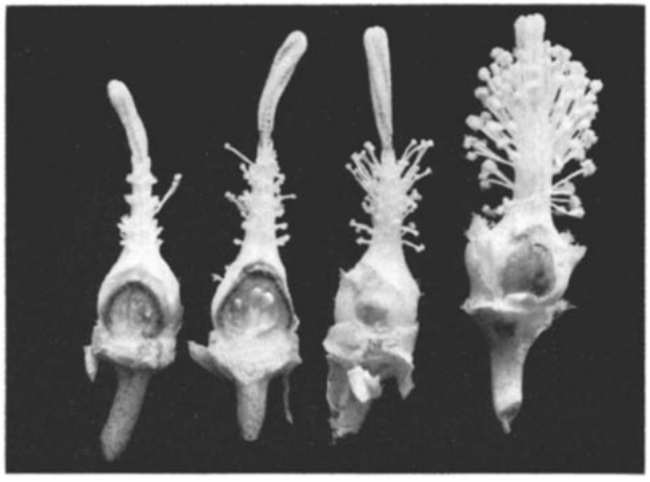

Figure 1. Three sterile flowers of Acala 44 cotton showing a range of another development. Normal flower at right.

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Table 1. Analyses of ratios observed in F_1 populations of a male sterile character in Upland cotton.

	Number of plants			χ^2	P (1:1)
	Sterile	Fertile	Total		
Population 1 (greenhouse)*	185	193	378	0.085	.70-.80
Population 2 (field)	230	260	490	1.837	.10-.20

* Several different populations, none with significant chi-square values, were pooled in this analysis.

F_1 support a genetic hypothesis where male-sterility is conditioned by one dominant gene. The male-sterile plants are heterozygous for this gene. A genetic-cytoplasmic interaction cannot be ruled out, but attempts to find such an interaction have been unsuccessful.

In keeping with previous work with male-sterility in *Gossypium,* this gene has been assigned the symbol Ms_4.

Literature Cited

1. JUSTUS, NORMAN, and LEINWEBER, C. L. A heritable partially male-sterile character in cotton. J. of Hered. 51:191–192. 1960.
2. ———, ———, MEYER, JAMES R., and ROUX, JEAN B. A partially male-sterile character in Upland cotton. Crop Sci. 3:428–429. 1963.
3. KOHEL, R. J., and RICHMOND, T. R. Tests for cytoplasmic-genetic interaction involving a genetic male-sterile stock of the genotype, ms_2ms_2. Crop Sci. 3:361–362. 1963.
4. RICHMOND, T. R., and KOHEL, R. J. Analysis of a completely male-sterile character in American Upland cotton. Crop Sci. 1: 397–401. 1961.

OXIDATIVE PHOSPHORYLATION BY ROOT AND SHOOT MITOCHONDRIA FROM CORN SEEDLINGS AS AFFECTED BY TEMPERATURE[1]

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THE classical studies relating growth and temperature in plants show a rapid decline in sustained growth rate once the optimum temperature has been exceeded. For corn (*Zea mays* L.) seedlings this optimum is about 30° C. (4). Physiological processes associated with growth, such as respiration, are similarly affected. The highest temperature at which respiration rates can be sustained in most plant tissue is close to the optimum for growth, 30° C. or less (3, 6). Impaired respiration could obviously be a significant factor in declining growth at high temperatures.

Various hypotheses have been advanced to explain the deleterious effects of high temperature on respiration and growth. Most commonly it is supposed that enzymes are inactivated, the rate of inactivation being a function of temperature and time (1). It is sometimes pointed out, however, that enzymes obtained from plants are not damaged by temperatures of about 35° C., although plants are injured (2). It may be that certain metabolites or co-factors are limiting, or that the organization of certain enzyme complexes is disrupted.

In this vein, we wondered if oxidative phosphorylation in plant mitochondria might not be differentially susceptible to high temperature. The fact that a plant is rapidly oxidizing substrate does not necessarily mean that ATP is being formed efficiently. High temperatures may serve to uncouple phosphorylation and thus reduce growth.

We have investigated this possibility using mitochondria obtained from the roots and shoots of etiolated corn seedlings. Corn seedlings (*Zea mays,* WF9 × M14) were germinated in the dark at 28° C. for 4 days on paper toweling saturated with $10^{-4}M$ $CaCl_2$. Fifty grams of entire roots or shoots were ground in an ice-cold mortar with 100 ml. of 0.4*M* sucrose, 0.005*M* EDTA, and 0.05*M* KH_2PO4, adjusted to pH 8.0 with tris(hydroxymethyl)amino methane. Mitochondria were collected by centrifugation in the cold as the particulate fraction sedimenting at 12,000 g for 15 minutes after clearing the homogenate at 2,000 g for 10 minutes. The mitochondria were washed once in the grinding medium and suspended in 0.5*M* sucrose. Oxidative phosphorylation was determined by standard Warburg techniques with a medium consisting of 62 μmoles potassium phosphate (pH 7.5), 475 μmoles sucrose, 50 μmoles α-ketoglutarate, 150 μmoles glucose, 3 μmoles $MgSO_4$, 3 μmoles ATP, 0.13 mg. CoA, 0.25 mg. thiamine pyrophosphate, 0.20 mg. NAD, 25 KM units hexokinase, and about 0.2 mg. mitochondria N in a volume of 2.8 ml. Reactions were carried out at temperatures ranging from 10 to 50° C., the incubation time being varied to allow for the uptake of approximately 100 μl. oxygen.

Although not graphically presented here, the respiration of root tips and mesocotyl tissue was also determined. The results were similar to those already reported in the literature (1, 3, 6) with maximal respiration at 45–50° C. in short term experiments. Over a period of a few hours these initially high rates declined, but at 35° C. or lower the respiration rates were maintained.

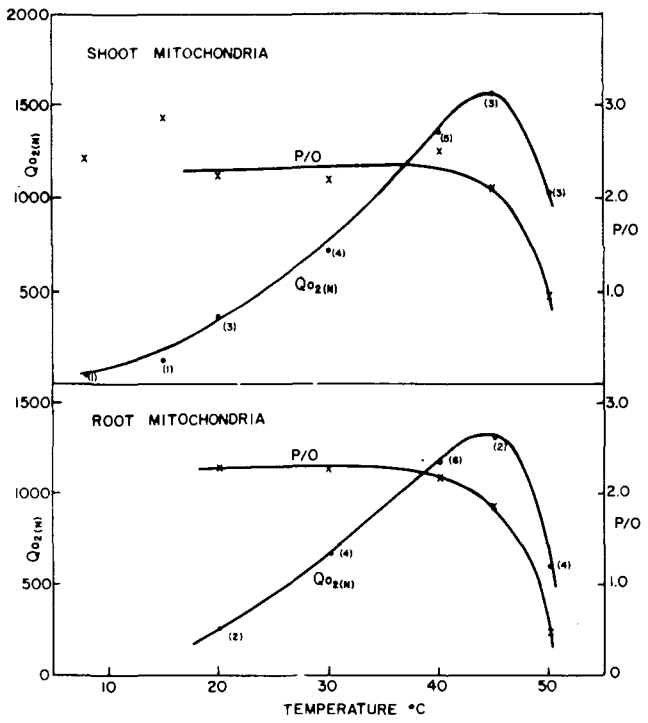

Figure 1. Effect of temperature on oxidative phosphorylation by shoot and root mitochondria from maize seedlings. Numerals in parentheses refer to the number of experiments at the indicated temperature. $Q_{O_2(N)}$ = μl. O_2/hr/mg N. P/O = μmoles phosphate esterified μ/atom oxygen consumed.

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