Cotton Dust Answer May Be to Breed the Bracts Off 'Em

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Cotton plants that drop their bracts before harvest could help solve the plant dust problem that is linked to textile workers' brown-lung disease.

Bracts are small, specialized leaves adjacent to the flower and, later, to the cotton boll. Picked along with the boll by mechanical harvesters, the brittle bracts get pulverized in the ginning process and become a major ingredient in cotton dust. The U.S. Occupation Safety and Health Administration has labeled cotton dust one of the five most important target health hazards in the country.

Two wild relatives of cotton from Baja California have bracts that fall off before the boll opens, but these plants do not produce cotton fiber. At the University of Arizona, a cross between one of these wild plants and a commercial variety of cotton was made. After a decade of selection, cotton plants that drop bracts before the bolls open were isolated.

Now, through a backcrossing program, we are trying to breed a bract-dropping cotton that has commercially acceptable growth, yield, and fiber properties. A new research grant from the National Institute for Occupational Safety and Health boosts the chances for success during the next few years.

Brown-lung disease, also called byssinosis, strikes an unknown number of textile workers. Victims include workers in linen, jute and other fibers, as well as cotton. Their chests tighten, they cough, and their bronchial tubes shrink, typical symptoms of allergy. By federal estimates, nearly a quarter-million Americans are potential byssinosis victims. The North Carolina Public Interest Research Group more than triples that estimate. Most cotton from Arizona is spun in other countries, where workers lack the advantage of the dust-control regulations recently set for American textile factories.

Byssinosis Research

The exact cause of byssinosis remains unknown, but evidence fingers cotton bracts as an important factor. About two-thirds of identifiable cotton dust comes from bracts.

Above: Dr. Hiroshi Muramoto checks unopened cotton bolls on a test plant growing in Tucson. Bracts have dropped off of the two bolls between his hands, but not yet from the one at upper right.

Page 14: Bracts are the sharply lobed, modified leaves at the base of cotton flowers and bolls.

Studying byssinosis in 1966, Drs. Arend Bouhuys and P. J. Nicholls of the Department of Epidemiology and Public Health at Yale University School of Medicine prepared water extracts from bracts, regular leaves, stems and other components of cotton dust and tested the extracts on human volunteers. Only the bract material caused the allergy symptoms of byssinosis.

The identity of the chemical that stimulates the allergic reaction is still uncertain. Dr. Ragnar Rylander of Sweden has offered evidence that it may be a toxin produced by bacteria that live in the dust. Research at Mount Sinai Hospital in New York has pointed to a compound called lacinilene C-7 methyl ether that is present in dried bracts but not in green ones.

Bouhuys and Nicholls have suggested that cotton breeders develop a bractless cotton, but none of the world's four cultivated species or 30 wild species of cotton is bractless.

Bracts are modified, leaf-like appendages. They cover the bud, called a "square" on cotton. The unfurling petals force the bracts apart, but the bracts later close back in to cover the young boll. They open a final time, and wither as the boll ripens, but they remain attached. On two wild species from Baja California, called *G. harknessii* and *G. armourianum,* the bracts fall off before the boll reaches maturity. On cultivated cotton, even the chemical defoliants applied before mechanical harvesting to do remove the bracts.

A bract that falls off early is called "caducous," similar to the word deciduous that applies to oak leaves and baby teeth.

The caducous-bract *G. armorianum* cotton was crossed with the cultivated species *G. hirsutum* ten years ago. One complication was that the wild species has two sets of chromosomes (diploid), and the cultivated one has four sets (tetraploid), so the offspring has three sets (triploid). Since the three sets can not divide evenly for reproduction, that offspring is sterile.

Quality Selection

Fortunately, a chemical called colchicine can double plants' chromosome numbers. Cells of the offspring cotton were treated with colchicine. The resulting variety with six sets of chromosomes (hexaploid) is not sterile.

For five generations, the hexaploid plants grew in the field and pollinated freely. This allowed natural selection for fertility to take place. Some of the plants dropped their bracts. Others did not. In 1974 and 1975, three caducous-bract plants were selected for a closer look. Fibers from their bolls were short and weak.

Seeds from these three plants were grown in 1976. Five of the resulting 24 plants were caducous. Seeds from these five, planted the next year, produced a higher proportion of bract-droppers, including some with acceptable fiber strength and fiber fineness, but not fiber length.

Attempts to develop a caducous-bract cotton with commercial potential are proceeding on two tracks. Repeated selection for desirable traits in successive generations of the plants with six sets of chromosomes is one track. The other is crossing the caducous, hexaploid plants with other cottons that already have the desired growth and fiber qualities.

One aim in the first process is to produce a true-breeding, caducous-bract plant, one whose seeds all grow into bract-droppers. Seeds from 1978 selections, planted in 1979, produced up to 50 percent caducous offspring, with one progeny breeding true. Fiber quality in the 1978 selections is better than that of the 1977 selections.

Numbers Game

Caducous selections with six sets of chromosomes have been crossed with five different commercial varieties of cotton. In the second and succeeding generations, offspring are selected that have caducous bract and other desired traits, and these selections are backcrossed to the commercial variety. Up to four generations have reproduced in our various backcross lines.

Trying to breed the bract-dropping trait into a commercial cotton variety is, in part, a numbers game. The number of times the genes are suffled by genetic crossing increases the odds of getting the right deal of the genes.

The new research grant will allow growth and testing of many more plants each year, including a second crop in a greenhouse. Flowers on each plant to be crossbred must be pollinated by hand to prevent the self-pollination that is normal in cotton.

One advantage this project has over other breeding work is that caducous trait is easily identified. Also, the number of genes that govern it appears to be small.

Whether the breakthrough will come next year or a few years later is impossible to predict, but we are optimistic that a commercial variety of cotton that drops its bracts before harvest will be available to farmers in the 1980s. That will be a big step toward a cleaner cotton and control of brown-lung disease.