

River Thames contained the equivalent of 0.62 gm. phosphorus per head per day. In this case 40 per cent only of the phosphorus present in the crude sewage passes to the river, and 60 per cent is retained in the sludge.

It is interesting to note that the total amount of phosphorus excreted is given by Fowler¹ as 1.48 gm. P per head per day; Mathews² gives the phosphorus ingested in the food of an adult as 1.2–2.0 gm. P per day, while Sherman³ regards 1.5 gm. P per day as the lowest intake compatible with safety for the adult.

Armstrong⁴ gave the phosphorus in the sewage from Great Britain as equal to 150,000 tons of rock phosphate a year and stated that most of this reached the sea. On the basis of the figures we have obtained, the amount of phosphorus in sewage from a population of 42 million inhabitants is equivalent to about 116,000 tons of calcium phosphate per annum, and by suitable treatment of the sewage, 46–60 per cent of this could be recovered in a usable form.

We hope to make a more detailed study of this subject when circumstances permit in order to supplement the information we already possess, and to extend our investigations by a study of the losses of phosphorus and nitrogen during sewage purification.

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¹ Fowler, G. J., "An Introduction to the Biochemistry of Nitrogen Conservation" (London, 1934), p. 247.

² Mathews, A. P., "Physiological Chemistry" (New York, 1924), 3rd Edit., p. 755.

³ Quoted by Lester, J. S., "Nutrition and Diet in Health and Disease" (London, 1934), 2nd Edit., p. 121.

⁴ Armstrong, E. F., NATURE, 150, 453 (1942).

Breeding of a Cotton Immune from Natural Crossing

BALLS ("The Cotton Plant in Egypt", 1912) made the discovery that in the cotton plant, self pollen was somewhat prepotent over foreign pollen, in interspecific crosses between Egyptian cotton (*Gossypium barbadense* L.) and Upland cotton (*G. hirsutum* L.). Thus if stigmas of *barbadense* were pollinated with a mixture of *barbadense* and *hirsutum* pollen, most of the ovules were fertilized with *barbadense*. The reverse was found with *hirsutum*. The prepotency of self pollen over foreign pollen was rediscovered by Jones some years later in maize, and other plants are now known to follow this rule.

But Balls went further and showed that some F_1 pollen was prepotent over self pollen, though he did not deduce any theoretical consequences from this fact. This observation made me believe that in an interspecific cross there must be segregation for velocity of pollen tube growth conditioned by minor modifiers (now called polygenes by Mather). If there were many minor genes for velocity it should be possible to concentrate them by stringent selection and produce new types in which self pollen grew so rapidly that no foreign pollen would grow fast enough to fertilize.

The plan adopted was as follows, and the experiments lasted from 1929 until 1935, when I left Trinidad for Brazil.

The cross:

Upland: <i>y</i> , cream corolla	<i>barbadense</i> : <i>Y</i> , yellow corolla
<i>p</i> , cream pollen	<i>P</i> , yellow pollen
<i>s</i> , spotless corolla X	<i>Sf</i> , faint spot
<i>r</i> , green plant body	<i>R</i> , red plant body

The F_1 showed dominance of *Y*, *P* and *R*. *Sf* could not be usefully employed because penetrance was too low.

The first backcross of F_1 on to the triple recessive *hirsutum* Upland.

The female triple recessive was selfed at 8 a.m., much pollen being applied. Afterwards F_1 pollen was applied at intervals of one hour later, two hours later, etc., to eight hours later.

Approximately ten bolls with roughly 210 seeds was the objective from each of the treatments.

The results. As my notes were all lost on leaving Trinidad I can only give very approximately the nature of the results.

It was found that a considerable number of F_1 pollen tubes could beat the self tubes even when the latter had four hours start. A hundred plants were grown from each treatment, making eight hundred plants in all. Approximately eleven plants of composition *R Y P r y p* were secured from the four-, five- and six-hour treatments.

It would have been desirable to have tested each of these plants in a similar series of treatments to those given above, but time and space did not permit of this.

For the second backcross on to *hirsutum* triple recessive a mixture of pollen from all the eleven plants was used.

The second backcross results. The exact numbers are not available, but it may be said that a much greater number of foreign tubes were able to fertilize at the four-, five- and six-hour intervals.

The third backcross. The pollen of ten *R Y P r y p* plants was mixed and applied at the same intervals after self-pollination.

The number of plants from foreign pollen was slightly superior to the number in the second backcross, and the whole population was Upland in most of its characteristics.

The self population. All plants resulting from the four-, five- and six-hour treatments, about sixty in number, were self-fertilized, and grown in progeny rows. All triple recessives were self-fertilized, to create a series of lines identical with Upland except for the presence of the rapid pollen tube genes.

Five plants only were available to continue the experiment. Progeny rows of the five were interspersed among a collection of mixed hybrids of *hirsutum*, *barbadense* and *purpurascens* ancestry.

If we had been successful in concentrating some of the rapid pollen tube growth genes, some plants in these five rows would breed true to type *r y p* and vegetative characteristics and could therefore be termed immune to natural crossing.

Unfortunately the experiment was interrupted at this point, and has only recently been resumed. Its practical importance for application to other crops is too obvious to need emphasizing.

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