3. Non-random fertilization of pollen in mixtures.

Two experiments have been conducted to study the relative effectiveness of pollen of different strains in pollen mixtures.

The first experiment involved two yellow varieties, Jarvis and Krug, and two white varieties, Weekley and Zapalote Chico. Four pollen mixtures were made by mixing pollen of 5 plants of a yellow variety with that of 5 plants of a white variety. Each mixture was applied to the silks of at least 6 plants of each of the four varieties. At harvest, two 100 kernel samples of each ear were classified as having been fertilized by white or yellow pollen. Ears which were difficult to classify were discarded.

The results (Table 1) show that a greater proportion of white pollen functioned on the parental variety with white endosperm than on the parental yellow variety. This difference is statistically significant and indicates that pollen in mixtures tends to be more effective on the strain from which it came. The magnitude of the selective fertilization effect varies among varieties as indicated by a significant interaction between mixtures and varieties. There is no significant difference for percent white (or cream) kernels between the non-parental strains which indicates that the effect is not associated with white or yellow endosperm *per se*.

The second experiment involves divergent selection for selective fertilization in the varieties Jarvis and Weekley. Two hundred plants of each variety were planted in adjacent rows. Pollen mixtures were made by selecting two plants, one from Jarvis and the other from Weekley, which flowered at exactly the same time. Pollen collected from these two plants was mixed, and the mixture was applied to their silks. At harvest, 120 pairs of ears were obtained in which each had been pollinated by its own pollen mixed with that of the other member of the pair. One hundred kernels of each ear were classified as having been fertilized by a white or a yellow pollen grain. Pure white kernels on the ear of the white variety and deep yellow kernels on the ear of the yellow variety represent self-fertilized seeds. Selfed seed of pairs of plants was selected on the basis of the proportion of selfed to outcrossed kernels.

Table 1

The relative effectiveness of pollen of white and yellow endosperm varieties in pollen mixtures.

Pollen** Mixture	Percentage of White or Cream* Kernels			
	Parental Variety		Non-Parental Variety	
	Yellow	White	Yellow	White
J + Z	33	56	42	42
K + Z	35	66	35	44
J + W	49	51	54	50
K + W	48	67	44	69

*White kernels on a white tester; cream kernels on a yellow tester.

**J = Jarvis Golden Prolific (Yellow Endosperm)
Z = Zapalote Chico (White Endosperm)
K = Krug Yellow Dent (Yellow Endosperm)
W = Weekley (White Endosperm)

Table 2

The result of divergent selection for percentage of self seed on pairs of plants pollinated with a mixture of their pollen.

Sub-population*	Percent Self Seed		Percent of pairs of ears with more than 50% self seed
	Mean	Range	
Inbreeders	57.05	44 - 71	78.9
Neutrals	50.82	34 - 64	57.9
Outbreeders	47.45	31 - 62	33.3

*Inbreeders: Selected for high proportion of self seed.
Neutrals: Selected for approximately 50% self seed.
Outbreeders: Selected for low proportion of self seed.

Three selection criteria were employed: high proportion of selfed seed (inbreeders), low proportion of selfed seed (outbreeders), and 50% selfed seed (neutrals).

Selfed progeny of selected pairs were self-pollinated in a winter nursery and any segregating ears were discarded. S_2 progeny of each pair were planted in adjacent rows, and individually paired plants within the S_2 progenies were pollinated by mixtures of their pollen, and the classification and selection processes described above were repeated. Selfed progeny of selected pairs were self-pollinated in a winter nursery to eliminate segregating ears. S_4 progeny of the surviving lines of each variety which had been selected by each criteria were intermated to produce pairs of subpopulations designated as inbreeders, outbreeders and neutrals.

The second cycle of selection was initiated within pairs of subpopulations of the two varieties in the manner described above. The data obtained for the initiation of the second cycle provide an evaluation of the effectiveness of the first selection cycle (Table 2). Selection response occurred in both directions, although the mean difference from the neutral population suggests that selection for a high proportion of selfing (inbreeders) was more effective than selection for a low proportion of selfing (outbreeders). The greatest difference among the three subpopulations is shown by the percentage of pairs with more than 50% self seed.

The response to divergent selection demonstrates that individual genotypes exist in these populations which cause selective fertilization, and that both negative and positive assortative mating occurs. The fact that both kinds of deviations from random fertilization occur is further evidence that endosperm color is not in itself associated with selective fertilization.

The existence of gametic selection in pollen mixtures has a bearing upon techniques employed in the intermating and maintenance of populations, particularly in the early generations of composite or synthetic populations. A commonly used technique is to collect and mix pollen of a large number of plants and then pollinate at random a number of ears.

This may result in significant departures from random mating, as demonstrated by the differential effectiveness of pollen in mixtures. The alternative techniques of making controlled plant to plant crosses will avoid gametic selection between pollens of different plants and may result in fewer deviations from random mating.

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4. Comparison of selection methods for increased yield.

Four selection experiments which involve the two open-pollinated varieties, Jarvis and Indian Chief, provide a comparison among three alternative methods for systematic improvement of grain yield. Two of the three methods lead to improvement of the varietal hybrid, whereas the third method involves improvement of the varietal composite. One method being studied is direct selection for performance of the varietal hybrid by reciprocal recurrent selection procedures. Another of the methods is full-sib family selection within each variety separately. The improved varieties are crossed, and their improvements are utilized indirectly in their hybrid. The third method is to intermate the original variety hybrid for several generations to form the varietal composite, and subsequently to improve the varietal composite by full-sib selection.

Comparisons have been made among these procedures after 3 selection cycles and again after 6 selection cycles. After 3 selection cycles there was no detectable difference between the two methods which lead to an improved variety hybrid. The improved variety hybrid was distinctly superior to the improved varietal composite. However, after 6 selection cycles, the highest yield was obtained in the varietal hybrid resulting from reciprocal recurrent selection. This crossbred population was 20.4% greater in yield than the original varietal hybrid, and 10.7% greater than the average yield of two commercial double cross hybrids. The yield of the crossbred when the varieties were improved separately was 15.1% greater than the yield of the original varietal hybrid, and approximately 5.3% above the average of the two commercial hybrids. The yield of the varietal composite after 6 selection cycles is