FREQUENCY CHANGES IN MIXTURES OF Af-af, St-st, Tl-tl GROWN UNDER MINIMAL AND INTENSE COMPETITION.

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A fundamental principle in population biology is the concept of fitness. The fitness or realized reproduction of an individual depends on the organism's phenotype interacting with the environment. A particular genotype may show a wide range of fitness under different physical conditions and competitive situations. Because organisms exhibit this flexibility of response with respect to fitness it is unlikely that a single genotype of plant raised in monoculture will produce the maximum number of seeds (offspring) under the varying pressures encountered in field conditions.

In a plant such as Pisum where the commercial yield is closely correlated with a major component of fitness, namely total number of seeds produced, investigations of changes in fitness may have important practical consequences.

As a preliminary study of fitness and competition in Pisum, mixtures of eight different genotypes affecting foliage type were tested under two forms of spatial competition in the field at Geneva, NY. The eight genotypes, furnished by G. A. Marx, were isogenic lines derived as F6's from a backcross involving three major gene loci.

The genotypes utilized were all possible combinations of Af-af, St-st, and Tl-tl. Afila homozygotes have leaflets replaced by extra tendrils, st homozygotes have reduced stipules, and tl (acacia) homozygotes have tendrils replaced by leaflets. The interaction between af and tl produces clusters of small leaflets. No other obvious morphological changes occur due to interaction in any of the eight genotypes.

The eight genotypes were mixed together in equal ratios and grown on trellises in the field in 1977. Phenotypes were scored in the seedling stage. Dry seed was bulk-harvested and replanted on trellises in the field in 1979. Again plants were scored as seedlings and dry seed was harvested. Samples from 1979 seed were grown to seedling stage in the greenhouse and scored. The ratios of the phenotypes of these seedlings represent the population ratios after two generations of field selection under minimum spatial competition.

A similar planting scheme was followed with a mixture of the eight genotypes grown under intense spatial competition in drilled plots. These conditions were comparable with commercial cultural conditions. The drilled plot initial mixture of seed inadvertently contained twice as much of the AfAf stst T1T1 genotype as the other genotypes.[1/] This error may have confounded the results due to density dependent selection. However, for ease of comparison such selection was assumed to be negligible and the AfAf stst TlTl were halved as correction procedure.

The results (Table 1) show dramatically the changes in composition of the mixtures. The equal numbers of phenotypes in the field both on trellises and in drilled plots in 1977 indicate equal and high germination rates for all genotypes. After one generation the mixtures from trellises and drilled plots were significantly different from the initial ratios and from each other. While fitness measured as total number of dry seeds is not perfectly correlated with marketable yield, mixtures of two or more genotypes may increase yield.

[1/] sole responsibility for the mixture lies with G. A. Marx - Ed.

Table 1. Frequency of plants in each of 8 combinations of Af-af St-st Tl-tl grown under minimal (a) and intense (b) competition.

(a) Minimum spatial competition

Phenotype			Trellis in field (Spring 1977)	Trellis in field (Spring 1979)		Flats in greenhouse (Fall 1979)	
Af	St	Tl	No.	No.	%	No.	%
+	+	+	25	48	15.7	110	22.2
+	+	-	24	90	29.5	167	33.7
+	-	+	25	45	14.7	59	11.9
+	-	-	24	39	12.8	58	11.7
-	-	+	24	9	3.0	2	0.4
-	+	-	24	46	15.1	69	13.9
-	+	+	26	14	4.6	24	4.8
-	-	-	24	14	4.6	6	1.2
			196	305		495	

(b) Intense spatial competition

Phenotype			Drilled plots (Spring 1977)		Drilled plots (Spring 1979)		Flats in greenhouse (Fall 1979)	
Af	St	Tl	No.	%	No.	%	No.	%
+	+	+	107	9.8	359	18.5	95	20.0
+	+	-	125	11.5	258	13.3	100	21.0
+	-	+	257	23.7	558	28.8	126	26.5
+	-	-	123	11.3	230	11.9	67	14.1
-	-	+	119	10.9	34	1.7	0	0
-	+	-	117	10.8	227	11.7	42	8.8
-	+	+	114	10.5	179	9.2	38	8.0
-	-	-	125	10.5	94	4.8	8	1.7
			1087		1939		476	

After two generations of selection, the ranked fitness of the genotypes was similar in both trellised and drilled plots (Table 2). A Spearman rank correlation (Snedecor § Cochran, Statistical Methods, 6th ed. 1967. p. 194) was significant at the .01 level. AfAf StSt tltl and AfAf StSt T1T1 were clearly superior competitors in this regime; afaf stst tltl and afaf stst TlTl were severely reduced in number, with the remaining four genotypes exhibiting intermediate values.

These preliminary results suggest several experiments concerning the effect of various genotype mixtures on marketable yield.

Table 2. Ranking of phenotypes after two generations of minimal and intense competition.

Minimum competition			Intense competition (corrected)		
Rank	Phenotype	%	Rank	Phenotype	%
1	+ + -	33.7	1	+ + -	24.2
2	+ + +	22.2	2	+ + +	23.0
3	- + -	13.9	5	+ - -	16.2
4	+ - +	11.9	4	+ - +	15.3
5	+ - -	11.7	3	- + -	10.2
6	- + +	4.8	6	- + +	9.2
7	- - -	1.2	7	- - -	1.9
8	- - +	0.4	8	- - +	0

Spearman rank correlation (r_s) = .905**

The results were tested by standard Chi-square techniques and were found significant at the .001 level.

DESYNAPTIC ALLELIC PEA MUTANTS

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Two chlorophyll-mutant lines which were produced from treatment of seeds with EI (line 9) and EMS (line 12) also were found to contain meiotic mutations. These mutations seem to have arisen simultaneously with the chlorophyll mutations in the initial cells, following mutagen treatment of seeds.

Study of meiosis of meiotic mutants revealed that mutant genes in both lines do not influence the process of conjugation of chromosomes in zygotene-pachytene cells, but disturb chiasma formation, though to a different extent. As a result of this disturbance, both mutant lines developed univalents in the first metaphases, laggards at anaphases, high pollen sterility, and slightly reduced seed production (Table 1).