Competition Between Near-Isogenic Genotypes

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THIS paper augments a succession of California reports dealing with survival of genotypes and varieties in populations. It features three sets of near-isogenic lines. These were grown competitively for seven generations. Two heterozygotes of these near-isogenics were also grown in pure and in mixed stands.

LITERATURE REVIEW

The California studies under review dealt with the two extremes for evolutionary potential in populations. Obviously a four-variety mixture is far simpler and a multiple-hybrid composite much more diverse than most natural populations undergoing adaptive change. This contrast was ignored in 1949 when the use of “evolutionary breeding” was questioned because of a yield-survival variance found in sampling four pure-line varieties (10). For the conditions under which Vaughn and Atlas barley were yield-tested, Vaughn was more productive (10). There seems to have been an unrecognized bias, however. Vaughn can be sown and managed to yield either strikingly more or less than Atlas (6). Furthermore, the reported 7% yield advantage for Vaughn, based on 114 California tests (10), has since, with a total of 319 tests, been turned into a 2% deficit (8). And though both varieties are losing favor, the 1960 acreage ratio in California was 10 to 1 in favor of Atlas. Significant yield difference estimates when broadly projected may sometimes create real errors.

The prevalence and severity of diseases are greatly reduced in populations with mixed genotypes (16). This knowledge greatly alters the projections from pure-line plots that assumed large yield reductions from scald and mildew on the Atlas plants in a mixture (10).

There are other difficulties in assessing the nature and magnitude of population shift. Certain marker genes show very poor survival (12). Even heterozygotes differ widely in survival capacity (5). Adaptive improvement and the development of associations seem to be coincident (2). Thus nonrandom survival in complex populations seems to be integrated with their progressive adaptive improvement (13). This improvement in practical breeding terms is really an economic growth-rate. How better to use and exploit this population phenomenon is one of the major problems challenging plant breeders. Allard (1) too recognizes its reality and the potential of getting more production from compatible genotypes than from a pure-line variety.

Though we are seeking primarily to reconcile all our reports, recognition of related work is pertinent. It involves particularly three other national plant-breeding groups. Frankel in Australia, after early contributions on competition in pure and in mixed stands. Vaughn can be sown and managed to yield either strikingly more or less than Atlas (6). Furthermore, the reported 7% yield advantage for Vaughn, based on 114 California tests (10), has since, with a total of 319 tests, been turned into a 2% deficit (8). And though both varieties are losing favor, the 1960 acreage ratio in California was 10 to 1 in favor of Atlas. Significant yield difference estimates when broadly projected may sometimes create real errors.

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Table 1--Mean yields per acre of near-isogenic awned and awnless wheats grown in California, 1946-59.

<table>
<thead>
<tr>
<th>Variety type</th>
<th>No. paired tests</th>
<th>Mean yield, lb./A.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Awned</td>
<td>Awnless</td>
</tr>
<tr>
<td>Baart</td>
<td>75</td>
<td>2538</td>
</tr>
<tr>
<td>Onas</td>
<td>40</td>
<td>2652</td>
</tr>
<tr>
<td>Ramona</td>
<td>43</td>
<td>2028</td>
</tr>
</tbody>
</table>

Additional studies have recently been reported by Wiebe et al. (18) on the effects of inter-plant competition in barley and the relation of these effects to selection procedures.

EXPERIMENTAL EXTENSIONS

In plant research there is increasing emphasis on controlled environments for study of specific processes. We used near-isogenic lines to control the genetic environment.

A previous study compared awned and awnless forms of two wheat varieties. The test stocks were produced by reciprocal backcrossing. From widespread testing over a 3-year period it was shown that awns increased yield about 7%, principally from increased seed weight (9). This difference can now be further confirmed from 1946-59 tests (Table 1). Part of these tests dealt with the yield components and again suggested only a seed weight difference. Though grouped as 3 variety types, these test isogenics with 10 to 14 backcrosses also included diversities in maturity, height, and glume color. The productive advantage of the wheat awn seems to be real.

Awned and awnless Onas wheat isogenics from backcrosses were mixed in a 2 to 1 ratio and grown progressively for 7 years as shown in Table 2. No significant population shift resulted, even though the initial mixture was dominated by the larger seeded component. Thus a small yield difference, probably based solely on seed weight, had no impact on population structure. The awned condition in this case depends on two recessive genes. These are yield-influencing genes without an adaptive impact on survival under competition.

A 1 to 1 mixture of rough and smooth-awned Atlas barleys developed by backcrossing was also successively...

1 Contribution from Crops Research Division, ARS, USDA, and Agronomy Department, University of California, cooperating. Received Sept. 14, 1961.
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