COMPOSITIONAL STABILITY OF AN OAT MULTILINE

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Received 13 April 1981

INDEX WORDS

Avena sativa L., oats, multiline, compositional stability, blend, near-isogenic lines, competitive ability, Puccinia coronata, crown rust.

SUMMARY

Mixtures of genotypes are frequently unstable in composition when propagated over successive generations. This study was designed to test whether a multiline cultivar of oats (Avena sativa L.) created to control crown rust disease (caused by Puccinia coronata CDA.) would reflect differential near-isogenic line survivals when propagated under conditions of either presence or absence of rust. An oat multiline cultivar synthesized from near-isogenic lines that had different genes for resistance to crown rust was propagated under rust-free and rust epiphytotic conditions for four successive generations. In the rust-free environment, one near-isogenic line, CI 9192, which was inferior in yielding ability, was reduced significantly from 20% to 10% of the mixture, and CI 9184, which has no yield deviation from normal, increased from 20% to 38%. The other three near-isogenic lines were stable at about 20%. Also, in the rust line of descent, CI 9192 and CI 9184, respectively, decreased and increased significantly.

Our results have implications with respect to seed production practices for multiline cultivars; they also raise the question of whether a multiline is stable enough in composition to be called a cultivar.

INTRODUCTION

Genotypic mixtures or blends of field crops behave differently from their component lines grown in pure stands. Blends can (a) be more stable than their component lines (ALLARD, 1961; FREY & MALDONADO, 1967; SHORTER & FREY, 1979), (b) be equal to or higher yielding than their component lines (JENSEN, 1952; FREY & MALDONADO, 1967; CLAY & ALLARD, 1969), and (or) (c) have greater protection from disease than the mean of their component lines in pure stands (FREY et al., 1977; WOLFE & BARRETT, 1980). Because of the effects of natural selection, however, changes in the genotypic composition of mixtures do occur (HARLAN & MARTINI, 1938; SUNeson & WIEbe, 1942; SUNeson, 1949; RASMUSson et al., 1967; KHALIFA & Qualsset, 1974; JENNINGS & de JESUS, 1968).

The competitive ability of a genotype that is grown in a mixture is determined by

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the interaction of various plant traits. Because of the number of traits potentially involved and the complexity of interactions possible, compositional shifts within a mixture are generally unpredictable. As a result of such interactions, genotypic predominance in a mixture may not be related to yielding ability (Harlan & Martini, 1938; Suneson & Wiebe, 1942; Suneson, 1949) or disease resistance (Suneson, 1949), but may be related to such factors as tiller survival (Lee, 1960) and plant height (Jennings and De Jesus, 1968; Khalifa & Qualset, 1974).

Similarly, the effect of natural selection on a segregating bulk population is unpredictable. Whereas Suneson (1956) found that natural selection increased the frequency of high-yielding lines in bulk barley populations, Jennings & Herrera (1968) reported the domination of low-yielding segregates in a bulk population of rice (Oryza sativa L.), largely because the low-yielding types were tall and vegetatively aggressive. In Iowa, USA, bulk populations of oats have been evaluated for several quantitatively inherited traits, and generally, natural selection has altered the means (Romero & Frey, 1966; Frey, 1967; Fatunla & Frey, 1974; Gonzalez-Rosquel, 1976; Adegoke, 1979) and variances (Fatunla & Frey, 1974; Gonzalez-Rosquel, 1976) of many traits. Shifts in trait means both relative to time and magnitude could be attributed to specific environmental influences (Gonzales-Rosquel, 1976; Adegoke, 1979). Using different mass selection techniques for seed weight, Simons (1972) was successful in changing the frequency of tolerant genotypes in bulk populations of oats exposed to crown rust epiphytotics for several generations.

The new approach to disease control using multiline cultivars and cultivar mixtures of small grains has introduced the question: Will the composition of multiline and mixtures change when they are propagated under either disease-free or disease epiphytotic conditions for several generations? Theoretically, compositional shifts could occur in any environment due to the different inherent competitive abilities of the near-isogenic lines (NIL's), and under disease conditions due to differential survivals caused by differential reactions to pathogenic races and different levels of resistance. Shifts in the NIL composition of multiline cultivars could be of critical importance if they occurred during the generations of propagation required to advance supplies from foundation to certified seed classes.

Our study was designed to determine whether (a) the NIL composition of a multiline cultivar of oats might change over four generations of propagation and (b) whether any shift that might occur was related to the NIL's and/or to the presence of disease in the oat population.

MATERIALS AND METHODS

Equal numbers of seeds of five near-isogenic lines (CI 9192, CI 9183, CI 9184, CI 9190, and CI 9191) of oats were mixed to form the multiline cultivar for this study. All NIL's were developed by backcrossing to CI 7555 as the recurrent parent, so all had similar genetic backgrounds. CI 9192, CI 9183, CI 9184, and CI 9190 were composites from Bc3F3 panicle rows that were homozygous for crown rust resistance and phenotypically similar to the recurrent parent for agronomic traits. Development of CI 9191 was identical except that Bc4F3 panicle row were composited. Data from previous experiments showed that although the five NIL's were similar, some differences