Monosomic Analysis of Leaf Rust Reaction, Awnedness, Winter Injury and Seed Color in Pawnee Wheat

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The use of monosomic plants offers a special method of studying the inheritance of characters in polyploid species. Investigations utilizing monosomic types in common wheat, Triticum vulgare Vill., were initiated at Kansas State College in 1947. This report deals with the results of crosses with 16 different monosomics of Chinese spring wheat crossed to Pawnee winter wheat for a study of the inheritance of leaf rust reaction, awn expression, winter injury, and seed color.

REVIEW OF LITERATURE

The occurrence of monosomic individuals (2n-1) frequently has been mentioned in the literature. They have been reported in Jimson weed (2), corn (11), Drosophila (5), tobacco (4) wheat (6, 7, 9, 10, 13, 14, 19) and in oats (5). Clausen and Cameron (4) summarized nearly 20 years of work with monosomics in Nicotiana tabacum, an allotetraploid with 2n = 48. The entire set of 24 possible monosomics in that species has been isolated. A total of 18 genes have been located on 9 chromosomes by the use of these monosomics.

Sears (14, 15, 16, 17) reported the identification of 19 of the possible 21 monosomics in common wheat, and now he has produced all 21 monosomics in the Chinese spring wheat variety. Sears also reported that when a monosomic wheat plant was self-fertilized, about 73%, 24, and 3% of the progeny were monosomic (2n-1), disomic (2n), and nullisomic (2n-2), respectively. A monosomic wheat plant pollinated with a disomic gives progeny with approximately 75% monosomic and 25% disomic plants.

Seventeen genes have been located in varieties of Triticum vulgare, through the use of monosomics and nullisomics in various crossing procedures. Sears (16) reported the following in Chinese wheat: (1) the gene b, on chromosome IX slightly suppresses awn development, but less actively than its allele B; (2) other genes on chromosome IX are responsible for suppression of speltoidy, for square-headedness, and for pubescent nodes; (3) a hooded factor, Hd on chromosome VIII shortens and recurs awns; (4) chromosome X carries an active awn-suppressing gene, B2; (5) chromosome XVI has a gene for red seeds and dominant allele to the sphaerococcum gene which causes short culms, dense spikes, and small, spherical grains; (6) chromosomes II and XX visibly carry weak factors promoting awn length; and (7) chromosome III carries genes essential to normal synapsis. Sears and Rodenhirser (18) reported that the variety Tintstein has two dominant, complementary genes for resistance to stem-rust race 56 on chromosome X. According to Sears, as reported by Shebeski and Wu (20), Red Egyptian has a factor for resistance to races 17 and 56 of stem rust on chromosome XX and another factor for resistance to stem rust races 38, 56, and 138 on chromosome VI.

O'Mara (12) reported that Marquis wheat carries a strong awn inhibitor, B1 on chromosome IX. Unrau (22) reported awn suppressors (B2) on chromosome IX in Hymar and Pawnee, and recessive alleles of the two awn-inhibitor factors in Chinese spring on chromosomes VIII and X of Hymar. A gene for red chaff on Chromosome I in Hymar, the clubhead gene was located on chromosome XVII, and one of two genes for winter habit on chromosome XVI.

The resistance of Pawnee wheat to race 9 of leaf rust was compared with that of the cross Pawnee × Red Chief was reported by Penny. A single, partially-dominant factor.

Watkins and Ellerton (23) reviewed much pertinent to the inheritance of leaf rust in wheat and pointed out the correlation of awnedness in several wheat species. According to them, awnedness expression requires the presence of at least two genes. The presence of one or more awn-inhibiting genes in most of the cases of awnless and other partially-awned wheats. These facts obtained in the conventional analysis, are consistent with those resulting from monosomic analysis.

Resistance to winter injury has been reported in several instances and appears to be complex in its inheritance.

Nilsson-Ehle in 1911 showed that single dominant factors were responsible for the various kernel color found in wheat (Sears 17). Sears (14) showed that Chinese wheat contains a single factor for red seed color, chromosome XVI, and unpublished work at Kansas State College has shown that Pawnee wheat has only one factor for red seed color.

MATERIALS AND METHODS

Seed of 19 of the 21 monosomics and nullisomics in the variety Chinese wheat was obtained from E. R. Sears. Monosomic stocks used were very short-awned, had a normal growth habit, and showed adult plant resistance to leaf rust. Monosomics were used as the female parents in crosses with Pawnee, a bearded, hard red winter wheat that is resistant to race 9 of leaf rust. Successful crosses of Pawnee with 16 monosomics including chromosomes I through XII, XV through XVII, and XXI. These races were grown in the greenhouse during the winter of 1947-48.

Seeding reaction to race 9 of Puccinia triticic was determined in the greenhouse for the Pawnee and all F1 plants, and selected families of F2 plants. Race 9 urediospores supplied by C. O. Johnston were grown on seedlings of Cheyenne, a susceptible variety. Purity of the race was checked by periodic testing upon the differential leaf-rust-host races. F12 plants were obtained from seedlings of Cheyenne, a susceptible variety, and were sown in the field in the fall of 1948 to permit growth of F2 plants before inoculation and were kept in a moist chamber for 24 hours after inoculation. Rust reactions were made in accordance with the scale of growth, and showed adult plant resistance to leaf rust. These races obtained in the conventional manner check the genes essential to normal awn development, but less actively than its allele b, on chromosome IX, and for pubescent nodes; (3) a hooded factor, Hd on chromosome VIII shortens and recurs awns; (4) chromosome X carries an active awn-suppressing gene, B2; (5) chromosome XVI has a gene for red seeds and dominant allele to the sphaerococcum gene which causes short culms, dense spikes, and small, spherical grains; (6) chromosomes II and XX visibly carry weak factors promoting awn length; and (7) chromosome III carries genes essential to normal synapsis. Sears and Rodenhirser (18) reported that the variety Tintstein has two dominant, complementary genes for resistance to stem-rust race 56 on chromosome X. According to Sears, as reported by Shebeski and Wu (20), Red Egyptian has a factor for resistance to races 17 and 56 of stem rust on chromosome XX and another factor for resistance to stem rust races 38, 56, and 138 on chromosome VI.

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