Hybridization, Cytological, and Inheritance Studies of a Sorghum Cross - Autotetraploid Sudangrass x (Johnsongrass x 4n Sudangrass)

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Hybrid progeny, originating from a cross between Johnsongrass (Sorghum halepense (L.), Pres.) and autotetraploid common Sudangrass (S. vulgare var. sudanense (Piper), Hitchc.) made by Dr. L. F. Randolph at Cornell University, Ithaca, N. Y., has been grown in the Sudangrass breeding nursery at Kansas State College, Manhattan, Kans., since 1942. Some promising selections suitable for pasturage were isolated, but these selections have a dry, pithy stalk which lowers somewhat their palatability to livestock. In 1948 the better selections were crossed with juicy-stalked autotetraploid Sudangrass in an attempt to combine the juicy-stalk character with the desirable characteristics of the Johnsongrass × 4n Sudangrass selections. The progenies of four crosses were observed genetically to learn the mode of inheritance of dry vs. juicy stalk and also purple vs. brown plant color. The parental material and progenies were studied cytologically to learn the behavior of the chromosomes and, thus, evaluate the success of the cross. Data on the frequency of hybridization between the Johnsongrass × 4n Sudangrass selections and both diploid and autotetraploid Sudangrass also are included.

REVIEW OF LITERATURE

The genus Sorghum is comprised of three numerical chromosome groups: one group with an n number of five is represented by S. versicolor Anderss., a second group with an n number of 10 is represented by S. vulgare, and a third group with an n number of 20 is represented by S. balepense (5, 8, 14). Aside from the numerical relationship of the chromosome complements, there is evidence that the three groups represent the diploid, tetraploid, and octoploid forms of the genus. Huskins and Smith (7) and Chin (4) found quadrivalents among the meiotic chromosomes of S. vulgare. In respect to S. balepense, Huskins and Smith (7) observed chromosome associations higher than quadrivalents. Usually all the chromosomes of S. vulgare associate as bivalents, and most of the chromosomes of S. balepense associate as bivalents, with a few quadrivalents (5, 7, 10). Because of this usual association of chromosomes, S. vulgare is commonly referred to as the diploid and S. balepense as the tetraploid, and unless otherwise stated these two species will be treated in this manner for the remainder of this paper.

Longley (10) considered S. balepense to be derived from Sorghum ancestors with an n number of 10 chromosomes. Karper and Chisholm (8) concluded that the size of the chromosomes in S. versicolor, S. vulgare, and S. balepense indicated that the evolution of these species involved processes other than the mere doubling of the chromosome number. Garber (5) found chromosomal evidence which he believed indicated that the five-chromosome sorghums played no part in the evolution of sorghums of higher chromosome number, but he stated that there was no reason to assume that one parent of S. balepense belonged to a species other than S. halepense.

Apparently all the 10-chromosome varieties of S. versicolor freely with one another (5, 8, 14). Attempts have been made to cross S. versicolor with the two higher chromosomelike species such attempts have been unsuccessful (5, 8). Although S. versicolor and S. balepense hybridize occasionally under natural conditions, Vinall (13) obtained only three seeds in numerous such crosses. Basile (3, 8) obtained only one seed from 386 emasculated florets in a cross of S. vulgare and S. balepense. Randolph reported success in obtaining cross-fertilized seed in an attempt to hybridize S. balepense and colchicine-induced autotetraploid S. vulgare.

Brink and Cooper (3) stated that seed abortive breakdown is probably the most effective barrier to hybridization between diploids and their tetraploid derivatives. In their studies of Lycopersicon pimpinellifolium, these investigators found that 4n × 4n matings gave endosperm development, whereas 2n × 4n matings gave slow endosperm breakdown. Usually sperm breakdown is probably the most effective barrier to hybridization. Swanson and Parker (12) demonstrated that a stalk character in S. vulgare is inherited as a simple dominant to the dry stalk (D) being dominant to juicy stalk (d). Vijiaraghavan, Pillai, and Ayyar (11) reported types of plant color, purple and brown, expressed in the plant. They found purple plant color (P) and over brown plant color (p). Ayyangar, Ayyar, and Rao (2) demonstrated that the P gene for plant color and the D gene for plant color are also linked with 30% crossover values.

Lindstrom (9) pointed out that the most probable inheritance in tetraploids is either random or regular segregation, with the former being demonstrated in eight chromosome combinations which will give a 35:1 F2 ratio. Of these, the maximum, a 20:8:1 F2 ratio, Hayes and Immordino found for chromosome chromosome segregation occurs only when the chromosome is involved in 50 or more crossovers units from the other chromosome. For closer distances the ratios are intermediate to those expected for chromosome and chromosome segregation. The chromosome segregation as the gene becomes closer to the kinetochore, Sansome (11) has presented formulae for the gametic output expected for the various phases of tetraploids.

MATERIALS AND METHODS

Seven Johnsongrass × 4n Sudangrass selections were made from parental material. The genotype of these selections studied specifically was DDDD PPPP. All the selections had retained the rhizomatous habit of growth of S. vulgare. There was variation between selections in size and vigor of the rhizomes, but in no case were they as large and vigorous as those produced by Johnsongrass planted directly in the greenhouse.

Seven autotetraploid Sudangrass plants were made from seed by Swanson and Parker (12) in a cross of S. vulgare and S. halepense. These plants were grown and propagated in the greenhouse until the second generation. The first and second generations were soaked in an aqueous solution of colchicine and treated in a manner similar to the first generation. Two of these plants appeared to be entirely tetraploid, but the remainder of the 10-chromosome varieties of S. vulgare also were grown and propagated in the greenhouse until the second generation. The first and second generations were soaked in an aqueous solution of colchicine and treated in a manner similar to the first generation. Two of these plants appeared to be entirely tetraploid, but the remainder of the 10-chromosome varieties of S. vulgare also were grown and propagated in the greenhouse until the second generation. The first and second generations were soaked in an aqueous solution of colchicine and treated in a manner similar to the first generation. Two of these plants appeared to be entirely tetraploid.