THE INFLUENCE OF GENOTYPE AND ENVIRONMENT ON UNIVALENT TRANSMISSION IN TWO MONOSOMICS OF *AVENA SATIVA* L.

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ABSTRACT

The influence of genotype and environment on univalent transmission was studied in two monosomics, 15 and 21, of *Avena sativa*.

The effect of variety and four temperature levels on the univalent transmission rate of three monosomics for chromosome 21 was measured. The transmission rates were quite close for all three monosomics under the lowest temperature (50°F) but the two Garry monosomics had a comparatively higher transmission rate than Taylor's monosomic at 60, 70 and 80°F. Taylor's monosomic was quite tolerant to all temperature treatments.

The effect on the univalent transmission of temperature level at meiosis only, compared with its effect on both meiosis and flowering was also studied on Taylor's monosomic. It showed that there is no significant difference between these two treatments. In general, the monosomic transmission rate is high under high temperatures and low under low temperatures.

The influence of seed source and variety on monosomic transmission rate was studied on three monosomics for chromosome 15 and five monosomics for chromosome 21 grown under similar environments. The two monosomic-15 lines obtained from X-irradiation showed a higher

transmission rate than that found in the monosomic obtained spontaneously.

The univalent transmission rates determined for five different monosomic lines of chromosome 21 were not consistent. Monosomics from the same variety as well as from different varieties may have similar or quite different transmission rates. Thus this characteristic cannot be used safely in the identification of different monosomics in producing a series.

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INTRODUCTION

During the last decade phenomenal progress has been achieved in the field of plant aneuploidy. Apart from the value of aneuploids as a genetic tool, the use in practical plant breeding is being explored. The production of aneuploid series, especially monosomics, in polyploid species of economic crops, has resulted in major advances in simplifying the analysis of polyploid inheritance, in locating genes on specific chromosomes and in analyzing chromosome translocations.

The production and maintenance of monosomic lines largely depend on the behaviour of the univalent chromosomes. If the univalent transmission rate for each chromosome is found to be specific in a species, it would provide an additional tool in the identification of different monosomics in a series. It would be especially advantageous if the univalent transmission is unaffected by changes in the environment.

Recently several monosomics have been produced in common oats, *Avena sativa* L., and identified from karyotype studies (McGinnis 1962). The present study has been carried out on two of them, 15 and 21, to determine the effect of genotype and environment on univalent transmission. Several sources of both monosomics were available making possible genotypic comparisons.

LITERATURE REVIEW

Following the discovery of monosomics in wheat in 1924 by Kihara (11), monosomics have been produced in a number of other crops including tobacco, cotton and oats. The review of literature concerning transmission rates in monosomics of these crops will be presented separately.

I. WHEAT (*Triticum aestivum* L.)

In 1924, Kihara (11) was first to discover monosomics in this species. He also studied the meiotic behaviour of the univalent. Since that time many monosomics have been produced by various workers.

Nishiyama (16) studied the transmission rate in a monosomic. The transmission of $n = 20$ and $n = 21$ gametes was found to be respectively 11 and 89% in the pollen and 73 and 27% in ovules.

Sears in 1944 (24) studied the transmission rates of male and female $n - 1$ gametes in monosomics. He observed that the transmission rates through the ovules was about 75% regardless of the chromosome involved and through pollen it varied from 1 to 15% depending on the chromosome concerned. He attributed the greater frequency of $n - 1$ female gametes to the frequent failure of the univalent chromosome to be included in the gamete, whereas the low percentage of n - 1 male gametes was due to their inability to compete with normal n gametes. No evidence was found of preferential selection in favour of normal male gametes by the ovules. The same author in 1952 (25) compared the transmission rates of mono-telosomic, mono-isosomic and normal monosomic plants. He did not find differences among them in female gametes, but on the male side, differences were quite evident with the mono-isosomics. He also reported that where the monosomic was an isochromosome, 26.4% of functioning male gametes were n - 1, 30.0% were 20 + telo and 43.6% were 20 + iso.

Morrison (15) from the study of meiotic behaviour of monosomics concluded that 97% of the P.M.C.'s showed 20 bivalents and pollen grains with 20 chromosomes were twice as numerous as those with 21 chromosomes, but the pollen grains with 20 chromosomes were 30 times less effective in competition with pollen grains having 21 chromosomes.

II. TOBACCO (Nicotiana, spp.)

Clausen and Goodspeed in 1926 attributed the fluted and corrugated characters in N. tabacum to the monosomic condition (5), the first aneuploids to be studied in this crop.

Lammerts (12) studied the inheritance of monosomics in N. rustica. He reported the percent of functional female n-1 gametes (with 23 chromosomes) ranged between 31 and 75%. In only 3 of 7 monosomics studied were n-1 gametes transmitted with an appreciable frequency through the male.

Olmo (19) reported that in N. tabacum 45.6 to 83.2% of the female gametes were n-1, whereas the transmission of n-1 male gametes ranged between 0 and 7.3%, and averaged 2%.

Greenleaf (9) suggested that the frequency of univalent elimination was the same in both male and female gametogenesis in N. tabacum and that about 80% of all megaspores were n-1 regardless of the chromosome concerned.

Clausen (3) isolated twenty or more monosomics of N. tabacum and found the monosomic transmissions differed from one another. He mentioned the value of monosomic analysis in this amphidiploid species for associating a gene or gene complex with a specific chromosome and also for analyzing chromosomal translocations.

In 1944, Clausen and Cameron (4) completed the monosomic series comprising 24 monosomics. They observed that all were identifiable on the basis of the behaviour of the monosome in meiosis, of pollen characteristics, of ovular abortion, of seed production and of n-1 gamete transmission ratios. Each monosomic was characterized by a specific transmission rate, the range being 5-80%.

III. COTTON (*Gossypium hirsutum* L.)

Endrizzi (7), in 1963, conducted genetic analysis of six primary monosomics and one tertiary monosome of cotton. He based his classification on cytological data and was thus able to classify six different monosomes which were found to be quite stable. The n-1 gametes were transmitted with a high frequency through the egg but very rarely through the pollen. Endrizzi, *et al.*(8), advocated the use of monosomics as a tool for developing better cotton.

Brown and Endrizzi (1), in 1964, studied the origin, fertility, and transmission of monosomics. The percentage of monosomic plants from the progeny of selfed monosomics ranged between 20.7 and 40.4, most being close to 36%. They also reported data on two monosomics (MI and MII) regarding monosome transmission through the male and female.

In 24 plants of MI x *G. hirsutum* 8 were monosomics (about 67% *n* gametes and 33% *n-1* gametes on female side). In the reciprocal cross only 1 monosomic plant was found among 97 (about 1% *n-1* gametes in the pollen). In MII, 2 of 24 plants from the cross with *G. hirsutum* pollen were monosomics. In the reciprocal cross, out of 108 plants studied, no monosomics were detected. It showed that the transmission of *n-1* gametes in pollen is extremely low.

IV. OATS (*Avena sativa* L.)

Huskins (10), in 1927, was the first to observe monosomics in heterozygous fatuoid plants in oats. He also reported the selective elimination of fatuoid male gametes.

Nishiyama (17) studied the origin of fatuoid oats and also observed the behaviour of the univalent chromosome in the monosomic plants. For the calculation of univalent transmission he employed the number of micronuclei in tetrads and he compared these findings with the actual transmission rates. From the presence and absence of the micronuclei in tetrads he calculated the proportion of *n-1* and *n* pollen grains to be 6:1. He suggested that the same ratio of 6:1 may be applied to the *n-1* and *n* gametes in the female giving the frequency of zygotes as 36(*2n-2*), 12(*2n-1*) and 1(2*n*). He also observed that the average sterility of 41 chromosome plants was 57.24%. He