Agronomic and Quality Characteristics of High Protein F2-derived Families from a Soft Red Winter-Hard Red Winter Wheat Cross

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Protein content of the grain is a major quality factor in wheat. During 60 years of hard wheat breeding, little progress in the amount of protein synthesized in the wheat grain has been recorded. Two reasons are apparent. Known genetic differences in grain protein content among varieties of the hard winter wheats were small, whereas environmental effects were comparatively large (1, 2, 3). Distinctly superior genetic sources of high protein within Triticum aestivum were not identified until 1950 (7). Among the hard winter wheats, the variety Comanche was recognized for its comparatively high-protein grain and Wichita was established as one of the lower protein varieties. The difference between the two generally was less than 1% actual protein.

The soft winter wheat variety Atlas 66 was introduced into the Nebraska breeding program in 1953 as a new source of leaf rust resistance and high protein. It was used in crosses with both Wichita and Comanche. In 1954, the North Carolina Agricultural Experiment Station reported that Atlas 66, a high-yielding variety, produced significantly more protein in its grain than other soft winter wheats. Varieties of equal yield with which it was compared (7). Beginning in 1953, Atlas 66 was compared with Wichita, Comanche, and other hard winter wheats at locations in the southern part of the hard red winter wheat region to establish whether it produced more protein in its grain than other hard winter wheats. During a 3-year period of testing, Atlas 66 consistently produced more protein than Wichita and Comanche but was significantly lower yielding than the 2 varieties in most trials. Whether the protein superiority of Atlas 66 would persist when its yield was equal to these varieties could not be established conclusively. Later trials in Oklahoma and Texas in 1957 in which Atlas 66 was as productive as Wichita and Comanche clearly demonstrated that Atlas 66 produces grain with higher protein content than these hard winter wheats when yields are comparable (5).

Agronomic relations and inheritance of high protein in wheat have been studied extensively in the greenhouse and field at Lincoln, Nebraska, since 1956. The results of portions of the experimentation have been reported (5, 6, 9, 10). The superiority in protein content of Atlas 66 over Wichita and Comanche appears to be in the range of 1 to 3% actual protein on the basis of these studies (6, 10). Multigenic control of the high protein characteristic was indicated (6, 10). Heritability estimates of grain protein as high as 0.86 have been calculated (10).

The results of a 5-year study of selected F2-derived families from the cross Atlas 66 × Comanche are reported here. Data on yield, protein, agronomic characteristics, and quality are presented.

EXPERIMENTAL PROCEDURE

Atlas 66 was crossed with Comanche and Wichita at Lincoln, Nebr., in 1953. The F1 generation was propagated in the greenhouse in 1953. The parent varieties and F1 seed from a single cross of Atlas 66 × Wichita and 2 crosses of Atlas 66 × Comanche were space-planted in the field in the fall of 1956. F2 plants were harvested individually and the grain was analyzed for protein content. A portion of the seed of each F2 plant was replanted, along with an appropriate number of rows of the parent varieties in the fall of 1957. F2 rows were harvested in 1958.

Grain yield and protein content of the grain were recorded. Thirty-eight F2-derived families from the Atlas 66 × Comanche crosses were chosen for further testing on the basis of high protein in the F1 and high grain yields in the F2.

The families and parents were seeded in rod-row plots at Lincoln in a randomized complete block design with three replications. The trials were continued for three years. No selection within families was practiced during the testing period. The number of families was reduced to 15 in the 1961 tests on the basis of agronomic performance and protein content of the grain in trials during the preceding 2 years. Trials were conducted at Lincoln and North Platte, Nebr., in 1961. Winter survival, date of heading, plant height, rust infection, grain yield, test weight, and protein content of the grain were recorded each year. In all years the trials were conducted on land fallowed in the preceding year. Nitrogen fertilizer was not used.

Limited quality tests were performed on the grain harvested in 1960. The grain was milled on the Brabender Quadrumat Pilot Mill at a temper (moisture content) of 15.3%. Since the quantity of seed was small, no variation in temper was attempted. However, the procedure allowed for a visual comparison of relative milling types. A 25-gram micro-baking procedure adapted from the procedure for 100-gram doughs described by Finney and Barmore was followed (4). An oxidation level found to be satisfactory for commercial varieties in 1960 was used.

More extensive quality tests were conducted on a composite of grain of each family from the Lincoln and North Platte tests in 1961. Samples of approximately 500 grams were milled at a moisture content of 13.5% on a Buhler Laboratory Mill (model MLU-

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