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HARD WHITE WINTER WHEAT FOR KANSAS

Gary M. Paulsen*

Wheat is Kansas' most important crop, and many changes in varieties and production methods have occurred over the years. Turkey hard red winter wheat was not the first type grown by early settlers. However, it quickly became the predominant variety after its introduction in 1874 because of excellent adaptation to the state's climate and soils. Modern varieties still retain much of the genetic heritage of Turkey, but they are more productive and shorter, mature earlier, and have greater resistance to pests and winter-killing than the original variety. An even greater change—from red grain to white grain—might occur during—the next few decades. Wheat scientists at the Kansas Agricultural Experiment Station, in other states, and at private companies have been working for over 20 years to develop improved varieties of hard white winter wheat for their regions. Many of these programs have advanced lines that could be released for production in the near future.

What Is Hard White Winter Wheat?

Hard white winter wheat is similar to hard red winter wheat. The plants are alike and both have hard grain endosperm for making bread, but the color of the seed coat (bran) is different. Bran color is determined by one, two, or three major genes that don't affect other plant traits. The original Turkey hard red winter wheat had three genes for red bran, but many modern varieties of hard red winter wheat have only one or two of these genes. White wheat, in contrast, has no major genes for bran color.

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Hard white wheat is not a new crop. Farmers in China, the major wheat producer in the world and an important customer for U.S. wheat, grow white wheat varieties in areas with suitable climate. Australia, a major competitor of U.S. wheat on the world markets, grows only hard white spring wheat varieties, some of which make excellent Oriental-style noodles as well as baked products. In Kansas, small amounts of hard white winter wheat are grown by producer associations. Other classes of white wheat are grown in California, Michigan, New York, and the Pacific Northwest.

Advantages of White Wheat

Many good reasons support considering production of hard white winter wheat instead of hard red winter wheat in Kansas. The most important reason is that customers, from the miller to the baker to the consumer, prefer white wheat whenever they have a choice. This preference is particularly strong in foreign markets, which purchase one-half to two-thirds of the wheat produced in Kansas.

Researchers at the Kansas Agricultural Experiment Station were aware of several advantages of hard white winter wheat when they started the project. White grain can be milled at a slightly higher extraction rate to yield more flour than red grain, making each bushel of white wheat more valuable. The higher extraction rate often increases the flour's content of protein, an essential component for bread making. The flour also has a better color score, a measure of flour quality used by some countries. Products baked from whole wheat flour, which are popular in the U.S. and overseas, or from flour milled at a high extraction rate (as required by some foreign governments) have a more pleasing appearance when they are made from white grain instead of red grain. As one researcher stated, "people eat with their eyes." Finally, researchers recognized the possibility that the bran, long considered a by-product of the milling of red wheat, would be a valuable co-product for breakfast cereals when it came from white wheat.

Additional advantages of white wheat were discovered by other researchers as the project progressed. A recipe for bread dough was found to require less sugar when it was made with white wheat flour instead of red wheat flour. This difference would have important economic and nutritional benefits. Taste panels comparing various baked products always preferred those from white wheat over those from red wheat. The reason for this preference for white wheat products isn't known, but it is suspected to be related to the absence of chemical pigments that give red wheat its color.

Development of the New Crop

Development of hard white winter wheat was started by the late Dr. Elmer G. Heyne, who was leader of the wheat breeding project at Kansas State University in Manhattan. During a sabbatical leave in Australia during the late 1960s he recognized that conditions might be even more favorable in Kansas than in Australia for production of white wheat. Other scientists in the Kansas Agricultural Experiment Station joined him to study the agronomic, grain quality, and economic problems of introducing the new type of wheat in the state. They quickly found that hard white winter wheat was highly adapted, the grain quality was advantageous, and the economics were favorable. However, serious problems remained in producing white wheat, developing varieties that had desirable characteristics, learning all the potential uses of the grain, and introducing the new class into a system that was structured for hard red winter wheat.

The major production problem for hard white winter wheat is susceptibility of the grain to preharvest sprouting. Rain, high humidity, and low temperatures after ripening cause white grain to sprout in the spike. Although white grain is more susceptible to preharvest sprouting than red grain, even some varieties of hard red winter wheat sprout in the field. This occurred over wide areas of Kansas in 1979 and 1989. Preharvest sprouting destroys the breadmaking ability of wheat and leaves the grain fit only for livestock feed.

Resistance to preharvest sprouting once was attributed to the pigment for grain color in red wheat; because white wheat lacked the pigment, it could not resist sprouting. This theory was disproved when several sources of genetic resistance to preharvest sprouting were discovered in white wheat, including one in Kansas. Mr. Earl G. Clark, a wheat breeder and farmer in Sedgewick, Kansas, developed many famous varieties of hard red winter wheat during the first half of the century. He routinely left his experimental wheats standing in the field for 2 months after they ripened and, by repeated selection, also developed a hard white winter wheat, Clark's Cream, that was highly resistant to preharvest sprouting. Researchers at the Kansas Agricultural Experiment Station transferred the excellent sprouting resistance in Clark's Cream to improved experimental lines, which were released for use by other wheat breeders in 1988.

The use of resistant varieties and prompt harvest should minimize the problem of preharvest sprouting in Kansas. Weather in the major wheat areas of central and western Kansas during June, when wheat

ripens, is usually unfavorable for preharvest sprouting. Production in eastern Kansas, where the rainfall and humidity are higher, might be discouraged until varieties with high levels of sprouting resistance are available.

New wheat varieties must be well adapted, high yielding, and resistant to pests and adverse weather conditions and produce quality grain. Combining all of these traits into a new variety is a long process. Established breeding programs for hard red winter wheat usually take 10 years or longer to develop a new variety. The program to develop improved varieties of hard white winter wheat took even longer, because it "started from scratch" without any experimental lines or related germplasm. The first experimental lines came from crosses between red wheat parents, which produce a proportion of white grain progeny when they have only one or two genes for red grain. These early lines generally were well adapted and high yielding, but the grain had low test weight and lacked all the quality traits that are associated with white wheat. Crosses with new germplasm and careful selection of the progeny eventually resulted in experimental lines that contained all the desirable traits.

Cereal scientists have identified uses besides bread making for hard white winter wheat. Some experimental lines make good noodles, which are important foods in the Far East. Other lines might be used for steamed breads and flat breads, which also are important foods in many parts of the world. Expanding the uses of hard white winter wheat produced in Kansas would increase the value of the crop to growers.

Introducing hard white winter wheat into a system that is dominated by hard red winter wheat is probably the last major obstacle to the success of the new class. Kansas is known worldwide as the "wheat state" for production of hard red winter wheat with excellent grain quality. A complex system of suppliers, storage and handling facilities, transportation, and marketing has evolved to serve this large industry. As one example of the difficulty of introducing the new wheat into the system, the Federal Grain Inspection Service didn't recognize hard white wheat as a new class until recently. All white wheats—hard, soft, spring, winter, and several others—were in a single class that was replaced in 1990 by two new classes, hard white wheat and soft white wheat.

Keeping grain of hard red winter wheat and hard white winter wheat separate is essential because of the substantially discounted prices paid for mixed grain. Extra care will be needed during planting, harvesting, storing, and moving grain to avoid this problem. However, long experience in other states where several classes of wheat are produced suggests that mixing of the grain can be prevented. Kansas growers and elevator operators already are doing this where hard red winter wheat and soft red winter wheat are produced and where grain lots with different protein contents are separated.

Hard white winter wheat might be produced initially under a contractual or identity-preserved system. Under this system, growers' associations, private firms, or other groups would contract with individual producers to raise the grain and then contract with users to market it. Such a system might be needed at the beginning, when the volume of grain is small and the marketing channels are not developed. After hard white winter wheat is established, it could be grown and sold just as hard red winter wheat is today.

Producing Hard White Winter Wheat

The performance data in Table 1 show that grain yield and test weight of hard white winter wheat equal those of hard red winter wheat. Yields of white wheat averaged 60 bushels per acre in dryland trials and 74 bushels per acre in irrigated trials compared with 64 and 72 bushels per acre, respectively, for Jagger in 1997. Average test weights were 60 pounds per bushel for both wheats in dryland trials and 58 and 57 pounds per bushel for the white and red wheats, respectively, in irrigated trials. Both KS84063-HWExp, an advanced experimental line of hard white winter wheat, and Jagger, the most popular variety of hard red winter wheat in Kansas in 1998, were developed by Dr. Rollin Sears, leader of the wheat breeding project at Kansas State University in Manhattan. The wheats were evaluated by the crop performance project headed by Mr. Kraig Roozeboom.

All production practices (seeding date, seeding rate, fertilization, and harvesting) are alike for hard white winter and hard red winter wheat. The same equipment is used for both crops. However, extra attention is needed to avoid mixing the grain. Volunteer wheat must be controlled completely when one class of wheat is planted after the other. Drills, combines, hauling equipment, and storage areas must be cleaned carefully. Seed for planting the next year's crop of one class should be harvested from areas at least 20 to 50 feet away from fields of the other class.

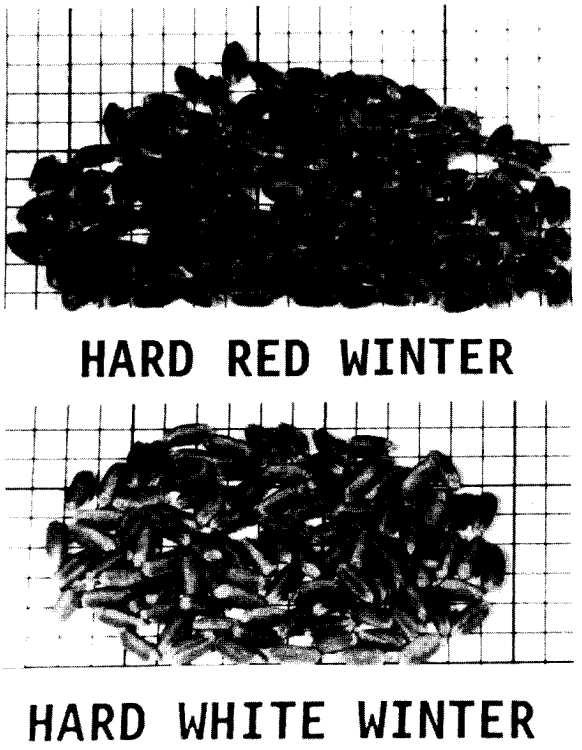
The problem of preharvest sprouting of hard white winter wheat also must be considered. The grain should be harvested promptly after it ripens to avoid exposure to wet, humid weather. If white and red

wheats ripen simultaneously, white wheat should be harvested first. Grain that has sprouted extensively should not be used for seed in the next year.

Table 1. Grain yield and test weight of KS84063-HWExp hard white winter wheat and Jagger hard red winter wheat in the 1997 Kansas Wheat Performance Tests[1]

Trial and County	Grain Yield		Test Weight	
	KS84063-HWExp	Jagger	KS84063-HWExp	Jagger
	bu/acre		lbs/bu	
Dryland Trials				
Brown	60	67	60	61
Riley	63	77	61	62
Franklin	80	42	64	61
Labette	73	85	60	59
Republic	63	57	61	62
Harvey	77	77	59	59
Reno	55	59	58	60
Sumner	39	45	54	53
Ellis	64	74	61	61
Thomas	56	70	60	62
Greeley	41	56	59	60
Finney	48	53	60	60
Irrigated Trials				
Stafford	77	59	59	55
Thomas	72	92	61	62
Greeley	76	68	60	58
Stevens	73	70	54	54

[1] Data adapted from the publication by Kraig Roozeboom (senior author) 1997 Kansas Performance Tests with Winter Wheat Varieties. Report of Progress 790, K-State Research and Extension. July 1997.



The Future of White Wheat

Hard white winter wheat has excellent potential to be a successful crop in Kansas. It has significant advantages and is well-suited to the state's climate and soils. New varieties with high grain yield and quality will ensure that the crop is competitive with modern varieties of hard red winter wheat. The change in color will follow the other successful changes that have kept wheat the most important crop in Kansas for so many years.

Hard white winter wheat might occupy much, if not most, of the wheat acreage of central and western Kansas within the next few decades. Some premium for hard white winter over hard red winter wheat might be expected. However, even without a premium, producers would still benefit from the market advantages of white wheat.

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