Disease-Resistant Oats

by T. R. STANTON

THIS IS the story of a single oat seed and how it revolutionized a large industry. The story goes back to 1929, the year it was found that Victoria oats could withstand crown rust. Crown rust was the scourge of oats; even though three or four varieties were partly resistant, crown rust caused heavy losses every time it became epidemic. Worse, there seemed to be scant prospect of ever breeding oats that could resist it. Two years later, opportunities for constructive breeding were further enhanced by the discovery of the even greater resistance of the variety named Bond. Further, Victoria and Bond were found to be resistant to certain smuts. So they became founders of family trees whose fruits include the amazing Clinton and Benton oats.

The Department of Agriculture had brought Victoria in 1927 from Uruguay, where it had been selected from the so-called "common oat of the country," which probably had been introduced many decades earlier from the Mediterranean region. Bond was originated by the Department of Agriculture of New South Wales from a cross between a sport of the wild red oat (*Avena sterilis*), and Golden Rain, the well-known Swedish variety of common oats (*A. sativa*). It was brought here in 1929.

Victoria is a late, vigorous red oat belonging to the species *A. byzantina*. Bond likewise is a red oat, but of midseason maturity and with a very stiff straw and plump grains. Neither Victoria nor Bond is satisfactory for farm production in this country, but for breeding material they are among the most valuable ever introduced into the United States.

In 1930, at what was then the Department's breeding laboratory in Arlington, Va., Victoria was crossed with Richland. Richland, the pollen or male parent, is a Kherson type with high resistance to stem rust and excellent crop characteristics. It had been grown extensively in the Corn

Belt since 1916. From this pollination only one original crossed, that is, only one so-called "baby hybrid" seed was obtained. But that one seed was enough to change radically the production of oats in the principal producing area of the United States.

The precious seed was planted at Aberdeen, Idaho, in 1930. In 1931 and later, numerous selections from the progeny of this plant were tested for rust and smut resistance at several stations.

From these progenies a group of early short-strawed, Richland-like selections were obtained. They had a combination of resistance to the rusts and smuts, high yield and quality, and a straw that stood up better than that of Richland. From the group, Boone, Control, and Tama were distributed by the Iowa Agricultural Experiment Station. Vicland, Cedar, and Vikota were increased and distributed, respectively, by the experiment stations of Wisconsin, Nebraska, and South Dakota.

These are now dominant varieties of oats in nearly all Corn Belt States. In several States, they are grown almost to the exclusion of other oat varieties. They also have spread rapidly into the Northeastern States. It is estimated that they were grown on approximately 30 million acres in 1946, two-thirds of the oat acreage of the United States that year. They have added many millions of dollars to the agricultural wealth of the country and have placed oats on a much better economic basis. Vicland is the most widely grown of the group. According to agronomists at the Wisconsin station, the 400 million bushels of Vicland oats constituted one-fourth of the 1945 national oat production.

So far, about 30 named varieties have been obtained directly or indirectly from Victoria crosses. Seven named kinds stem from Bond crosses—fewer than from Victoria because of the difficulty in finding lines that are sufficiently uniform.

Bond, however, is an excellent parent. Clinton and Benton are the first varieties developed from Bond crosses to be extensively increased for distribution in the Corn Belt. Three others, Eaton, Bonda, and Mindo, were scheduled for later distribution.

Clinton and Benton originated as selections from a mating between Iowa D69 and Bond made at Ames, Iowa, in 1932. The Iowa D69 parent was the product of earlier cooperative oat-breeding work at the Iowa station. It originated from a cross between Green Russian, one of the pre-Victoria kinds, and Richland, but was not quite good enough to distribute for commercial production.

Numerous productive high-quality strains were selected at Ames from the Iowa D69 × Bond cross. They were highly resistant to the rusts and fairly resistant to the smuts. Because of their excellent performance in Iowa, seed of certain selections was forwarded for testing at the Indiana and Illinois stations in 1939 and 1940. The selection 1335–3 proved to be outstanding for disease-resistance, high yield, quality, and standing

ability. It was named Clinton for the Clinton counties in Iowa, Indiana, and Illinois, the three States in which its merits became evident.

A total of 680 progeny rows of Clinton were sown at Ames in 1943 for a purification test. They were checked for resistance to the rusts and smuts and also for uniformity of plant and grain characters. Those that passed inspection were harvested in bulk. Twenty-five pounds of this purified seed was sown at Mesa, Ariz., in the winter of 1943–44, under the direction of A. T. Bartel. The resulting crop of 67 bushels was sown at Aberdeen, Idaho, in the late spring of 1944 under the direction of J. L. Toevs. More than 1,200 bushels of seed were obtained and distributed to farmers in Iowa, Indiana, and Illinois for further increase of the selection in 1945.

About 43,000 bushels of Clinton seed were produced in 1945. This supply was increased again on selected farms in 1946, to nearly two million bushels of seed that were made available to growers in 1947. Clinton has been superior to Tama, Boone, Cedar, and Vicland in Iowa, because of its better resistance to crown rust, stem rust, leaf spot, and lodging and because of its higher yield and test weight. In tests at the Iowa station, the average acre yield of Clinton has been about 16 bushels higher than that of Tama. In 49 and 42 Iowa Standard Community Grain Trials in 1945 and 1946, respectively, Clinton outyielded Tama by about the same margin.

Clinton also has made satisfactory yields in coordinated uniform nursery tests made in cooperation with agricultural experiment stations of the North Central and Northeastern States, but its general performance has not been so promising as in the Iowa tests. Clinton has stiff straw and is well adapted for combine harvesting.

Benton, a sister selection of Clinton, demonstrated its value first at the Purdue University Agricultural Experiment Station in Indiana. There it has been under test, formerly as Selection 1263–1, since 1939. More than 1,300 bushels of Benton were produced by that station in 1945 and distributed to some farmers in Indiana, Iowa, and Illinois for increase in 1946. Thus Benton is being distributed jointly by the experiment stations of the three States.

The chief advantages of Benton and Clinton over Boone, Vicland, and Tama are greater productivity, higher test weight, better resistance to crown and stem rust, and a much stiffer straw. Clinton and Benton are not entirely perfect, however; they are highly susceptible to a hitherto little-known form of crown rust, which was somewhat more prevalent in 1945 than in previous years, and may lessen their future value to some extent. Benton and Clinton are similar in their reaction to the rusts and smuts and also in productiveness, although Clinton may be slightly superior in average yield. In tests in field plots at Lafayette, Ind., Benton, Clinton, and Tama each has averaged around 68 bushels an acre from

1942 to 1945, but in the nursery yield tests at that station, Clinton and Benton averaged about 17 bushels more than Boone.

Benton differs from Clinton primarily in being 4 or 5 inches taller and in having a slightly larger kernel. Benton usually can be distinguished from Clinton in the field by the presence of a collar of short hairs just below the upper stem node. Where a taller variety is desired on the thinner upland soils, Benton may be preferable to Clinton. It also is more uniform than Clinton in certain plant characters.

Eaton resulted from an Iogold-Bond cross made at Ames in 1932. The selection was sent to the Michigan Agricultural Experiment Station at East Lansing in 1940. There it was mass-selected for uniformity of plant height and grain color by E. E. Down and his associates. Eaton is an early to midseason white oat with thin hulls, high test weight, and stiff straw. It also is resistant to crown rust, stem rust, and the oat smuts. In the tests in Michigan, Eaton has been superior in yield and quality to the rust-susceptible, standard variety Huron. Its very stiff straw should make it popular for combine harvesting in Michigan.

Bonda was developed from a Bond-Anthony cross made at the Minnesota Agricultural Experiment Station at St. Paul. It is an early to midseason oat with yellowish-white to white kernels of superior test weight. Its very stiff straw is more resistant to lodging than Tama and Vicland under Minnesota conditions. Bonda is highly resistant to crown rust, stem rust, and smuts. Bonda is fairly uniform in plant and kernel characters and has been a high yielder. It also is especially well adapted for combine harvesting. Seed of Bonda has been increased for distribution to Minnesota farmers in 1947.

Mindo also was developed by the Minnesota station from the cross Bond × [(Minota-White Russian) × Black Mesdag]. It is an early common oat with rather small yellow grains of excellent test weight. The straw is rather short, stiff, and very resistant to lodging. Mindo has the same resistance to the rusts and smuts as Bonda, and is fairly uniform in plant and kernel characters. It also has yielded high and is of promise as a new early oat for Minnesota.

New Oats for the Southwest

Sporadic epidemics of rust, especially of crown or leaf rust, have reduced the yield of oats in the Southwest for many years. The standard rust-susceptible varieties, such as Fulghum (Kanota), Columbia, Fulton, and Red Rustproof, have suffered heavily, with the result that several so-called poor oat years, including 1945, have been experienced by producers of oats.

To meet this crisis, some new, early, highly productive spring red oat varieties with high resistance to the rusts and smuts have been developed

from Fulton × Victoria-Richland and Markton-Fulghum × Victoria-Richland crosses. They were made at Aberdeen, Idaho, in 1935. From these crosses, the new varieties Osage and Neosho were released in Kansas; Ventura, a sister selection of Osage, was released in California in 1945. Osage and Ventura resemble Boone and Vicland in many characteristics of plant and kernel, but they mature a little earlier and have an even shorter straw. Neosho is a red oat with a very stiff straw and resistance to the rusts. It also resists certain races of the oat smuts. Osage, Neosho, and Ventura appear to be well adapted to the climate of Kansas and Southwestern States where red oats are grown.

There they should vitalize oat production in the same way that Boone, Tama, Vicland, and Cedar have in the northern oats areas.

Winter Oats for the South

Less important from the national standpoint, but of great value to the South, are several new disease-resistant varieties developed for fall seeding. These were selected from crosses of Victoria and Bond with standard common and red oat varieties such as Lee, Custis, Fulghum, Fulgrain, and Red Rustproof (Nortex).

Some of the most promising new winter varieties have come from a cross between Lee and Victoria. Lee is a hardy productive high-quality oat, but very susceptible to the rusts and smuts. The varieties developed and distributed from this cross are Letoria and Lelina in North Carolina; Stanton (strains 1, 2, 3, and 4) in South Carolina and other Southern States; Lega, Lelate, Levic, and Leroy in Georgia; Florilee in Florida; and DeSoto in Arkansas. These represent a rather distinct new type of common winter oats. They have less hull and better grain characters than are found in many of the more widely grown Red Rustproof strains, a fact not fully appreciated at first by southern oat growers.

Traveler is a promising new variety resistant to crown rust and smut developed from a Victoria-Custis cross at the Arkansas Agricultural Experiment Station. Custis is a sister selection of Lee and of similar type. The cross was made at Fayetteville, Ark., in 1937, where the strain, later named Traveler, was selected. Traveler is a productive, short, fairly stiff-strawed, winter-resistant oat, bred primarily for grazing and clipping purposes. The variety is somewhat variable in certain plant characters and may need further purification.

Varieties of red oats that resist crown rust and smut, originating from crosses of Victoria and Fulghum-type oats, are Quincy Red (Quincy No. 1), and Fultex. Quincy Red was selected from a cross made in 1930 between Fulghum (Kanota) and Victoria. Selections from this cross were first tested at Ames for resistance to crown rust. Then they were grown at Experiment, Ga., and from there, for a more rigid test, they

were sent to the North Florida Agricultural Experiment Station at Quincy, where heavy natural epidemics of crown rust occur almost every year. Quincy Red was so outstanding for yield as well as for resistance to crown rust that it was increased and distributed. Quincy Red resembles the Fulghum parent in general appearance. The grain of Quincy Red is plump and reddish in color and tests as much as 38 pounds to the bushel in favorable seasons. It has made oats a safe crop in northern Florida, where practically no oats were grown before crown-rust-resistant varieties became available. Quincy Red also has spread into the adjoining areas of Georgia and Alabama.

Fultex, a short, stiff-strawed kind, resistant to crown rust and moderately resistant to smut, also was developed from a Fulghum-Victoria cross. The selections giving rise to Fultex were subsequently developed at Substation No. 6, Denton, Tex. Although not a top-notcher in grain quality and yield, Fultex is on the increase in north-central Texas and adjacent States, mainly because of its adaptability to combine harvesting.

Some of the most widely grown southern early red oats with resistance to crown rust and smut have been developed by a commercial seed company from crosses of Victoria with the original Fulgrain, which is resistant only to the oat smuts. Fulgrain originated from a cross between Norton 20–93 (Big Boy) and Navarro, made at Hartsville, S. C., in 1925. Fulgrain was crossed with Victoria to obtain resistance to crown rust. This cross produced Fulgrain (strains 4, 5, 6, 7, and 8) and also Victorgrain, a new varietal type; both varieties were resistant to crown rust and smut. Several strains of Victorgrain have been released for commercial production. Fulgrain is the earliest red oat grown extensively in the South. For this reason, it is usually recommended where earliness is of major importance. Both the Fulgrain and Victorgrain strains have contributed substantially to the agricultural wealth of the South.

Red oat varieties with resistance to crown rust and smut have been originated from a cross made at Arlington, Va., in 1930, between Nortex, a typical Red Rustproof oat, and Victoria. These new varieties include Ranger, Rustler, Rangler, and Carolina Red. Ranger and Rustler were selected and proved at College Station, Tex., and Rangler was developed at Denton, Tex. Carolina Red was released in 1943 by a southern commercial seed company. These varieties are rather typical of the Red Rustproof type. Despite their disease resistance, they have not been significantly better in average yield than the Nortex parent in tests. Ranger and Rustler were distributed to farmers by the Texas station after 1940. Ranger is just being increased for possible farm production.

Quincy Gray originated as a selection from a cross of Victoria-Norton × Red Rustproof at Quincy, Fla., where it was released for commercial production in the early 1940's. The cross had been made at the Georgia Agricultural Experiment Station. Quincy Gray is a late-maturing,

short, stiff-strawed, grayish-white oat, somewhat intermediate between red and common oats in grain characters but with very little winter resistance. It is also known as Quincy No. 2 and Quincy White. Quincy Gray resists crown rust and smut, but is of much less economic importance than Quincy Red. It is grown only to a limited extent in north Florida and adjoining southern Georgia and Alabama.

Verde was selected from a backcross involving Red Rustproof and Victoria-Richland. The original hybrid material from the cross made at Aberdeen, Idaho, in 1934, was sent to College Station, Tex., in 1935. Verde is resistant to both rusts and smuts. It is rather typical of the Red Rustproof type of oats, but is earlier in maturity. Verde was distributed in the fall of 1944.

Verde is recommended for growing only in southern Texas, because it is not sufficiently hardy to be grown in central Texas. The chief value of Verde oats is for pasture and as the raw material for the manufacture of dried green-grass food and pharmaceutical products. When the oats are to be dried green, the leaves are clipped periodically while they are young.

Camellia is the only named variety of commercial red oats developed for the South from Bond crosses. It originated from a Bond-Alber cross made in 1933, from which numerous selections were tested at Ames, Iowa, for resistance to crown rust and smut. These were later sent to the Louisiana Agricultural Experiment Station for testing. The selection Louisiana 629, which proved to be outstanding for yield and resistance to crown rust, was later named Camellia and distributed to farmers. It is similar to the Bond parent in most plant characters, except that the grains are somewhat larger. Camellia is even more resistant to crown rust than is Bond and also carries resistance to some oat smuts. It is not yet fully uniform in plant characters. Nevertheless, Camellia has made oat production feasible in a region in which very little small grain of any kind had been grown previously.

Thus the offspring of Victoria have markedly improved the economic status of oats as a farm crop. They have given the farmer a larger supply of feed grain at a lower cost and have provided a surplus of grain to sell. Losses from epidemics of crown rust and other diseases have been greatly reduced and, generally, higher yields of oats of superior quality are now being harvested.

Furthermore, the new disease-resistant varieties developed from Bond crosses and now being distributed give promise of making oats a still more satisfactory crop. They are more resistant to the rusts, higher yielding, and of better quality and, above all, have a much stiffer straw. They are exceedingly well adapted for combine harvesting, something farmers have been wanting for a long time.

However, in 1946 the varieties originating as offspring of Victoria suffered somewhat from the attacks of a new *Helminthosporium* blight.

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Whether this disease will continue to damage these varieties remains to be seen. It has been designated as a new species of *Helminthosporium* and has been found on timothy and certain other grasses. Fortunately, the new varieties developed from Bond crosses are resistant to this disease; hence, they are being increased and distributed as rapidly as possible for commercial production. In 1946, these new varieties from Bond crosses continued to be outstanding for yield, quality, disease resistance, and stiffness of straw in nearly all tests conducted in the northern part of the United States. In brief, they give every indication of eclipsing and replacing the yet relatively new and history-making varieties originating from the Victoria-Richland cross.

Despite these outstanding accomplishments in oat improvement, there is need to do still more breeding, because hitherto unknown or relatively unimportant races of smuts and rusts are becoming more prevalent. Other destructive diseases are appearing that may jeopardize the value and usefulness of these epoch-making varieties. Fortunately, varieties and strains with basic resistance to these new rusts, smuts, and other diseases are available for breeding purposes.

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FOR FURTHER READING

Stanton, T. R.: *Maintaining Identity and Pure Seed of Southern Oat Varieties,* U. S. D. A. Circular 562, 1940.

Stanton, T. R., and Coffman, F. A.: *Grow Disease-Resistant Oats,* U. S. D. A. Farmers' Bulletin 1941, 1943.

Stanton, T. R., and Coffman, F. A.: *Disease-Resistant and Hardy Oats for the South,* U. S. D. A. Farmers' Bulletin 1947, 1943.

Stanton, T. R., Coffman, F. A., and Tapke, V. F.: *Field Studies on Resistance of Hybrid Selections of Oats to Covered and Loose Smuts,* U. S. D. A. Technical bulletin 422, 1934.