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Small-Grain Varieties and Hybrids
To Greenbug Attack

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EXPERIMENT STATION

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Reaction of Small-Grain Varieties and Hybrids To Greenbug Attack

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The greenbug [*Toxoptera graminum* (Rond.)] is one of the most serious pests of small grains in the Central and Southwestern States. It causes some damage every year, and several severe outbreaks have occurred. Since 1882, when it was first reported in the United States from Virginia, there have been 15 outbreaks, the most serious ones in 1907, 1942, 1950, and 1951. Each of these outbreaks caused a loss estimated at more than 50 million bushels of grain.

In recent years insecticides have been developed that will control the greenbug. However, this method of control is expensive and may not be practical in areas where yields are low because of drought, winter killing, or other hazards. Since control by cultural practices and by parasites and predators is not always dependable, it was necessary to seek a more satisfactory method. One of the most promising ones is the development of resistant varieties of small grains for areas that are frequently and heavily infested with the greenbug.

Although greenbug-resistant varieties of all small grains would be highly desirable, resistance in just one crop might greatly reduce the overall population. In some years heavy populations build up in the southern portion of the Great Plains during the winter and spread north early in the spring. Growing one or more resistant varieties in southern areas should therefore help protect susceptible crops growing further north.

In Oklahoma from 1947 to 1953 a study was made to find greenbug-resistant germ plasm for use in small-grain improvement. In the course of the work an effort was also made to obtain information on the inheritance of resistance.

Review of Literature

Differences in reaction of plant varieties to insect attack have been recognized for more than a hundred years. Published records include information on resistance of nearly a hundred plant species to more than that number of insect species. Several reviews of the literature on insect resistance in plants have been issued and a thorough coverage of the field is presented by Painter (13).

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Resistance of plants to aphids has been reported more frequently than that to any other group of insects. An outstanding example is the resistance of grapes to the grape phylloxera [*Phylloxera vitifoliae* (Fitch)], discussed by Bioletti *et al.* (3). Other plants resistant to aphids include apples to the wooly apple aphid [*Eriosoma lanigerum* (Hausm.)], Le Pelley (12); gooseberries to the gooseberry witchbroom aphid [*Myzus houghtonensis* now *Kakimia houghtonensis* (Troop)], De Long and Jones (6); corn to the corn leaf aphid [*Aphids maidis* (Fitch)], Snelling *et al.* (16), and the corn root aphid [*Anuraphis maidi-radidis* (Forbes)], Gernert (9); peas and alfalfa to the pea aphid [*Macrosiphum pisi* (Harris)], Searles (15) and Dahms and Painter (5); raspberry to the raspberry aphid [*Amphorophora rubi* (Kalt)], Huber and Schwartze (10); and cantaloupes and cotton to the cotton aphid [*Aphis gossypii* (Glov)], Ivanoff (11) and Dunnam and Clark (7).

Published data on the resistance of small-grain varieties to aphids have been confined to the greenbug. Patch (14) reported this aphid on 62 species of grasses (Gramineae), but observations on varietal resistance have been limited. Fenton and Fisher (8) noted differences in susceptibility to attack among oat varieties, Lee, Nortex, and Red Rustproof being more seriously damaged than Kanota, Coker Fulghum No. 4, or Columbia.

Walton (18), at the Southern Great Plains Field Station, Woodward, Okla., found a difference in the reaction of barley varieties to a greenbug infestation and also in their ability to recover from greenbug injury. However, he found no highly resistant barley varieties.

Atkins and Dahms (2) studied the reaction of several hundred varieties of wheat, barley, and oats to the greenbug outbreak of 1942 in nurseries at Denton and Chillicothe, Tex., and Lawton, Okla. The most resistant strains of wheat were selections from the cross Marquillo X Oro, which are resistant to the hessian fly [*Phytophaga destructor* (Say.)]. Denton, Early Blackhull, Wichita, and a few Chinese and Russian strains also showed some resistance. However, none of the wheat varieties tested appeared to have sufficient resistance to withstand heavy attacks. They found that several barley varieties, mostly from the Orient (chiefly China and Korea), showed high resistance to attack and were able to produce a crop when all surrounding varieties were killed. None of the oat varieties was highly resistant, although Fulwin and Tennex were somewhat less susceptible than Wintok.

Several workers have observed that greenbugs cause more injury in proportion to their numbers than do other grain aphids. Webster (19) noted the severe damage caused by small numbers of greenbugs, and indicated a belief that a pathological condition was associated with the aphid. Wadley (17) described the injury to oats and suggested that the reddening and discoloration of the plants was due to a chlorophyll-destroying enzyme that the greenbugs injected into the plant.

Chatters and Schlehuber (4) studied the mechanics of greenbug feeding and the difference in injury to plant cells of barley, oats, and wheat, and attempted to associate morphological plant characters with resistance or susceptibility. They found that greenbug damage varies from lysis in *Hordeum*, cell-wall modification in *Avena*, to a combination of lysis and cell-wall modification in *Triticum*. Greenbug stylets tend to enter tissues intercellularly and less frequently through the stomatal apparatus. The phloem appears to be the ultimate feeding site, and the injection

of saliva, rather than the intake of food, appears to be the primary cause of tissue damage. They found some evidence that resistance in barley was related to the thickness of the leaf and the length of the extended stylet. However, they stated that the evidence obtained was insufficient to substantiate such an hypothesis and concluded that resistance to greenbugs is probably physiological rather than morphological.

Materials and Methods

VARIETIES TESTED

Most of the tests for resistance to greenbugs were made with wheat, oats, and barley; however, some strains of rye, rye X wheat, and wheat X wheatgrass were included.

Since previous work [Atkins and Dahms (2)] had indicated that some barley varieties from the Orient appeared to be highly resistant to greenbugs, a special effort was made to test all available barley varieties that originated in that part of the world. However, the importance of testing the resistance of locally adapted and promising strains was not overlooked. Varieties that were known to be resistant to other insects, such as the hessian fly and chinch bug, also were tested. The world collection of small grains maintained by the Department of Agriculture's Field Crops Research Branch has been the source of supply for many varieties. Agronomists and plant breeders throughout the United States also have supplied seed.

Wheats from all sections of the world were tested. Special emphasis, however, was placed on Marquillo hybrids, Hope derivatives, and wheats of oriental origin. Locally adapted strains and varieties that showed some resistance to other insects, such as the hessian fly and the wheat stem sawfly, also were tested.

Oat varieties tested were primarily those of oriental origin and locally adapted strains.

Only common diploid varieties and one tetraploid variety of rye were tested.

Plants of otherwise susceptible commercial varieties of wheat, barley, and oats that survived heavy greenbug infestations in the field were selected and their progeny tested for resistance in the greenhouse.

In addition to the common bread wheat, *Triticum vulgare* Vill. (*T. aestivum* L.), other species of *Triticum* tested were *compactum*, *macha*, *spelta*, *vavilovi*, *durum*, *dicoccum*, *dicoccoides*, *persicum*, *polonicum*, *pyramidale*, *timopheevi*, *turgidum*, and *monococcum*. Some interspecific and intergeneric hybrids were also included.

The number of varieties of small grains tested for resistance to the greenbug from 1947 through 1953 are given in Table 1.

SOURCE OF GREENBUGS

The greenbugs used for all the greenhouse tests were descendants from one greenbug collected near Stillwater in the fall of 1947. The cultures were compared frequently with greenbugs collected at random in Oklahoma, and no differences were noted in varietal reaction.

Cultures were propagated on Tenkow barley growing in 6-inch pots. Greenbugs usually were placed on the plants 10 to 14 days after seeding and were removed to uninfested plants as soon as a moderate amount of injury had occurred.

GREENHOUSE TESTS

Resistance was determined in the greenhouse by separate tests for preference, tolerance, and fecundity. Greenhouse temperatures were regulated manually and usually ranged from 60° to 80° F.

For the preference and tolerance tests, varieties were planted in 6-inch pots. Eight varieties were planted in each pot, usually 7 of the test variety and 1 check, although sometimes there were 6 test and 2 check varieties. Three seeds of each variety were planted in rows radiating from the center of the pot. Generally 21 varieties were tested at a time with one check per pot, or 18 varieties with 2 checks. Thus, 3 pots were required for each replication. Six replications were planted, the varieties being randomized for each set. The planting design was, therefore, a form of randomized block with 3 pots constituting a block. The soil used was a Reinach sandy loam fairly high in organic matter, with physical properties suitable for greenhouse work. After the seed was planted, the pots were placed in a metal pan containing 2 to 3 inches of water and left until the moisture had reached the soil surface. This method of planting and watering prevented movement of the seed prior to germination, and usually excellent emergence was obtained within 4 to 6 days.

Three to four days after emergence the seedlings were thinned to 1 per row, or 8 per pot. An effort was made to select uniformly vigorous seedlings, and at the

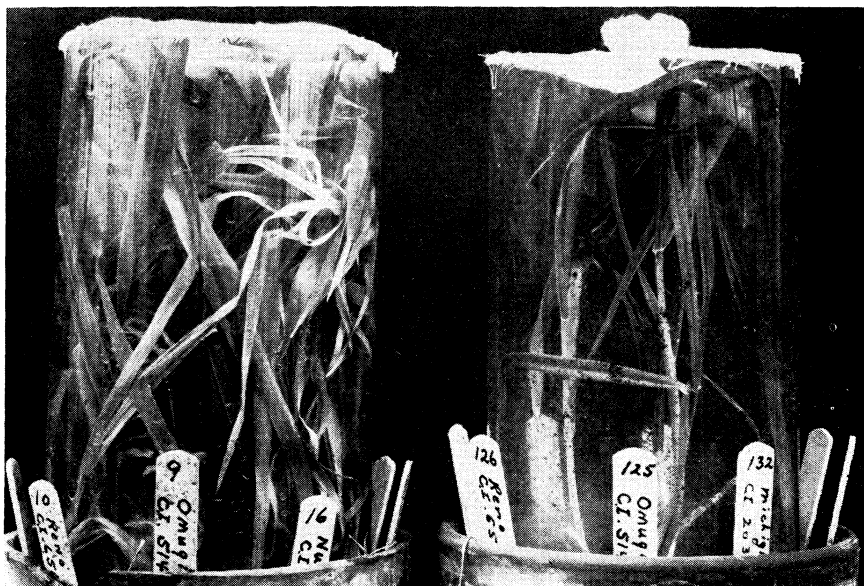


Fig. 1.—Cages used to confine greenbugs for greenhouse tolerance tests. Infested plants are usually killed before they reach this stage.

same time those that were in the same relative location within each pot. This usually resulted in the 8 plants forming a circle 3½ to 4½ inches in diameter in the pot. Two weeks after seeding, the plants were about 5 to 7 inches tall and of a suitable size for infestation.

The cages (Fig. 1) used in the preference and tolerance tests were made of transparent cellulose nitrate plastic 0.2 inch thick. A tube 12 inches long and 5 inches in diameter was constructed. One end was closed with coarse mesh cloth, and the other end was placed in the soil around the plants.

The height of each plant was recorded before infestation. All pots of five replications were infested with five 4- to 6-day-old nymphs per plant. In some of the 1947 tests 10 or 12 nymphs were used on each plant. Nymphs were counted on a sheet of paper and brushed off in the center of each pot, giving them an equal opportunity to go to any plant. Pots of the sixth replication served as uninfested checks. The check plants were measured and caged on the same day that the other plants were infested.

The number of greenbugs per plant was determined daily for the first 4 days, and these results were used as a measure of preference.

To determine its tolerance to greenbugs each plant was rated daily as follows according to the estimated percentage of leaf area damaged:

Rating	Percent damage
0 -----	0-10
1 -----	11-20
2 -----	21-40
3 -----	41-60
4 -----	61-80
5 -----	Beyond recovery

The plants were not rated 1 until they had been damaged more than 10 percent, because a lesser amount of injury could not be attributed definitely to greenbugs. The number of days from the date of infestation until a rating of 5 was obtained was the main criterion used for tolerance. A few tests in which the plants were highly resistant and alive 35 days after infestation were then terminated. However, in 1947 some tests were not terminated until 50 days after infestation.

When any plant was rated 5, the height of the corresponding variety in the uninfested check was recorded. The height of infested plants was measured at the end of the test. From these measurements a tolerance value designated as "growth factor" was determined by the following formula:

$$\frac{A'-A}{B'-B} \times 100 = \text{growth factor (percent)}$$

where A = height of plant before being infested.

A' = height of infested plant when dead.

B = height of corresponding check plant when others were infested.

B' = height of corresponding check plant when infested plant was dead.

In the fecundity tests three plants of the variety to be tested were grown in a 6-inch pot and each plant was caged separately. An alate (winged) greenbug

having just reached the adult stage was placed on each plant. Two such pots (six plants) were used for each variety to be tested. The cages consisted of transparent cellulose nitrate plastic 0.1 inch thick made into tubes 6 inches long and 2½ inches in diameter. The number of nymphs produced by each alate female was determined at the end of 7 days. In recent tests the small cages were then removed and the larger tolerance cage was placed over the three plants. Injury ratings were recorded daily, and the plants were allowed to grow until killed by greenbugs. This constituted another type of tolerance test.

If an individual plant showed a high resistance or the rate of reproduction on it was extremely low, the plant was saved and allowed to produce seed.

INHERITANCE STUDIES

In the inheritance studies, hybrid plants from four winter barley crosses were subjected to artificial infestation in the greenhouse in 1950 and 1951.¹ The parent varieties were Omugi (C. I. 5144)² and Dobaku (C. I. 5238), of Korean origin, an unnamed variety (C. I. 5087) of Chinese origin, Tenkow (C. I. 646), and Ward (C. I. 6007). The first three varieties were selected because previous workers had indicated their resistance to greenbugs, and the last two varieties, both highly susceptible, because they are the leading varieties grown in Oklahoma. All the varieties are 6-row types with covered seed. Omugi, Tenkow, and Ward have rough awns and lax heads. Dobaku also has rough awns but compact heads. C. I. 5087 is an intermediate hooded type with lax heads.

Most of the emphasis was placed on the reactions of the F₂ generations. Only limited numbers of crossed seed were available for F₁ reactions.

F₂ Hybrid Tests

Four crosses were tested separately in the F₂ study. The barley crosses and planting dates were:

I	-----Dobaku X Ward	-----October 4, 1950
II	-----Dobaku X C. I. 5087	-----November 21, 1950
III	-----Omugi X Tenkow	-----January 13, 1951
IV	-----Omugi X Ward	-----February 27, 1951

Seed of the parents of crosses I and II was the progeny from parent plants. For crosses III and IV, however, seed of the actual parent plants was not available, so that parent checks were planted from bulk lots.

Three seeds of each parent and a check variety and single F₂ seeds were planted in each pot. The parents and checks were later thinned to one plant each. In crosses I and II Omugi was planted as a resistant check, so that only 5 F₂ seeds were included in each pot. In crosses III and IV Omugi was one of the parents, so that 6 F₂ seeds were planted in each pot.

¹ William Henry McDonald, Jr., carried out these studies in partial fulfillment of the requirements for the degree of master of science, Oklahoma A. and M. College, 1952. Thesis entitled "Inheritance of Resistance to the Greenbug (*Toxoptera graminum* Rond.) in Winter Barley Hybrids."

² C. I. refers to the accession number of the Field Crops Research Branch.

In the inheritance studies the ratings were determined as follows from the estimated percentage of greenbug leaf damage:

Rating	Percent damage
10 -----	0-10
7 -----	11-35
5 -----	36-60
3 -----	61-80
1 -----	81-99
0 -----	100

Ratings were made for 46 days on cross I, 92 days on cross II, 34 days on cross III, and 40 days on cross IV. However, approximately 85 percent of the plants in cross II lived only 20 to 30 days.

Analysis of variance was used for the parental and check data from all four crosses from two aspects: (1) preference of greenbugs; and (2) tolerance of plants as measured by (a) accumulated ratings and (b) the amount of growth.

The preference of greenbugs for a given plant was determined from the number on the plant each day for the first 4 days. The accumulated rating is the total rating value given to each plant obtained by multiplying a given rating by the number of days the plant received that rating. The total value from all the ratings for the plant was then determined.

F₁ Hybrid Tests

F₁ hybrid plants from three of the four crosses previously mentioned, their reciprocals, and parents were tested. F₁ plants were tested in the same manner as were the F₂ plants, but the F₁ data, because of low numbers, were not analyzed in the same way.

INSECTARY TESTS

During the 1952-53 season approximately 300 varieties of small grains were tested for resistance in an insectary under artificial light. They were planted in rows in a wooden flat 17 by 21 by 4 inches, 10 varieties in each flat and 10 plants of each variety. A check variety was included in each flat. Fourteen days after seeding, the height of each plant was recorded and each flat was infested with greenbugs. The greenbugs used to infest each flat were not counted, but were those produced from the progeny of 100 4- to 6-day-old bugs caged on Tenkow barley for 14 days.

The condition of each plant was recorded at 48-hour intervals, and the height of plants was measured when they were killed. The criterion used for resistance were the days required for greenbugs to kill the plants and the amount of growth the plants made after being infested.

FIELD TESTS

Each year except 1948 nursery plantings were made to determine the reaction of small-grain varieties to natural infestations of greenbugs. As a general rule, only varieties that had shown some resistance in the greenhouse were tested in

the field. However, agronomically adapted varieties were included regardless of their reaction in the greenhouse. All field tests were conducted at Stillwater, except in 1947 when tests were made at Lawton, Okla. Varieties were seeded in February or March in three-row plots, 5 or 10 feet long with 12-inch spacing between rows. Varieties were replicated three times in a randomized block arrangement. The seeding rate was 1 bushel per acre for wheat and 2 bushels for oats and barley. In order to obtain maximum greenbug injury, plants should be small at the time of infestation. Therefore, all varieties, including winter types, were seeded in the spring. Since many of them failed to produce seed, a fall-planted nursery also was necessary unless seed supplies were available from other sources. Field testing of certain varieties was therefore delayed for 2 to 3 years.

The criteria used for determining resistance under field conditions depended on the intensity of the infestation. The percent of leaves injured was the criterion most commonly used, based on examination of leaves from the center of the middle row of each plot. Where damage was severe, this percentage was estimated. The intensity of infestation was determined by counting the greenbugs on 1 foot of the middle row of each plot. This count also gave some indication of preference. In several cases visual greenbug injury ratings for the entire plot were made as follows: 0, none; 1, slight; 2, moderate; 3, severe; 4, very severe; 5, injured beyond recovery.

The visual injury ratings were usually continued after the termination of greenbug infestation and thus gave a measurement of the ability of a variety to recover from injury.

PLANT CHARACTERS AND RESISTANCE

A study of barley varieties was made in 1947 to determine what agronomic characters, if any, are associated with greenbug resistance or susceptibility.³ On March 17, 48 varieties were seeded in four-row nursery plots 10 feet long. The habit and rate of growth, number of culms per foot in the row, leaf characteristics, and height of plant were noted during the growing season.

Samples of 10 culms were collected from each of 35 varieties that produced heads under conditions of late-spring seeding. The 7 most resistant and the 6 most susceptible varieties (as indicated by greenhouse tests) were studied and classified morphologically by a method similar to that used by Aberg and Wiebe (1). Observations and measurements were made on the following characters:

Awns—persistent or deciduous, length, rough or smooth, awned or hooded, none or slight twist

Spike—average number of spiklet groups per head, length, erect or nodding

Hairiness—long or short hair on rachis edges, long or short rachilla hairs

Glume awns—length

Kernels—color, covered or naked

Leaves—shade of green, number, length, width, smooth or rough, waxiness, color of midrib

³ U. J. Grant carried out some of these studies in partial fulfillment of the degree of master of science, Oklahoma A. and M. College, 1948. M. S. thesis title: "The Reaction of Certain Barley Varieties to Greenbug Attack."

Stems—anthocyanin absent or present, collar shape (open or closed) length of internode

Growth type, or the degree of prostrateness or erectness and height of plant, was determined on April 29, May 13, June 4, and June 21.

The lengths of rachilla and of rachis hairs appeared to be correlated with resistance of varieties of barley to greenbugs.

For more definite determinations exact measurements of 5 rachilla and 5 rachis hairs were made on each of the 35 varieties that produced heads in the field test. Measurements were recorded to the nearest 0.044 mm. with the aid of a 30-power binocular and a micron scale. Calculations were made to determine the correlation between the lengths of the rachilla and rachis hairs, and also the relationship between rachilla hair length and tolerance to greenbugs.

Results and Discussion

BARLEY

Preference and Tolerance Tests

Many of the barley varieties tested in the greenhouse showed a high degree of resistance to the greenbug. Varieties that were as resistant as Seibaku C. I. 5229 in any one of the four criteria are given in Table 2. Each variety was compared with the check—Ward—in the same test. There were 16 varieties of which all the plants were alive at the end of the 50-day test period, and several varieties lived four times as long as Ward after being infested. All three recommended varieties—Ward, Tenkow, and Harbine—were very susceptible, and lived less than an average of 15 days. Kearney and Dicktoo, two varieties that show some promise for Oklahoma especially in rigorous winters, were highly resistant in these tests. They also had a very low preference rating.

The varieties that showed a high degree of tolerance were also less preferred than Ward. Generally, there was a fairly close relationship between tolerance and preference; that is, varieties with a low preference rating had a high degree of tolerance. However, in some cases, especially in several of the Suwon varieties, there appeared to be little relationship between these two factors.

A growth factor was not obtained on many of the varieties; however, where this information was available, the resistant varieties (except some Suwons and one or two others) that were infested grew from 50 to 90 percent as much as the uninfested checks. Infested plants of the three recommended varieties—Ward, Tenkow and Harbine—grew approximately 20 percent as much as uninfested check plants.

In one test with 30 Korean barleys for which information was available on both the growth factor and the length of life of plants after infestation (expressed in terms or percent of Ward in the same tests), a correlation coefficient of 0.85 was obtained. This might indicate that growth factor is a fairly good criterion of resistance or susceptibility. Some resistant varieties had low growth factors, but none of the susceptible varieties had high growth factors. Since this factor is calculated from only one check plant from each variety, no definite conclusions should be drawn from this figure alone.



Fig. 2.—Resistance of barley varieties to attack of the greenbug in 3-row 10-foot plots: Left, Omugi C.I. 5144; center, C.I. 9174; right, Nandomugi C.I. 5234. Stillwater, Okla., 1951.

The reproduction rate of greenbugs confined to resistant varieties was only about half that of greenbugs on the susceptible recommended varieties. Two varieties—Chae-yae-chang C. I. 7408 and Cha-dae-maec C. I. 7404—and some of the Omugi X Ward, Omugi X Tenkow, and Seibaku X Tenkow hybrids were unsatisfactory for greenbug reproduction.

All the varieties that showed a high degree of resistance, except Dicktoo and Kearney, originated in China, Korea, or Japan.

In 1950, 33 plant selections were made from areas of barley fields in which all but a few plants had been killed by greenbugs. When plants grown from these selections were tested in the greenhouse, none was found to be resistant.

During the 1952-53 season, a few barley varieties that had previously been checked for resistance in the greenhouse were tested in the insectary to determine whether comparable results would be obtained by the two methods. Results of these tests are shown in Table 3. Since several plants of some of the resistant varieties were alive when the insectary tests were terminated 40 days after infestation, the records do not indicate as much resistance when compared with Ward as in the greenhouse tests.

Natural field infestations of greenbugs were abundant enough to cause injury only in 1947 and from 1950 to 1952, inclusive. In 1947 the nursery was seeded at Lawton and the other 3 years at Stillwater. The infestation was very light in 1947 and very severe in 1951. The 1950 and 1952 infestations were of about equal intensity and could be classified as moderate. Figure 2 shows the reaction of susceptible and resistant varieties to a severe greenbug infestation in 1951. The leaf injury for each variety included in the barley nurseries during the 4 years is shown in Table 4. Additional injury records and some yield data for the 1951 nursery are shown in another section of this bulletin.

The resistant varieties had from one-third to one-fifth as much leaf injury as the susceptible varieties. The new variety Kearney was highly resistant in these tests, as were all varieties that had been highly resistant in the greenhouse tests.

Greenbug resistance records also were taken on unreplicated nursery plots that were sown for seed increase. Some of these varieties were resistant, but were never advanced to the replicated nursery. The reaction of 12 of the varieties is shown in Table 5. The unnamed varieties C. I. 5093, C. I. 4195, and Corbel especially were highly resistant in both tests.

The effect of a severe natural infestation of greenbugs on the yields of 30 barley varieties is shown in Table 6. They were grown in triplicated nursery plots at Stillwater in 1950 and 1951. In 1950 few, if any, greenbugs were on the plants, but in 1951 the seedlings were heavily infested when very small. Under the latter condition 14 varieties produced little or no grain, whereas several showed outstanding resistance and produced fairly good yields. The yields of any resistant variety were about the same in both years. In contrast, most of the highly susceptible varieties had little or no yield in 1951, but fair to good yields in 1950 in the absence of greenbugs. For example, C. I. 9174 and Quinn produced 32.2 and 27.4 bushels per acre, respectively, in 1950, but only 0.2 and 3.4 bushels in 1951. Fayette, Harbine, Tenkow, and Ward showed similar reductions in yield. Omugi, which was highly resistant, produced 28.6 bushels in 1951 compared with 19.3 bushels in 1950.

Typical winter and spring varieties as well as intermediate varieties were tested. Plantings were not made until early in February in both years, but this did not seem to favor the spring varieties. The highest yielding variety in 1950—Okla. No. 1005, Sel. C. I. 9174—is classed as a winter type as is Omugi, the highest yielding variety in 1951.

Inheritance of Resistance

F₁ Tests

Barley crosses were studied in the greenhouse in an effort to obtain information on the genetics of resistance to greenbugs. The parents, certain resistant and susceptible checks, and F₁ and F₂ populations were planted.

Although the numbers of F₁ and parent plants were small, in general the hybrid plants were considerably more resistant than the susceptible parent plants. The growth and the accumulated ratings are shown in Tables 7 and 8. In the cross Omugi X Ward both the average growth and the accumulated rating of the F₁ exceeded those of the resistant parent, Omugi. The F₁ of Dobaku X Ward was equal to the susceptible parent in average growth and was closer to it than to the resistant parent in average accumulated rating. There was a rather striking difference in reaction between the hybrids obtained from the two seedings of the Omugi X Tenkow cross, but no explanation can be offered at present.

Analysis of Parental and Check Data

Mean-square values from the analysis of variance of the parental and check data from each of the four crosses included in the F₂ study are presented in Table 9.

Data for crosses I and II are presented in relation to the Omugi check. In crosses III and IV Omugi was a parent of the cross; therefore, the data are presented on a direct basis.

In the preference test the data showed a highly significant difference at the 1-percent level between varieties for crosses I, II, and III, but for cross IV no

significant difference at the 5-percent level. The behavior of this cross appears to have been somewhat abnormal in the preference test.

The data for accumulated rating and for tolerance of barley to greenbug attack as measured by the amount of growth indicate that there is a highly significant difference at the 1-percent level between varieties in all four crosses.

F₂ Tests

Distribution data for tolerance as measured by the accumulated ratings and by the amount of growth of the parent, check, and the F₂ plants of the four crosses are presented in Tables 10 and 11. As examples, the distribution of the Dobaku x Ward cross is given in Figures 3 and 4.

Classification of the F₂ plants for resistance in all four crosses, as measured by the accumulated rating and the amount of growth, was determined by using the point at which the lines representing the distribution of the two parents intersect. This point was determined in relation to the averages of the parent, check, and F₂ plants. There is, in general, a break in the distribution curve of the F₂ plants at this point, or where the line representing the F₂ distribution is approaching a natural breaking point.

Resistance as measured by the preference of greenbugs for certain barley plants did not show a satisfactory distribution of the parent plants. Consequently, the F₂ plants were not classified for resistance and susceptibility to greenbug attack on this basis.

There is some overlapping of the parents for the accumulated rating and amount of growth tests of each cross, but it could be assumed that the same pheno-

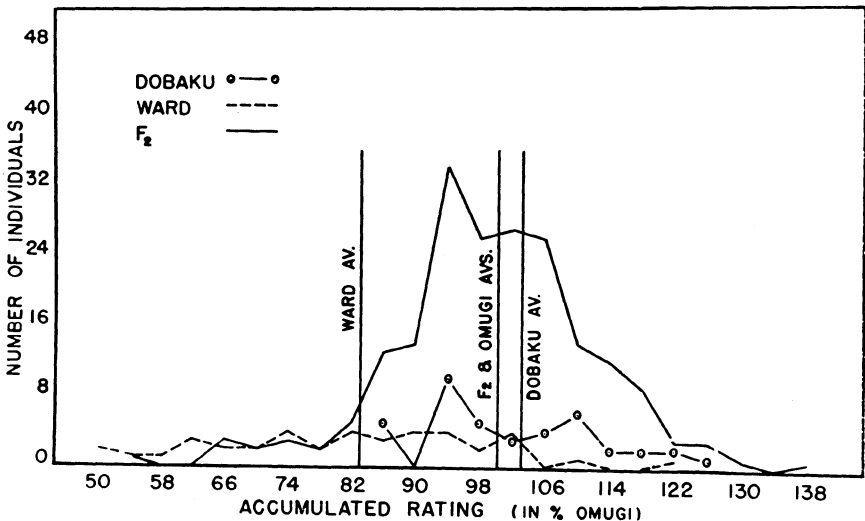


Fig. 3.—Distribution of parent and F₂ plants of Dobaku x Ward by accumulated rating classes when tested under artificial infestation of greenbugs at Stillwater, Oklahoma, 1950-51.

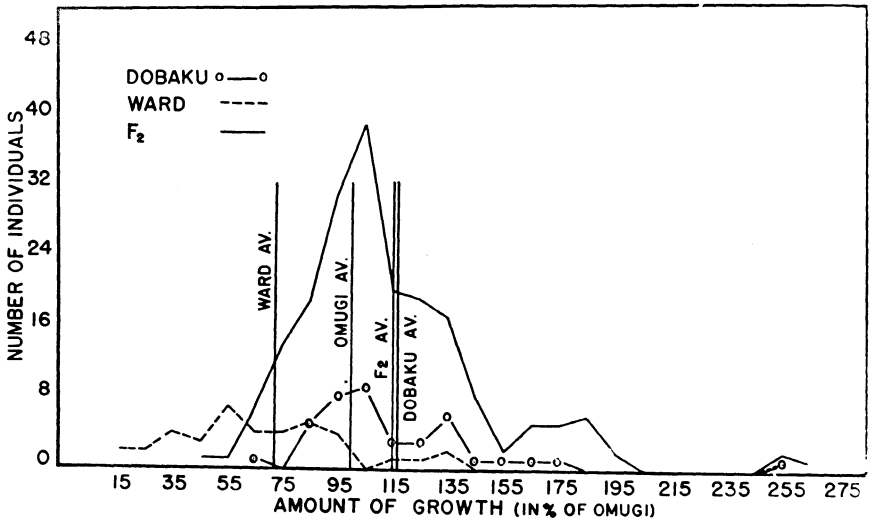


Fig. 4.—Distribution of parent and F₂ plants of Dobaku x Ward by amount of growth classes when tested under artificial infestation of greenbugs at Stillwater, Okla., 1950-51.

menon is taking place in the distribution of the F₂ plants. The fact that each test or measurement supports the other in all crosses indicates that the assumptions probably are correct for classification of plants as to resistance to greenbug attack.

In Figure 3 and Table 10 the data for the accumulated rating test with Dobaku X Ward show that the mean for the F₂ plants is between that of the two parents, although closer to that of the resistant parent. The average for the F₂ plants is 100 percent of the Omugi check, for Dobaku 103 percent, and for Ward 83 percent. All plants with a rating of 92 percent and less were classified as susceptible and those with higher ratings as resistant. Figure 4 and Table 11 show that there is very little difference between the mean amount of growth of the resistant parent and that of the F₂ plants. The average growth of the F₂ plants during infestation was 115 percent for Omugi and 116 percent for Dobaku. During the same period Ward showed an average growth of only 72 percent for Omugi. The F₂ plants were classified as susceptible if the amount of growth was 85 percent or less of the Omugi check.

On this basis the tolerance tests for the resistant and susceptible plants show an observed segregation ratio of 156:43 for the accumulated rating and 162:37 for the amount of growth. For a 13:3 ratio, totals of 160 resistant and 39 susceptible plants would be expected. The observed and expected ratios, along with the chi-square and P values, are shown in Table 12.

Segregations for observed and expected numbers of resistant and susceptible plants for the four crosses are also given in Table 12. The genetic symbols proposed to account for the ratios are as follows:

Dobaku (Grb Grb grb₂ grb₂) X Ward (grb grb Grb₂ Grb₂)

Dobaku (Grb Grb grb₂ grb₂) X C.I. 5087 (grb grb grb₂ grb₂)

Omugi (Grb Grb Grb₃ Grb₃) X Tenkow (grb grb grb₃ grb₃)

Omugi (Grb Grb) X Ward (grb grb)

Grb in Dobaku and in Omugi may or may not be the same gene. At present no evidence is available to determine this. However, crosses have been made to provide material for such a study.

Plant Characters and Resistance

Although the infestation in the field in 1947 was not sufficient to show differences in the reaction of barley varieties to greenbugs, an analysis of the agronomic characters revealed that all seven varieties determined as most resistant in greenhouse tests had long-haired rachillas. These varieties were Omugi, Seibaku, Shumaki, Dobaku, Dorshu, C.I. 5087, and Kumflide. Furthermore, the six most susceptible varieties had short-haired rachillas. They included Fayette, Michigan Winter, Reno, Tenkow, Ward, and Oklahoma No. 1005. Although no significant correlation existed between the rachilla hair length and the tolerance to greenbug attack, all the outstanding resistant varieties had long rachilla and rachis hairs, and all the varieties showing the least resistance had short ones. However, later inspection revealed that some varieties of intermediate greenbug reaction also had long rachilla and rachis hairs. No other agronomic characters were found to be correlated with resistance to greenbugs.

In addition to the detailed inheritance study already discussed, other experiments were conducted with various generations of barley hybrids.

In the spring of 1947 the highly resistant Omugi and the moderately resistant varieties Seibaku and Shumaki were crossed with Ward, Tenkow, and a composite hybrid selection C.I. 7152, a spring variety having considerable disease resistance. F₁ plants from these crosses were grown at Sacaton, Ariz., in 1948.⁴

In a preliminary trial 4 F₁ plants of the cross Shumaki X Tenkow were tested in the greenhouse for greenbug resistance. Their reaction was similar to that of the susceptible parent plants (Tenkow), an indication that resistance may be recessive in this case. Shumaki was only moderately resistant. When a limited number of F₂ plants of the same cross were tested in the greenhouse in 1949, 12 of them were susceptible, 9 were intermediate, and only 3 were as resistant as Shumaki. Although the data are too meager to afford conclusions, these results tend to confirm the dominance of susceptibility observed in the F₁ plants of this cross.

From 7 other crosses studied in the greenhouse 181 F₂ plants were tested. Of these, 163 plants were at least as resistant as the resistant parent, 9 were intermediate in reaction, and 9 were susceptible. After 30 days of testing, this experiment was discontinued to allow the resistant plants to mature. Ward and Tenkow were crossed with resistant F₂ plants of Omugi X Ward, and a resistant F₂ plant of Seibaku X Tenkow was backcrossed to Tenkow. Thirteen plants from this material gave a resistant reaction, an indication that resistance was dominant.

In 1950 approximately 75 F₃ hybrid plants resulting from resistant F₂ plants were grown in the field at Stillwater. Nearly all of them survived a natural in-

⁴ This material was grown through the courtesy of G. A. Wiebe, Field Crops Research Branch, Beltsville, Md.

festation of greenbugs and other aphids, whereas more than half of the susceptible parent plants were killed. In 1951, 81 F_4 hybrids from the resistant F_3 's were grown at Stillwater in single plant rows along with appropriate parental checks. These hybrids were from the crosses Ward X Seibaku, Seibaku X Tenkow, Omugi X Tenkow, and Omugi X Ward. They were also exposed to a natural infestation of greenbugs, but little damage resulted. Of the plant rows grown, 40 were saved and harvested in bulk for further testing and selection. A total of 39 of these F_5 hybrids were grown at Woodward or Stillwater in 1952, and 14 were saved for further testing. All 14 are being retested in the greenhouse (1953); 10 have been included in the triplicate yield nursery and 4 have been continued in the observation nursery, both at Stillwater.

Most of the selections, now in the F_6 generation, are vigorous-growing, apparently well-adapted types with a high degree of greenbug resistance, but all have a somewhat weak straw like their parents. Additional crosses have been made to obtain greenbug-resistant selections with stiffer straw.

In 1952, 50 F_2 hybrids from individual F_1 plants were grown at Stillwater or Woodward, and 39 of them were harvested as bulk hybrids. A total of 50 F_3 bulk hybrids from individual F_2 plants also were grown, and 30 of them were saved. Each hybrid had as one parent one of the greenbug-resistant varieties Dobaku, Omugi, or an unnamed variety C.I. 5087. The other parent was usually an adapted variety (Harbine, Tenkow, Ward, or Missouri B400) or a variety with resistance to one or more races of loose smut (*Ustilago nuda*). The last included North Carolina Hooded 26 and Dohadak. All the bulk hybrids that were saved are being tested in the greenhouse for reaction to greenbugs.

A number of crosses were made in 1952 in an effort to develop strains having combined greenbug resistance, winter-hardiness, stiff straw, and disease resistance. Some of the F_1 plants from these crosses are being grown in the field at Stillwater and others are being tested in the greenhouse.

WHEAT SPECIES AND RYE

The reaction of some of the more resistant wheat varieties to greenbugs in greenhouse tests is shown in Table 13. Each variety was compared with the Pawnee check in the same test. All varieties had a growth factor above 80 or the percent of Pawnee was 30 or below for preference, 115 or above for tolerance, or 50 or below for fecundity. None of the varieties showed a high degree of tolerance. Two of the best—*Triticum vulgare* var. National No. 62 and *T. durum* var. Belagatch—were, respectively, 30 and 36 percent more tolerant than Pawnee. A few varieties of the other wheat species and intergeneric hybrids were less tolerant than the more resistant strains of *T. vulgare* and *T. durum*.

There was little relationship between results from the two tolerance tests. Usually this can be explained by the difference in fecundity of the greenbugs. Varieties on which there was a high rate of reproduction usually had rather poor ratings for tolerance when the initial infestation was one female per plant. For example, the highest fecundity shown for the *Triticum vulgare* group, Kang-To-Shin-Ryac P. I. 157568, was 36 percent above Pawnee. This variety had a tolerance rating (when the initial infestation was one female per plant) of 10 percent below Pawnee. In contrast, greenbugs feeding on Seu-seun No. 4 P. I.

157591 reproduced only 52 percent as fast as when feeding on Pawnee and the corresponding tolerance was 21 percent above that of Pawnee.

A few varieties had a very low preference rating and should receive more critical testing. Some of the rye X wheat hybrids had exceedingly low fecundity records. On rye X wheat Wd. 44h4-3 only about one-fifth as many bugs were produced as on the Pawnee check.

Several varieties showed ability to make good growth after being infested (growth factor). Six of the infested varieties of *Triticum vulgare*, two *durums*, three intergeneric hybrids, and one each of *persicum*, *pyramidale*, *turgidum*, and *monococcum* grew at least 90 percent as much as the non-infested check.

In 1950, 492 plant selections were made from areas of wheat fields in which all but a few plants had been killed by greenbugs. These selections, which included 8 varieties from 45 fields, were tested in the greenhouse during the 1950-51 season. There was only a slight difference in reaction between plants grown from these selections and from unselected seed.

During the 1952-53 season approximately 175 wheat strains that previously had been tested in the greenhouse were tested for resistance in the insectary. The reaction of varieties that lived at last 15 percent longer than Pawnee in the same test is listed in Table 14. In all tests some plants appeared to be rather susceptible. However, one variety of *Triticum durum*, Dickinson No. 485 C. I. 3707, showed a high degree of resistance. Seed of this variety planted in the field in 1953 and grown to maturity showed some "off-type" heads, an indication that the seed was mixed. Additional tests indicated that the true durum Dickinson was susceptible, but that plants grown from the off-type seed were highly resistant.

Only a few of the *Triticum vulgare* group showed resistance in the insectary test. Chiefkan X Oro-Tenmarq C. I. 12518 and New Chief were among the more resistant varieties.

The reaction of wheat varieties to greenbugs in field tests in 1947 and 1950-52 is shown in Table 15. Several of the varieties had less leaf injury due to greenbugs than the Pawnee check or than any of the adapted varieties grown in the hard red winter wheat area. However, the difference was not great and none of the varieties could be considered as being highly resistant. Several Nanking varieties, Hope, and a few Hope hybrids were the more resistant.

The reactions of a few wheat varieties tested in nonreplicated 3-row plots in 1947 are shown in Table 16. A Marquillo X Oro selection obtained from the Kansas rust nursery, Manhattan, Kans., was the most resistant in this group. This variety appeared to be as resistant as some of the better varieties from China.

OATS

The reaction of some oat varieties to greenbugs in greenhouse tests is shown in Table 17. All varieties had a growth factor above 40 or, if below 40, the percent of Wintok in the same test was 50 or below for preference, or 115 or above for tolerance, or 60 or below for fecundity. None of the varieties showed a high degree of resistance. On an average the plants lived less than 20 days after being infested. Two spring varieties—Cherokee and Andrew—that are adapted to Oklahoma conditions were over 40 percent more tolerant than Wintok; however,

owing to the high susceptibility of Wintok, they cannot be considered as being resistant. Although there was considerable variation in preference and fecundity, none of the varieties indicated a high degree of resistance.

In 1950, 15 plant selections were made from areas of oat fields in which all but a few plants had been killed by greenbugs. When plants grown from these selections were tested in the greenhouse, none was resistant.

The reaction of some spring-seeded oat varieties to a natural greenbug infestation is shown in Table 18. None of the varieties showed a high degree of resistance, and most of them were more susceptible than Wintok. Andrew was the most resistant, but had only 13 percent less leaf injury than Wintok.

The effect of a moderate infestation of greenbugs on spring-seeded oat varieties grown at Stillwater in 1952 is shown in Table 19. There appeared to be some relationship between the amount of leaf injury and the yield per acre. Five of the highest yielding varieties were among the six varieties showing the least injury. One selection of Victoria-Hajira-Banner X Fulghum-Victoria had a very good test weight and good yield, but showed rather severe greenbug injury. Since this injury occurred in February and March, such a record might indicate the ability of a variety to recover.

Summary

Several hundred varieties and hybrids of small grains were tested for resistance to the greenbug [*Toxoptera graminum* (Rond.)] in the greenhouse, insectary, and field. Resistance was determined in the greenhouse in separate tests for preference, tolerance, and fecundity, and in the insectary from the days required for the greenbugs to kill the plants and the growth made after being infested. Varieties that showed some resistance in the greenhouse were tested in the field to determine their reaction to natural infestations.

Many of the barley varieties showed a high degree of resistance. All highly resistant varieties except Dicktoo and Kearney originated in China, Korea, and Japan. Preliminary data on F₁ and F₂ hybrid populations of crosses between susceptible and resistant varieties indicated that the resistance to greenbugs was inherited. With few exceptions resistance appeared to be dominant to susceptibility and was probably governed by two or more genes. There was no apparent correlation between readily visible morphological characteristics of the barley plant and greenbug resistance, although all the resistant varieties studied had long rachilla and rachis hairs.

None of the wheat and rye varieties tested showed a high degree of resistance; however, several (especially some durum) were considerably more tolerant than varieties now grown in the hard winter wheat area. Plants grown from some "off-type" seed found in one durum variety, Dickinson No. 485 C. I. 3707, showed considerable resistance when tested in a special insectary.

Although there was some variation in the reaction of oat varieties to greenbug attack, none showed a high degree of resistance. Two spring varieties, Andrew and Cherokee, which are adapted to Oklahoma conditions, were less susceptible than Wintok.

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Table 1.—Numbers of small grains tested for greenbug reaction, 1947-53.

Grain	Greenhouse (A)	Field (B)	Both greenhouse and field (C)	Insectary* (D)	Total* (A+B—C)
Wheat					
<i>Triticum vulgare</i>	331	140	118	51	353
<i>Triticum durum</i>	207	0	0	200	207
Other species	23	0	0	14	23
<i>Triticum</i> X <i>Agropyron elongatum</i>	64	4	4	0	64
Other intergeneric hybrids	8	6	6	0	8
Rye	5	0	0	5	5
Oats	205	62	46	0	221
Barley	543	80	46	10	577
Total	1386	292	220	280	1458

* Previously tested in either greenhouse or field.

Table 2.—Resistance of barley varieties and hybrids listed in order of tolerance to greenbugs in greenhouse tests at Stillwater, Okla., 1947-53.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Unnamed	4240	China	5	41	43	422	--	9	38
"	4205	"	6	50	42	418	--	9	50
Tongu	5159	Korea	5	46	47	410	--	8	36
Unnamed	4203-2	China	6	38	40	408	--	11	62
"	4243-1	"	5	38	45	404	--	7	33
"	4240-2	"	5	38	42	394	--	7	32
"	4202-1	"	8	55	42	386	--	12	64
Suwon No. 31	7454	Korea	5	91	50	385	53	5	42
Kido	5145	Korea	6	43	44	382	--	11	46
Suwon No. 31	7453	"	6	89	48	379	29	5	41
Koranbaku	5253	"	6	60	43	375	--	16	60
Kedaka-Rokkaku	7377	Japan	6	82	50	373	59	13	100
Nandomugi	5254	Korea	7	68	45	365	--	11	51
Unnamed	4195-2	China	5	38	38	363	--	10	56
Hoku	5179	Korea	5	46	39	362	--	10	47
Unnamed	4227-1	China	5	42	42	357	--	9	51
Suwon No. 28	7450	Korea	5	75	50	357	48	8	59
Tongpori	5208	"	7	70	39	351	--	14	68
Unnamed	2518	China	5	40	38	351	--	8	41
Unnamed	7294	Japan	9	81	50	343	72	9	94
Suwon No. 4	7431	Korea	5	79	50	343	69	7	64
Gubori	5248	"	7	75	39	342	--	16	62
Suwon No. 26	7448	Korea	4	64	50	338	64	6	55
Suwon No. 8	7437	"	5	68	50	338	53	8	71
Unnamed	4202-2	China	6	41	35	338	--	10	53
Chae-rae-chang	7408	Korea	5	47	50	333	96	3	15
Unnamed	5093	"	6	44	39	333	--	11	50
Dobaku	5238	"	6	59	40	332	--	13	55
Chae-rae-chang	7407	"	4	37	50	329	93	7	42

Table 2.—Continued.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Dicktoo	5529	N. Dak.	2	26	50	329	90	6	41
Chae-rae-bac	7406	Korea	4	34	50	329	79	4	21
Kearney	7580	Nebraska	2	23	50	329	91	9	62
Unnamed	5097	Korea	7	60	41	327	--	13	58
Cha-dae-maec	7404	"	4	44	50	325	73	3	18
"	7405	"	5	53	50	325	95	5	31
Suwon No. 4	7430	"	4	75	50	325	71	7	64
Suwon No. 5	7432	"	6	69	50	325	91	8	75
Zairai	5153	"	7	50	40	313	--	22	51
Suwon No. 13	7439	"	5	64	50	313	71	10	88
Changu	5169	"	5	47	32	312	--	8	35
Bac-dong No. 38	7459	"	5	91	44	311	36	7	52
Chosiz	5227	"	6	56	38	209	--	11	45
Suwon No. 13	7440	"	6	83	50	309	58	9	80
Raishu	5214	"	5	42	34	307	--	13	62
Omugi	5144	"	6	55	41	306	85	11	59
Tori	5246	Korea	6	56	42	306	--	11	48
Koso	5134	"	6	50	39	305	--	9	40
Aizu No. 2	7364	Japan	6	90	47	303	89	6	51
Huwan	1080	China	8	54	24	300	--	14	24
Shokum	5233	Korea	6	59	38	300	--	10	45
Corbel	1113	China	7	52	26	298	--	13	63
Tongubori	5252	Korea	6	54	35	297	--	17	72
Unnamed	5095	"	6	47	34	287	--	15	64
Coolie	1060	China	8	55	26	286	--	11	53
Kersho	5232	Korea	6	57	38	285	--	11	46
Seibaku	5229	"	8	72	39	284	35	9	42
Gumish	5228	"	6	58	37	284	--	14	59
Rokuben	5135	"	7	56	39	284	--	6	26
Chang-mang-ryuc-kac	7409	"	4	54	50	272	91	4	24

Table 2.—Continued.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Bano	2472	China	7	50	27	269	--	16	91
Seneca	2245	"	10	63	23	267	--	17	80
Shonan	5255	Korea	7	65	35	266	--	13	57
Unnamed	5096	"	6	48	34	266	--	12	55
Suwon No. 6	7434	"	4	59	44	263	62	10	86
Meimi	5136	"	8	58	31	262	--	15	63
Suwon No. 29	7451	"	4	69	36	258	47	5	37
Shonuru	5251	"	7	76	35	257	--	11	57
Chinorme	1079	China	8	49	22	252	--	16	75
Dorshu	5154	Korea	8	43	29	252	--	13	58
Mizuho No. 12	7382	Japan	5	86	48	249	82	10	62
Unnamed	4195	China	6	46	23	239	--	13	66
Huwan	2254	"	8	55	23	239	--	14	81
Bizen wase No. 36	7368	Japan	5	73	35	238	52	16	124
Unnamed	4236-1	China	8	56	22	235	--	9	34
"	5087	"	8	63	29	229	--	7	38
Nando	5108	Korea	8	69	30	228	--	9	40
Suwon No. 15	7443	"	6	85	38	228	42	8	75
Chinese Awnless	2278	China	9	61	21	226	--	9	54
Unnamed	5092	"	6	49	29	224	--	17	27
Seibaku x Tenkow									
F ₅ Stw.	514615	Okla.	14	91	44	222	58	5	43
Omugi x Ward F ₅ Stw.	514646	"	17	38	36	222	79	1	11
Yong-wol-ryuc-kac	7457	Korea	5	75	31	222	38	12	92
Omugi x Ward F ₅ Stw.	514662	Okla.	11	31	42	221	66	6	52
Unnamed	4195-1	China	6	47	23	221	--	11	63
Omugi x Ward F ₅ Stw.	514651	Okla.	11	35	42	218	58	1	11
Unnamed	4236-2	China	8	62	24	217	--	12	51

Reaction of Small Grains to Greenbug Attack

Table 2.—Continued.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Chan-nam-shin No. 5	7410	Korea	5	54	36	217	38	13	76
Omugi x Ward F ₅	Stw. 514650	Okla.	15	38	36	214	63	2	16
"	Stw. 514667	"	13	35	37	214	89	2	13
Blubak	2445	China	8	58	20	213	--	15	86
Seibaku x Tenkow F ₅	Stw. 514609	Okla.	12	84	43	211	66	3	24
Unnamed	4242	China	8	76	19	211	--	10	40
Suwon No. 6	7435	Korea	5	72	31	211	53	8	70
Unnamed	5094	"	7	57	26	210	--	19	79
Kipo	5242	"	8	62	26	210	--	10	45
Seibaku x Tenkow F ₅	Stw. 514605	Okla.	15	100	41	208	56	4	35
Shimabara	5196	Korea	17	84	23	207	--	8	78
Seibaku x Tenkow F ₅	Stw. 514610	Okla.	11	54	39	205	52	5	41
Unnamed	7296	Japan	10	100	21	201	43	11	113
Omugi x Ward F ₅	Stw. 514658	Okla.	4	9	35	201	86	3	27
Seibaku x Tenkow F ₅	Stw. 514604	"	13	93	41	201	54	4	35
"	Stw. 514621	"	13	73	37	196	75	2	13
"	Stw. 514614	"	11	59	39	196	61	6	52
Omugi x Ward F ₅	Stw. 514660	"	14	41	36	196	79	3	22
Chan-chon-chaе-rae	7412	Korea	6	64	32	195	45	8	46

Table 2.—Continued.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Omugi x Ward F ₅	Stw. 514669	Okla.	8	16	32	195	81	3	26
Seibaku x Tenkow F ₅	Stw. 514620	"	11	50	37	193	59	5	41
Kosaba No. 2	7347	Japan	6	58	19	192	29	8	51
Zenra	5138	Korea	8	60	24	189	--	24	92
Seibaku x Tenkow F ₅	Stw. 514625	Okla.	13	77	35	185	63	3	22
Kumflide	730	China	10	54	24	184	--	14	71
Omugi x Ward F ₅	Stw. 514645	Okla.	9	56	35	183	26	9	16
Seibaku x Tenkow F ₅	Stw. 514618	"	12	62	36	183	53	3	27
Ward x Seibaku F ₅	Stw. 514580	"	17	71	40	180	68	5	40
"	Stw. 514575	"	14	63	41	178	76	5	46
Omugi x Ward F ₅	Stw. 514648	Okla.	9	27	33	177	50	2	20
Borinuru	5245	Korea	7	67	22	177	--	9	41
Omugi x Ward F ₅	Stw. 514655	Okla.	16	56	32	176	79	1	9
Seki-tori	7423	Korea	8	85	26	172	36	5	31
Ward x Seibaku F ₅	Stw. 514589	Okla.	16	76	39	170	77	4	35
Kochi-Wasehadaka	7346	Japan	7	59	17	168	51	16	102
Suwon No. 18	7444	Korea	5	80	26	167	46	9	82
Mecca	1051	China	7	62	21	166	--	18	91
Ward x Seibaku F ₅	Stw. 514587	Okla.	22	106	40	165	74	5	44
"	Stw. 514573	"	14	73	38	163	65	5	44
Santoku	7389	Japan	4	77	31	163	91	--	--
Zungu	5158	Korea	8	60	18	161	--	17	73
Banando	5210	"	8	65	20	161	--	15	90
Ward x Seibaku F ₅	Stw. 514578	Okla.	13	59	37	160	63	7	57

TABLE 2.—Continued.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Nigrate	2444	China	9	54	16	159	--	14	81
Kogendo	5262	Korea	7	72	23	159	--	19	83
Ward x Seibaku F ₅	Stw. 514588	Okla.	13	54	37	159	78	2	16
Seibaku x Tenkow F ₅	Stw. 514624	"	11	57	32	156	70	8	66
Omugi x Tenkow F ₅	Stw. 514635	"	11	67	32	156	50	--	--
Ward x Seibaku F ₅	Stw. 514598	"	24	100	35	155	70	5	44
Omugi x Tenkow F ₅	Stw. 514629	"	8	89	33	152	49	4	31
"	Stw. 514640	"	14	70	33	152	63	2	20
Ward x Seibaku F ₅	Stw. 514593	"	12	55	34	152	86	7	61
Omugi x Tenkow F ₅	Stw. 514637	Okla.	9	91	32	151	58	3	24
Mugish	5213	Korea	6	48	13	151	--	11	70
Suwon No. 27	7449	"	8	65	30	151	27	6	58
Omugi x Tenkow F ₅	Stw. 514630	Okla.	13	66	32	151	73	3	24
Kobai-sai No. 1	7343	Japan	8	70	16	148	36	14	86
Dang-baci No. 42	7416	Korea	6	59	24	148	40	8	51
Sung-mac No. 126	7426	"	6	92	22	146	35	9	78
Unnamed	4244	China	7	54	12	145	--	16	58
Buchiang	1043	"	9	63	16	144	--	12	59
Shigo-washadaka No. 6	7351	Japan	9	68	16	144	15	14	86
Yokozuna	7308	"	4	40	23	142	36	11	118
Dang-baci No. 42	7417	Korea	7	91	22	140	46	12	74
Bae-chi	7401	"	6	84	25	140	39	10	58
Wanhing	6252	China	8	58	16	140	--	17	84
Suwon No. 25	7447	Korea	7	101	22	137	35	7	66
Ward x Seibaku F ₅	Stw. 514597	Okla.	14	57	30	136	71	7	63
Kotsu	5161	Korea	8	59	15	135	--	15	65
Hakkoku	7371	Japan	5	71	19	135	38	19	149
Obaku	5231	Korea	8	60	16	134	--	15	71
Amarillo	1073	China	11	58	11	133	--	16	76
Gumshu	5217	Korea	5	38	13	133	--	14	84

Table 2.—Continued.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Ward x Seibaku F ₅	Stw. 514595	Okla.	14	84	34	132	92	9	74
Shiromugi No. 8	7358	Japan	7	86	19	132	38	13	106
Rokakudo	5197	Korea	7	59	14	128	—	14	84
Tanikaze No. 105	7394	Japan	5	121	28	126	64	14	99
Envoy	1045	China	9	56	16	126	—	21	108
Aizu No. 6	7303	Japan	10	91	24	124	36	11	119
Omugi x Tenkow F ₅	Stw. 514636	Okla.	7	33	26	122	77	1	6
Shimane-Omugi No. 1	7392	Japan	5	98	24	121	86	11	72
Michigan Winter	2036	Indiana	9	83	16	120	—	18	91
Ward x Seibaku F ₅	Stw. 514592	Okla.	17	73	24	118	62	10	86
Sekitori-sai No. 1	7390	Japan	6	125	25	117	66	12	81
Yokuzuna	7400	"	4	90	22	114	69	12	85
Wasebozu	7397	"	6	107	22	113	53	15	102
Hisein	1053	China	9	67	14	113	—	20	104
Kogendo	5204	Korea	9	67	10	113	—	14	87
Lompoc	1312	-----	5	62	15	112	—	21	81
Zehra	5189	Korea	10	77	11	110	—	18	77
Keiroku	5240	"	8	66	12	109	—	19	87
Bac-chi	7402	"	7	86	17	109	46	10	63
Heian	5201	"	7	57	11	106	—	14	84
Kobinkatagi	7344	Japan	9	92	12	105	51	21	128
Raiden	7387	"	4	99	25	105	74	15	103
Bomnbori	5243	Korea	6	47	13	105	—	14	66
Han River	205	China	10	61	12	104	—	15	75
Reno	6561	Kansas	14	97	13	104	—	—	—
Tenkow	646	Maryland	10	97	14	103	21	46	94
Omugi No. 4	7385	Japan	5	99	21	100	45	13	92
Unnamed	4901	China	7	49	11	100	—	20	100
Ward (check)	6007	Okla.	9	100	14	100	20	66	100

Table 2.—Concluded.

Variety	C.I. or selection No.	Source	Preference		Tolerance		Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Ward (%)	Days Plant Lived (No.)	Comparison with Ward (%)		Nymphs produced per female in 7 days (No.)	Comparison with Ward (%)
Washadaka	7361	Japan	5	62	13	96	14	11	85
Yamato-Hadaka	7362	"	7	93	13	93	36	20	158
Harbine	7524	Okla.	12	126	12	93	--	19	98
Omugi-Shin No. 1	7386	Japan	6	130	19	92	65	16	110
Memesh	593	China	6	46	10	77	--	19	96

Table 3.—Tolerance of barley varieties and hybrids to greenbugs in the greenhouse and insectary at Stillwater, Okla., 1952-53.

Variety	C.I. or selection no.	Greenhouse		Insectary	
		Plant life (Days)	Comparison with Ward (%)	Plant life* (Days)	Comparison with Ward (%)
Dobaku	5238	40	332	32	151
Omugi	5144	41	306	40	192
Seibaku	5229	39	284	33	161
Omugi X Ward F ₅	Stw. 514658	35	201	40	192
Seibaku X Tenkow F ₅	Stw. 514604	41	201	40	192
Omugi X Ward F ₅	Stw. 514669	32	195	40	192
Ward X Seibaku F ₅	Stw. 514588	37	159	40	192
Omugi X Tenkow F ₅	Stw. 514636	26	122	37	179
Tenkow	646	14	103	11	64
Ward (check)	6007	14	100	21	100

* Tests terminated after 40 days.

Table 4.—Greenbug injury to spring-seeded barley varieties in natural infestations at Lawton and Stillwater, Okla., 1947, 1950-52.

Variety	C.I. or selection no.	Source	Leaves injured (percent)				Average	Comparison with Ward (percent)
			Lawton 1947	1950	Stillwater 1951	1952		
Unnamed	4240-2	China	--	--	15	13	14	18
Hoku	5179	Korea	--	--	19	--	19	20
Unnamed	4240	China	--	--	14	17	16	20
Kearney	7580	Neb.	--	--	22	10	16	21
Kido	5145	Korea	--	--	21	--	21	21
Shokum	5233	"	--	--	23	--	23	23
Gumish	5228	"	--	--	23	--	23	24
Unnamed	5097	"	--	--	24	--	24	24
Zairai	5153	"	--	--	22	18	20	26
Meimi	5136	"	--	--	18	22	20	26
Changu	5169	"	--	--	14	27	21	27
Unnamed	4203-2	China	--	--	27	--	27	27
Nandomugi	5254	Korea	--	--	21	23	22	29
Zehra	5189	"	--	--	--	16	16	29
Unnamed	4227-1	China	--	--	--	16	16	29
"	5096	Korea	--	28	17	15	20	30
Kumflide	730	China	--	--	30	--	30	31
Omugi	5144	Korea	--	33	16	15	21	31
Chosiz	5227	"	--	27	21	--	24	32
Kogendo	5262	"	--	--	32	--	32	32
Lopat	2477	China	--	--	32	--	32	32
Unnamed	4202-1	"	--	35	15	16	22	32
"	4202-2	"	--	25	18	23	22	33
Tongu	5159	Korea	--	31	18	18	22	33
Ludwig	7525	Neb.	--	--	32	19	26	33
Tongpori	5208	Korea	--	33	17	22	24	36
Koranbaku	5253	"	--	36	16	22	25	36
Dicktoo	5529	N. Dak.	--	--	--	21	21	37
Gatami	575	Manchuria	--	30	25	--	28	37
Dobaku	5238	Korea	--	38	20	19	26	38
Unnamed	4243-1	China	--	33	24	--	28	38

Table 4.—Continued.

Variety	C.I. or selection no.	Source	Leaves injured (percent)				Average	Comparison with Ward (percent)
			Lawton	Stillwater				
			1947	1950	1951	1952		
Composite Cross Sel.	7530	Neb.	--	38	18	23	26	38
Unnamed	5087	China	23	28	25	--	25	40
Rokuben	5135	Korea	--	--	21	--	21	42
Debaku Sel.	-----	Okla.	--	--	--	24	24	43
Seibaku	5229	Korea	19	32	25	30	27	44
Unnamed	4195-1	China	--	24	--	--	24	47
Colonial	7570	N. Car.	--	34	48	--	41	56
Kersho	5232	Korea	--	30	--	--	30	60
Koso	5134	"	--	31	--	--	31	61
Unnamed	4195-2	China	--	31	--	--	31	63
Gubori	5248	Korea	--	33	--	--	33	67
Tongubori	5252	"	--	34	--	--	34	67
Abyssinian	1231	Ethiopia	27	--	--	--	27	68
Son	5148	Korea	--	34	--	--	34	69
Dorshu	5154	"	--	35	--	--	35	69
Unnamed	5092	China	27	--	--	--	27	70
Nu Er Ta	741	"	29	--	--	--	29	74
Quinn	1024	Australia	--	--	78	--	78	80
Lochink	2460	China	32	--	--	--	32	81
Sunrise	6272	N. Carolina	--	41	--	--	41	82
Sonbaku	5151	Korea	33	--	--	--	33	83
Wong	6728	China	33	--	--	--	33	85
Borido	5236	Korea	34	--	--	--	34	87
Luth	908	Minn.	35	--	--	--	35	89
Shumaki	5222	Korea	35	--	--	--	35	89
Peru	707	N. Africa	35	--	--	--	35	90
Michigan Winter	2036	Indiana	39	43	--	--	41	92
Fayette (Okla. Str.)	245	Okla.	31	--	96	--	64	93
Harbine	7524	"	--	43	97	--	70	95
Nassau	7022	New Jersey	37	--	--	--	37	95
Besert 13	3899	Tunis	--	--	94	--	94	96
Tenkow	646	Maryland	39	42	95	59	59	96
Lico	6279	Colorado	--	--	94	--	94	97

Table 4.—Concluded.

Variety	C.I. or selection no.	Source	Leaves injured (percent)				Average	Comparison with Ward (percent)
			Lawton 1947	1950	Stillwater 1951	1952		
Tucker	7039	W. Va.	38	--	--	--	38	98
Atlas	4118	Calif.	--	--	97	--	97	100
Composite Cross Sel.	Wd. 35h10-2	Okla.	--	--	97	--	97	100
Okla. No. 1005 Sel.	9174	"	40	47	100	--	62	100
Ward (check)	6007	"	39	50	98	56	61	100
Dinar	729	Tunis	--	--	99	--	99	101
Besert 14	3900	"	--	--	99	--	99	101
Flynn I	5911	Oregon	40	--	--	--	40	102
Calif. Mariout	1455	Egypt	--	--	100	--	100	102
Black Smyrna	191	Asia Minor	--	--	100	--	100	102
Composite Cross Sel.	8061	Okla.	--	52	--	--	52	104
Smooth Awn 86	6268	Virginia	41	--	--	--	41	104
Reno	6561	Kansas	42	--	--	--	42	106
Brier	7157	W. Virginia	44	--	--	--	44	112
Beecher	6566	Colorado	44	--	--	--	44	113

Table 5.—Greenbug injury to some of the more resistant spring-seeded barley varieties grown in unreplicated nursery plots at Stillwater and Lawton, Okla.

Variety*	C.I. No.	Source	Leaves injured (percent)	Comparison with Ward (percent)
Unnamed	5093	Korea	20	21
"	4195	China	9	22
Corbel	1113	"	25	26
Unnamed	2269	"	30	31
"	5094	Korea	15	37
"	5095	"	16	39
Shonuru	5251	"	16	39
Huwan	1080	China	40	41
Nunca	2473	"	28	42
Karubori	5259	Korea	18	44
Mignon	999	Russia	24	58
Arlington Awnless	702	-----	25	60

* Nunca, Mignon, and Arlington Awnless grown at Lawton in 1947, all others grown at Stillwater in 1950 or 1951.

Table 6.—Yields of spring-seeded barley varieties grown in the absence of greenbug in 1950 and under a severe greenbug infestation in 1951 at Stillwater, Okla.

Variety	C.I. No.	1950		1951		1951	
		Bushels	Rank	Bushels	Rank	Percent of leaves injured	Rank
Atlas	4118	17.0	23	1.8	22	97	24
Besert 13	3899	16.2	25	0.1	25	94	19
Besert 14	3900	17.4	21	0.1	25	99	27
Black Smyrna	191	22.1	17	0.0	27	100	30
Calif. Mariout	1455	10.3	29	0.0	27	100	28
Chosiz	5227	25.0	9	20.1	6	21	10
Colonial	7570	19.7	18	14.6	15	48	17
Composite Cross Sel.	7530	17.2	22	19.8	8	18	6
Dinar	729	13.7	26	0.0	27	99	26
Dobaku	5238	22.5	16	23.4	4	20	9
Fayette (check)	245	25.4	7	5.9	17	96	22
Gatami	575	23.7	11	19.9	7	25	14
Harbine (check)	7524	26.3	5	5.8	18	97	23
Koranbaku	5253	23.1	13	21.8	5	16	2
Kumflide	730	13.2	27	9.1	16	30	15
Lico	6279	10.2	30	0.0	27	94	20
Lopat	2477	25.3	8	17.8	12	32	16
Okla. No. 1005 Sel.	9174	32.2	1	0.2	24	100	28
Omugi	5144	19.3	19	28.6	1	16	3
Quinn	1024	27.4	3	3.4	20	78	18
Seibaku*	5229	25.5	6	3.4	20	25	12
Tenkow (check)	646	26.4	4	5.7	19	95	21
Tongpori	5208	28.3	2	23.8	3	17	4
Tongu	5159	23.7	11	24.8	2	18	6
Unnamed	4202-1	17.8	20	18.2	11	15	1
"	4202-2	23.0	15	18.3	10	18	8
"	4243-1	12.5	28	15.7	13	24	11
"	5087	16.5	24	14.9	14	25	12
"	5096	23.1	13	19.7	9	17	4
Ward (check)	6007	24.7	10	1.2	23	98	25

* Poor emergence in 1951.

Table 7.—Distribution of individual F₁ hybrid and parent barley plants according to amount of growth during the period of infestation with greenbugs in the greenhouse at Stillwater, Okla., 1951. Figures indicate number of plants.

Parent or cross	2 cm.	5 cm.	8 cm.	11 cm.	14 cm.	17 cm.	20 cm.	23 cm.	Total	Average (cm.)
Seeded on March 3										
Cross III:										
Omugi	1	-	3	--	--	--	--	--	4	6
Tenkow	3	1	-	--	--	--	--	--	4	2
F ₁	1	9	5	--	--	--	--	--	15	5
Seeded on October 27										
Cross I:										
Dobaku	-	-	-	--	--	1	1	--	2	18
Ward	-	-	1	--	1	--	--	--	2	11
F ₁	-	1	1	1	3	--	--	--	6	11
Cross III:										
Omugi	-	-	-	1	3	--	1	--	5	14
Tenkow	-	1	2	1	1	--	--	--	5	9
F ₁	-	-	-	3	3	6	2	4	18	17
Cross IV:										
Omugi	-	-	-	--	--	2	1	--	3	18
Ward	-	1	-	2	--	--	--	--	3	9
F ₁	-	-	-	2	1	--	4	8	15	20

Table 8.—Distribution of individual F₁ hybrid and parent barley plants according to accumulated tolerance rating during the period of infestation with greenbugs in the greenhouse at Stillwater, Okla., 1951. Figures indicate number of plants.

Parent or cross	Accumulated rating class														Total	Avg. rating
	55	65	75	85	95	105	115	125	135	145	155	165	175	185		
Seeded on March 3																
Cross III:																
Omugi	-	-	-	-	1	-	-	-	2	1	-	-	-	-	4	128
Tenkow	-	-	2	-	1	1	-	-	-	-	-	-	-	-	4	88
F ₁	2	2	1	1	2	4	2	1	-	-	-	-	-	-	15	91
Seeded on October 27																
Cross I:																
Dobaku	-	-	-	-	-	-	-	1	-	-	1	-	-	2	140	
Ward	-	-	1	-	1	-	-	-	-	-	-	-	-	2	85	
F ₁	-	-	2	-	1	1	-	1	-	1	-	-	-	6	103	
Cross III:																
Omugi	-	-	-	-	-	1	1	-	1	1	-	1	-	5	133	
Tenkow	-	-	1	-	1	-	3	-	-	-	-	-	-	5	103	
F ₁	-	-	2	-	-	1	2	4	2	4	2	1	-	18	128	
Cross IV:																
Omugi	-	-	-	-	-	-	-	-	-	-	3	-	-	3	155	
Ward	-	-	-	-	2	-	-	-	-	1	-	-	-	3	112	
F ₁	-	-	1	-	-	-	1	-	-	-	4	2	3	4	15	160

Table 9.—Analyses of variance of parental and check data for each of the four crosses of the preference and tolerance tests at Stillwater, Okla., 1950-51. Unless noted otherwise, the mean squares for all varieties were significant at the 1-percent level.

Variation	Degrees of freedom	Mean squares		
		Preference	Accumulated rating	Amount of growth
Cross I — Dobaku, Ward, and Omugi check				
Total Varieties	119			
Errors	78	4,727	19,128	1,182
		429	542	26
Cross II — Dobaku, C.I. 5087, and Omugi check				
Total Varieties	116			
Errors	76	1,404	4,851	557
		164	221	12
Cross III — Omugi and Tenkow				
Total Varieties	77			
Errors	38	6,647	17,490	786
		207	248	17
Cross IV — Omugi and Ward				
Total Varieties	73 (71) ¹			
Errors	36 (35)	1,386 ²	16,501	879
		429	289	14

¹ Degrees of freedom for the preference test. Because Omugi in one pot had no greenbugs on it during the 4-day period, this pot was omitted in the analysis.

² Not significant.

Table X. --Tolerance of Parent, Check, and F₂ Plants of Four Barley Crosses to Artificially Induced Greenbug Attack as Measured by the Accumulated Rating Test at Stillwater, Okla., 1950-51. Figures Indicate Number of Plants.

Variety or cross	Accumulated rating classes																			Total	Average rating				
	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118	122			126	130	134	138
Cross I:																									
Omugi (ck.)	-	-	-	-	-	-	-	-	-	-	-	-	(40) ^{1/}	-	-	-	-	-	-	-	-	-	-	40	100
Dobaku	-	-	-	-	-	-	-	-	-	5	-	10	5	3	4	6	2	2	2	1	-	-	-	40	103
Ward	2	1	1	3	2	2	4	2	4	3	4	4	2	4	-	1	-	-	1	-	-	-	-	40	83
F ₂	-	1	-	-	3	2	3	2	5	13	14	34	26	27	26	4	2	9	3	3	1	-	1	199	100
Cross II:																									
Omugi (ck.)	-	-	-	-	-	-	-	-	-	-	-	-	(40) ^{1/}	-	-	-	-	-	-	-	-	-	-	40	100
Dobaku	-	-	-	-	-	-	-	-	-	1	4	10	6	10	5	2	-	-	-	1	-	-	-	39	104
C. I. 5087	-	1	-	-	-	1	1	1	1	6	10	6	8	2	3	-	-	-	-	-	-	-	-	39	92
F ₂	-	1	-	-	-	1	1	-	3	8	14	27	40	41	39	13	9	1	1	1	-	-	-	200	100
Variety or cross	102	106	110	114	118	122	130	138	142	146	154	162	170	178	186	194	198	202	210	218	222	226	Total	Average rating	
Cross III:																									
Omugi	-	-	-	-	-	-	1	1	1	2	2	2	3	6	4	2	4	4	2	2	1	1	-	39	164
Tenkow	1	-	1	-	4	1	8	5	1	8	2	1	1	5	-	1	-	-	-	-	-	-	-	39	134
F ₂	-	2	2	1	1	2	2	5	12	13	17	19	21	22	22	18	18	12	13	9	4	2	-	227	156
Variety or cross	120	124	128	136	144	152	160	168	176	184	188	192	200	204	208	216	224	228	232	236	244	248	Total	Average rating	
Cross IV:																									
Omugi	-	1	-	-	1	-	2	1	1	-	1	3	6	2	5	3	1	4	2	-	-	1	-	39	176
Ward	4	1	1	8	4	4	1	-	1	2	3	2	-	1	1	-	1	1	1	-	-	-	-	38	146
F ₂	-	1	1	-	2	2	4	8	8	11	15	13	12	27	30	20	21	13	11	3	9	1	3	233	178

^{1/} In percent of Omugi.

Table XI. --Tolerance of Parent, Check, and F₂ Plants of Four Barley Crosses to Artificially Induced Greenbug Attack as Measured by the Amount of Growth (in Percent of Omugi) During Infestation at Stillwater, Okla., 1950-51, Figures Indicate Number of Plants

Variety or cross	Growth classes in centimeters															Total	Average growth (cm.)												
	25 15	45 35	65 55	85 75	105 95	125 115	145 135	165 155	185 175	205 195	225 215	245 235	265 255	275															
Cross I:																													
Omugi (ck.)	-	-	-	-	-	-	(40)	-	-	-	-	-	-	-	-	-	40	100											
Dobaku	-	-	-	-	1	-	5	8	9	3	3	6	1	1	1	1	-	40	116										
Ward	2	2	4	3	7	4	4	5	4	-	1	1	2	-	-	-	-	40	72										
F ₂	-	-	-	1	1	7	14	19	31	39	20	19	17	8	2	5	5	6	2	-	-	-	-	2	1	-	199	115	
Cross II:																													
Omugi (ck.)	-	-	-	-	-	-	-	(40)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	100
Dobaku	-	-	-	-	1	1	4	5	2	4	9	2	3	2	1	-	3	-	-	-	1	-	-	1	-	-	-	39	126
C.I. 5087	1	1	1	1	5	10	8	3	4	-	1	1	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	39	78
F ₂	-	-	-	7	9	9	20	27	32	20	24	19	8	7	-	2	2	2	1	1	3	6	-	-	-	-	1	200	107
Variety or cross	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	Total	Average growth (cm.)											
Cross III.																													
Omugi	-	1	1	1	2	2	6	6	6	5	4	1	1	2	-	1	39	17											
Tenkow	1	2	3	6	8	13	1	2	1	1	-	1	-	-	-	-	39	10											
F ₂	1	2	9	14	40	43	35	26	15	16	4	11	3	3	3	2	227	14											
Cross IV																													
Omugi	-	-	-	-	2	2	4	4	10	6	2	1	2	3	1	-	37	18											
Ward	-	1	4	3	8	9	3	5	3	1	-	-	-	-	-	-	39	11											
F ₂	-	1	1	2	6	15	35	32	34	44	27	14	11	8	-	3	233	18											

Table 12.—Inheritance of resistance in four winter barley crosses to manual infestation of greenbugs at Stillwater, Okla., 1950-51.

Test	Resistant plants (no.)		Susceptible plants (no.)		Chi square	P value
	Observed	Expected	Observed	Expected		
Cross I — Dobaku X Ward (13:3)						
Accumulated rating	156	160	43	39	0.510	0.30-0.50
Amount of growth	162	160	37	39	0.128	0.50-0.70
Cross II — Dobaku X C.I. 5087 (3:1)						
Accumulated rating	146	150	54	50	0.427	0.50-0.70
Amount of growth	145	150	55	50	0.667	0.30-0.50
Cross III — Omugi X Tenkow (9:7)						
Accumulated rating	136	128	91	99	1.146	0.20-0.30
Amount of growth	122	128	105	99	0.645	0.30-0.50
Cross IV — Omugi X Ward (3:1)						
Accumulated rating	181	175	52	58	0.827	0.30-0.50
Amount of growth	173	175	60	58	0.092	0.70-0.80

Table 13.—Reaction of some of the more resistant varieties and hybrids of wheat and rye in order of tolerance to greenbugs in greenhouse tests at Stillwater, Okla., 1947-53.

Variety, hybrid, or species ¹	C.I., P.I., or selection number	Source	Preference		Tolerance Tests				Growth factor	Fecundity	
			Greenbugs per plant (No.)	Comparison with Pawnee (%)	One ²		Two ³			Nymphs produced per female in 7 days (No.)	Comparison with Pawnee (%)
					Plant life (Days)	Comparison with Pawnee (%)	Plant life (Days)	Comparison with Pawnee (%)			
<i>Triticum vulgare:</i>											
National No. 62	149107	China	7	55	--	--	18	130	--	15	94
Saline	12674	Illinois	7	19	--	--	20	130	66	14	118
Martin	4636	Washington	7	81	--	--	13	129	--	15	76
Purple Straw	1915	Russia	8	18	--	--	19	125	44	10	82
Anderson	12536	U. S. D. A.	9	52	--	--	17	124	82	17	100
Tsing-Yong 302	149112	China	9	86	--	--	19	122	--	16	100
Blue Jacket	12502	Kansas	8	66	--	--	11	121	--	22	100
Nanking	124364	China	7	98	--	--	12	121	--	15	75
Chey.-Tq. x Mqo.-Oro	Ks. Sel. 45618	Kansas	9	89	--	--	11	121	--	21	99
Chancellor	12333	Georgia	19	49	--	--	19	120	69	14	114
Chey. x Turkey	12142	Nebraska	9	88	--	--	10	119	--	14	72
Fulcaster	6471	Kansas	8	66	--	--	12	119	--	21	97
Mqo. x Oro	37RN1433-6	"	9	69	--	--	18	118	--	17	107
Hope	8178	S. Dakota	25	63	--	--	13	118	--	24	109
Chey. x Tq.	11972	Kansas	7	69	--	--	12	118	--	19	87
National No. 483	149109	China	7	62	--	--	19	118	--	15	97
Nanking No. 360	124332	China	10	90	--	--	11	117	--	17	78
Minhardi	5149	Minnesota	8	100	--	--	11	117	--	16	80
Paw. x Oro	Wd. 44h1-34	Oklahoma	9	80	--	--	12	116	--	19	88
Kaw.-Mqo. x Kaw.-Tq.	12331	Kansas	9	67	--	--	16	116	--	15	99
Nanking No. 22-14	124363	China	7	81	--	--	11	115	--	16	80
Nanking No. 68	124279	"	7	66	--	--	11	115	--	15	73
Med.-Hope x Paw.	12141	Kansas	8	67	--	--	11	115	--	18	82

Table 13.—Continued.

Variety, hybrid, or species ¹	C.I., P.I., or selection number	Source	Preference		Tolerance Tests				Fecundity		
			Green- bugs per plant (No.)	Com- pari- son with Pawnee (%)	One ²		Two ³		Growth factor	Nvmphs produced per female in 7 days (No.)	Com- pari- son with Pawnee (%)
					Plant life (Days)	Com- pari- son with Pawnee (%)	Plant life (Days)	Com- pari- son with Pawnee (%)			
<i>Triticum vulgare</i> —continued											
Comanche	11673	Kansas	7	89	--	--	16	113	--	16	81
Seu-seun No. 3	157590	Korea	17	106	22	122	16	112	34	18	66
Norin No. 10	156641	Japan	25	70	23	100	16	111	97	--	--
Triumph	12132	Okla.	8	105	--	--	14	110	--	14	72
Seu-seun No. 4	157591	Korea	24	65	22	121	19	109	35	14	52
Clarkan	8858	Kansas	8	83	--	--	13	108	41	14	70
Norin No. 50	155271	Japan	18	97	23	137	17	107	42	14	105
Seu-seun No. 1	157588	Korea	19	105	19	104	18	107	94	19	77
Seu-seun No. 8	157595	"	17	66	21	119	17	106	30	18	68
Norin No. 27	182581	Japan	31	122	29	100	18	105	95	12	100
Kang-To-Shin-Ryac	157568	Korea	27	143	21	90	17	104	86	20	136
Norin No. 24	182585	Japan	22	118	27	95	19	103	80	9	70
Norin No. 17	182587	"	17	76	27	91	19	103	85	14	119
Westar	12110	Texas	7	88	--	--	14	103	--	11	57
Nang-Rim No. 17	157578	Korea	32	73	20	86	16	103	83	16	121
Saitama	155279	Japan	16	95	26	132	16	103	93	12	81
Seu-seun No. 10	157597	Korea	21	92	22	121	16	102	25	18	68
Seu-seun No. 2	157589	"	18	89	23	126	18	102	55	19	72
Wichita	11952	Kansas	6	80	--	--	14	101	--	13	67
Norin No. 61	182591	Japan	17	69	27	95	19	101	83	9	80
Pawnee	11669	Neb.	18	100	27	100	17	100	50	20	100
Norin No. 25	182582	"	23	103	27	92	19	99	86	13	115
Norin No. 67	155277	"	25	114	25	126	17	99	55	9	55
Suwon No. 95	157690	Korea	22	100	21	121	20	97	42	18	60
Norin No. 26	155266	Japan	17	143	23	120	18	96	36	10	61
Norin No. 36	182571	"	33	153	20	93	18	96	94	12	104

Table 13.—Continued.

Variety, hybrid, or species ¹	C.I., P.I., or selection number	Source	Preference		Tolerance Tests				Fecundity		
			Green- bugs per plant (No.)	Com- pari- son with Pawnee (%)	One ²		Two ³		Growth factor	Nymphs produced per female in 7 days (No.)	Com- pari- son with Pawnee (%)
					Plant life (Days)	Com- pari- son with Pawnee (%)	Plant life (Days)	Com- pari- son with Pawnee (%)			
<i>Triticum vulgare</i> —continued											
Nang-Rim No. 38	157581	Korea	22	113	23	99	17	95	83	16	112
Lochiga Sakitori I	182578	Japan	29	174	20	94	182	94	88	13	114
Tenmarq	6936	Kansas	11	143	--	--	12	94	--	12	61
Ponca	12128	Kan.-Okla.	9	95	--	--	11	93	--	20	96
Cheyenne	8885	Neb.	15	114	--	--	13	93	--	13	68
Haya Komugi	182565	Japan	35	106	20	94	17	93	95	13	102
Norin No. 43	182586	"	21	140	29	100	18	92	80	11	90
<i>Triticum macha</i>	P-49-79.2-2		7	26	--	--	24	111	75	10	111
<i>Triticum spelta</i>	P-50-70.1-1		15	84	--	--	23	98	87	10	111
<i>Triticum vavilovi</i>	P-49-79.2-2		21	73	--	--	24	112	86	--	---
Belagatch	3643	Russia	11	36	24	88	23	136	46	8	85
Golden Ball	5059	Africa	9	32	--	--	18	135	--	--	---
Kubanka	2094	Russia	11	67	31	78	20	135	38	10	121
Kahla	2088	Algeria	16	39	31	80	22	133	35	14	117
Dur-Oran	3986	"	17	51	--	--	21	132	--	--	---
Mahmoudi	3816	Tunis	11	33	28	112	22	131	16	4	50
Minieh	1751	Egypt	18	80	42	105	22	131	50	15	125
Unnamed	3649	Turkestan	16	38	23	84	21	126	59	12	118
"	3766	Russia	12	32	25	91	19	125	53	10	109
Durum No. 4	3321	N. Dak.	8	18	--	--	21	125	69	7	73
Mahmoudi	3809	Tunis	16	60	21	82	20	124	--	12	174
Unnamed	3856	Algeria	15	55	--	--	20	123	53	--	---
Pentad	3322	N. Dak.	11	28	29	112	20	123	51	5	60

Table 13.—Continued.

Variety, hybrid, or species ¹	C.I., P.I., or selection number	Source	Preference		Tolerance Tests				Fecundity		
			Green- bugs per plant (No.)	Com- pari- son with Pawnee (%)	One ²		Two ³		Growth factor	Nymphs produced per female in 7 days (No.)	Com- pari- son with Pawnee (%)
					Plant life (Days)	Com- pari- son with Pawnee (%)	Plant life (Days)	Com- pari- son with Pawnee (%)			
<i>Triticum durum</i> -continued											
Unnamed	4526	India	9	23	--	--	18	122	--	--	--
Kubanka	2234	Russia	16	96	31	78	19	122	47	9	100
Jalalia	4563	India	20	86	--	--	23	122	--	--	--
Howrah	4562	"	23	65	--	--	18	121	57	--	--
Unnamed	2431	Egypt	15	41	32	79	17	120	52	5	50
Agini	3845	Algeria	9	42	--	--	23	120	--	--	--
"	3844	"	6	18	--	--	19	119	--	--	--
"	4587	Africa	13	69	--	--	22	119	--	--	--
Unnamed	3984	Tunis	9	32	--	--	20	118	--	--	--
"	3656	Japan	10	24	23	79	22	118	49	17	150
"	3160	Tunis	13	66	32	103	25	118	90	7	81
Missogen	2468	Germany	18	78	36	111	19	118	25	10	59
Tigharia	4564	India	21	90	--	--	23	118	45	--	--
Unnamed	3647	Turkestan	13	25	25	91	17	117	--	14	149
Beliouni	3848	Algeria	12	42	--	--	22	117	--	--	--
Realforte	3813	Tunis	15	51	27	102	19	116	65	9	88
Unnamed	3158	"	15	95	26	81	24	116	31	9	88
Candéal	4524	Philippines	13	87	--	--	20	116	--	--	--
Unnamed	3162	Tunis	17	111	27	90	23	116	22	10	131
Velvet Don	2122	Russia	9	54	27	66	19	115	42	12	100
Unnamed	4525	India	12	34	--	--	18	115	--	--	--
"	3117	Tunis	5	50	28	109	20	113	30	9	46
Saragolla	2228	Italy	12	57	38	95	20	112	92	9	111
Mahmoudi	3824	Tunis	6	28	--	--	21	109	--	--	--

Table 13.—Continued.

Variety, hybrid, or species ¹	C.I., P.I., or selection number	Source	Preference		Tolerance Tests				Fecundity		
			Green- bugs per plant (No.)	Com- pari- son with Pawnee (%)	Plant life (Days)	Com- pari- son with Pawnee (%)	Plant life (Days)	Com- pari- son with Pawnee (%)	Growth factor	Nymphs produced per female in 7 days (No.)	Com- pari- son with Pawnee (%)
<i>Triticum durum</i> - continued											
Dickinson No. 485	3707	N. Dak.	6	37	29	118	21	108	88	9	88
Kubanka	3303	Russia	7	57	29	100	24	107	36	6	47
Unnamed	5143	Spain	9	29	—	—	16	105	—	—	—
"	3146	Tunis	21	105	32	103	19	104	—	6	44
"	3141	Tunis	16	75	27	109	22	102	42	8	45
Penquite	3068	Abyssinia	11	41	30	115	22	102	68	8	48
Unnamed	3136	Spain	15	88	29	113	21	101	56	8	48
"	3069	Abyssinia	12	70	32	121	21	90	70	7	41
Number 7	3323	N. Dak.	8	21	28	102	20	88	68	9	103
Adjini	1594	Algeria	16	125	39	121	17	87	32	13	96
Kubanka	1354	Russia	9	51	40	123	16	85	31	9	56
<i>Triticum persicum</i>	P-50-53-2	-?-	12	56	—	—	23	107	92	—	—
<i>Triticum polonicum</i>	70738	-?-	4	13	—	—	20	117	76	9	77
<i>Triticum pyramidale</i>											
Beladi	7265-5	Egypt	14	45	—	—	21	119	90	9	78
<i>Triticum turgidum</i>											
Gaza 277	12616	Egypt	13	62	—	—	22	121	81	12	96
Barrigon yaqui 52	-----	Mexico	14	86	—	—	21	102	90	10	86
<i>Triticum monococcum</i>	119422	Turkey	13	58	—	—	22	123	55	10	83
<i>Triticum monococcum</i>	94743	Russia	16	73	—	—	19	101	95	14	118
<i>Intergeneric hybrids</i>											
Rye x Wheat	Wd. 44h4-3	Okla.	8	61	—	—	13	122	—	5	21
Chinese Rye x <i>A.</i> <i>elong.</i> x Fwd.	Ks. 46-411	Kansas	18	93	—	—	15	119	—	—	—
Rye x Wheat	Wd. 44h4-14	Okla.	11	67	28	112	14	115	—	9	53

Table 13.—Concluded.

Variety, hybrid, or species ¹	C.I., P.I., or selection number	Source	Preference		Tolerance Tests				Growth factor	Fecundity	
			Green- bugs per plant (No.)	Com- pari- son with Pawnee (%)	One ²		Two ³			Nymphs produced per female in 7 days (No.)	Com- pari- son with Pawnee (%)
					Plant life (Days)	Com- pari- son with Pawnee (%)	Plant life (Days)	Com- pari- son with Pawnee (%)			
<i>Triticum-A. elong.</i> x Paw. F ₅	515921	Okla.	18	38	22	89	16	115	32	17	138
Rye x Wheat	Wd. 44h4-19	"	13	70	--	--	14	114	18	6	33
<i>Triticum-A. elong.</i> x Paw. F ₅	516218	"	26	135	28	105	22	106	90	10	100
<i>Triticum-A. elong.</i> x Paw. F ₅	516241	"	41	145	28	108	19	106	95	12	118
<i>Triticum-A. elong.</i> x Paw. F ₅	516224	"	14	185	28	105	23	104	95	12	118
<i>Secale cereale</i>											
Balbo rye	-----	Italy	7	74	--	--	14	124	--	22	100
Abruzzi rye	-----	"	8	66	--	--	12	115	--	22	96

¹ Abbreviations used in this table: *A. elong.* = *Agropyron elongatum*, Chey. = Cheyenne, Fwd. = Forward, Med. = Mediterranean, Mgo. = Marquillo, Paw. = Pawnee, and Tq. = Tenmarq.

² Original infestation one winged adult per plant.

³ Original infestation five nymphs per plant.

Table 14.—Tolerance of some of the more resistant varieties and hybrids of wheat and rye to greenbugs in the insectary at Stillwater, Okla., 1952-53.

Variety or hybrid*	C.I. or selection number	Source	Tolerance	
			Plant life (Days)	Comparison with Pawnee (%)
<i>Triticum vulgare:</i>				
Chiefkan X Oro-Tenmarq	12518	Kansas	20	139
New Chief	12714	"	19	134
Red Jacket	12713	"	21	123
Double Cross	12504	Texas	17	120
Marquillo-Oro X Comanche	Stw. 484233	Oklahoma	22	118
Mediterranean-Hope X Fulcaster	Tex. 114-44-75	Texas	21	116
Hard Federation Hybrid	12515	Oklahoma	26	116
Double Cross	12511	Texas	16	116
<i>Triticum compactum:</i>				
Elgin	11755	Wash. State	23	123
Hymar	11605	"	22	120
<i>Triticum durum:</i>				
Dickinson No. 485	3707	N. Dak.	29	170
Sbei	4588	Africa	18	129
"	4586	"	17	128
Marsters Perfection	4726	Australia	28	127
Mahmoudi	3816	Tunis	15	126
Lenah Khetifa	4585	Africa	17	125
Jalalia	4563	India	16	122
Unnamed	3166	Tunis	13	116
"	4526	India	14	115
<i>Intergeneric hybrids:</i>				
Chinese Rye X <i>A. elong.</i> X Fwd.*	Kansas 46-411	Kansas	19	132
<i>Secale cereale:</i>				
Tetraploid Rye (Tetra Petkus)	----	Germany	22	122

* Abbreviations used in this table: *A. elong.* = *Agropyron elongatum*, Fwd. = Forward.

Table 15.—Greenbug injury to spring-seeded winter wheat varieties and hybrids in natural infestations at Lawton and Stillwater, Okla., 1947, 1950-52.

Variety or hybrid*	C.I., P.I., or selec- tion number	Source	Percent of leaves injured					Comparison with Pawnee
			Lawton	Stillwater				
			1947	1950	1951	1952	Average	
Nanking No. 66	124278	China	25	--	--	--	25	68
Hope	8178	N. Dak.	27	--	--	--	27	73
Com. x Med.-Hope	12513	Texas	--	21	--	--	21	75
(Sinv.-Wich. x Hope-Chey.) x Wich.	12703	"	--	21	--	--	21	75
Timstein x (Mqo.-Oro x Kaw.-Tq.)	Stw. 516625	Okla.	--	--	--	37	37	77
Nanking No. 389	124339	China	29	--	--	--	29	77
Nanking No. 394	124341	"	29	--	--	--	29	78
Bkhl.-Oro x Paw.	Wd. 46A-174	Okla.	29	--	--	--	29	78
Mqo. x Oro	11979	Kansas	29	--	--	--	29	78
Timstein x (Mqo.-Oro x Kaw.-Tq.)	Stw. 516645	Okla.	--	--	--	39	39	80
Med.-Hope x Paw. ₂	12141	Kansas	30	--	--	--	30	80
Seabreeze	12611	Texas	--	21	79	40	47	81
Martin	4636	Wash.	30	--	--	--	30	81
Mqo.-Oro x Com.	Ks. 2796	Kansas	31	--	--	--	31	84
Reliant	12144	Okla.	31	--	--	--	31	84
Timstein x (Mqo.-Oro x Kaw.-Tq.)	Stw. 516617	"	--	--	--	41	41	84
Quivira x Tq.	12116	Kansas	32	--	--	--	32	85
(Kaw.-Mqo. x Tq.) x (Med.-Hope x Paw.)	Stw. 484129	"	--	24	85	40	50	86
Bkhl.-Oro x Paw.	Wd. 46h-114	"	32	--	--	--	32	86
Mqo. x Oro	11980	Kansas	32	--	--	--	32	86
Denton	8265	Texas	33	19	90	42	46	87
Timstein x (Mqo.-Oro x Kaw.-Tq.)	Stw. 516628	Okla.	--	--	--	43	43	88
Chiefkan	11754	Kansas	33	--	--	--	33	88
Clarkan	8858	"	33	--	--	--	33	89
Nebred x Med.-Hope	Okla. 42	Okla.	33	--	--	--	33	89
Bkhl. x Chey.	12101	Kansas	33	--	--	--	33	89
Kanred	5146	"	33	--	--	--	33	89
Mqo.-Oro x Pawnee	Stw. 484117	Okla.	--	25	--	--	25	89
Nanking No. 345	124326	China	33	--	--	--	33	89
Fultz x Hungarian	12017	Ind.	34	--	--	--	34	90
(Sinv.-Wich. x Hope-Chey.) x Wich.	12702	Texas	--	19	91	48	53	91

Table 15.—Continued.

Variety or hybrid*	C.I., P.I., or selec- tion number	Source	Percent of leaves injured				Comparison with Pawnee	
			Lawton	Stillwater		Average		
				1947	1950			1951
Com. x Bkhl.-Hd. Fed.	Wd. 43h2-329	Okla.	34	--	--	--	34	91
Fulcaster	6471	Kansas	34	--	--	--	34	91
Bkhl.-Oro x Paw.	Wd. 43h1-61	Okla.	34	--	--	--	34	92
Chey. x Tq.	11972	Kansas	34	--	--	--	34	92
Kan. x Hope-Hd. Fed.	12135	Colo.	34	--	--	--	34	92
Minhardi	5149	Minn.	34	--	--	--	34	92
Nanking No. 124	124364	China	34	--	--	--	34	92
(Kan. x Hd. Fed. x Tq.) x (Com. x Ks. Hope-Hussar) F ₈	1825-2	Kansas	--	--	91	--	91	93
Blue Jacket	12502	"	36	22	94	--	51	93
Tenmarq	6936	"	35	--	--	--	35	93
(Kan.-Hd. Fed. x Tq.) x (Com. x Hope-Hussar)	Stw. 516797	Okla.	--	--	--	45	45	93
Mqo.-Oro x Com.	Stw. 484243	"	--	20	97	--	59	93
Wich. x Mqo.-Oro	Wd. 487025	"	--	22	95	--	59	93
Med.-Hope x Med.	Tex. 97-38-7-2	Texas	--	24	94	--	59	94
(Med. 5993-23 x Hd. Fed.) x Hope- Med. 41-8-3)	Stw. 484254	Okla.	--	22	96	--	59	94
Quivira x (Kan.-Hd. Fed. x Pre- lude-Kan.)	12525	Kansas	--	--	92	--	92	94
Hard Federation Hybrid	12515	Okla.	--	--	92	--	92	94
Double Cross	12504	Texas	--	--	92	--	92	94
Quannah	12145	"	--	28	91	--	59	94
Sinv.-Wich. x Hope-Chey.	12701	"	--	25	93	47	55	94
Early Blackhull	8856	Kansas	32	--	95	--	64	94
Kaw.-Mqo. x Kaw.-Tq.	Ks. 2793	"	35	--	--	--	35	95
Mqo.-Oro x Paw.	Ks. 462676	"	--	22	97	--	60	95
Nanking No. 248	124316	China	35	--	--	--	35	95
Timstein x (Mqo.-Oro x Kan.-Tq.)	Stw. 516644	Okla.	--	--	--	46	46	95
Com. x Bkhl.-Hd. Fed.	12710	"	--	--	93	--	93	95
(Hope-Turkey x Turkey) x Com.	Wd. 487074	"	--	27	--	--	27	95
Ponca	12128	Ks. & Okla.	33	--	96	--	64	95
Mqo. x Oro x Eureka	Stw. 484282	Okla.	--	27	--	--	27	95
Med. Sel. x Hope-Med.	Tex. 98-40-118-5	Texas	--	27	--	--	27	95

Table 15.—Continued.

Variety or hybrid*	C.I., P.I., or selec- tion number	Source	Percent of leaves injured					Comparison with Pawnee
			Lawton 1947	Stillwater			Average	
				1950	1951	1952		
Bkhl.-Oro x Paw.	Wd. 43h1-86	Okla.	36	--	--	--	36	96
"	Wd. 43h1-94	"	36	--	--	--	36	96
Hope x Chey.	11969	Neb.	36	--	--	--	36	96
Kan. x Hope-Hd. Fed.	12136	Colo.	36	--	--	--	36	96
Kawvale	8180	Kansas	36	--	--	--	36	96
Kaw.-Mqo. x Kaw.-Tq.	12331	"	36	--	--	--	36	96
Red Chief	12109	"	36	--	95	--	65	96
Wich. x Mqo.-Oro	Wd. 487067	Okla.	--	25	96	--	60	96
Com. x Med.-Hope	12514	Texas	--	27	--	--	27	96
Blackhull	6251	Kansas	36	--	--	--	36	97
Chey. x Tq.	12104	"	36	--	--	--	36	97
Super Red	-----	"	36	--	--	--	36	97
Marquillo	6887	Minn.	36	--	--	--	36	97
Com. x Bkhl.-Hd. Fed.	Wd. 43h2-187	Okla.	--	--	95	--	95	98
Comanche	11673	Kansas	36	--	96	--	66	98
Wichita	11952	"	34	--	98	--	66	98
Mqo.-Oro x Pawnee	Ks. 462664	"	--	24	99	--	62	98
Concho	12517	Okla.	36	--	96	--	67	98
(Kan.-Hd. Fed. x Tq.) x (Com. x Hope-Hussar)	Ks. 1825-5	Kansas	--	--	96	--	96	98
Double Cross	12512	Texas	--	--	96	--	96	98
Nanking No. 158	124294	China	37	--	--	--	37	98
Nanking No. 221	124307	"	37	--	--	--	37	98
Triumph	12132	Okla.	38	--	95	--	67	99
Kaw.-Mqo. x Kaw.-Tq.	Stw. 484336	"	--	28	--	--	28	99
Mqo.-Oro x Pawnee	Ks. 462681	Kansas	--	28	--	--	28	99
Neb. 60 x Med.-Hope	12500	Neb.	--	28	--	--	28	99
Kiowa	12133	Kansas	37	--	--	--	37	99
Nanking No. 360	124332	China	37	--	--	--	37	99
Timstein x (Mqo.-Oro x Kaw.-Tq.)	Stw. 516604	Okla.	--	--	--	48	48	99
Westar	12110	Texas	39	--	96	--	67	100
Bkhl.-Oro x Paw.	Wd. 43h1-236	Okla.	37	--	--	--	37	100
Chey. x Bkhl.	12112	Neb.	37	--	--	--	37	100

Table 15.—Continued.

Variety or hybrid*	C.I., P.I., or selec- tion number	Source	Percent of leaves injured					Comparison with Pawnee
			Lawton	Stillwater			Average	
			1947	1950	1951	1952		
Pawnee	11669	Neb.	37	28	98	49	53	100
Timstein x (Mqo.-Oro x Kaw.-Tq.)	Stw. 516640	Okla.	--	--	--	49	49	100
Bkhl.-Oro x Paw.	12516	"	--	--	98	--	98	100
(Kan.-Hd. Fed. x Tq.) x (Com. x Hope-Hussar)	Stw. 516800	"	--	--	--	49	49	101
Chiefkan x Oro-Tq.	12134	Kansas	38	--	--	--	38	101
Mqo.-Oro x Paw.	12505	"	--	28	--	--	28	101
Bobin-Gaza-Bobin x Paw.	Stw. 516870	Okla.	--	--	--	49	49	101
Oro x Med.-Hope	12140	"	38	--	--	--	38	102
Apache	12122	Kansas	35	32	--	--	33	102
Mqo.-Oro x Paw.	12505	"	--	29	--	--	29	103
"	Ks. 484115	"	--	29	--	--	29	103
Kharkof	1442	Russia	38	--	--	--	38	103
Martin-Tq. x Chiefkan	12146	Texas	--	--	91	60	76	103
Cheyenne	8885	Neb.	39	--	--	--	39	105
Kan.-Hd. Fed. 254887 x Tq.			39	--	--	--	39	105
Nanking No. 22-14	124363	China	39	--	--	--	39	105
Rescue	12435	Canada	39	--	--	--	39	105
Med.-Hope x Fulcaster	Tex. 114-44-75	Texas	--	30	--	--	30	106
Bobin-Gaza-Bobin x Pawnee	Stw. 516847	Okla.	--	--	--	52	52	106
Bkhl.-Oro x Paw.	Wd. 43h1-297	"	40	--	--	--	40	106
Com. x Chey.-Bkhl.	12708	"	--	--	94	62	78	106
Minturki	6155	Minn.	40	--	--	--	40	107
Mqo.-Oro x Com.	Stw. 484233	Okla.	--	30	--	--	30	108
Moking	12556	Kansas	41	--	--	--	41	109
Martin-Tq. x Kharkof	12147	Texas	--	31	--	--	31	110
Med.-Hope x Fulcaster	Tex. 114-40-166-2	"	--	31	--	--	31	110
Chey. x Turkey	12142	Neb.	41	--	--	--	41	110
Tq. x Bkhl.	12126	Minn.	41	--	--	--	41	110
Chey. x Chiefkan	12129	Texas	41	--	--	--	41	111
Kaw.-Mqo. x Kaw.-Tq.	Stw. 484387	Okla.	--	31	--	--	31	111
Cimarron	12120	"	42	--	--	--	42	112
Bkhl.-Oro x Paw.	Wd. 43h1-98	"	42	--	--	--	42	112

Table 15.—Continued.

Variety or hybrid*	C.I., P.I., or selection number	Source	Percent of leaves injured				Comparison with Pawnee
			Lawton 1947	Stillwater		Average	
				1950	1951		
Hard Federation	4733	Australia	42	--	--	42	112
Mqo. x Oro	11978	Kansas	42	--	--	42	112
Martin x Tq.	50-37-92	Texas	42	--	--	42	112
Turkey	1558	Turkey	42	--	--	42	112
(Kan.-Hd. Fed. x Tq.) x (Com. x Hope-Hussar)	Stw. 516774	Okla.	--	--	--	56	114
Bobin-Gaza-Bobin x Paw.	Stw. 516858	"	--	--	--	56	115
Chey. x Early Bkhl.	12000	"	44	--	--	44	119
Nanking No. 68	124279	China	44	--	--	44	119
Timstein x (Mqo.-Oro x Kaw.-Tq.)	Stw. 516674	Okla.	--	--	--	58	119
Com. x Chey.-Bkhl.	Wd. 43h3-85	"	--	34	--	34	120
Mqo.-Oro x Pawnee	12851	Kansas	--	35	--	35	125
"	Ks. 45R2024	"	--	36	--	36	129
Med.-Hope x Fulcaster	Tex. 114-43-38	Texas	--	36	--	36	129
Mqo.-Oro x Paw.	Ks. 45R2027	Kansas	--	37	--	37	133
<i>Intergeneric Hybrids</i>							
Rye wheat	Wd. 44h4-14	Okla.	--	20	82	51	81
"	Wd. 44h4-9	"	--	23	--	23	83
"	Wd. 44h4-3	"	--	24	--	24	86
"	Wd. 44h4-19	"	--	20	95	57	91
"	Wd. 44h4-18	"	--	26	--	26	93
"	Wd. 44h4-20	"	--	27	--	27	95
Triticum x <i>A. elong.</i>	Ks. 46-4683	Kansas	--	27	--	27	96
"	Ks. 46-4708	"	--	27	--	27	96
Chinese rye x <i>A. elong.</i> x Fwd.	Ks. 46-411	"	--	29	--	29	103
Triticum- <i>A. elong.</i> x Pawnee F ₂	Stw. 515972	Okla.	--	--	--	59	121

* Abbreviations used in this table:

A. elong. = *Agropyron elongatum*

Bkhl. = Blackhull

Chey. = Cheyenne

Com. = Comanche

Fwd.

Hd. Fed.

Kan.

Kaw.

Med.

=

Forward

= Hard Federation

= Kanred

= Kawvale

= Mediterranean

Mqo.

Neb.

Sinv.

Tq.

Wich.

=

Marquillo

= Nebraska

= Sinvalocho

= Tenmarq

= Wichita

Table 16.—Greenbug injury to spring-seeded wheat varieties grown in unreplicated plots at Lawton, Okla., 1947.

Variety	C.I., P.I., or selection number	Source	Percent of leaves injured	Comparison with Pawnee (%)
Marquillo X Oro	42'RN2501	Kansas	26	70
Kawvale-Tenmarq X Comanche	12149	"	30	80
Turkey	12150	Colo.	30	80
Marquillo-Oro X Oro-Tenmarq	12406	Kansas	32	86
Marquillo X Oro	11851	"	35	94
Pawnee X Durum	94587	--	35	94
Chiefkan X Oro-Tenmarq	12148	Kansas	37	99
Marquillo X Oro	37FN634B	"	38	102
Red Chief X Marquillo-Oro F ₁	45FN1410	"	40	107
Composite Hybrid	12501	Neb.	45	121

Table 17.—Reaction of some of the more resistant varieties and hybrids of oats in order of tolerance to greenbugs in greenhouse tests at Stillwater, Okla., 1947-53.

Variety or hybrid*	C.I. or selec- tion no.	Preference		Tolerance		Growth factor	Fecundity	
		Green- bugs per plant (No.)	Comparison with Wintok (%)	Plant life (Days)	Comparison with Wintok (%)		Nymphs produced per female in 7 days (No.)	Comparison with Wintok (%)
Cherokee	3846	11	112	12	160	--	10	65
Camellia	4079	7	62	10	159	19	16	77
A-B x R-F	4673	10	107	11	151	--	12	76
Ukraine	3259	6	68	10	151	22	20	100
Abegweit	4970	7	73	9	149	23	20	100
Bannock	2592	6	74	9	147	8	19	96
Red Algerian	840	5	61	16	146	57	3	28
Calcutta	994	6	68	15	145	30	3	36
Nelson	4845	6	76	13	144	32	17	103
Uton	3141	7	90	10	144	33	20	99
Andrew	4170	8	86	10	141	--	14	90
Landhafer	3522	6	71	9	139	26	19	94
Hancock	3346	5	68	9	138	18	19	97
A-B x R-F	4674	8	88	10	138	--	14	86
Keystone	2146	6	70	9	137	30	20	100
Fleischman	5077	5	53	12	134	59	11	51
Black Algerian	3215	8	92	15	133	24	9	102
Bond x Rainbow	4253	8	85	10	132	--	13	82
Marion	3247	7	67	9	132	32	18	91
Green Mountain	1892	7	64	10	131	24	17	85
Taggart	4652	8	86	10	131	24	16	82
Westdale	3101	7	67	9	131	37	20	100
Fulgrain (Original)	3253	7	73	15	130	23	7	80
Richland	787	7	63	14	129	19	11	88
(Appler) Red Rustproof	1815	9	88	13	128	27	13	71
Storm King	1602	8	94	10	128	23	18	91
Ballidu	4497	10	101	9	127	--	15	93
Black Rival	807	7	82	12	126	6	12	81
Iogold	2329	7	59	12	126	33	12	93
Burt	2886	6	68	15	126	31	7	84

Table 17.—Continued.

Variety or hybrid*	C.I. or selection no.	Preference		Tolerance		Growth factor	Fecundity	
		Green- bugs per plant (No.)	Comparison with Wintok (%)	Plant life (Days)	Comparison with Wintok (%)		Nymphs produced per female in 7 days (No.)	Comparison with Wintok (%)
Clinton	3971	7	79	9	126	--	14	87
Enbaku	2854	5	48	10	126	33	14	67
Russian No. 77	2508	8	72	10	126	25	19	89
Bond	2733	5	59	15	125	38	5	53
Enbaku	2855	5	43	10	125	35	20	94
Belar	2760	8	93	15	123	42	5	61
Tartar King	1599	8	75	10	123	22	18	88
Coker No. 3	-----	--	--	20	123	--	12	104
Aida	4884	6	78	13	122	36	8	49
Frazier	2381	16	140	19	121	--	--	--
Cassel	2911	6	64	14	121	37	8	93
Kherson	459	7	65	11	121	16	15	114
Enbaku	2852	6	59	10	120	31	16	76
Marvelous	1999	8	85	9	119	21	20	98
Hobson	4842	8	75	11	119	17	10	63
Yakutsk	498	8	76	13	119	18	13	86
Santa Fe (Sept. 2)	4519	7	76	9	118	17	19	96
Fulmer	2912	6	63	13	118	19	10	111
Hozan Zairai	2858	5	48	9	118	35	18	84
White Oats	3463	7	93	9	118	23	19	93
Coast Black	1025	5	60	14	118	28	8	93
Black Tartar	3468	7	62	10	117	14	12	57
Hudson	1906	7	74	12	117	15	13	87
Oriental	1598	5	48	11	117	7	24	154
Early Red Rustproof	2823	8	89	14	117	17	9	97
Mexico 41-12	4908	6	71	12	117	25	16	97
Tobolsk	1709	6	64	13	117	11	13	85
Carton No. 5	1884	7	80	12	116	12	14	92
State Pride	1154	6	61	10	116	16	11	84
Tennessee 1922 x Bond-Iogold	4873	8	123	13	115	33	11	66
Black Mesdag	1877	7	90	13	114	42	9	85

Table 17.—Concluded.

Variety or hybrid*	C.I. or selec- tion no.	Preference		Tolerance		Growth factor	Fecundity	
		Green- bugs per plant (No.)	Comparison with Wintok (%)	Plant life (Days)	Comparison with Wintok (%)		Nymphs produced per female in 7 days (No.)	Comparison with Wintok (%)
Black Mogul	1074	7	88	13	114	44	11	102
Olney	4846	6	81	13	114	32	10	58
Navarro	966	8	88	13	112	15	5	57
Palestine	3600	9	123	12	112	26	8	48
Nakota	2883	5	48	13	111	18	8	86
Kanota	839	11	108	12	111	25	13	68
Neosho	4141	11	110	12	111	16	15	81
Klein 69-B	4118	8	72	11	110	42	11	68
Stanton Strain No. 1	3855	9	90	11	110	26	16	88
Kozan	3467	6	64	9	109	17	7	34
Tulun	4882	8	103	12	109	38	5	29
Astra	4887	6	87	12	109	44	8	46
Forkedeer	3170	14	132	12	106	--	13	81
Tennex	3169	13	121	12	106	--	15	97
Franklin	2892	8	91	12	105	25	5	44
New Nortex	3422	13	117	13	105	--	15	92
Nemaha	4301	10	105	7	100	--	13	81
Wintok (ck.)	3424	10	100	11	100	14	18	100
Traveler	4206	10	93	11	98	--	18	104
Vavilov	2465	5	48	11	98	7	10	116
DeSoto	3923	16	150	10	97	--	18	111
Fultex	3531	11	105	9	96	--	16	100

* Abbreviations used in this table: A-B = Anthony x Bond, R-F = Richland x Fulghum, and Tenn. = Tennessee.

Table 18.—Greenbug injury to spring-seeded oat varieties and hybrids in a natural infestation at Lawton and Stillwater, Okla., 1947 and 1950-52.

Variety or hybrid*	C.I. or selection number	Percent of leaves injured				Avg.	Comparison with Wintok (percent)
		Lawton	Stillwater				
		1947	1950	1951	1952		
Coastblack	1025	--	--	--	22	22	75
Winter Fulghum Selection	Stw. 462522	--	--	28	--	28	85
Andrew	4170	--	23	37	19	26	87
A-B X R-F	4673	--	24	--	--	24	88
Wintok Selection	Stw. 483143	--	--	30	26	28	89
Winter Fulghum Selection	Stw. 462546	--	--	30	--	30	90
"	Stw. 462567	--	--	30	--	30	90
Woodward Composite Selection	4829	--	--	28	30	29	94
Kanota	839	35	29	25	--	30	97
Forkedeer	3170	31	27	32	--	30	97
Frazier	2381	32	--	--	--	32	100
Wintok (check)	3424	32	27	33	29	30	100
Cherokee	3846	--	26	35	--	31	101
Tennex	3169	29	36	25	32	31	101
Arkansas 160	2502	32	--	--	--	32	101
Columbia	2820	32	--	--	--	32	101
Fulwin	3168	32	--	--	--	32	101
Woodward Composite Selection	4828	--	--	28	35	32	101
Letoria	3392	31	29	--	--	30	102
A-B X R-F	4674	--	24	33	35	31	102
Black Algerian	3215	--	28	--	--	28	103
Victorgrain	3692	33	--	--	--	33	103
Fulgrain Original	3253	--	23	38	33	31	105
Wintok Selection	Stw. 483136	--	--	35	--	35	105
Woodward Composite Selection	Wd. 3527-43-P8	--	--	35	--	35	105
"	Wd. 3527-43-P6	--	--	35	--	35	105
Fleischman	5077	--	--	--	31	31	106
Fulton	3327	32	31	--	--	31	106
Nemaha	4301	--	29	38	28	32	106
Traveler	4206	29	30	40	--	33	107
(Victoria X Hajira-Banner) X Fulghum-Victoria	Texas 73-44-46	--	--	--	32	32	109

Table 18.—Concluded.

Variety or hybrid*	C.I. or selection number	Percent of leaves injured				Avg.	Comparison with Wintok (percent)
		Lawton		Stillwater			
		1947	1950	1951	1952		
Osage	3991	32	34	--	--	33	110
Columbia X D69-Bond	4628	--	30	--	--	30	111
Lega	3379	36	31	--	--	33	113
Camellia	4079	--	25	43	--	34	113
Neosho	4141	30	33	42	--	35	113
Wintok (early selection)	5849	--	--	--	33	33	114
Fultex	3531	36	32	--	--	34	114
Wintok Selection	Stw. 483149	--	--	38	--	38	115
Bond	2733	--	30	40	--	35	115
Ventura	3989	36	32	--	--	34	115
Lelina	3404	32	37	--	--	35	117
Winter Fulghum	2500	38	--	--	--	38	118
Fulghum Coker No. 3	3666	38	--	--	--	38	119
De Soto	3923	33	27	50	--	37	119
Tama	3502	39	--	--	--	39	121
New Nortex	3422	36	36	--	--	36	121
Tennex X (Victoria X Hajira- Banner)	5113	--	--	41	--	41	123
Missouri 0-200	4626	--	34	--	--	34	123
Stanton Strain No. 1	3855	26	37	55	--	39	127
Winter Fulghum Selection	6570	--	--	--	37	37	129
Appler Red Rustproof	1815	32	30	60	--	41	132
Bond X Rainbow	4186	--	36	--	--	36	132
Belar	2760	--	25	60	36	40	134
Calcutta	994	--	--	45	--	45	135
Cimarron	5106	--	31	43	49	41	138
Le Conte	5107	--	--	47	--	47	140
Stanton Strain No. 2	4390	--	--	47	--	47	140
Stanton Strain No. 3	4543	--	--	47	--	47	140
Clinton	3971	--	25	60	--	43	141
Red Algerian	840	--	27	63	--	45	149
Andrew X Landhafer	5697	--	--	--	53	53	183

* Abbreviations used in this table: A-B = Anthony X Bond, and R-F = Rchland X Fulghum.

Table 19.—Greenbug injury to and yield of spring-seeded oat varieties grown under moderate infestation at Stillwater, Okla., 1952.

Variety	C.I. or selection number	Percent of leaves injured	Yield		Test weight	
			Bushels per acre	Rank	Pounds per bushel	Rank
Bond X Rainbow Selection	Stw. 477004	21	44	2	33	1
Clinton X Ventura	Stw. 476774	24	36	5	31	11
Clarion	5647	27	46	1	33	5
Sac X Hajira-Joanette	5927	30	36	6	33	3
Cherokee (check)	3846	32	27	13	31	12
Andrew (check)	4170	35	42	3	32	7
Kanota (check)	839	37	27	14	31	9
Andrew X Landhafer	5696	38	13	17	22	18
Neosho (check)	4141	38	24	15	30	15
(F ₁ Ventura X Camellia) X Clinton	5027	39	13	17	24	17
(Victoria-Hajira-Banner) X Fultex	Stw. 10509	39	21	16	31	9
Santa Fe X Clinton	5869	40	31	9	28	16
Nehaha (check)	4301	41	28	11	33	3
(Victoria-Hajira-Banner) X Fulghum-Victoria	Stw. 10506	43	34	7	31	8
(Victoria X Hajira-Banner) 5371 X Fulghum-Victoria	----	45	28	12	32	6
(Victoria-Hajira-Banner) X Fulghum-Victoria	Stw. 10503	45	36	4	33	1
(Victoria-Hajira-Banner) X Fulghum-Victoria	Stw. 10501	49	29	10	30	13
Cimarron (check)	5106	50	32	8	30	14