EVALUATION OF BARLEY VARIETIES FOR RESISTANCE TO THE CORN LEAF APHID, RHOPALOSIPHUM MAIDIS (FITCH)

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PREFACE

The author became interested in a study of the new concept of insect resistance in plants which is an economical method of biological control.

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INTRODUCTION

The corn leaf aphid, Rhopalosiphum maidis (Fitch), damages barley in Oklahoma in some years. This insect can be effectively controlled by spraying with parathion or other organic phosphorous compounds, but this method is not always practical. Barley is a crop of relatively low economic value, and the costs of insecticidal sprays are often prohibitive. Toxic residues sometimes remain on sprayed plants which create a hazard to livestock feeding on forage or grain, or to humans using barley products as food. Therefore, other means of controlling this pest of barley are needed.

Resistance to insects attacking small grains has been recognized for some time, but during recent years this phase of control has been more extensively studied. Varieties of barley, wheat and oats having resistance to the greenbug, Toxoptera graminum (Rond.), have been found, and this resistance has been transferred to hybrids by plant breeding. These facts suggested that there might be resistance to the corn leaf aphid in barley. Therefore a study involving the screening of barley varieties for corn leaf aphid resistant germ plasm was undertaken.

The author has been unable to find any references in the literature to screening tests designed to demonstrate the amount of corn leaf aphid resistance present in varieties of barley. The objective of this study was to determine sources of corn leaf aphid resistant germ plasm for use in developing resistant barley varieties.

REVIEW OF LITERATURE

Resistance of plants to insect attack has been known for more than 150 years. Extensive reviews of references on insect resistance in more than 100 plant species were given by Snelling (21, 22, 23) and Painter (15, 16). LePelley (12) stated that as early as 1831 George Lindley observed that the Winter Majetin apple was resistant to the woolly apple aphid, Eriosome lanigerum (Hausm.). Bioletti et al. (1) reported that certain grape stocks were resistant to the grape phylloxera, Phylloxera vitifoliae (Fitch). Painter (15, 19) discussed the economic value and biological significance of insect resistance in plants.

Small grains have been screened by many workers to find germ plasm resistant to insects. Dahms et al. (8) tested several hundred varieties and hybrids of small grains in search of resistance to the greenbug. Painter and Peters (17) reported that 2000 wheat strains tested were more susceptible to greenbugs than Pawnee, but about 4 percent carried some resistance. A single factor difference for resistance was indicated. Wood (26) screened 4600 wheat lines and found 19 varieties which showed a high degree of resistance to the greenbug.

Chada et al. (5) screened a large number of barley varieties for greenbug resistance. Among 1,230 winter and intermediate winter barleys, 76 were found with significant resistance. Among 4,445 spring-type barleys of the 6,174 varieties in the U.S.D.A. world collection, they reported 36 with resistance equal to or superior to that of Omugi. They also reported 74 oat varieties from the U.S.D.A. world oat collection

with resistance of significance.

Walton (24) found differences in reaction of barley varieties to greenbug infestation and also in their ability to recover from greenbug injury. Dahms and Wood (7) studied the reaction of barley varieties to the corn leaf aphid. They found that Colonial 2, C.I. 8062, possessed a high degree of resistance and Omugi, C.I. 5144 was very susceptible.

The first detailed inheritance studied on insect resistance in small grains was reported by Cartwright and Wiebe (2) in 1936. They concluded that Dawson wheat, the Hessian fly resistant variety, had two dominant factors for resistance which are complimentary and perhaps cumulative. Since then many reports on Hessian fly resistance in wheat by these and other workers have appeared in the literature.

Gardenhire and Chada (11) found in studying the inheritance of greenbug resistance in barley that resistance was derived from the same or closely linked genes. The symbol Grb grb had been assigned previously for this genetic character (McDonald (14), Dahms et al. (8)).

Curtis et al. (6) found that resistance in 2 wheat strains is conditioned by a single recessive gene pair designated as gbgb, common to both strains.

The corn leaf aphid, Rhopalosiphum maidis (Fitch), was first described by Dr. Asa Fitch (10). The injury caused in corn was also described. Davis (9) reported that this aphid has always been considered a serious pest of corn, sorghum, and broom corn.

This aphid has a worldwide distribution and is found in all areas of the United States where corn and sorghum are grown. McColloch (13) estimated that the feeding by this insect could cause a 53% loss in seed weight of Kafir sorghum. Wildermuth and Walter (25) reported that this

species was the most serious pest of barley in the southwestern United States.

Snelling et al. (21) stated that the corn leaf aphid is an especially serious problem in the production of foundation hybrid seed corn. They indicated the possibility of reducing injury through the use of resistant selections.

Dahms and Wood (7) reported that this aphid had caused severe damage to barley in Kansas, Oklahoma and Texas. Painter (18) stated that the corn leaf aphid is one of the major pests of corn, sorghum and barley, and that damage to the plant is due to the constant drainage of the plant liquids through feeding.

The previous studies on resistance of small grains to the greenbug provided knowledge regarding procedures and techniques to follow in searching for corn leaf aphid resistance in barley.

METHODS AND MATERIALS

The technique followed for studying resistance of barleys to the corn leaf aphid was similar to that described by Dahms et al. (8), Chada (4) and Wood (27) with modifications. Aphid cultures were maintained in the greenhouse on young RS-610 sorghum plants grown in 6-inch pots. Seven days after emergence the sorghum plants were infested with corn leaf aphids and confined in cylindrical cages constructed from .020-inch transparent cellulose nitrate plastic sheets. One end of the cage was closed with coarse muslin to confine the aphids and the other end was placed in the soil around the plants (Fig. 1.).

Seeds of all the barley varieties and hybrids used in these tests were obtained from the following sources: Agronomy Department, Oklahoma Agricultural Experiment Station - 132 varieties; Denton Substation, Texas Agricultural Experiment Station - 82 varieties; and Kansas Agricultural Experiment Station - 16 varieties. Many of the Oklahoma, the Kansas, and all of the Texas varieties and hybrids were greenbug-resistant. Also, 1,295 winter barleys were received from the Barley World Collection, Crops Research Division, U. S. Department of Agriculture. Tests were completed on 704 of these.

Barley varieties to be evaluated were seeded in rows in 21x17x4-inch flats. Each flat had 10 varieties consisting of 8 test varieties and one resistant (Colonial 2) and one susceptible (Omugi) check, with 10 plants of each variety as shown in figure 2. The soil mixture used was 4 parts of Reinach sandy loam and 1 part each of sand, peat moss,

and manure. To prevent plant infection from soil organisms the soil was sterilized in an autoclave for 24 hours under a pressure of 10 pounds per square inch.

A commercial fertilizer, Hyponex[1], was added to the soil at the rate of 1 tablespoon per gallon of water and each flat was thoroughly watered.

At plant emergence, the plants were infested with corn leaf aphids by placing heavily infested sorghum clippings in each flat.

After the susceptible check plants had sustained severe damage, each variety was rated periodically using the number system described by Dahms et al. (8) which measures tolerance according to the estimated percentage of leaf damage:

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

The number of days from the date of infestation until a rating of 5 was obtained was the criterion used for tolerance.

As barley plants require an extremely heavy infestation of corn leaf aphids before noticeable damage occurs, it became necessary to clip the plants several times throughout the experiment thus weakening them and reducing the surface area per aphid. Large numbers of

[1]Hyponex: Nitrogen-7%, Phosphoric acid-6%, Water soluble potash-19%, Chlorine-.05%. Hydroponic Chemical Co., Inc., Copley, Ohio.

the aphids were parasitized by the hymenopteron, Aphidius testaceipes (Cress). These were partially controlled by crushing the parasitized "mummies" with forceps and shielding the infested plants with muslin cages.

The adult parasites were also effectively controlled by using a wet bait made of 50% honey and .05% Dibrom applied to plastic sheets. These were suspended in the cages and in the greenhouse room where the tests were being conducted.

Mold and powdery mildew also became a serious problem due to the warm temperature and high humidity. Applications of fungicides such as sulphur, copper sulphate and Captan were very effective in eliminating fungal growth.

EXPERIMENTAL RESULTS

The first screening test for resistance to the corn leaf aphid involved 121 barley varieties obtained from the Agronomy Department, Oklahoma Agricultural Experiment Station. These were planted June 9, 1961, and the seedlings were infested 3 days after emergence. As the initial infestation was not satisfactory, the flats were reinfested 4 days later. The first injury ratings were made 24 days after infestation when the damage to the susceptible check plants showed an average rating of 3 as shown in figures 3 and 4. Subsequent ratings were made every 4 days. After the fourth rating, the susceptible check and most of the test varieties were damaged almost beyond recovery. However, some showed resistance and survived. Results of this test were presented in table 1.

The tolerance rating of Colonial 2, the resistant check in each flat, averaged 2 after infestation for 36 days. The susceptible check, Omugi, and many of the test varieties were injured beyond recovery after 36 days of infestation (Fig. 5).

Those varieties in the rating range 0-3 were considered as resistant and were used for further testing. Those with a rating above 3 were discarded because of susceptibility.

Varieties indicated by an asterisk in table 1 were considered as having resistance of significance and were retested. A retest of varieties showing significant resistance in the first retest was also made. In this test each flat contained 5 test varieties in addition

to the susceptible variety, Omugi, seeded in alternate rows (Fig. 6). In both retests the infestation was considerably heavier than in the original test. This heavier infestation was more severe, and the ratings had to be made at an earlier date than in the first test. Results of these two retests are presented in table 2.

On the basis of the data on the reaction of the barley varieties to the corn leaf aphid in the first and the second retests, the test varieties were grouped according to their degree of resistance. These data are presented in table 3. Seven of the test varieties had a high degree of resistance equal to that of Colonial 2. Seven had moderate resistance which was slightly less than that of Colonial 2. Those varieties having a low degree of resistance were so rated because they survived infestation when the susceptible check Omugi in the same flat was killed.

A study was made to determine the mechanism involved in resistance of barley to the corn leaf aphid. Counts of progenies resulting from uniform initial infestations on 79 susceptible Omugi and 79 resistant Colonial 2 plants were made 14 days after infestation. Table 4 shows a comparison of aphid numbers on susceptible Omugi and resistant Colonial 2. There were fewer corn leaf aphids on Omugi (86.3) than on Colonial 2 (102.5). This indicates that the mechanism of resistance was tolerance and not antibiosis. When the infestations were allowed to develop for 36 days on Omugi, 100 percent mortality resulted. However, Colonial 2 plants showed little evidence of injury even though they remained heavily infested.

DISCUSSION

Painter (17) stated that the primary problem in any study of insect resistance in plants is the finding of plant varieties that are sources of resistance. Several methods of screening small grains for resistance to the greenbug have been reported (4, 8, 27). These methods evaluated resistance as measured by preference, fecundity, tolerance and antibiosis. No intensive report on the insectary problems involved was made but Chada (4) suggested that in a controlled-environment insectary, having a year-round average temperature of 75°F., it is possible to conduct tests throughout the year. In an ordinary greenhouse, however, major difficulties are often encountered, such as: (1) parasitization of aphids by small hymenopterons; (2) extreme variations of temperature and humidity; (3) interference with normal plant growth by molds, fungi and diseases; and (4) aphid diseases.

In the corn leaf aphid resistant studies of barley reported here an initial screening was made on 121 varieties including many that are resistant to the greenbug, commercial varieties and new strains showing agronomic promise. Many varieties of the greenbug resistant lines were also resistant to the corn leaf aphid and some were susceptible. For example, Omugi, C.I. 5144, was highly resistant to the greenbug but very susceptible to the corn leaf aphid, while Colonial 2, C.I. 8062, was susceptible to the greenbug but highly resistant to the corn leaf aphid. The three hybrids of Rogers x Kearney, C.I. 10879, 10880, and 10881, were highly resistant to both greenbug and corn leaf aphid (Fig. 7).

However, nothing is known about the heredity of corn leaf aphid resistance.

The present studies indicate that antibiosis was not a factor in the resistance of barley to the corn leaf aphid, since pupulations were higher on the resistant varieties. In contrast, the work of several authors indicates antibiosis is responsible for resistance of small grains to the Hessian fly. The growing of resistant varieties has reduced the overall fly population to the extent that Hessian fly damage has been greatly reduced even on susceptible varieties.

In similar studies with wheat, barley and oats several workers reported that one of the mechanisms involved in resistance to the greenbug was antibiosis. Chada (5) found in insectary studies that the average progeny of a single female greenbug on Omugi[1] barley after 7 days was 6, whereas, on susceptible Wintex it was 20. Dahms et al. (8) in greenhouse studies reported similar results with resistant and susceptible barley varieties.

As a result of the present studies on the resistance of barleys to the corn leaf aphid, varieties possessing resistant germ plasm are now available to plant breeders for use in developing resistant hybrids. The discovery of quite marked resistance in selections of the Rogers x Kearney cross may be of importance to farmers in the event one or more of these are released. They also have the greenbug resistance and winter hardiness of Kearney. Selections C.I. 10879 and 10880 also have considerable mildew resistance (Smith et al., 20).

These studies provide additional tools for use in determining the

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[1]This variety is highly resistant to greenbugs, susceptible to corn leaf aphids.

mechanism of resistance to aphid attack. Varieties are now recognized which possess a high degree of resistance to the greenbug and little resistance to the corn leaf aphid; the converse, or resistance to the corn leaf aphid without resistance to the greenbug is also present. In addition, varieties have been identified which are resistant to both aphids. By a proper study of these three types of resistant plants, much may be learned concerning the mechanisms of resistance. If resistance could be associated with some definite plant character, plant breeders could breed for that character and develop resistant hybrids more easily.

Further research should be conducted on the mode of inheritance of corn leaf aphid resistance in barley, and on the factor or factors responsible for resistance. Continued cooperation between entomologists and plant breeders should speed this work.

SUMMARY AND CONCLUSIONS

Screening of barley varieties for resistance to the corn leaf aphid was performed in the greenhouse during the summer and fall of 1961. A total of 121 barley lines, consisting mostly of greenbug resistant lines, commercial varieties and hybrids were tested. Of this number, seven have been found which possess a high degree of resistance equal to that of Colonial 2, the most resistant variety previously reported. They include Davie, C.I. 9170; Rogers, C.I. 9174; N.C. 392, C.I. 10537; Decatur, C.I. 10546; and the following three Rogers x Kearney strains, C.I. 10879, C.I. 10880, and C.I. 10881. Seven had moderate resistance which was slightly less than that of Colonial 2 and twenty had a low degree of resistance. The last three hybrids in the highly resistant group, all varieties in the moderate, and many in the low resistance group are also greenbug resistant. Since many of the above lines were highly susceptible to the greenbug, it is assumed that greenbug resistance and corn leaf aphid resistance are not controlled by the same genetic mechanism.

Another study was made to determine the mechanism involved in resistance of barley to the corn leaf aphid. Counts of progenies resulting from uniform initial infestations on 79 susceptible Omugi and 79 resistant Colonial 2 plants were made 14 days after infestation. The average number of the aphids per plant on Omugi was 86.3, whereas, for Colonial 2 it was 102.5.

The fact that resistant Colonial 2 had a larger population of aphids than did susceptible Omugi, and yet showed little damage,

indicated that the mechanism involved was a high degree of tolerance. Tolerance is also the principal mechanism of greenbug resistance, although antibiosis is more of a factor than in the case of barley resistance to the corn leaf aphid. Greenbug fecundity is much lower on resistant than susceptible varieties, and the greenbugs are smaller in size after feeding on resistant varieties for successive generations.

LITERATURE CITED

1. Bioletti, F. T., F. C. H. Flossfeder, and A. E. Way. 1921. Phylloxera resistant stocks. Calif. Agric. Expt. Sta. Bull. 331, 139 pp.

2. Cartwright, W. B., and G. A. Wiebe. 1936. Inheritance of resistance to the Hessian fly in the wheat crosses Dawson x Poso and Dawson x Big Club. Jour. Agric. Res. 52: 691-695.

3. Chada, Harvey L. 1958. Greenbug resistance in winter and intermediate growth habit types of barley. Special Report W-93, USDA, ARS, Ent. Res. Div.

4. Chada, Harvey L. 1959. Insectary technique for testing the resistance of small grains to the greenbug. Jour. Econ. Ent. 52: 276-279.

5. Chada, Harvey L., I. M. Atkins, J. H. Gardenhire and D. E. Weibel. 1961. Greenbug-resistance studies with small grains. Texas Agric. Expt. Sta. Bull. 982, 18 pp.

6. Curtis, B. C., A. M. Schlehuber, and E. A. Wood, Jr. 1960. Genetics of greenbug, Toxoptera graminum (Rond.) resistance in two strains of common wheat. Agron. Jour. 52: 599-602.

7. Dahms, R. G. and E. A. Wood, Jr. 1954. Reaction of barley varieties to the corn leaf aphid, Rhopalosiphum maidis (Fitch). Special Report W-44. USDA, ARS, Ent. Res. Div.

8. Dahms, R. G., T. H. Johnston, A. M. Schlehuber and E. A. Wood, Jr. 1955. Reaction of small grain varieties and hybrids to greenbug attack. Oklahoma Agric. Expt. Sta. Tech. Bull. T-55, 61 pp.

9. Davis, John J. 1909. Biological studies on three species of aphidae. USDA Bur. of Ent., Tech. Series No. 12, Part VII. pp. 144-151.

10. Fitch, Asa. 1856. The maise aphis, Aphis maidis, n. sp. second report, Ins. New York State, Albany, pp. 318-320.

11. Gardenhire, James H., and Harvey L. Chada. 1961. The inheritance of greenbug resistance in barley. Crop Sci. 1: 349-352.

12. Le Pelley, R. 1927. Studies on the resistance of apple to the woolly aphis, Eriosoma lanigerum (Hausm.). Jour. Pomol. and Hort. Sci. 6: 209-241.

13. McColloch, J. W. 1921. The corn leaf aphis, Aphis maidis (Fitch) in Kansas. Jour. Econ. Ent. 14: 89-94.

14. McDonald, W. H. Jr. 1952. Inheritance of resistance to the greenbug, Toxoptera graminum (Rond.) in winter barley hybrids. Master Thesis, Oklahoma State University, 64 pp.

15. Painter, R. H. 1941. The economic value and biologic significance of insect resistance in plants. Jour. Econ. Ent. 34: 358-367.

16. Painter, R. H. 1951. Insect resistance in crop plants. The Macmillan Co., New York. 520 pp.

17. Painter, R. H., and O. C. Peters. 1956. Screening wheat varieties and hybrids for resistance to the greenbug. Jour. Econ. Ent. 49: 546-548.

18. Painter, R. H. 1958. Effect of the feeding of the four biotypes of corn leaf aphid, Rhopalosiphum maidis (Fitch) on susceptible White Martin sorghum and Spartan barley plants. Jour. Kansas Ent. Soc. 31: 93-100.

19. Painter, R. H. 1958a. Resistance of plants to insects. Ann. Rev. of Ent. 3: 267-290.

20. Smith, Olin D., A. M. Schlehuber and B. C. Curtis. 1961. Winter barley variety tests - Progress Report, 1960. Processed Series P-373. Oklahoma Agric. Expt. Sta.

21. Snelling, R. O., R. A. Blanchard and J. H. Bigger. 1940. Resistance of corn strains to the leaf aphid, Aphis maidis (Fitch). Amer. Soc. Agric. Jour. 32: 371-381.

22. Snelling, R. O. 1941. The place and methods of breeding for resistance in cultivated plants. Jour. Econ. Ent. 34: 335-340.

23. Snelling, R. O. 1941a. Resistance of plants to insect attack. Bot. Rev. 7: 543-586.

24. Walton, R. R. 1944. Greenbug injury on barley varieties at Woodward Oklahoma in 1943. Proc. Oklahoma Acad. Sci. 24: 38-42.

25. Wildermuth, V. L. and E. V. Walter. 1932. Biology and control of the corn leaf aphid with special reference to the southwestern states. USDA, Tech. Bull. 306.

26. Wood, E. A., Jr. 1958. Resistance of small grains to the greenbug. Special Report W-91. USDA, ARS, Ent. Res. Div.

27. Wood, E. A., Jr. 1961. Description and results of a new greenhouse technique for evaluating tolerance of small grains to the greenbug. Jour. Econ. Ent. 54: 303-305.

A P P E N D I X

Table 1. Reaction of 121 barley varieties and hybrids to corn leaf aphid infestation in the preliminary test.

Entry Number	Variety	C. I. or Selection Number	Injury Ratings Days after infestation 24	28	32	36
1	Davie	9170	2	2	2	2*
2	Cordova	7576	3	3	4	5
3	Rogers	9174	2	2	2	3*
4	Pace	9566	2	2	3	4
5	Marconee	8107	3	3	3	4
6	Dayton	9517	2	3	3	4
7	Hudson	8067	2	3	3	4
8	Taylor's y635	10528	3	3	4	5
9	N-C-392	10537	2	2	2	2*
10	Kenate	9570	3	4	4	5
11	Kenbar	7574	3	4	4	5
12	Oma	9569	2	2	3	3*
13	Tenkow	646	2	3	3	4
14	Tenn. upright 97-10-1	9543	2	3	3	4
15	Decatur	10546	1	1	2	2*
16	OAC G.H.	10435	2	2	3	3*
17	Ky 51-5752	10541	3	3	4	4
18	Chase	9581	3	4	4	5
19	Kentucky 1	6050	3	3	4	5
20	Ky 55-63	10432	2	2	2	3*
21	Mo. B. 1108	10664	2	2	2	3*
22	Nebr.52436	10656	3	3	3	4
23	Mo. B. 1131	10536	3	3	3	4
24	Va.59-37-3	10658	3	3	3	4
25	Purd. B. 466A7-7-3-3-2	10437	4	5	5	5
26	Purd. 3446A7-14	10545	4	5	5	5
27	Mo. B. 475	9168	2	3	3	3*
28	Reno	6561	2	3	4	5
29	Purd. B 446A7-7-2-2	10666	3	4	4	5
30	Harbine	7524	2	3	3	3*
31	MEB x Texas	9565	2	3	3	4
32	Ward	6007	2	3	4	5
33	Rogers x Kearney	10879	2	2	2	2*
34	Rogers x Kearney	10881	2	2	2	2*
35	Rogers x Kearney	10880	2	2	2	2*
36	Cordova x Omugi	41-54-716	3	3	4	4
37	Tex. 48-53-25	10662	3	3	3	3*
38	Wong	6728	3	3	3	4
39	Athens, Ga. 8	10434	2	3	3	3*
40	Tex. 46-54-68	10661	3	3	3	4
41	Tex. 41-54-757	10660	3	4	4	5
42	Va. 59-40-25	10659	3	4	4	5
43	Mo. B 1055	10534	3	3	4	5
44	Mo. B 1056	10431	3	3	3	4
45	Kyo-bae 35	7418	3	3	4	4

Table 1. Continued.

Entry Number	Variety	C.I. or Selection Number	Injury Ratings Days after infestation 24	28	32	36
46	Unnamed	7530	3	3	3	4
47	Unnamed	7529	3	3	3	4
48	Chang-Mang-Ryuc Kao	7409	3	3	3	4
49	Suwon 3	7428	2	3	3	3*
50	Unnamed	9224	3	3	3	4
51	Ward x Ward-Omugi	10531	4	4	4	5
52	Unnamed	4291-2	3	3	4	5
53	Chae-Rae-Chang	7408	3	4	4	5
54	Shokum	5233	3	4	4	5
55	Unnamed	7098	3	4	4	5
56	Yun-Wol-Rync-Kao	7458	3	4	4	4
57	Unnamed	5569	3	3	3	4
58	Rogers x Kearney	10880[1]	2	2	3	3*
59	Purd. B. 466A1-12-16	9574	3	4	5	5
60	Suwon 31	7453	1	2	2	2
61	Unnamed	9318	3	3	4	4
62	Suwon 31	7454	1	2	3	3*
63	Unnamed	9350	4	4	4	5
64	Unnamed	9349	3	3	3	4
65	Unnamed	9344	3	3	3	4
66	Suwon 15	7443	1	2	2	3*
67	Unnamed	9347	3	4	4	4
68	Unnamed	9354	3	3	3	4
69	White Russian	706	2	3	3	3*
70	Unnamed	4300	2	3	3	3*
71	Unnamed	7294	2	3	3	3*
72	Unnamed	9223	3	3	3	3*
73	Suwon 3	7428	2	3	3	3*
74	Caucasus	4334	2	3	3	3*
75	Hoku	5179	3	4	4	4
76	Unnamed	9352	3	4	4	4
77	Unnamed	4299-1	3	4	4	5
78	Chae-Rae-Chang	7407	3	4	4	4
79	Donjon	1264	2	3	3	3*
80	Dicktoo	5529	3	3	3	4
81	Unnamed	4290	2	3	3	3*
82	Mammoat	7420	2	3	3	3*
83	Unnamed	9226	2	3	3	3*
84	Unnamed	4326-2	3	4	4	4
85	Unnamed	9355	3	3	4	4
86	Suwon 13	7440	1	2	2	3*
87	Kyong-Nam 89	7419	2	2	2	3*
88	Suwon 29	7451	2	2	2	3*
89	Kido	5145	2	2	2	3*
90	Chae-Rae-Bao	7406	2	3	3	3*
91	Popeline	704	2	3	3	4

Table 1. Continued.

Entry Number	Variety	C.I. or Selection Number	Injury Ratings Days after infestation 24	28	32	36
92	Unnamed	4331	2	2	3	3*
93	Abyssinian Winter	2513	2	2	3	3*
94	Unnamed	4333	2	3	3	3*
95	Unnamed	4332	3	3	3	4
96	Unnamed	9230	3	3	3	4
97	Unnamed	4336	3	3	3	4
98	Unnamed	9319	3	3	3	4
99	Unnamed	4335	3	3	3	4
100	Nandomugi	5254	2	3	3	4
101	Unnamed	3357	3	3	3	4
102	Black Russian	2202	3	3	3	4
103	Unnamed	9450	2	3	3	3*
104	Raishu	5214	2	3	3	3*
105	Unnamed	4335-1	2	3	3	3*
106	Unnamed	9225	3	3	3	4
107	Unnamed	6683	3	3	3	4
108	Unnamed	2349	2	3	3	4
109	Unnamed	2350	2	3	3	4
110	Unnamed	9581	2	3	3	4
111	Abyssinian	1230	2	3	3	4
112	Unnamed	1231	1	1	2	2*
113	Zairai	5153	2	2	3	3*
114	Unnamed	7081	2	3	3	4
115	Unnamed	9516	3	3	4	4
116	Unnamed	10263	3	3	4	4
117	Mecca	1051	3	3	4	4
118	Samas	2272	2	3	3	4
119	Wanampipe	2356	2	3	3	3*
120	Dobaku	5238	2	3	3	3*
121	Kearney	7580	2	2	3	3*
	Omugi	5144	3.2	3.8	4.1	4.8[2]
	Colonial 2	8062	0.7	1.1	1.3	1.3[2]

*Selected for rescreening.

[1]This variety was twice included in the test but from 2 different sources. Source of seed may partially account for the different reactions.

[2]Average rating of 15 rows of Omugi and Colonial 2.

Table 2. The reaction of barley varieties selected for resistance to the corn leaf aphid when retested.

Entry Number	Variety	C. I. or Selection Number	Injury Rating: First Retest, Days after Infestation 20	24	28	32	Second Retest, Days after Infestation 20	24	28	32
1	Davie	9170	1	1	2	2	1	1	1	2
3	Rogers	9174	1	2	2	2	1	2	2	2
9	N.C. 392	10537	2	2	2	2	1	2	2	2
12	Oma	9569	2	3	3	4	2	2	3	3
15	Decatur	10546	1	1	2	2	1	1	2	2
16	OAC G.H.	10435	3	3	4	5	-	-	-	-
20	Ky 55-63	10432	2	3	3	4	-	-	-	-
21	Mo. B. 1108	10664	2	3	4	4	-	-	-	-
27	Mo. B. 475	9168	3	3	3	4	-	-	-	-
30	Harbine	7524	2	3	3	3	2	3	3	4
33	Rogers x Kearney	10879	1	1	2	2	1	1	2	2
34	Rogers x Kearney	10881	1	1	2	2	1	1	2	2
35	Rogers x Kearney	10880	1	1	2	2	1	1	2	2
39	Athens, Ga. 8	10434	2	3	3	3	2	3	3	4
49	Suwon 3	7428	2	3	3	3	2	3	3	4
58	Rogers x Kearney	10880	2	2	2	3	2	2	3	3
60	Suwon 31	7453	2	2	3	3	2	2	3	3
62	Suwon 31	7454	2	2	3	3	2	2	3	3
66	Suwon 15	7443	2	2	2	3	2	2	2	3
69	White Russian	706	3	3	3	4	-	-	-	-
70	Unnamed	4300	2	3	3	3	2	3	3	4
71	Unnamed	7294	3	3	3	3	2	3	3	4
72	Unnamed	9223	2	2	3	3	2	2	3	3
73	Suwon 3	7428	2	3	3	3	2	3	3	4
74	Caucasus	4334	3	3	3	4	-	-	-	-
79	Donjon	1264	2	3	3	4	-	-	-	-
81	Unnamed	4290	3	3	3	4	-	-	-	-
82	Mammoat	7420	3	3	4	4	-	-	-	-
83	Unnamed	9226	3	3	4	4	-	-	-	-
86	Suwon 13	7440	2	2	3	3	2	2	2	3
87	Kyong-Nam 89	8419	3	3	3	3	2	3	3	4
88	Suwon 29	7451	3	3	3	4	-	-	-	-
89	Kido	5145	2	3	4	4	-	-	-	-
90	Chae-Rae-Bao	7406	4	5	5	5	-	-	-	-
92	Unnamed	4331	2	3	3	3	2	3	3	4
93	Abyssinian Winter	2513	2	3	3	3	2	3	3	4
94	Unnamed	4333	3	3	3	3	2	3	3	4
103	Unnamed	9450	4	4	4	5	-	-	-	-
104	Raishu	5214	3	3	4	4	-	-	-	-
105	Unnamed	4335-1	3	3	3	4	-	-	-	-
112	Unnamed	1231	2	2	2	3	2	2	3	3
113	Zairai	5153	3	3	4	5	-	-	-	-
119	Wanampipe	2356	3	3	4	4	-	-	-	-

Table 2. Continued

Entry Number	Variety	C. I. or Selection Number	Injury Rating: First Retest, Days after Infestation: 20	24	28	32	Second Retest, Days after Infestation: 20	24	28	32
120	Dobaku	5238	2	3	3	4	-	-	-	-
121	Kearney	7580	2	3	4	4	-	-	-	-
	Omugi	5144	3.5	4	4.3	5[1]				
	Colonial 2	8062	1	1.5	2	2[1]				

[1]Average rating of 6 rows.

Table 3. Evaluation of degree of resistance of barley varieties and hybrids.

Entry Number	Variety	C. I. or Selection Number	Average[1] Injury Ratings	Degree of Resistance[2]
	Colonial 2 (Resistant check)		2.0	High
1	Davie	9170	2.0	"
15	Decatur	10546	2.0	"
33	Rogers x Kearney	10879	2.0	"
34	Rogers x Kearney	10881	2.0	"
35	Rogers x Kearney	10880	2.0	"
3	Rogers	9174	2.0	"
9	N.C. 392	10537	2.0	"
58	Rogers x Kearney	10880[3]	3.0	Moderate
86	Suwon 15	7440	3.0	"
112	Unnamed	1231	3.0	"
60	Suwon 31	7453	3.0	"
62	Suwon 31	7454	3.0	"
66	Suwon 15	7443	3.0	"
72	Unnamed	9223	3.0	"
12	Oma	9569	3.5	Low
30	Harbine	7524	3.5	"
39	Athens, Ga. 8	10434	3.5	"
70	Unnamed	4300	3.5	"
73	Suwon 3	7428	3.5	"
92	Unnamed	4331	3.5	"
93	Abyssinian	2513	3.5	"
71	Unnamed	7294	3.5	"
87	Kyong-Nam 89	7419	3.5	"
94	Unnamed	4333	3.5	"
20	Ky 55-63	10432	4.0	"
88	Suwon 29	7451	4.0	"
120	Dobaku	5238	4.0	"
21	Mo. B. 1108	10664	4.0	"
27	Mo. B. 475	9168	4.0	"
74	Caucasus	4334	4.0	"
81	Unnamed	4290	4.0	"
89	Kido	5145	4.0	"
105	Unnamed	4335-1	4.0	"
121	Kearney	7580	4.0	"

[1]Average rating of first and second retests after infestation for 32 days.
[2]High - 1,2; Moderate - 3; Low - 3.5 and above.
[3]See footnote (1) on Table 1.

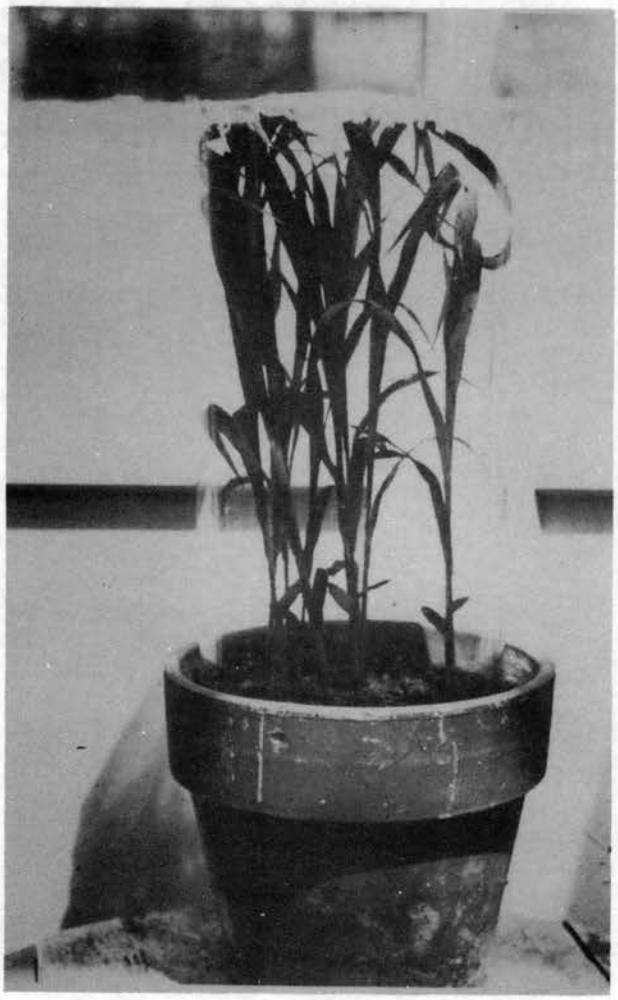

Figure 1. Caged RS-610 grain sorghum plants used to culture corn leaf aphids.

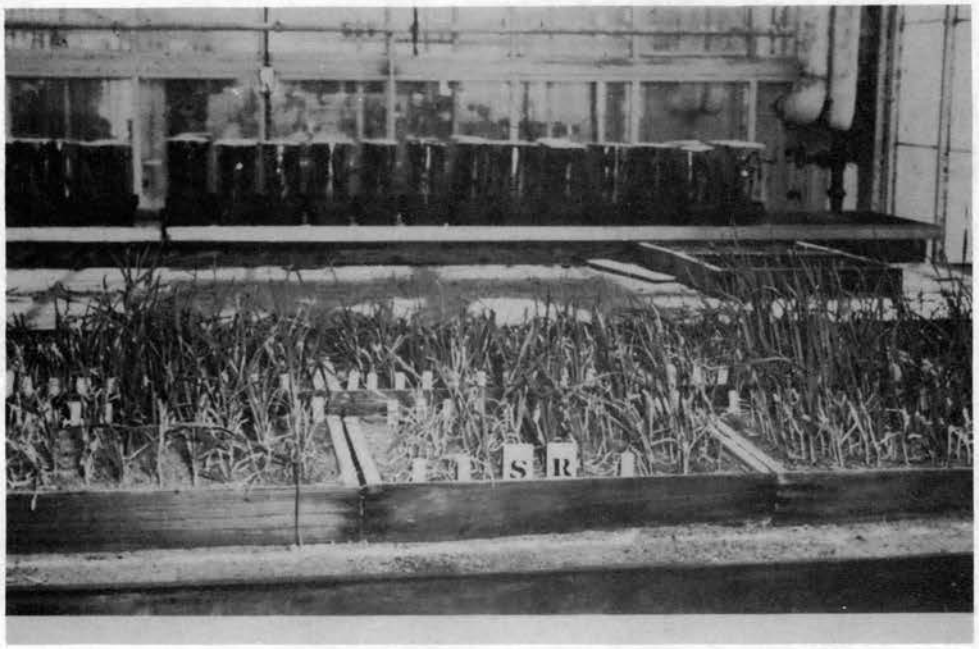

Figure 2. General view of the test varieties in the greenhouse. S and R indicate susceptible and resistant checks. Test varieties are indicated by small stake labels. Caged, potted plants in background contain corn leaf aphid cultures.

Figure 3. Reaction of barley varieties to the corn leaf aphid after infestation for 24 days. Resistant Colonial 2 (R) was green and showed little damage. Susceptible Omugi (S) and test varieties were yellowed and stunted.

Figure 4. Reaction of barleys to corn leaf aphid after infestation for 24 days. From left to right, Purd. B. 466 A7-7-3-3-2, Purd 3446 A7-14, Mo. B. 475, susceptible Omugi (S), resistant Colonial 2 (R), Reno, Purd. B. 446 A7-7-2-2, Harbine, MEB x Texan and Ward.

Figure 5. Reaction of barleys to corn leaf aphid infestation after 36 days. Resistant Colonial 2 (R) showed little damage in spite of being heavily infested, but susceptible Omugi (S) was dead. Test varieties show varying degrees of damage.

Figure 6. Survival of corn leaf aphid resistant barley varieties after infestation for 55 days. Susceptible Omugi in alternate rows (B,D,F,H, and J) was killed. Davie (A), Rogers (C), N.C. 392 (E), Decatur (G), and Rogers x Kearney C.I. 10879 (I), were resistant and survived.

Figure 7. Reaction of Rogers x Kearney hybrids and the parents to corn leaf aphid infestation after 50 days. (A)C.I. 10879, (C) C.I. 10881, and (E) C.I. 10880 selections of Rogers x Kearney cross. (H) Kearney and (J) Rogers, parents. Alternate rows B,D,F,G, and I, are Omugi check rows which were killed. Kearney (H), which had low resistance when initially infested, survived and made rapid recovery in growth by the end of 50 days.

VITA

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