NON-CULTIVATED GRASS HOSTS OF BIOTYPES OF CORN LEAF APHID, *Rhopalosiphum maidis* (Fitch), APHIDIDAE, HOMOPTERA

by

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INTRODUCTION

In this study an attempt was made to undertake positive identification of as many as possible of the wild or non-cultivated grass hosts of the corn leaf aphid, Rhopalosiphum maidis (Fitch). No recent extensive study has been made of corn leaf aphid hosts and as far as is known none of the existing literature reports investigation of grass hosts of the biotypes of the corn leaf aphid.

Two lines of study were emphasized: (a) a field study of grass hosts in Central Kansas and (b) a greenhouse determination of the aphid biotypes found on each host.

The principal 1962 study area was in central and northcentral Kansas. Most collections, 33, were made in Riley County. The other counties represented are Cloud, Dickinson, Ellis, Graham, Harvey, Jewell, Marion, McPherson, Morris, Reno, Riley, Sedgwick, and Thomas. Many more stops were made in Reno and McPherson Counties than collections would indicate.

The grasses collected in northwest Kansas in June of 1959 were found while with Dr. R. H. Painter on a hessian fly survey trip. Records are cited from Cloud, Ellis, Graham, Jewell and Thomas Counties.

The work was performed in Manhattan, Kansas, during the fall of 1958, the spring of 1959 and the summer of 1962.

LITERATURE

Corn Leaf Aphid in General

The corn leaf aphid, Rhopalosiphum maidis (Fitch), seems to have first been observed on corn in New York State by Dr. Asa Fitch in the year 1856. In his second report of the insects of New York he described the insect and proposed the name Aphis maidis. In 1862 Dr. Benjamin D. Walsh first noted the corn root aphis, Anuraphis maidi-radicis (Forbes) and considered it a root form of the corn leaf aphid. The resulting confusion continued until 1891 when S. A. Forbes conclusively demonstrated the two aphids to be distinct and separate species (Davis, 1909).

The aphid is found in the greater part of the world, chiefly between latitudes 50°N. and 40°S. The worldwide distribution of the corn leaf aphid may be seen on Map 67 of the Distribution Maps of Insect Pests, Commonwealth Institute of Entomology, Series A, 1956.

The aphid has been recorded in most of North America. The aphid has been reported in all 49 continental states except Alabama, Alaska, Arkansas, Georgia, Maine, Massachusetts, Montana, Nevada, New Hampshire, New Jersey, Oregon, Rhode Island, South Carolina, Vermont, Washington, West Virginia and Wisconsin. Of the above states all are considered within the expected range except the northwest states -- Montana, Nevada, Oregon, and Washington.

Of the Canadian provinces the aphid has been reported in New Brunswick, Quebec, Manitoba, Nova Scotia and Ontario by the Commonwealth Institute of Entomology (1956). MacNay (1955) reports the aphid in Saskatchewan and in Alberta in 1949. In his 1950 annual report to the Entomological Society of Ontario, MacNay refers to an aphid in British Columbia which may well have been Rhopalosiphum maidis (Fitch).

The corn leaf aphid reproduces parthenogenetically. Males have been reported only a few times. Only Das (1918), Wildermuth and Walter (1932), Cartier and Painter (1956) and Eastop (1954) have reported the presence of males.

Biotypes

Biotypes have been variously defined. Abercrombie, et al. (1951) in "A Dictionary of Biology," have linked biotypes and physiological specialization as the "existence within a particular species of a number of races or forms, which although indistinguishable in structure, show differences in physiological, biochemical, or pathogenic characters."

The existence of biotypes within insect species is a well known and established fact. Thorpe, in 1930, wrote of "biological races in insects and allied groups, long before the day of antibiotics, insecticides, and other manmade selective agents. In the same year Painter first reported the presence of biotypes in the hessian fly. Gallun (1955, 1956) reported selection of two additional races of fly, thus giving records for four known biotypes of the hessian fly.

There are at least five known physiological races of the pea aphid, Macrosiphum pisi Kalt., that have been isolated. Initially Harrington reported four distinct races in 1943 and followed in 1945 with a fifth race. Cartier (1959) reported three biotypes of the pea aphid from southern Quebec.

Several biotypes for the spotted alfalfa aphid are known. One strain is resistant to certain insecticides (Stern and Reynolds, 1958), another is able to live on a previously resistant variety of alfalfa (Pesho, et al., 1960), a fourth and possibly fifth strain is able to produce sexual generations (Dickson, et al. 1958; Manglitz, et al., 1962) and overwinter in the egg stage in Nebraska, although it normally reproduces parthenogenetically.

There is ample supporting evidence for the biotypes of the corn leaf aphid. Cartier and Painter first reported biotypes KS-1 and KS-2 in 1956. Two additional biotypes were isolated and reported in 1959 by Pathak and Painter. The later biotypes were designated KS-3 and KS-4. Additional work with biotypes has been reported by Pathak and Painter (1958a, 1958b, 1959), Maxwell and Painter (1962) and Singh (1962). Some of the known differences are related to fecundity on different hosts, auxin content of honeydew, temperature tolerance, damage to the host, starvation endurance, and reaction to carbon dioxide. The distinguishing features of the four known biotypes have been summarized by Painter and Pathak (1962).

Grass Hosts

Many of the older records of corn leaf aphid infestations are from corn and virtually all records are from cultivated crops. It has never been possible readily to assess the damage caused by the aphid; as a probable consequence the aphid was not considered important enough for extensive study of its alternate hosts.

The most extensive grass hosts survey is that found in the "Food Plant Catalogue of the Aphids of the World" by Patch (1938). Nine families of angiosperms, both monocots and dicots, are listed as hosts of the corn leaf aphid. Of these the Gramineae, or grasses, are the most numerous hosts, some 59 different species. The remaining eight families include only 12 hosts. It is quite probable that some of these records represent accidental relationships and are not actual hosts. Of the non-cultivated grass hosts listed by Patch, 13 would be expected to occur in Kansas. The Kansas species are: Cynodon dactylon (L.) Pers., Digitaria sanguinalis (L.) Scop., Echinochloa crusgalli (L.) Beauv., Elusine indica (L.) Gaertn., Eragrostis pilosa (L.) Beauv., Muhlenbergia mexicana (L.) Trin., Panicum capillare L., Panicum dichotomiflorum Michx., Phragmites communis Trin., Poa pratensis L., Setaria leutescens (Weigel) Hubb., Setaria viridis (L.) Beauv., Sorghum halepense (L.) Pers. Patch does not cite locations for the food plant records.

Davis, in 1909, reported corn leaf aphid in the field on Panicum crusgalli (Echinochloa crusgalli) and Panicum sanguinalis (Digitaria sanguinalis) at Urbana, Illinois. The same two grass species were found by him as accidental hosts in his greenhouse. His plants "became almost covered with Aphis maidis." Corn leaf aphids were then caged on Setaria glauca (=Setaria leutescens), Panicum crusgalli (=Echinochloa crusgalli), Panicum proliferum (=Panicum dichotomiflorum), Panicum sanguinalis (=Digitaria sanguinalis) and Polygonum pennsylvanicum. These particular plant species were chosen because they were common weeds in corn fields. The aphid fed freely on all of these grasses and Polygonum pennsylvanicum and maintained colonies until the plants died or were frozen.

Gillette and Palmer (1932, 1952) made collections of corn leaf aphid on the stems and leaves of Panicum crusgalli, Panicum capillare, and Setaria viridis at Denver and Fort Collins, Colorado. The aphid was reported by them to be found quite commonly throughout the region.

The above cited records are all, or in part, included in Patch (1938) world survey of aphid food plants.

In a study of the relative abundance of cereal aphids on barley and grasses in North Dakota, Post and Olson (1961) reported that 8 per cent of the aphids collected by sweeping or observed in barley were corn leaf aphid. Only 3.5 per cent of the aphids collected on grass were corn leaf aphid but the specific grasses were not identified.

In a study of cereal and grass aphids in Wisconsin Orlob and Medler (1961) report collecting Rhopalosiphum maidis on seven grass hosts. Of the seven hosts three occur as non cultivated grasses in Kansas: Agropyron repens (L.) Beauv. quackgrass; Bromus inermis Leyss., smooth brome; and Phleum pratensis L., timothy.

Knowlton and Fronk (1942) have found Rhopalosiphum maidis on Poa nevadensis Vasey ex Scribn. and Dactylis glomerata (L.) in Utah. Of these two grasses, only Dactylis glomerata occurs in Kansas.

The earliest known Kansas record of corn leaf aphid is from corn in the year 1904. Kring (1952) in his Aphids or Plant Lice (Aphididae, Hemiptera) in Kansas mentions the corn leaf aphid as occurring on several grasses; however, these were unidentified.

In a study of Kansas Aphididae, Sanborn (1904) lists Setaria glauca and Sorghum halepense as hosts. There is no indication as to where in Kansas these records were taken.

The Kansas State University Insect Collection contains corn leaf aphids collected on Digitaria filiformis (L.), an erect variety of crabgrass.

The only known report of a specific biotype in connection with wild grasses is by Pathak and Painter in 1959. They reported that KS-1 had been collected from Panicum dichotomiflorum and a colony of KS-2 from Sorghum halepense.

The term "host" as used by the author concerning his own research is defined as: a plant on which the corn leaf aphid may live and maintain or

increase in number by reproduction, a plant on which the species could survive indefinitely.

MATERIAL AND METHODS

Soil and Plant Material

The soil mixture used in the greenhouse to grow Reno barley was four parts black loam, one part sand and one part sheep manure.

Reno barley seed was secured from the Agronomy Department. The Piper Sudan 4148-11 plants were from selected seed taken from the Piper Sudan 428-1 plants of Cartier and Painter (1956), Pathak and Painter (1959) and Singh (1962).

About 10 or 15 seeds were planted into four inch pots and allowed to grow until the two or three leaf stage, at which time they were infested with corn leaf aphids.

The barley plants were caged in cylinders 3 inches in diameter and 8 inches in height made of cellulose nitrate sheets. Each cylinder had two to four one-inch air holes on the walls. These air holes and the top of the cylinder were covered with a fine mesh nylon cloth which was glued on with Duco cement. The bottom of the cage was thrust into the soil in the pot. The aphids were thus effectively caged on the barley plants.

Transparent plastic boxes (3" x 1-1/2" x 2/5") were used to confine the aphids on barley or Piper Sudan 4148-11 leaves. The boxes

were hinged so that the two halves were of equal height when the box was open. Small openings, somewhat thicker than a leaf blade, were cut from the opposing halves on each end. During tests the leaf blade was passed through these openings. To protect the leaf and prevent the escape of aphids the blade was padded with cellulose cotton. Two one half inch air vents on each side of the box were covered with fine mesh nylon.

Biotype Determination

The method used for identification of corn leaf aphid biotypes was the same as that reported by Pathak and Painter (1959). In each test 10 apterous females were used, as reported by Pathak in his dissertation (1958) and Pathak and Painter (1959).

The 4148-11 tests were conducted in the greenhouse, under sunlight. Tests on Reno barley at 45°F. were performed in a Percival walk-in growth chamber.

The aphids for biotype determination were progeny of those corn leaf aphid found on the grass hosts in the field. The aphids were not removed from the host in the field but the plants were placed in pots and the aphids allowed to reproduce in the greenhouse while still on their original grass host. After the colonies became stronger some aphids were removed and placed on caged Reno barley plants. The colonies were maintained on the barley until the aphids were needed for test purposes. This procedure seemed to yield a higher percentage of

colonies than when individual aphids were taken from grass plants in the field and immediately placed on young barley plants in the greenhouse.

Grass Hosts

Planted and volunteer fields of the known crop hosts, barley, sorghum, and corn, were employed as study areas. Fields of known hosts were selected because an infestation of corn leaf aphid would then be readily apparent. Thus it could be assumed that adjacent grasses had also been subject to infestation. When making survey trips into the field an attempt was made to collect grasses from fields located 10 to 15 miles apart. The desired host-insect relationship was not found in all fields.

Attempts to find corn leaf aphids were begun in April. Initially only barley fields were utilized but later in the season sorghum and corn fields were searched due to the advance of the season, maturity of the barley, and the gradual availability of the sorghum and corn.

Naturally infested grasses in the field were potted in four-inch pots together with the soil in which the grass was naturally growing. Greenhouse soil was not used to pot any of the grasses at any time, but all of the collected grasses were allowed to continue growing and mature in their original soil. No grasses were collected that did not actually carry aphids at the time collected.

Usually there was no knowledge regarding the species of grass being collected at the time of the collection. In the greenhouse the aphid

populations were allowed to increase on their collected plant host. Thus there was no question as to whether the grass was in reality a host or merely represented an accidental association of corn leaf aphid and grass.

Most collections were made between May 19 and July 31. May 19 was the earliest date that the corn leaf aphid was found on grasses. July 31 was used as an arbitrary point for termination of collections.

Final species determinations of the grasses were made by Dr. Lloyd C. Hulbert of the Botany and Plant Pathology Department and Dr. Kling Anderson of the Agronomy Department.

Unless otherwise noted all scientific names of grasses are as given in Hitchcock, "Manual of the Grasses of the United States," Second Edition, 1950. Gates, "Grasses in Kansas," 1936, was used as the authority to determine whether or not a given grass species is naturally found within the confines of the state of Kansas. The common names of grasses are those given by Anderson (1961).

RESULTS AND DISCUSSION

Biotypes

Fifty-eight aphid colonies from 10 grass species were studied. The specific biotypes were determined on 49 different colonies. An additional six colonies were not secured in time to make determinations. Thus a total of 64 colonies were obtained from 82 different grass-aphid associations.

As shown by Table 1 nearly three fourths of the colonies were identified as biotype KS-1. Only those colonies that produced 24 or more progeny during the 10-day test on 4148-11 are known to be KS-2. The 6 colonies that were either KS-2 or KS-3 were not caged on Westar wheat and therefore could not be differentiated. Only one colony reacted like biotype KS-4.

Even though all of the colonies were not identified as to biotypes it would seem that the percentage of KS-1 is appreciably higher than the 58 per cent reported by Pathak and Painter (1959). By adding the KS-2 and KS-2 or KS-3 totals we find that they comprised almost 19 per cent of the total colonies analyzed as compared to 29 per cent reported by Pathak and Painter. The number of colonies that reacted like KS-4 was too small to make a valid comparison. Present results are too fragmentary to determine the cause for this ostensible difference.

Two or more biotypes were collected from seven of the 10 fields from which more than one colony of aphids was obtained. There was no reason to suspect that all of the known biotypes could not live on any of the wild grass hosts studied. Greenhouse studies are needed to determine accurately whether or not all four of the biotypes can utilize the same grasses as hosts. Table 1 indicates the number of colonies of each biotype that were collected on the different hosts. No aphid colonies were obtained from Bromus japonicus or Tripsacum dactyloides, although these grasses were observed in the field with corn leaf aphids upon them.

Table 1. Occurrence of the four biotypes of corn leaf aphid on wild grass hosts in Kansas.

Host	Biotypes					Total
	KS-1	KS-2	KS-4	KS-2 or KS-3	KS-1 or KS-4	
Cenchrus pauciflorus	3	0	0	0	0	3
Digitaria sanguinalis	2	2	0	0	0	4
Echinochloa crusgalli	11	0	0	1	0	12
Erichloa contracta	1	0	0	0	0	1
Panicum capillare	1	0	0	0	0	1
P. dichotomiflorum	11	2	0	4	1	18
Setaria faberii	2	0	0	0	0	2
Setaria leutescens	2	0	0	0	0	2
Setaria viridis	4	1	0	1	1	7
Setaria sp.	0	0	1	0	0	1
Sorghum halepense	6	0	0	0	1	7
Total Sample	43	5	1	6	3	58
Total Per cent	74.14	8.62	1.73	10.34	5.17	

Grass Hosts

The cultivated hosts of the corn leaf aphid have been extensively studied; therefore, emphasis was placed on those species of grass which were found in fields of barley, sorghum and corn. This study undertook to reveal the native grass hosts of the corn leaf aphid.

The distribution of corn leaf aphid per unit area was assumed to be equal. As far as is known migration in the spring is northward from Texas and Oklahoma in conjunction with the prevailing southerly winds (McColloch 1929, Cartier and Painter 1956, Medler 1960, Orlob and Medler 1961). The author has investigated isolated sorghum plants in mid-summer and found most of them to be infested with corn leaf aphid, thus seeming to support the theory of rather wide and uniform dispersal. Orlob and Medler (1961) report that grain aphids, especially the corn leaf aphid, are able to find preferred hosts even when individual plants are planted among non-host vegetation.

Corn leaf aphids were not collected on several of the known grass hosts. The principal occurrence of some grasses was outside the study area, and from the ecology of some, they are not likely to be met in barley, sorghum or corn fields. Gates (1940) plotted the distribution of Kansas flora. From his maps it is apparent that certain known hosts would probably not be encountered in the study area. The distribution of Eragrostis pilosa is mostly in the western half of the state and not in the

areas studied. The common reed, Phragmites communis, has a very limited occurrence in the state and scarcely any in the area encompassed. In addition, its habitat is swamps or marshes and therefore not likely to occur within the limits set for the study, within cultivated fields of barley, corn or sorghum. The known distribution of Poa pratensis is scattered throughout the state; local occurrence is not recorded by Gates in a major portion of the study area. Bermuda grass, Cynodon dactylon, is extensively cultivated in Kansas lawns but is not commonly found in well cultivated fields. Map 278 (Gates, 1940) shows it to be found in very few counties, mostly outside the study area. Muhlenbergia mexicana (L.) occurs in about half of the study area, but would not be expected in most fields. Its preferred habitat is wet meadows, low woods or thickets, and low waste places (Gates, 1940). Two species, Bromus inermis and Agropyron repens, occur only in one county of the study area. Orlob and Medler (1961) report that only individual aphids were found on Bromus inermis. Another species, Phleum pratensis also had only individual aphids upon it. Phleum pratensis does not occur in about half of the study area.

It is of interest to note that over half of the known Kansas hosts of Rhopalosiphum maidis are introduced species mostly from Europe. Seven of the 12 collected grasses and seven or possibly eight of the remaining nine known grass hosts are not native to North America as indicated in Table 2.

The grass hosts studied belong to four tribes. Bromus japonicus belongs to the Festuceae, Sorghum halepense to Andropogoneae, Tripsacum dactyloides to Tripsaceae. The other nine species, including the two grasses collected most frequently, are of the tribe Paniceae. Of the 82 reported records all but nine are of the Paniceae.

The group of grasses collected with aphids have similar habitats. All prefer waste places and/or cultivated ground and thus frequently are considered weeds. Of the known hosts listed by Patch (1938) all the host grasses that should be found within the prescribed limitations of the study were collected except Muhlenbergia mexicana. It may be partially ruled out on the kind of habitat or its rather scattered distribution.

Of the thirteen grasses listed by Patch as being hosts and also occurring within the state of Kansas seven were collected with corn leaf aphid. In addition five species not previously recorded as hosts were identified, thus raising the total of known Kansas hosts to eighteen. The previously unknown hosts that were identified are Bromus japonicus, Cenchrus pauciflorus, Erichloa contracta, Setaria faberii and Tripsacum dactyloides. It would seem that none of these five hosts are strongly preferred by the corn leaf aphid. Table 2 indicates the species collected, the number of collections and the native region of each of the grasses. The Setaria sp. of Table 1 and 2 was not in seed and therefore could not be positively identified by Dr. Kling Anderson.

Table 2. Grass hosts of the corn leaf aphid in Kansas.

Grass	Common Name	Number of Collections[1]	Native Region
Bromus japonicus	Japanese brome	1	Eurasia
Cenchrus pauciflorus	sandbur	5	North America
Digitaria sanguinalis	crabgrass	8	Europe
Echinochloa crusgalli	barnyardgrass	15	Old World
Erichloa contracta	prairie cupgrass	2	North America
Panicum capillare	common witchgrass	2	North America
P. dichotomiflorum	fall panicum	25	North America
Setaria faberii	giant bristlegrass	3	China
Setaria leutesens	yellow bristlegrass	3	Europe
Setaria viridis	green bristlegrass	9	Europe
Setaria sp.	foxtails	1	
Sorghum halepense	johnsongrass	7	Mediterranean region
Tripsacum dactyloides	eastern gamma grass	1	North America
Total		82	

(1) Numerical records here do not agree with those in Table 1 since the biotype was not determined for all colonies collected.

Relative Host Preference

In a study of the biology of the corn leaf aphid Wildermuth and Walter (1932) list the relative host preferences for cultivated crops. The most preferred host was barley, then grain sorghum and least preferred, corn. Kring (1952) listed the aphid as preferring corn to wheat, and barley as the preferred small grain host. According to Davis (1909) broom corn is preferred among the sorghums. Davis used broom corn as a host for most of his life history studies of the corn leaf aphid.

From the literature it is not possible to determine whether barley or broom corn is the better host but it is possible to list sorghum, corn and lastly wheat as being preferred in that order. This relative order was borne out in the author's personal observations of corn leaf aphid on these crops, except broom corn. Since broom corn is no longer abundant it may be possible to designate barley as the preferred cultivated host.

None of the literature citing collections of corn leaf aphid on grasses listed any host preferences that the aphids might have revealed. This is probably due to the fact that host records were treated as incidental and not of primary interest.

Of the material collected in this study it would seem that Panicum dichotomiflorum would be the preferred host. A close second was Echinochloa crusgalli. The distribution of Panicum dichotomiflorum in the state is about 50 per cent more extensive. The whorl also would seem

to be more suited to the biology of the aphid than the whorl of Echinochloa crusgalli. Some colonies found on Echinochloa crusgalli were very strong. The developing boot of Echinochloa crusgalli as well as the maturing head were observed to harbor aphids. Both species of grass were collected simultaneously with aphids at only one stop. Further comparison of these two grasses is necessary to definitely determine which of the two is the preferred host. From observation it would seem that both P. dichotomiflorum and Echinochloa crusgalli are better hosts than corn, but not as acceptable to the aphid as barley and Sorghum vulgare.

The grasses in the genus Setaria are good hosts. Seed of Setaria viridis and Setaria leutescens was often in the soil used in the greenhouse. The seedling grasses were frequently caged with the barley plants. These seedlings then frequently served as hosts after the aphids had killed the barley. The foxtails are probably not as acceptable to the aphid as fall panic grass and barnyard grass but are definitely better than subsistence hosts.

Tripsacum dactyloides is one of the closest North American relatives of corn, Zea mays. Because of its taxonomic position it was investigated as a possible host of the corn leaf aphid. Clones of eastern gammagrass in Harvey, Marion, Reno and Riley County were examined but only one nymph was found. Since the adults of aphids are more mobile than the nymphs (Kennedy and Stroyan, 1959) it is assumed that the nymph was born on the plant. Tripsacum dactyloides is in all likelihood one of the least important hosts.

Sorghum halepense is an adequate host, but not one on which large colonies of aphid were found. Collections of Johnson grass made were late in the season, October, 1959. No corn leaf aphid were found on Johnson grass in mid-summer of 1962.

Two grasses that seem to merit special study are Bromus japonicus and Cenchrus pauciflorus. Japanese brome is an early maturing annual. Most of its development takes place before corn leaf aphids are abundant. Only one collection of Japanese brome was made in Sedgwick County. Greenhouse studies are needed to assess the actual host potential. If Japanese brome is a good host the aphid could overwinter because of the early spring appearance of the grass.

The sandbur was collected five times as a host in the study, one collection each in Cloud, Dickinson, Graham, Jewell and Riley counties. This wide geographic spread would seem to indicate that the sandbur is an adequate host. The sandbur could possibly be a host on which the corn leaf aphid overwinters in Kansas or to the south.

A listing of the author's conclusions as to the relative host preference, most to least preferred, would be as follows: Group 1, Panicum dichotomiflorum, Echinochloa crusgalli; Group 2, Setaria viridis, Setaria leutescens, Setaria faberii, Cenchrus pauciflorus, Sorghum halepense; Group 3, Digitaria sanguinalis, Panicum capillare, Erichloa contracta; Group 4, Bromus japonicus; and Group 5, Tripsacum dactyloides.

The grasses of group 1 and group 2 are definitely good hosts, group 1 being definitely superior. Digitaria sanguinalis, Panicum capillare, and Erichloa contracta seem to be adequate, but not grasses on which large colonies were found. Wheat as a host would seem to belong between group 3 and group 5. Tripsacum dactyloides would be classified as a subsistence host.

Unanswered Questions

In a Dickinson County corn field barnyard grass and other grasses were observed to have a good aphid population (June 22, 1962). At the same time adjacent corn seemed to have hardly any corn leaf aphids. One possible conclusion might be that the corn leaf aphid prefer several of the non-cultivated grasses to corn, even though they are called corn leaf aphids.

The above observation suggests that greenhouse studies are needed to determine relative preference between grass species and also to perform fecundity studies using the various grasses as hosts. Research of this nature could possibly yield a new technique to differentiate the biotypes or even reveal additional biotypes. In addition, these studies might begin to explain the differences in relative abundance of the various biotypes.

Further extensive field studies should be undertaken for several reasons: (a) to increase the number of records of grass hosts, (b) to

search for and study any possible non-grass hosts, and (c) to study the possibility that the corn leaf aphid can overwinter in Kansas on any one of its non-cultivated hosts.

SUMMARY

The non-cultivated grass hosts of the corn leaf aphid were investigated by potting infested grass specimens growing within fields of known hosts and growing them to maturity in the greenhouse. Of 82 collections 12 different grasses in four different tribes were found to be hosts. Grasses collected were: Bromus japonicus, Cenchrus pauciflorus, Digitaria sanguinalis, Echinochloa crusgalli, Erichloa contracta, Panicum capillare, Panicum dichotomiflorum, Setaria faberii, Setaria leutescens, Setaria viridis, Sorghum halepense and Tripsacum dactyloides. Of these Bromus japonicus, Cenchrus pauciflorus, Erichloa contracta, Setaria faberii, and Tripsacum dactyloides were not previously known to be hosts of the corn leaf aphid. Panicum dichotomiflorum, with 25 collections and Echinochloa crusgalli, with 15 collections, seem to indicate these species as the best non-cultivated hosts.

The biotypes of 58 corn leaf aphid colonies collected on these hosts were determined according to the method reported by Pathak and Painter (1959). The biotypes of 58 colonies were identified, 9 only in part. As it is on cultivated hosts KS-1 was the dominant biotype, 74.13 per cent of those colonies determined.

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APPENDIX

Records of occurrence of corn leaf aphid on non-cultivated grasses in Kansas

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
			Bromus japonicus		
Sedgwick	3 mi. N Wichita	May 19, 1962	barley field edge	lost in transit	---
			Cenchrus pauciflorus		
Dickinson	11 mi. S Abilene	June 22, 1962	S end of corn field	lost in transit(1)	---
Cloud	1 mi. E Jct US 24 & 81	June 1, 1959	barley field	increased	KS-1
Jewell	Esbon Exp Fld	June 1, 1959	barley plot	increased	KS-1
Graham	4 mi. SE Hill City	June 2, 1959	summer fallow	increased	KS-1
Riley	Ashland Agronomy Farm	June 27, 1962	sorghum	lost in transit	---
			Digitaria sanguinalis		
Reno	15 mi. W Hutchinson on US 50	May 31, 1962	vol sorghum	strong colony	KS-1
Dickinson	11 mi. S Abilene	June 22, 1962	edge of corn field	lost in transit	---

(1) Host plant headed.

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
			Digitaria sanguinalis cont.		
Riley	Ashland Agronomy Farm	June 27, 1962	sorghum	increased	KS-2
Riley	Ashland Agronomy Farm	June 27, 1962	sorghum	increased	KS-2
Riley	Ashland Agronomy Farm	June 27, 1962	corn field	lost in transit	---
Riley	Ashland Agronomy Farm	June 27, 1962	corn field	collected too late	---
Riley	Ashland Agronomy Farm	June 27, 1962	corn field	collected too late	---
Riley	Ashland Agronomy Farm	June 27, 1962	sorghum	increased	KS-1
			Echinochloa crusgalli		
Harvey	2 mi. S Mound-ridge	May 31, 1962	barley field	strong colony	KS-1
Harvey	1/2 mi. W Mound-ridge	June 14, 1962	barley field	good colony	KS-1
Dickinson	11 mi. S Abilene	June 22, 1962	corn field edge	good colony	KS-1
Dickinson	11 mi. S Abilene	June 22, 1962	corn field edge	good colony	KS-1

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
		Echinochloa crusgalli cont.			
Dickinson	11 mi. S Abilene	June 22, 1962	corn field edge	good	KS-1
Dickinson	11 mi. S Abilene	June 22, 1962	corn field edge	good	KS-1
Marion	2 mi. S Durham	June 22, 1962	corn field	increased	KS-1
Marion	2 mi. S Durham	June 22, 1962	corn field	good	KS-1
Riley	Ashland Agronomy Farm	June 27, 1962	corn field	increased	KS-1
Riley	2 mi. S Manhattan	June 27, 1962	corn field	increased	KS-1
Morris	9 mi. S White City	June 30, 1962	sorghum field	lost in transit	---
Morris	9 mi. S White City	June 30, 1962	sorghum field	collected too late	---
Riley	Ashland Agronomy Farm	Oct. 1, 1958	barley plot	increased	KS-2 or KS-3
Ellis	Hays Exp Sta	June 2, 1959	barley plot	increased	KS-1
Thomas	Colby Exp Sta	June 2, 1959	barley plot	lost in transit	---

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
			Eriochloa contracta		
McPherson	2 mi. N 2 W of Buhler	June 14, 1962	roadside	good colony	KS-1
Morris	2 mi. S White City	June 30, 1962	sorghum field	collected too late	---
			Panicum capillare		
Harvey	Kan St Exp Fld	May 31, 1962	headed barley field	lost in transit	---
Jewell	Esbon Exp Fld	June 1, 1959	barley plot	increased(1)	KS-1
			Panicum dichotomiflorum		
Harvey	Kan State Exp Fld	May 31, 1962	headed barley field	strong colony	KS-1
Harvey	Kan State Exp Fld	May 31, 1962	headed barley field	strong colony	KS-2
Harvey	Kan State Exp Fld	May 31, 1962	headed barley field	good colony	KS-1 or KS-4

(1) Only one individual aphid.

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
		Panicum dichotomiflorum cont.			
Harvey	Kan State Exp Fld	May 31, 1962	headed barley field	lost in transit	---
Harvey	Kan State Exp Fld	May 31, 1962	headed barley field	good colony	KS-1
Harvey	2 mi. S Mound-ridge	May 31, 1962	headed barley field	good colony	KS-2
Riley	Agronomy farm	June 5, 1962	barley plots	lost in transit	---
Riley	Agronomy farm	June 5, 1962	barley plot	strong colony	KS-1
Riley	Agronomy farm	June 5, 1962	barley plot	lost in transit	---
Riley	Agronomy farm	June 5, 1962	barley plot	lost in transit	---
Riley	Agronomy farm	June 5, 1962	barley plot	lost in transit	---
Riley	Agronomy farm	June 5, 1962	barley plot	strong colony	KS-1
Riley	Agronomy farm	June 5, 1962	barley plot	strong colony	KS-1
Riley	Agronomy farm	June 5, 1962	barley plot	good colony	KS-2 or KS-3

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
		Panicum dichotomiflorum cont.			
Riley	Agronomy farm	June 5, 1962	barley plot	lost in transit	---
Riley	Agronomy farm	June 5, 1962	barley plot	good colony	KS-1
Riley	Agronomy farm	June 5, 1962	barley plot	good colony	KS-1
Riley	Agronomy farm	June 5, 1962	barley plot	strong colony	KS-1
Harvey	12 mi. S Hillsboro	June 14, 1962	barley fld	good colony	KS-2 or KS-3
Harvey	12 mi. S Hillsboro	June 14, 1962	barley fld	lost in transit	---
Harvey	12 mi. S Hillsboro	June 14, 1962	barley fld	good colony	KS-1
Harvey	12 mi. S Hillsboro	June 14, 1962	barley fld	good colony	KS-1
Harvey	12 mi. S Hillsboro	June 14, 1962	barley fld	good colony	KS-1
Harvey	7 mi. E Buhler	June 14, 1962	barley fld	good colony	KS-2 or KS-3
McPherson	2 mi. N 2 W of Buhler	June 14, 1962	barley fld	good colony(1)	KS-2 or KS-3

(1) 99 per cent frozen out.

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
			Setaria faberii		
Dickinson	11 mi. S Abilene	June 22, 1962	corn field edge	good[1]	KS-1
Riley	Ashland Agronomy Farm	June 27, 1962	sorghum nursery	good	KS-1
Marion	W edge Marion	June 30, 1962	corn field	lost in transit	---
			Setaria lutescens		
Sedgwick	3 mi. N Wichita	May 19, 1962	barley field	increased	KS-1
Marion	2 mi. S Durham	June 22, 1962	corn field	increased	KS-1
Morris	3 mi. W Delavin	June 30, 1962	corn field	collected too late	---
			Setaria viridis		
Marion	2 mi. S Hillsboro	June 14, 1962	barley field	good colony	KS-2 or KS-3
Harvey	12 mi. S Hillsboro	June 14, 1962	barley field	increased	KS-1
Harvey	16 mi. S Hillsboro	June 14, 1962	barley field	increased	KS-1

(1) Host plant headed.

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
			Setaria viridis cont.		
Harvey	16 mi. S Hillsboro	June 14, 1962	barley field	increased	KS-1
Dickinson	11 mi. S Abilene	June 22, 1962	corn field	increased	KS-1
Riley	3 mi. S Manhattan	June 27, 1962	sorghum field	small colony increased	KS-1 or KS-4
Riley	3 mi. S Manhattan	June 27, 1962	sorghum field	small colony increased	KS-2
Morris	3 mi. W Delavin	June 30, 1962	corn field	lost in transit	---
Morris	9 mi. S White City	June 30, 1962	sorghum field	collected too late	---
			Setaria sp.		
Morris	8 mi. S White City	June 30, 1962		increased	KS-4
			Sorghum halepense		
Riley	Behind Insectory # 3	Oct. 10, 1958	waste land	increased	KS-1
Riley	Insectory # 3	Oct. 10, 1958	waste land	increased	KS-1

County	Locality	Date	Ecological Conditions	Fate of orig. colony in greenhouse	Biotype identified
		Sorghum halepense concl.			
Riley	Insectory # 3	Oct. 10, 1958	waste land	increased	KS-1
Riley	Insectory # 3	Oct. 19, 1958	waste land	increased	KS-1
Riley	Insectory # 3	Oct. 10, 1958	waste land	increased	KS-1
Riley	Insectory # 3	Oct. 10, 1958	waste land	increased	KS-1
Riley	Insectory # 3	Oct. 21, 1958	waste land	increased	KS-1 or KS-4
		Tripsacum dactyloides			
Riley	3 mi. W Manhattan	June 6, 1962	railroad right-of-way	single aphid lost in transit	---

NON-CULTIVATED GRASS HOSTS OF BIOTYPES OF CORN LEAF APHID, *Rhopalosiphum maidis* (Fitch), APHIDIDAE, HOMOPTERA

by

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AN ABSTRACT OF A THESIS

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The non-cultivated grass hosts of biotypes of the corn leaf aphid, Rhopalosiphum maidis (Fitch), were studied in Kansas during the fall of 1958, spring of 1959 and the summer of 1962. Two lines of study were emphasized: (a) a field study of the grass hosts and (b) a greenhouse determination of the aphid biotypes.

Patch (1938) listed 59 grasses as hosts of the corn leaf aphid. Of these 13 are found in Kansas. The seven most likely to be found in fields of barley, sorghum or corn and which were recorded here as hosts were Digitaria sanguinalis, Echinochloa crusgalli, Panicum capillare, Panicum dichotomiflorum, Setaria leutescens, Setaria viridis, and Sorghum halepense. Five new hosts were identified: Bromus japonicus, Cenchrus pauciflorus, Erichloa contracta, Setaria faberii, and Tripsacum dactyloides. Eighty-two grass-corn leaf aphid associations were recorded.

The biotypes of the aphids collected on the grasses were determined by the method reported by Pathak and Painter (1959). Of the colonies 74.13 per cent reacted in a way indicating that they were biotypes KS-1. The remainder were KS-2, KS-2 or KS-3 and KS-4.

Corn leaf aphids were collected most commonly on Panicum dichotomiflorum and Echinochloa crusgalli. Relative corn leaf aphid preferences for all the collected grasses were in the following order: Panicum dichotomiflorum, Echinochloa crusgalli, Setaria viridis, Setaria leutescens, Setaria faberii, Cenchrus pauciflorus, Sorghum halepense,

Digitaria sanguinalis, Panicum capillare, Erichloa contracta, Bromus japonicus and Tripsacum dactyloides.