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Wheat Streak Mosaic

ITS CAUSE AND CONTROL IN NEBRASKA

EXTENSION SERVICE - UNIVERSITY OF NEBRASKA
COLLEGE OF AGRICULTURE AND U. S. DEPARTMENT
OF AGRICULTURE COOPERATING W. V. Lambert, Director

CONTROL MEASURES

Destruction of volunteer wheat advisable

Volunteer wheat arising early, either before the normal time of harvest or shortly thereafter, is often a source of virus-carrying mites. If it is mite-infested, this volunteer wheat will display rolled and trapped leaves and may even be infected with streak mosaic. The early volunteer wheat should be destroyed at least two weeks before wheat is again seeded. Volunteer wheat emerging late in the summer, several weeks after harvest, is of little consequence and may be ignored.

Date of planting important

Generally, the later the wheat is planted, the less it is exposed to virus-carrying mites in the fall. Therefore, winter wheat should be planted as late as good agronomic practices will allow. However, it must be borne in mind that the effectiveness of late planting depends upon the extent of warm weather in the fall. If high temperatures prevail long into the fall and early winter, even wheat planted at a very late date may suffer from wheat streak mosaic.

Elimination of grasses not warranted

On the basis of the available evidence, the destruction of native perennial and annual grasses in the vicinity of wheat fields is not warranted. These grasses do not appear to be important in the development of wheat streak mosaic epidemics. Under certain conditions, particularly with the prolongation of warm weather in the fall, it is possible that virus-carrying mites from native grasses may create minor epidemics in the wheat crop. Normally, however, this does not appear probable.

Miticides not effective

Owing to the limitations in effectiveness of the miticides, plus the difficulty in knowing when to apply them, the use of miticides on the winter wheat crop in the fall is not advisable.

Wheat Streak Mosaic: Its Cause and Control in Nebraska

JOHN L. WEIHING[1]

WHEAT STREAK MOSAIC has been given much publicity in recent years, and has often been blamed for wheat crop failures caused by other diseases, particularly crown and root rots. In some years wheat streak mosaic has been epidemic over considerable areas in Nebraska and has caused extensive losses. More frequently, the disease has occurred in localized areas, involving one or several farms. Studies on the nature and spread of the disease have brought about greater understanding of its peculiarities and the development of practical control measures.

SYMPTOMS OF THE DISEASE

All commercially grown winter and spring wheat varieties are susceptible to wheat streak mosaic and can be severely damaged by it. Fields infected with wheat streak mosaic seem to start normal growth in the spring. As the weather becomes warmer, the crop appears retarded and frequently looks as if it were suffering from nitrogen deficiency. Close examination of the leaves reveals yellow streaking or mottling (figure 1). The plants tend to spread out in contrast to their normal upright growth. Fewer stems may be produced and occasionally some of them grow crooked, bending at certain nodes (joints of the wheat stem). Sometimes part of the stems will grow to normal height while the rest will be considerably shorter. The head may or may not fill and shriveled grain may be common. Losses vary from negligible to total.

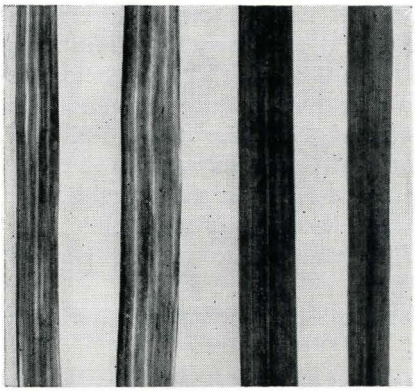

Figure 1.—The light streaking of the two wheat leaves on the left is typical of western streak mosaic symptoms. In nature the color of the streak is yellow. The two leaves on right are healthy.

[1] Extension Plant Pathologist.

The research which contributed most of the information presented in this circular was conducted by R. Staples, Entomology Department, and W. B. Allington, Plant Pathology Department, Nebraska Agricultural Experiment Station. Their work is reported in detail in Nebraska Research Bulletin 178.

FACTORS INVOLVED IN DISEASE SEVERITY

Time of infection is a very important factor in the destructiveness of streak mosaic. The earlier the infection in the life of the plant, the more severe will be the disease. Plants that contract the disease shortly after they have emerged and are in the two- and three-leaf stage may eventually die or, if they survive, will be stunted and nonproductive. Winter wheat that becomes infected in the spring will develop some streaking of the leaves but yield loss will be slight if it occurs at all. The time infection occurs, between fall and spring, determines the amount of loss.

Temperature influences the rapidity of symptom development and perhaps to some extent the damage caused by streak mosaic. Cool weather retards symptom expression, so the disease is not usually noticeable in the spring until after a period of warm weather. Disease symptoms generally cannot be seen in the fall unless temperatures are above normal.

CAUSE

Wheat streak mosaic is caused by a virus.[2] In order for the virus to live and multiply it must be within a susceptible plant such as wheat. It cannot get into a plant by direct penetration but must be placed in contact with inner living tissues through contamination of fresh wounds or injection during feeding by a mite carrier. The virus does not necessarily cause the death of plant cells. It alters some of the normal living processes of the cells so that they produce virus particles which gradually become distributed throughout the plant. When a considerable portion of the plant's normal functions are disrupted at the expense of virus production, the plant takes on the characteristic abnormal appearances described in the section on symptoms. The ability of the virus to alter over-all normal plant development is closely correlated with time of infection.

When the plant dies the virus also dies. Cold or hot weather does not destroy the virus inside the plant.

TRANSMISSION OF THE VIRUS

A microscopic mite called the wheat curl mite is mainly responsible for transmitting the mosaic virus. As the mite feeds on mosaic-infected wheat it brings virus into its body. The virus remains alive in the body of the mite for a while—just how long has not yet been determined. When the contaminated mite is moved to a healthy plant and begins to feed, virus particles are secreted from the mite into the plant tissues where they establish initial infection.

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[2] Viruses are disease-producing entities so small that they cannot be seen with ordinary microscopes. Plant virus particles reproduce when in a suitable plant but no one has ever succeeded in getting them to multiply outside a plant.

The disease can easily be transmitted by mechanical means but this is relatively unimportant in the field. Juice extracted from mosaic-infected plants contains the virus. By wetting one's fingers with such juice and immediately rubbing the leaves of a healthy plant, virus particles can be made to lodge in fresh wounds where they bring about instantaneous infection. Mechanical transmission from winds whipping healthy and diseased leaves together or from livestock grazing rarely occurs in the field.

LIFE CYCLE OF THE WHEAT CURL MITE

The wheat curl mite must be magnified about 20 times before it can be seen with much clarity. The mites are wingless, white, cigar-shaped creatures having four legs near their head (figure 2). They tend to feed near the edge of the wheat leaf, causing the edges of the leaf blade to roll inward tightly and to enclose the mites. This protects the mites from the sun and other weather elements. Severe leaf rolling on young plants causes the tips of the subsequently emerging leaves to be trapped (figure 3). Leaf trapping is common in fields of young wheat heavily infested with mites.

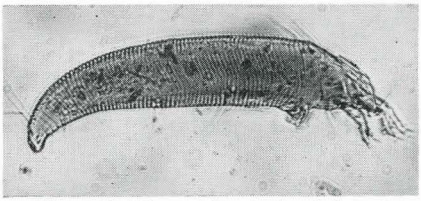

Figure 2.—Photomicrograph of the wheat curl mite. Magnified 200 times.

The mite reproduces by laying eggs. At temperatures around 80°F. the egg incubation period is three days. The mite molts twice before reaching the adult stage which is attained in four to five days. Nearly all individuals are females, each of which produces an average of 12 eggs. The complete cycle from egg to egg is 8 to 10 days. Theoretically one mite could have approximately 180 quadrillion descendants in 50 days. During the winter the mites are found alive but inactive at the base of the leaves in the crown of the plant. They do not "freeze out" during Nebraska winters.

FACTORS NECESSARY FOR EPIDEMICS

A great many mites carrying the wheat streak mosaic virus are necessary for the development of an epidemic of streak mosaic. In western Nebraska the most common source of mites is early volunteer wheat. The severe hailstorms which are so common to this area result in excellent growth of volunteer wheat in mid-July. Rains following shortly after harvest also create early volunteer growth. The volunteer becomes infested with mites carrying the mosaic virus. By September 1 the mite population reaches astronomical numbers and the mosaic virus is spread throughout the volunteer field. A fall-planted field of wheat adjacent to the volunteer field will also become infested with the mosaic-carrying mites. Brisk winds carry volumes of the mite from

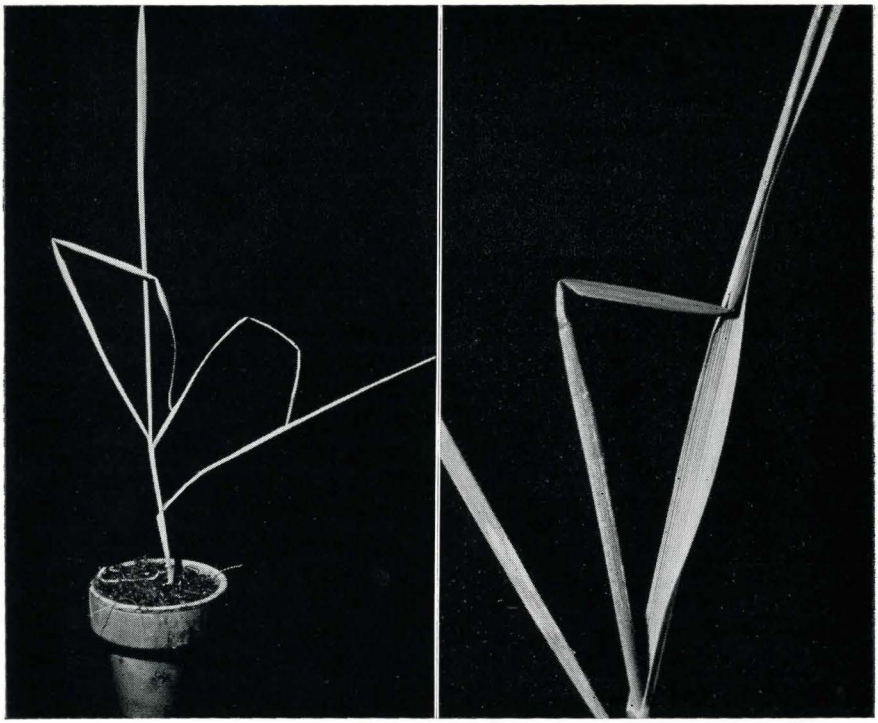

Figure 3.—Younger wheat leaves that have been trapped in rolled older leaves. The leaf rolling has been caused by feeding of the wheat curl mite. Leaf trapping occurs commonly in young fields heavily infested with the wheat curl mite.

the volunteer field to the planted wheat. It is necessary that large numbers of mites be deposited on the new wheat for the disease to become devastating. If only a few mites settle on the field, there is not enough time for the development of large mite populations before winter. During the winter the mite becomes quiescent and resides on the crown of the plant.

GRASSES AS SOURCE OF MITES AND MOSAIC VIRUS

The mite will survive only a day or two if it does not have a living plant on which to feed. The virus also requires a living plant in order to survive. It is not possible for the mosaic virus to remain alive in the soil or in dead material. The virus can overwinter in winter annuals such as wheat or in susceptible perennial grasses. The table on the opposite page summarizes information on grasses capable of harboring the mite and those suseptible to mosaic. Some are a possible source for both.

It is very unlikely that any epidemics would arise directly from the weedy or pasture grasses. To cause an epidemic they would have

to provide the virus and also be suitable hosts for the mite. The native species of annual grasses commonly found infected with wheat streak

Grass plants tested for mite survival and mosaic susceptibility[1]

Scientific name	Common name	Increase of mites	Mosaic susceptible
	GRASS CROP PLANTS		
Avena sativa	Oat	none	yes
Hordium vulgare	Barley	poor	yes
Panicum miliaceum	Millet (proso)	none	yes
Secale cereale	Rye	poor	yes
Setaria italica	Millet (foxtail)	poor	yes
Sorghum vulgare	Sorghum	fair-good[2]	no
Sorghum vulgare var. *sudanense*	Sudan grass	poor[2]	no
Zea mays	Corn	poor-fair[2]	yes
	ANNUAL GRASSES		
Aegilaps cylindrica	Jointed goatgrass	fair-good	yes
Avena fatua	Wild oats	none	yes
Bromus japonicus	Japanese chess	none	yes
Bromus secalinus	Cheat	none	yes
Bromus tectorum	Downy chess	none	yes
Cenchrus pauciflorus	Sandbur	good	yes
Digitaria ischaemum	Smooth crabgrass	fair-good	yes
Digitaria sanguinalis	Crabgrass	none	yes
Echinachloa crusgalli	Barnyard grass	poor	yes
Elensine indica	Goosegrass	none	no
Eragrostis cilianensis	Stinkgrass	poor	yes
Euchlaena mexicana	Teosinte	poor	no
Panicum capillare	Witchgrass	none	yes
Setaria lutescens	Yellow foxtail	none	no
Setaria verticillata	Bristly foxtail	poor	yes
Setaria viridis	Green foxtail	poor	yes
	PERENNIAL GRASSES		
Agropyron elongatum	Tall wheat grass	none	no
Agropyron smithii	Western wheatgrass	poor-fair	no
Alopercurus pratensis	Meadow foxtail	none	no
Arrhenatherum elatius	Tall oatgrass	poor	no
Buchloe dactyloides	Buffalograss	none	no data
Bouteloua curtipendula	Side oats grama	none	no
Bouteloua gracilis	Blue grama	none	no
Bouteloua hirsuta	Grama	good	yes
Bromis inermis	Smooth brome	very poor	no
Dactylis glomerata	Orchard grass	none	no
Elymus canadensis	Canada wild-rye	fair	yes
Oryzopsis hymenoides	Indian ricegrass	poor	yes
Panicum virgatum	Switch grass	none	no
Phalaris arundinacea	Reed canary grass	none	no
Sorghum halepense	Johnson grass	good	no
Sorghastrum nutans	Indian grass	none	no

[1] This table was compiled from data given in various technical journal articles written by R. V. Connin, Agr. Res. Serv., U.S.D.A., W. H. Sill, Jr., Dept. of Botany and Plant Pathology, Kansas State College, and J. T. Slykhuis, Plant Pathologist, Lethbridge, Alberta, Canada.

[2] Depending on stage of growth and variety.

mosaic in Nebraska, particularly in the western regions of the state where epidemics of wheat streak are more prevalent, are green foxtail, stinkgrass and witchgrass. However, these grasses fail to maintain colonies of the mite. Infection of these grasses occurs when a virus-carrying mite by chance becomes lodged on one of them and begins to feed. On these plants the mite fails to propagate and to build up large numbers that could be blown into a fall-planted wheat field.

Other field crops now grown in the wheat producing areas are not believed to play an important part in epidemics of wheat streak mosaic. Although corn, oats, barley, millet and rye can all be infected, they either do not grow at a suitable time of the year or they do not support large populations of the leaf curl mite.

The importance of perennial grasses in the development of western streak mosaic is rather difficult to determine. Western wheatgrass is an excellent host for the mite but it is immune to the virus. Indian ricegrass is not often found to be infested with the mite but is capable of being infected with wheat streak virus. Canada wild rye is a common perennial and is susceptible to wheat streak mosaic virus. Occasionally mites are found on this host. It is conceivable that virus-carrying mites could be blown from Canada wild rye and Indian ricegrass to wheat. Perennial grasses may be more important than annuals in providing an interim host for mites and virus between wheat harvest and the emergence of volunteer wheat. Normally, however, mites and virus derived from either annual or perennial grasses do not develop to epidemic proportions in either cultivated or volunteer wheat. Rather they are believed to provide the nonepidemic quantity of wheat streak mosaic found in some wheat fields year after year. On the basis of information now available, annual and perennial grasses seem relatively unimportant in the epidemic spread of wheat streak mosaic in Nebraska.

MITICIDES INEFFECTIVE UNDER FIELD CONDITIONS

In laboratory tests it was found that certain miticides were effective in killing the wheat curl mite. These miticides, however, failed to have any appreciable effect in control of western streak mosaic in the field. Several factors contributed to the lack of control. The mite has natural protection against a toxic substance sprayed on infested volunteer wheat since feeding by the mite causes the leaves to roll, and within the roll it is beyond reach of the chemical. To be an effective protectant for a fall-planted wheat field, the miticide would have to kill incoming virus-carrying mites before they have time to feed because infection takes place simultaneously with feeding. There is little possibility of eliminating mites this quickly with present miticides. Also, the chemical must remain on the plants at least two months to provide adequate protection from mite infestation.

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