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EC 66-1815
(Revised)

# Wheat Streak Mosaic

## ITS CAUSE AND CONTROL IN NEBRASKA

UNIVERSITY OF NEBRASKA-LINCOLN
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RASKA
HOME ECONOMICS
EXTENSION SERVICE
AND U. S. DEPARTMENT OF AGRICULTURE COOPERATING
E. F. FROLIK, DEAN J. L. ADAMS, DIRECTOR

## CONTROL MEASURES

### ● Destruction of volunteer wheat advisable

Hail occurring at the soft to medium dough stage can result in volunteer wheat which has mites and mosaic. If it is mite-infested, this volunteer wheat will display rolled and trapped leaves. Such early volunteer should be destroyed a few weeks before wheat is seeded in an adjacent field. Volunteer wheat emerging following a tillage operation or following harvest is of little consequence and may be ignored. Volunteer emerging from fields hailed when they were dead ripe is usually not a hazard.

### ● 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.

Based on many years of tests in various areas of western Nebraska the following rule of thumb may be used in determining the best seeding date for winter wheat. For specific areas in western Nebraska (4000 feet base elevation, September 10 base date) each 100 feet difference in elevation means one day difference in planting time. The higher the elevation, the earlier the best planting date. The lower the elevation, the later the best planting date.

| Location | Elevation | Best Planting Date |
|---|---|---|
| Chase County | 3268 | September 15–25 |
| Banner County | 3800 | September 15–20 |
| Box Butte County | 4000 | September 10 |
| Kimball County | 5100 | September 1 |

### ● 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.

# 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.

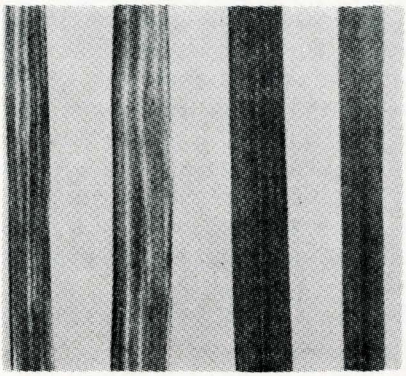

**Figure 1.—The light streaking of the two wheat leaves on the left is typical of western streak mosaic symptoms. In nature the color of the streak is yellow. The two leaves on the right are healthy.**

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[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.

[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.

## ● 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 wtih mites.

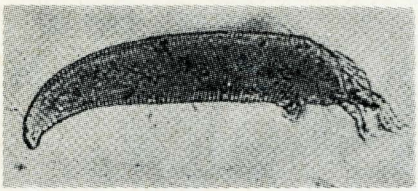

**Figure 2.—Photomicrograph of the wheat curl mite. Magnified 200 times.**

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 RELATED TO EPIDEMICS

There are always some mosaic infected plants and mites in a wheat field in the spring. As the wheat matures, mites migrate from the dying foliage to the crease of the kernels. This is usually at the soft to medium dough stage. A hail at this time which breaks over the stalks and drives the heads to the ground may result in the seed germinating almost immediately and the appearance of the volunteer grain within a few days. The mites that are in the crease of the kernel migrate to the newly developing plants where they begin feeding and reproducing. A virus-carrying mite will transmit the virus to the seedling and subsequently there will be a build-up of the mite population and extensive distribution of the virus within the volunteer.

By the time the fall-planted wheat is up, the mite population in the early volunteer will be astronomical. Wind will carry large numbers of the mites into adjacent wheat fields. This will result in transmission of the wheat streak mosaic virus.

Hail which occurs when the grain is deadripe causes volunteer which is free of mites and mosaic when it emerges. Some mites may occur later in such volunteer, but they may not build up a population to a sufficient level to be important.

Volunteer plants do not develop from wheat hailed early in the

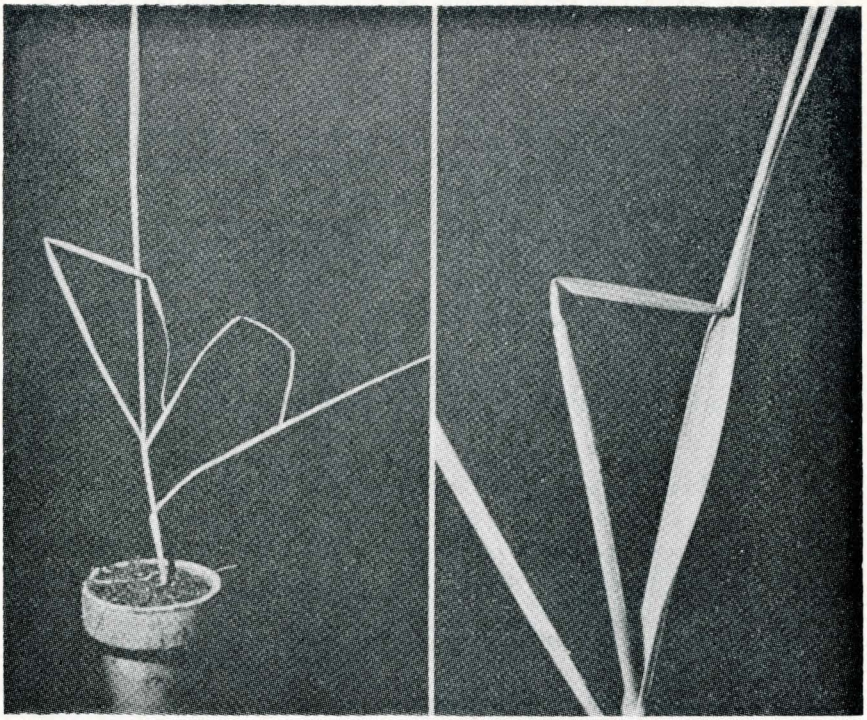

**Figure 3.—Younger wheat leaves that have been trapped in rolled older leaves. The leaf rolling has been caused by feeding of the wheat curl mite. Leaf trapping occurs commonly in young fields heavily infested wtih the wheat curl mite.**

growing season because of lack of kernels capable of germinating.

Although early volunteer wheat is the usual source of mites in the fall, foxtail millet may be another source. This plant is susceptible to the wheat streak mosaic virus and mites can live on it but not so well as on wheat. Nevertheless, there may be a high rate of infection 50 to 100 yards into a wheat field adjacent to foxtail millet.

There are a number of factors related to the severity of reaction of the wheat plants to wheat streak mosaic.

1. There are a number of strains of the virus causing a difference in severity.

2. The wheat varieties react differently to the various strains.

3. The time of infection is very important. Early fall infection is more damaging than that occurring later in the fall. Losses from spring infection are negligible.

4. Temperature is important in symptom expression. Symptoms become more apparent when temperatures rise above 75° F.

**Control:** Destroy volunteer which arises immediately following a hail-storm on wheat fields that were in the soft to medium dough stage. The volunteer that comes up after the tillage operation will

not be a hazard if there is a good kill of the volunteer produced by the hailstorm.

Do not plant foxtail millet next to a field that is to be fall planted to wheat unless the millet is to be destroyed before the wheat comes up.

## ● GRASSES AS SOURCE OF MITES AND MOSAIC VIRIUS

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 susceptible 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 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.

(6-56-5M)
(10-57-5M)
(Revised, 10-66-5M)

**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 University and J. T. Slykhuis, Plant Pathologist, Lethbridge, Alberta, Canada.
[2] Depending on stage of growth and variety.