Volume 14 | Number 9 Article 3

3-1-1960

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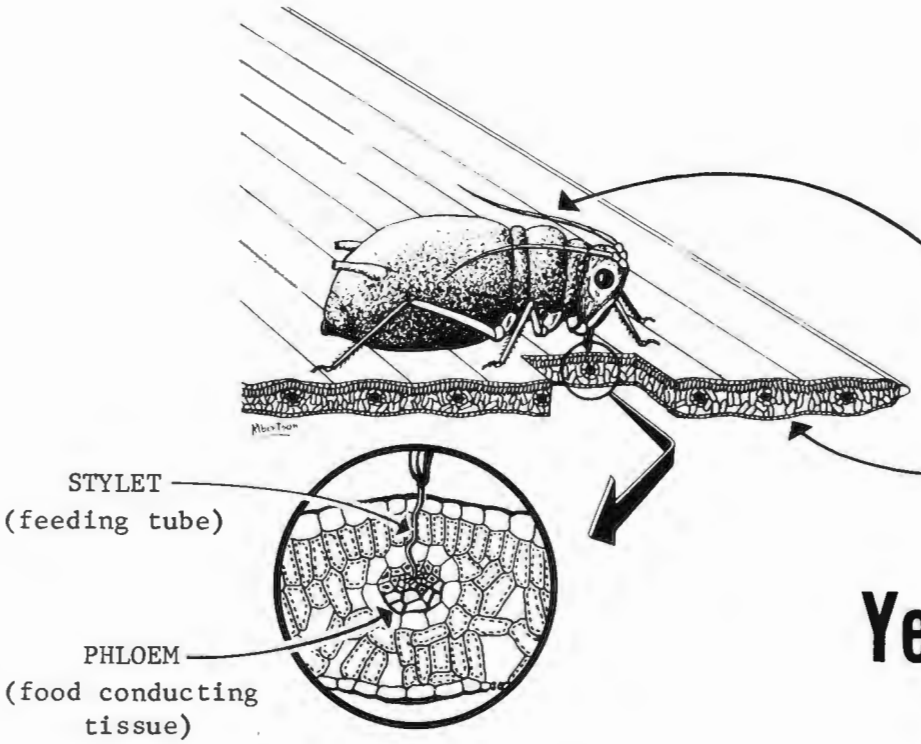
J. A. Browning
Iowa State University

D. C. Peters
Iowa State University

K. J. Frey
Iowa State University



Virus + Aphids + Oats = Yellow Dwarf of Oats

by J. A. Browning, D. C. Peters and K. J. Frey

ONE OF THE BEST oat crops in Iowa history was produced in most of Iowa in 1959. Favorable weather and absence of diseases prevailed in most of the state. But — because of yellow dwarf—one of the *worst* oat crops was produced in parts of southern and northwestern Iowa.

"Yellow dwarf," formerly called "red leaf," is a disease of oats, wheat, barley and many grasses. It's caused by a virus—the same type of disease agent that causes the common cold, polio and smallpox in man.

The yellow dwarf virus is transmitted only by insects. It doesn't live in the soil or in the seed. At least six kinds of aphids or plant lice carry the virus from plant to plant.

What Happens? Aphids, feeding with their piercing-sucking mouth parts in the food-conducting tissues or phloem of a cereal plant, take up the virus with their food. An aphid must feed about 8 hours to take up enough virus to transmit it. But once the aphid has obtained the virus, it is able to inject the virus into the phloem of healthy plants for the rest of its life (up to 3 weeks). The aphid generally has to feed on a healthy plant for about 24 hours to inoculate it—though, under some conditions, the aphid may do the job in as little as 5 minutes. An aphid doesn't transmit the virus to her offspring, and each young aphid must obtain the virus anew by feeding on a diseased plant.

The virus multiplies in the vital food-conducting tissue of the plant. Then, plugging and distortion of this tissue results in the characteristic disease symptoms. These don't appear until several weeks after the plants are infected. Lady beetles (see cover) and adverse weather often destroy the aphids before growers know that the aphids or the disease are present in their small-grain fields.

Symptoms: Symptoms (photo 1) are most severe when plants are infected while young. Barley (in which the disease was first described) is dwarfed, and the leaves turn a golden yellow—hence, the name "yellow dwarf." Oats range from dull yellow through shades of bright yellow to brilliant red—hence, the name "red leaf." The red leaf color isn't always present, however, and, since the disease was first described as "yellow dwarf" in barley, this name is preferred for both barley and oats as well as other grasses.

Diseased plants may reach less than half their normal height. The heads may be severely blasted, or plants may fail to head altogether. The root systems are dwarfed also

Photo 1: A yellow dwarf diseased oat plant. Note the many light-colored (actually yellow) leaves and the white, blasted spikelets at the base of the plant heads.

J. A. BROWNING is associate professor of plant pathology, D. C. PETERS is assistant professor of entomology, and K. J. FREY is professor of farm crops.

and, in a drouth year, may be unable to reach or absorb sufficient water to maintain the plant. Severely affected plants have a sugary substance exuded onto the leaves. Fungi thrive on this, and dead or dying plants may take on a blackened appearance from mold development.

Plants that become infected later have less severe symptoms—possibly only the flag leaf or leaves on late-formed tillers turning yellowish or reddish. But yields can still be reduced. In experiments in Illinois, Clintland oats inoculated in the 3-leaf stage had yields depressed 94 percent below plants not inoculated. The same variety inoculated at the boot stage suffered a yield reduction of 22 percent.

It Is Serious: Yellow dwarf is one of the most severe diseases of small grains. In fact, it can be much more severe than either crown rust or Victoria blight—two oat diseases well known to Iowa farmers.

While yellow dwarf wasn't recognized as being caused by a virus until 1951, the disease apparently has been present for a long time. An outbreak occurred on oats throughout the Ohio River Valley in 1907. The first serious outbreak in Iowa was in 1949, causing an estimated loss of 15 percent of the oat crop. The disease was present only in trace amounts from then until 1959 when it was the most serious disease of oats in Iowa and throughout the nation. About 12 percent of the Iowa oat crop was lost to yellow dwarf in 1959. The disease was even more serious in other states.

Areas of the north-central states where the disease was most severe in 1959 are shown in the map. Why did the disease attack oats in Missouri and southern Iowa—and then abruptly jump to northern Iowa and Minnesota? Why the unaffected area between Illinois and central Wisconsin? Why were there many good fields of oats in the affected areas and some poor ones in the unaffected areas?

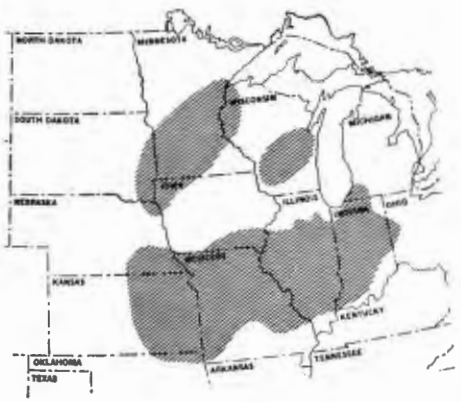
Many of the answers to these and other problems are tied up in understanding the aphids that transmit the yellow dwarf virus and how the insects obtain the virus from diseased plants and inject it into a healthy plant. And the distance between the diseased and healthy plants may be anywhere from a few inches to several hundred miles.

The yellow dwarf virus can overwinter in perennial grasses along fence rows and roadways. In the spring, overwintered aphid eggs hatch, and the aphids feed on infected grasses, then move to oats on which they feed and to which they can carry the virus. For this reason, the first diseased plants appear along the edges of fields (photo 2). Virus-laden aphids fly or are blown into the field where they start other colonies of aphids. The aphids increase in numbers as the virus builds up inside the plants. Aphids spread from these colonies to nearby plants. Thus, circular areas of diseased oats appear, surrounded by healthy oats (photo 3).

The most severely diseased plants—those inoculated first with the virus—are always in the center of the circles. This type of spread occurs every year in Iowa. This is the type that resulted in small oat crop losses from 1950 through 1958. It also occurred in 1959 in central and northern Iowa.

1959 Was Different: In 1959, however, another type of spread also occurred. And it resulted in the distribution of aphids over large sections of the Midwest in a very short time. Scientists have known for a long time that rust spores develop in the South and, under certain weather patterns, are carried by air currents to the northern spring-grain regions where they can settle over whole states in a single night. Aphids apparently can be blown into Iowa in the same way.

Several factors contributed to make this type of yellow dwarf spread so "effective" in 1959. First, the yellow dwarf disease was very severe on winter grains in the southern states. Second, greenbugs — a species of aphid which is serious on winter grains and which transmits yellow dwarf — overwintered unusually far north in 1958-59. Third, weather formations occurred which were



Areas of the north-central states where oats were severely affected in 1959. (Map, courtesy of H. C. Murphy and D. E. Western.)

Photo 2: Light area shows severe yellow dwarf along edge of field of oats.

Photo 3: Oats near the center of a small, circular, yellow dwarf infected area in a field of Clintland oats. The healthy oats (hand held) were collected only a few feet away.

just right for taking the greenbugs north where they settled rather uniformly over large areas of the spring-oat growing region.

Where the greenbugs landed was determined mainly by weather conditions. Oats in some large areas became infested with greenbugs while others, like most of Iowa, remained relatively free of greenbugs and of the disease. There was still some yellow dwarf in the areas uninfested with greenbugs, but probably from aphids that overwintered locally. There also were many fields in the infested area that escaped serious yellow dwarf damage.

Locally: Many factors contribute to the severity of yellow dwarf in any given field. These include variety, age of plants when infected, the field's fertility level, the stand of plants and moisture supply.

Variety reactions to yellow dwarf were well illustrated in 1959. Three Iowa Oat Variety Tests — at Doon, Seymour and Olds—were in yellow dwarf areas. Yield information from the test at Doon in 1958 and 1959 is shown in the table. The 1958 yields are representative of the relative yielding ability of the varieties in the absence of diseases. Notice that yields were high for all varieties in 1958. In 1959, with yellow dwarf as the only disease of consequence, the yields of some varieties were reduced to as low as 5 or 6 bushels per acre.

Putnam and Newton varieties were most resistant to yellow dwarf. Minhafer, Bonham and Cherokee were moderately resistant when compared with the highly susceptible varieties, Sauk and Clintland.

Age influences the response of oats to yellow dwarf; the younger the plants when infected with the virus, the more damage the virus causes to the plant. So fields planted early in a well-prepared seedbed have a better chance of escaping serious damage.

Fertility and stand level are also related to the severity of damage by yellow dwarf. Oats fertilized with nitrogen are less affected. In 1959 the disease was more severe on oats following corn than on oats following soybeans. Presumably this was because of fertility differences. Another example is that yellow dwarf was more severe on oats grown on the low fertility Ida-Monona soil type (photo 4) than on Galva-Primghar soil (photo 5) in the same Plymouth County locality.

Sparse stands resulting from poor fertility or seedbed preparation, low seeding rate, etc., increased yellow dwarf damage. Apparently the aphids move from plant to plant more easily in a thin stand than in a thick one. A good stand is a barrier to wind and local aphid movement.

The Future: What's the outlook for the future? Some varieties, though currently not adapted to Iowa, are resistant to yellow dwarf. Scientists are working to transfer this resistance to adapted varieties. Meanwhile, the Newton and Putnam varieties are the most resistant varieties available.

In choosing an oat variety, however, it's important to keep the frequency of damage from the several oat diseases in proper perspective. Crown rust is generally serious in Iowa on the average of 1 year in 3; yellow dwarf has been serious only about 1 year in 10. So the odds favor choosing a variety that's rust resistant or one early enough to escape rust. Minhafer, Putnam, Bonham, Cherokee, Burnett, Clintland 60 and Goodfield are varieties in these categories. And, whatever variety is chosen, wise agronomic practices of planting early to obtain a good stand on a fertile seedbed will lessen damage if yellow dwarf or rust do strike.

Spraying oat fields early in the spring to kill aphids might be effective in controlling yellow dwarf. But the cost would probably make this practice uneconomical. If the disease does become severe, clipping the oats will stop them from competing further with the forage seeding. *Don't,* however, plow under the oats if they're underseeded with forage legumes. Yellow dwarf doesn't attack legume crops. Even if the oat crop is a total loss (and this is unlikely) the forage seeding should be successful if other conditions are favorable for it.

Oat yields at Doon, Iowa, 1958 and 1959, with varieties listed in order of increasing susceptibility to yellow dwarf.

Variety	Yield (bu./A.) 1958	1959
Putnam	73	57
Newton	97	59
Minhafer	89	37
Bonham	80	35
Cherokee	86	36
Beedee	99	40
Richland	88	27
Nehawka	—	28
Clarion	100	31
Nemaha	83	24
Burnett	101	24
Minton	—	18
Goodfield	—	16
Fayette	85	11
Clinton	81	10
Clintland 60	92	11
Garry	124	13
Clintland	92	5
Sauk	111	6

Photos 4 and 5: Two fields of oats in the same locality of Plymouth County. Left, yellow dwarf in oats in Ida-Monona type soil. At right, oats free of yellow dwarf on Galva-Primghar type soil.