Yellow Dwarf Disease

a new and damaging virus disease of cereals transmitted by aphids

John W. Oswald and Byron R. Houston

First of two articles on a study of yellow dwarf of cereals in California

Yellow dwarf disease is caused by a virus which is transmitted by at least five species of grain-infesting aphids. In the 1951 outbreak the disease was responsible for the loss of an estimated 10% of the California barley crop, and yield losses in late-planted oat and wheat were also extreme.

Five grain-infesting aphids—corn aphid, apple-grain aphid, grain aphid, grass aphid, and greenbug were tested on extremely susceptible varieties of the three major cereals including three barley varieties, Ventura and Coast Black oats, and Baart 38 wheat. Aphids of each species when fed on diseased barley plants and then transferred to barley, wheat and oat seedlings transmitted yellow dwarf virus. The percentage of transmission ranged from 93.2% for the corn aphid to 26.8% for the grass aphid.

The virus persisted in the aphid vectors up to 120 hours, permitting one aphid to infect a great number of plants.

Tests with non-viruliferous—non-virus-carrying—aphids of all five species showed that the virus, and not direct aphid injury was the cause of yellow dwarf.

All attempts to transmit yellow dwarf by mechanical means, by seed or in the soil were negative.

Symptoms

The severity of symptoms depends on the age of the plants at the time they become infected.

Symptoms of yellow dwarf. A. Club Mariont Barley—4 months old. *Left,* healthy; *right,* plants of same age inoculated at the seedling stage with aphids. B. *Left,* healthy barley leaf; *right,* two leaves showing characteristic yellowing. C. Oat leaves; *left,* healthy; *right,* leaf showing yellow green blotches in leaf blade in advance of tip reddening.

Barley leaves of plants infected in the seedling stage turn a brilliant golden yellow—sometimes almost orange—at the tips within 12 to 15 days after inoculation. The yellowing progresses downward, mainly along the leaf margins, and gradually supplants all the normal green pigmentation of the leaves. In some varieties—Atlas 46—yellowing may start as irregular blotches midway in the leaf blade as well as at the tip. These areas later coalesce and leaves become totally yellow. The areas of the plants that remain green often are dark—almost a blue-green. This is particularly evident under conditions of high fertility. Leaves on infected plants are erect and appear to be thicker and stiffer than normal.

On some varieties a longitudinal green and yellow striping occurs on the new growth of infected plants. The areas adjacent to and over the veins remain green whereas the interveinal tissues become chlorotic to yellow. A few varieties exhibit a marked serration—saw-tooth pattern—of the leaf margins.

Another symptom of yellow dwarf in barley is extreme stunting. In the variety Blackhulless, infected plants are less than half the normal size within a month following inoculation and rarely attain a height of over 6″. No heads are produced but plants remain alive for long periods when not crowded out by healthy plants. The root system of an infected plant is as retarded as the top growth.

New growth produced by plants infected at intermediate growth stages—tillering to jointing—becomes yellow but stunting is less severe. Such plants manage to head but the grain produced is less than normal and of a lower test weight.

When infected at still later stages of growth the only visual evidence of yellow dwarf in barley is a bright yellowing of the uppermost leaves, particularly the flag leaf.

Under field conditions the disease often appears first in plants growing along the margins. Occasionally, circular spots, 10′–20′ in diameter, are encountered in which infection and damage are extreme.

On infected oats symptoms and disease development follow those described for barley, except that the discoloration of the leaves is a red rather than a yellow. The degree of stunting varies with variety. In extremely susceptible varieties—Victoria or Coast Black—infected plants are dwarfed by one half within five weeks after inoculation and fail to head.

An additional and consistent symptom of yellow dwarf in oats is a blasting of the flower parts. This may involve a few florets or entire heads. Blasted florets are completely devoid of seed and are

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California's Wheat

most of state's wheat of strains developed by backcross breeding

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A total of 15 improved backcrossed strains of popular wheat varieties were distributed in California between 1937 and 1950.

The improved strains—which carry numbers, following the variety name, to denote the year of its development—can not be distinguished from the original varieties whose names they bear except by testing to a specific race of bunt. Further separation of the 15 improved varieties would require other tests because a continuing sequence of improved strains, such as Baart 38 and Baart 46, have been produced from the old Baart variety. The backcross method of breeding—which emphasizes continued likeness—requires specific testing to determine the precise identity of seed stocks under examination.

In 1952, 289 field samples—collected in 30 counties during a survey in 1951—were identified by tests at Davis. The improved and nonimproved strain proportions of each variety type were determined precisely.

The varieties in the accompanying table are listed in three groups. The first group of five varieties has received the most intensive breeding and occupied 50.6% of the acreage in 1934 and 84.6% in 1949. The survey indicated that about 80% of the 1951 acreage, of these five varieties, was sown to improved strains which are resistant to bunt and to stem rust. White Federation 38, the most widely grown variety, was grown on 94.4% of the fields sown to strains of White Federation.

Bunt resistance only has been added to the six last named varieties listed in the table. In 1934—before any of the improved varieties had been produced—these variety types comprised 40.4% of the total wheat acreage of California. By 1949 this acreage was reduced to 10.6%, including the bunt resistant forms of these varieties. Three of these varieties are practically extinct.

The other varieties not listed by name in the table include remnants of old varieties or recent introductions from other states or countries. They are grown in only one half as many fields as in 1934, and now occupy about 4.5% of the total acreage.

The survey further indicated that about 75% of the 1951 wheat acreage of California was in improved types; that there is an increasing dominance of the more highly improved varieties; and, that there has been a decline in the number of varieties grown.

A continuing series of further improvements in the principal varieties are scheduled for release. Benefits from these accruing improvements will not necessarily require a change from a desired variety type, but merely a change to seed stocks of the most improved form of the variety.

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Acreage Occupied by Backcross Improved Wheat Varieties in California in 1951, as Determined from 289 Identified Field Samples Collected in 30 Counties

Variety type	Proportion of acreage				Designations of latest improved release of variety
	State-Federal survey estimates		Survey of 1951 crop		
	1934	1949	Type total	Backcross improved[1]	
	Pct.	Pct.	Pct.	Pct.	
White Federation ...	17.1	32.2	24.6	94.4	White Federation 38
Ramona	0.1	25.3	24.2	85.7	Ramona 50
Baart	27.6	19.9	15.6	71.1	Baart 46
Big Club	5.5	5.2	13.1	55.3	Big Club 43
Poso	0.3	2.0	2.4	71.4	Poso 48
Total	50.6	84.6	79.9		
Onas	4.6	5.0	7.3	40.1	Onas 41
Pacific Bluestem	7.1	3.6	4.5	76.9	Pacific Bluestem 37
Bunyip	11.4	1.8	2.8	12.5	Bunyip 41
Federation	9.3	0.2	0.7	0	Federation 41
Sonora	5.5	0	0.3	0	Sonora 37
Escondido	2.5	0	0		Escondido 41
Total	40.4	10.6	15.6		
Others	9.0	4.8	4.5		

[1] Percentage of each varietal type devoted to improved backcross strains.

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white as compared to the normal color of developing seeds.

As with barley the intensity of symptoms is directly correlated with the age of the plant when infected. Late infections of oats can be recognized only by the characteristic reddening of late emerging leaves.

Wheat infected in the seedling stage shows a darker than normal green color of the outer leaves, a chlorosis of the new growth and an over-all stunting—one third to one half of normal size. The heading is sparse, and the yield is negligible.

Infection of wheat at later growth stages—after tillering—shows a bright yellowing starting at the tips of newly formed leaves. There seems to be little if any stunting in wheat infected much after the tillering stage.

None of the major cereal crops—barley, oats, and wheat—show any mottle of a mosaic type. Neither leaf serration nor head blasting have been encountered as symptoms of the yellow dwarf disease in wheat.

Rye appears to be the most tolerant of the small grains to yellow dwarf. This observation is limited to one variety, Merced, which exhibited no discoloration and little or no stunting in fields where barley, oats and wheat were severely damaged.

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