Take-all Root Rot in Winter Wheat

By John M. Hart and Neil W. Christensen

Researchers have developed a package of best management practices (BMPs) for high yield wheat production in western Oregon. A major problem with wheat following wheat in the area is take-all root rot which can reduce yields as much as 50 percent. The BMPs developed focus on controlling this pathogen as a basic part of the management program. Recommendations are divided into: preplant-liming and stubble management, and growing season-fertilization and weed and disease control.

TAKE-ALL ROOT ROT of wheat is common in western Oregon whenever consecutive crops of wheat are grown. This disease may reduce yield by as much as 50 percent in second or third winter wheat crops.

Take-all is caused by the soilborne fungus *Gaeumannomyces graminis* var. *tritici (Ggt)* which infects the roots, crown and basal stem of plants. Symptoms are most obvious near heading and include stunting or uneven growth, poor tillering, blackened roots and crowns, premature ripening, and white heads with few kernels. Fungicides and resistant cultivars are not viable options for disease control.

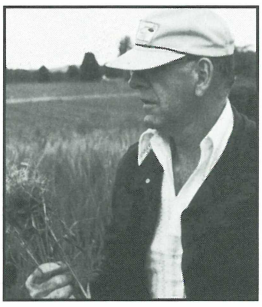
Where take-all is anticipated, specific soil and crop management practices can be used to minimize yield loss. Important management practices include cropping history and rotation, weed control, stubble management, planting date, soil pH and liming, fall and spring fertilization, and control of other diseases.

Cropping History and Rotation–Crop rotation is the best way to control take-all. The pathogen persists in infected host debris which serves as the primary source of inoculum for infection of subsequent wheat crops. Survival of the fungus in the absence of a host is poor. A 1-year break from wheat or barley is usually sufficient to reduce the take-all risk to an insignificant level. Suitable break crops include oats, corn, beans, vegetables, oilseed crops and annual legumes for seed.

Disease severity and yield loss can be substantial in second, third and fourth wheat crops, with the worst take-all usually occurring in the third consecutive crop. Take-all becomes less severe, and yields usually increase, with the fifth or sixth successive wheat crop.

Weed Control and Stubble Management–The take-all fungus invades wheatgrass and quackgrass (*Agropyron spp.*), bromegrass (*Bromus spp.*) and bentgrass

The authors acknowledge the contributions of the late Thomas L. Jackson. For over 30 years, Dr. Jackson promoted Oregon agriculture through practical scientific endeavors as professor of soil science at Oregon State University. In 1976, Dr. Jackson observed that wheat plots fertilized with ammonium chloride were less affected by take-all than were plots fertilized with other N sources. This observation was the starting point for research that developed the management program described in this article.



DR. T.L. JACKSON (now deceased) is shown as he examined wheat roots for evidence of take-all infection.

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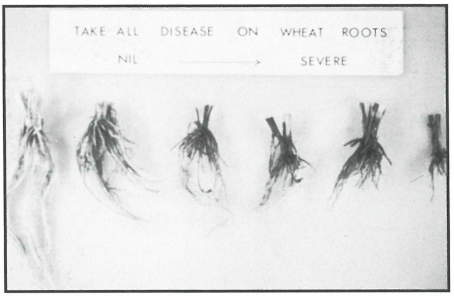

ROOTS shown in photo exhibit little to severe infection by take-all fungus.

(*Agrostis spp.*), as well as wheat and barley. These weeds along with volunteer wheat and barley may contribute to unexpected disease outbreaks when first-year wheat follows a legume crop infested with host grasses. Killing grassy hosts with tillage or herbicides a few months before planting wheat may not reduce the risk of take-all since the fungus persists in host debris. We recommend advance, long-term control of grassy hosts for rotations including wheat.

When wheat will be planted following wheat, stubble should be chopped to reduce size before plowing to a depth of 8 inches to bury host crop residue, the primary inoculum source. This delays or minimizes seedling infection and increases the probability that other control measures will slow disease progress.

Soil pH and Liming–Increasing the pH of moderately acid soils through liming generally increases the severity of take-all and reduces grain yield, **Table 1**. Other management practices such as application of ammonium-N (NH_4^+) plus chloride (Cl) in the spring are more effective in controlling take-all when soil pH is near 5.5. In contrast, soils with pH 5.2 or less, especially those with low phosphorus (P) soil tests, may respond favorably to liming. Liming an acidic, low-P Nonpareil soil . . . pH 5.2, 12 parts per million (ppm) Bray P-1 P . . . increased yield of third-year wheat from 30 to 64 bu/A and decreased the percentage of whiteheads (a symptom of take-all) from 63 to 14 percent. When pH-sensitive crops are grown in rotation with two or more years of wheat, lime should be applied after the last wheat crop is harvested.

Planting Date–On well-drained valley-floor soils, delaying planting until late October can reduce early infection of seedlings and increase grain yield, especially if other disease control measures are practiced. Care should be taken, however, because of the risk of fall rains. Planting on valley-floor soils with reduced drainage or on hill soils should not be delayed. A survey of 126 growers reporting results from 495 fields showed that planting after October 12 reduced yields by 14 to 26 bu/A on hill or poorly-drained soils.

Fertilizer Management–Nutrient deficiencies at any time during the growing season will increase the severity of take-all. Ensuring that nitrogen (N), P, sulfur (S) and potassium (K) are adequate at planting is especially important. Nitrogen-P-S or N-P-K-S fertilizers should be banded with the seed when the risk of take-all is high.

Ammonium-N, rather than nitrate (NO_3^-), should be applied because uptake of NH_4^+-N creates an environment favor-

Table 1. Liming (soil pH) and N fertilizer source affect winter wheat grain yield on moderately acid soils with a high risk of take-all.

	Soil pH						
	Willamette soil			Woodburn soil		Woodburn soil	
Spring N source	5.5	6.0	6.2	5.5	6.5	5.5	6.0
	bu/A						
Ammonium nitrate	–	–	–	–	–	93	70
Ammonium sulfate	67	60	61	52	57	112	94
Ammonium chloride	85	75	65	70	56	114	96
LSD (P=0.05)	10			9		5	
	Planted Oct. 27 120 lb N/A spring			Planted Nov.3 120 lb N/A		Planted Oct.20 160 lb N/A	

Table 2. Fertilization and planting date effects on winter wheat grain yield on high soil test P site with high risk of take-all (third year wheat)[1].

	Planting date			
	October 4		October 27	
	Cl, lb/A			
P_2O_5, lb/A	35	435	35	435
	bu/A			
0	41	50	61	74
60	40	73	65	82
LSD (P=0.05)		20		12

[1] Bray P-1, 125 ppm

These data also illustrate that the entire management package must be adopted for maximum benefit.

Sources of spring-topdressed N can influence the severity of take-all and grain yield. Studies have shown that yields were generally higher with ammonium chloride (NH_4Cl) than with ammonium nitrate (NH_4NO_3) or urea. Fertilization with NH_4Cl compared to ammonium sulfate [$(NH_4)_2SO_4$] also significantly increased grain yield in seven of nine growing seasons, **Table 3**. This compares favorably with results of a survey of 126 growers who reported average Cl responses of 12 bu/A.

able to the growth of microorganisms antagonistic to the take-all fungus. Sulfur is more often deficient for wheat in western Oregon than is K and should be routinely applied at planting. Phosphorus should be routinely applied since P deficient plants are more susceptible to take-all, and infected seedlings have poorly functioning root systems. When take-all is present, wheat will respond to banded P fertilizer on soils where no response would be expected in the absence of take-all.

Much like the yield response to soil pH, response to banded P is also affected by other factors. Planting date and Cl application affected yield response from banded P on a soil with a high soil test P level, **Table 2**. The highest yield (but not always significantly higher) at either planting date was obtained with a band application of P and more than 100 lb Cl/A. Comparison of yields with 435 vs 35 lb Cl/A emphasizes the need for adequate Cl before the banded P is effective. Grain yields from later planting on well-drained soils tend to be higher.

Since NH_4Cl is not commonly available, a combination of $(NH_4)_2SO_4$ plus potassium chloride (KCl) to supply ammonium-N and Cl is recommended for areas likely to be infected with take-all. Sufficient KCl to supply at least 100 lb Cl/A should be topdressed with $(NH_4)_2SO_4$ by Feekes Growth Stage 5.

Control of Other Diseases–Other common diseases that may need control measures include strawbreaker foot rot caused by *Pseudocercosporella herpotrichoides* and Septoria leaf and glume blotches caused by *Septoria tritici* and S. *nodorum*. Plants infested with take-all are commonly much more susceptible to Septoria.

Table 3. Spring-topdressed N fertilizer effects on wheat yield.

	Year of harvest (no. of experiments)								
Spring N source	1978 (2)	1980 (3)	1981 (3)	1983 (1)	1984 (1)	1986 (4)	1987 (2)	1988 (2)	1989 (1)
	bu/A								
Urea	–	–	–	–	–	111a	93a	86a	144ab
NH_4NO_3	–	–	–	–	85a	109b	94ab	93b	141ab
$(NH_4)_2SO_4$	54a	88a	66a	52a	106b	111a	99b	98b	138a
NH_4Cl[1]	66b	107b	80b	70b	106b	111a	107c	116c	151b

[1] Equivalent to $(NH_4)_2SO_4$ (21-0-0) plus KCl (0-0-60) to supply at least 100 lb Cl/A
N rates varied from 120 to 160 lb/A
Yields in a column followed by the same letter are not significantly different (P=0.05)

Summary

Crop management plays an important role in controlling take-all induced yield losses and reduced profitability. But remember, adoption of a complete management package produces the best results . . . and best returns. Summarized recommendations include:

Pre-plant management

- **Liming.** A soil pH of 5.5 is desirable for combating take-all. Apply lime only if the soil pH is 5.2 or less.
- **Stubble.** Chop stubble and plow deeply to bury the inoculum.

Planting

- **Planting date.** On well-drained valley-floor soils, delay planting until late October if possible. Do not delay planting beyond mid-October on hill soils or valley-floor soils with reduced drainage.
- **Fertilization.** Band 20 to 30 lb N/A as ammonium, 30 to 50 lb P_2O_5/A and 10 to 15 lb S/A. Apply 25 to 30 lb K_2O/A if a soil test indicates the need for K.

Growing season

- **Fertilization.** Apply 140 to 180 lb N/A as $(NH_4)_2SO_4$ plus 100 lb Cl/A as KCl before Feekes growth stage 5. Alternatively, apply 40 lb N/A and 100 lb Cl/A at late tillering (Feekes 4; mid-Feb.) and the remaining N within 3 to 4 weeks, but before jointing (Feekes 6).
- **Weed Control.** Control weeds to minimize competition with wheat for nutrients and moisture.
- **Disease Control.** Control leaf diseases such as Septoria and other root diseases by using resistant varieties or fungicides to ensure maximum benefit from other aspects of this management plan to reduce yield loss from take-all.■

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