that were originally virus-free were sprouted in sand and the slips planted in replicated plots at Davis.

At harvest each plant was examined for russet crack. The originally virus-free roots produced russet-crack-infected plants as follows: 10 of 22 roots kept with russet-crack roots and aphids; 2 of 18 roots kept with russet-crack roots but without aphids; and 2 of 20 roots kept alone without russet-crack roots or aphids. The 10 percent infection rate in the controls probably reflects aphid transmission within the experimental plots during the growing season. The results indicate that infection by russet crack can occur in storage and suggest that clean foundation seed should not be in the same storage as field-grown sweet potatoes.

A critical point in the epidemiology of russet-crack disease is the role of other sweet potato cultivars as reservoirs of the causal agent. In the field an occasional root of other cultivars, such as 779 and Garnet, has been found with russet-crack-like symptoms. Although attempts to graft inoculate from these cultivars to Jersey plants in the greenhouse were inconclusive, it seemed likely that these cultivars could be reservoirs of russet crack. To test this possibility, rooted sprouts of virus-free Jersey were transplanted into several commercial fields planted with other cultivars. In the fall these Jersey trap plants were hand dug and examined for russet-crack symptoms. The appearance of symptoms on the roots of the trap plants was presumptive evidence that the cultivar in the field was the source of infection.

The results show that Garnet, Jewell, and 779 are reservoirs of the russet-crack agent even though they may show no symptoms. Direct evidence that plants other than Jersey can harbor the virus was obtained by taking cuttings of Garnet, Jewell, and 779 from plants in seven of the fields in which the Jersey trap plants showed russet-crack symptoms. These cuttings were grafted to virus-free Jersey plants in the greenhouse and, in each instance, russet crack was recovered. Thus, these cultivars are potential symptomless reservoirs of the russet-crack agent.

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Wheat and barley response to nitrogen

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Wheat and barley are important crops to the Tulelake Basin and other intermountain valleys of northern California. Both bread wheats and durum wheats are grown. Barley is used for malting and as a feed grain. The yields of barley and wheat vary widely from field to field and from year to year, ranging from 2000 to 7000 pounds per acre. These fluctuations are attributed to climatic and soil factors, and to the cultural practices followed.

New varieties are continually being introduced to the area as possible replacements for those currently grown. To assure maximum production and acceptable quality, cultural practices should be evaluated for each variety grown in the area.

Since both irrigation and nitrogen fertilizer rates are known to affect yield and quality, the influence of these factors on several barley and wheat varieties was investigated over a three-year period at the Tulelake Field Station.

The Tulelake Station, located near the Oregon border at an elevation of 4042 feet, is characterized by a short growing season with frost likely any time during the crop growing season. Soils are high in organic matter (approximately 12 percent) and the water table is high (ranges 3 to 4 feet).

Two irrigation methods were studied—flood irrigation, the commonly used method, and sprinkler irrigation, a method growing in popularity. Four nitrogen fertilizer levels (40, 80, 120 and 160 pounds of nitrogen per acre as ammonium sulfate) were used. The irrigation and fertilizer treatments were studied over three barley and three wheat varieties.

The barley varieties included two six-row types (Wocus 71, a feed barley, and Larker, a malting barley) and a two-row malting barley, Klages. The wheat varieties were Leeds, a durum wheat, and two bread or common wheat types—Anza and Bluebird II. Leeds is a tall variety while the other two wheats are shorter and more resistant to lodging.

The experimental area was uniformly cropped, prior to the test, to wheat or barley for one year with no fertilizer applied. Each year the experimental area was divided into a sprinkler- and flood-irrigated section. Varieties and fertilizer rates (supplied from ammonium sulfate) were applied within each section using a split-block design. In 1973 and 1975 the experimental area was preirrigated before fertilization and seeding. Weather conditions prevented preirrigation in 1974.

The flood irrigated section received one or two crop irrigations depending upon soil moisture and weather conditions. This plot received about 8 and 11 acre inches of water in 1974 and 1975 respectively. The sprinkler irrigated section received only three irrigations from a solid set sprinkler system. This plot received about 4, 5, and 7 acre inches of water in 1973, 1974, and 1975 respectively.

Even distribution of water through the sprinkler system was difficult after plants became taller than 30 inches, and sprinkler applications were discontinued at that time. Total water applied from each irrigation system was not the same within or between years; sprinklers applied less than did flood irrigation.

The experiments were drill planted at approximately 130 pounds of seed per acre. Yields were obtained by harvesting a 100 square foot area with a small combine.

Flood irrigation

Average nitrogen response showed a significant curvilinear response (table 1). However, the interaction of nitrogen with varieties and year was also significant. The interaction can be illustrated by the difference in year-to-year performance for Leeds and Anza wheat (table 1). The two varieties showed similar yield response to nitrogen over the first two years of the study. However, performance in 1975 was quite different. Differences in lodging resistance between varieties and differential lodging in some years and at higher nitrogen rates may partially explain the interaction. The variety interaction with nitrogen was not significant. Table 1 also illustrates the larger year-to-year differences in production under similar cultural practices.

Klages gave higher yields at 120 pounds than at 80 pounds nitrogen per acre in some years, but malting quality was adversely affected. Yields of Klages and Larker were increased by nitrogen application, however the residual nitrogen in the soil before planting should be the determining factor for nitrogen applications for maximum yield and acceptable malting quality. Wocus 71 responded to high nitrogen application, and yield increased with each increment of nitrogen in 1973. The yield declined at 120 and 160 pounds of nitrogen in 1974, and at 160 pounds of nitrogen in 1975.

Variety response

Of the three barley varieties evaluated, Wocus 71 produced the highest yields (table 1). Anza was the most productive wheat variety. The yield results correspond closely with yield information from other evaluation trials. As mentioned above, varieties showed a significant interaction with years and nitrogen rates.

Sprinkler irrigation

Mean yield response to nitrogen rates under sprinkler irrigation was similar to that obtained under flood irrigation (table 2). Nitrogen rates showed significant interaction with years but not with varieties. The three way interaction (years, nitrogen levels, and varieties) was not significant.

Under the system of sprinkler irrigation used, variety performance was similar to that obtained under flood irrigation culture.

Mean variety yields favored Anza wheat and Wocus 71 barley. These varieties are of major importance in the Tulelake Basin and the results here confirm earlier observations. Choice of variety would depend upon relative demand and premiums associated with high quality.

Mean nitrogen response shows that application rate per acre of 40 pounds is less than optimum, and 160 pounds is excessive. Current grower practice falls within 80 to 120 pounds of nitrogen, shown most efficient in this study. The use of the grain after harvest would determine how much nitrogen fertilizer needs to be applied. For malting barley, high nitrogen fertilizer rates may decrease quality by producing high protein grain. In wheat, however, high protein usually is associated with high quality.

Although variety response and nitrogen rates were different in different years, there is little the grower can do to minimize this effect. Therefore, the mean responses to nitrogen and variety are useful.

The lack of significant interaction of nitrogen rate with variety indicates variety evaluation at a median nitrogen rate should provide reliable data for variety recommendation.

The irrigation systems studied were too limited to allow us to reach general conclusions. The results should not be interpreted to mean one irrigation technique is superior to another. However, problems of watering tall plants suggest that either different varieties must be selected for sprinkler and for flood irrigation, or sprinkler system design must allow for varieties of different heights.

It appears in this study that available water became a limiting factor in increasing the cereal crop yields under sprinkler irrigation. Yield of Klages and Wocus 71 barley varieties and Anza wheat was 4095, 5208, and 4703 pounds per acre respectively under limited water supply. The reduction in yield was only 12 to 15 percent when compared with flood irrigation. These varieties performed well under inadequate water supply (table 2).

The flood and sprinkler irrigation methods need to be further studied and amount of irrigation water applied needs to be monitored under both irrigation methods. The optimum yields were obtained at 80 pounds of nitrogen per acre for Klages, Larker, Wocus 71, Bluebird II, and Anza, and 40 pounds of nitrogen per acre for Leeds.

Previous studies conducted with Wocus 71 on soil uniformly cropped to cereals without nitrogen for two years showed that this variety responded to higher nitrogen rates than reported in this study. These differences could be due to higher residual nitrogen in the soil in this study.

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TABLE 1. Effect of Nitrogen Levels on the Yield of Barley and Wheat Under Flood Irrigation

		Yield of varieties—pounds per acre						
Year	N levels	Kalges	Larker	Wocus 71	Leeds	Blu.II	Anza	Mean
1973	40	5118	5009	6207	4982	5363	6207	5481
	80	5254	5336	6589	4873	5581	5990	5603
	120	5754	5282	6861	4737	5445	5690	5627
	160	5254	5227	7215	4792	5527	5445	5577
	MEAN	5343	5214	6718	4846	5479	5833	5572
1974	40	4214	3757	4639	3463	3136	3692	3816
	80	4345	3986	4901	3692	3430	4018	4062
	120	4607	4018	4672	3627	3300	4149	4062
	160	3887	3920	4443	3038	3104	3724	3686
	MEAN	4263	3920	4664	3455	3243	3896	3907
1975	40	4247	3376	5663	4574	4901	5772	4756
	80	5118	3920	6316	4683	6098	6534	5445
	120	4465	4465	6643	4029	6534	6970	5518
	160	3812	3812	5772	4356	7079	6752	5264
	MEAN	4411	3893	6099	4411	6153	6507	5246
MEAN 3 years	40	4526	4047	5503	4340	4467	5224	4684
	80	4906	4414	5935	4416	5036	5514	5037
	120	4939	4588	6059	4131	5093	5603	5069
	160	4318	4320	5810	4062	5237	5307	4842
	MEAN	4672	4342	5827	4237	4958	5412	4908

Variety LSD .05 = 357 pounds per acre.

TABLE 2. Effect of Nitrogen Levels on the Yield of Barley and Wheat Under Sprinkler Irrigation

		Yield of varieties—pounds per acre						
Year	N levels	Kalges	Larker	Wocus 71	Leeds	Blu.II	Anza	Mean
1973	40	4928	3948	5581	4383	5037	5853	4955
	80	5037	3948	5091	3948	4438	5391	4642
	120	4601	3648	5282	3757	4928	5527	4624
	160	4574	3594	5254	3648	4438	5336	4474
	MEAN	4785	3785	5302	3934	4710	5527	4674
1974	40	3071	2123	4084	2483	2516	3169	2908
	80	3365	2908	4509	3136	2744	3430	3349
	120	3528	2548	4476	2744	2712	3169	3196
	160	2614	2418	4803	2450	2483	2777	2924
	MEAN	3145	2499	4468	2703	2614	3136	3094
1975	40	4138	2831	5445	3703	4574	4574	4211
	80	4901	3376	5881	3920	5227	5445	4792
	120	4356	3376	6534	3485	5554	5881	4864
	160	4029	3376	5554	3158	5445	5881	4574
	MEAN	4356	3240	5854	3567	5200	5445	4610
MEAN 3 years	40	4046	2967	5037	3523	4042	4532	4025
	80	4434	3411	5160	3668	4136	4755	4261
	120	4162	3191	5431	3329	4398	4859	4228
	160	3739	3129	5204	3085	4122	4665	3991
	MEAN	4095	3175	5208	3401	4174	4703	4126

Variety LSD .05 = 295 pounds per acre.