INTERNAL RIB NE
HEAD LETTUCE IN IMP

HUNTER JOHNSON, JR. D. R. WOODRUF

Mature head of Climax variety (to left) showing internal rib necrosis with close-up photo (to right) detailing a section of affected midrib.

DURING THE WINTER LETTUCE SEASON of 1969 in the Imperial Valley, a serious physiological disorder developed in many fields as the lettuce crop approached maturity. The disorder was widespread throughout the Valley and was serious enough to cause losses in the field and in transit, and reduced shipments. Shippers, field men, and research workers had observed similar symptoms on mature lettuce plants in previous years, but the disorder had never reached the epidemic proportions it did in 1969.

The symptoms of the disorder are most simply described as a diffuse, dark, gray-green discoloration of the lower midrib. The tissue affected is entirely internal and is usually located in the parenchyma cells between the vascular bundles. Epidermal tissues are not affected by this disorder in the field. Areas of discolored tissue are elongated, often extending 3 or 4 inches up the midrib. Symptoms are most distinct in the wrapper leaves and outer clasping head leaves but may extend farther into the head in serious cases. The symptoms are most apparent in mature heads, although small affected areas of tissue have been observed in young plants prior to the heading stage.

Various names have been applied to this disorder, such as "blackheart," "gray rib," "rib blight," "gray streak," and "internal rib necrosis." Because a common name is needed, the term "internal rib necrosis" is suggested as best describing this condition.

In 1969, internal rib necrosis occurred in plantings that matured roughly between late January and mid-February. The main variety grown for harvest during this period is Climax. Plantings of Climax and other varieties maturing before and after this period were generally unaffected. Observations in varietal plots reported from the Imperial Valley Field Station in February 1969 indicated that only one of eight commercial varieties maturing at that time showed the disorder. The field problem followed a cold, rainy period; therefore, it was suggested that these environmental conditions were predisposing factors, and that Climax was highly susceptible. It was also suggested that irrigations close to harvest or just prior to rainfall, particularly on heavy soils, influenced development of internal rib necrosis.

In the fall of 1969 an experiment was established at the U.S.D.A. Southwestern Irrigation Field Station, Brawley, to learn more about internal rib necrosis in relation to variety, date of planting, and irrigation management. Four varieties were used in the trial: Forty-Niner, Climax, Golden State D, and Vanguard. These varieties were chosen because heads mature over the range of planting dates included in the trial. Plantings were made at two-week intervals on September 24, October 8, October 22, and November 5. Each planting date was split for irrigation treatment so a "normal" irrigation could be compared with a "wet" treatment. Both irrigation treatments were identical through the last irrigation which was made about 10 days prior to harvest. For the "wet" treatment an additional irrigation was applied three to five days before harvest. All plantings were on conventional raised

CROSIS OF ERIAL VALLEY

Planting resistant varieties appears to be today's only solution to the closely related Imperial Valley lettuce problems of (1) internal rib necrosis (see photo) which develops in the field during maturity, and (2) rusty rib (see cover) which develops after harvest during cold storage. The popular variety Climax is highly susceptible to both.

T. W. WHITAKER

42-inch beds, with two rows of plants spaced approximately 12 inches apart in the row. Plots were 50 ft long and replicated three times.

Planting and harvest dates and the periods of cold weather and rainfall that occurred over the experimental period are shown in the graph. Although there were several nights in early December during which minimum temperatures were in the mid-30's, the first prolonged cold period began on December 30 and lasted for about 10 days. Another cold period occurred in late January but lasted for only two or three days. Rainfall of consequence occurred on February 10 and 11 (0.52") and on March 1–5 (0.94"). Temperatures were relatively warm with no cold nights during these periods.

The September 24 planting was harvested on December 18 (85 days) when heads were soft and immature. Subsequent harvests were on December 23, December 30, and January 8. On the last harvest, heads were hard and over-mature. All heads from each harvest were thoroughly examined for symptoms of internal rib necrosis. None was found in any of the treatments.

October 8

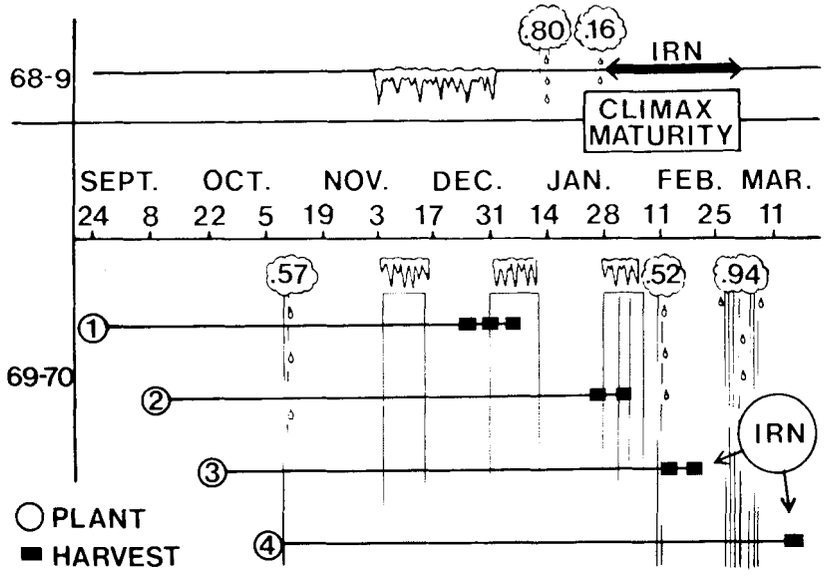
The October 8 planting was harvested on two dates: January 27 (103 days) and February 4. All heads were carefully examined for internal rib necrosis. In the second harvest one head of the Climax variety was found to have a small amount of affected gray-green tissue at the base of one of the midribs. This plant was from "normal" irrigation treatments.

The October 22 planting was harvested on February 17 (115 days) and February 20. Rain (0.52") fell on February 10 and 11. A period of low night temperatures with morning frosts and some ice in the heads occurred from January 28 through about February 6. Examination of the heads at harvest showed that a high percentage of Climax was moderately-to-severely affected with internal rib necrosis (see table 1). The other varieties were entirely unaffected. Harvested heads of all varieties were firm to hard.

The November 5 planting was harvested on March 13 (128 days). The heads were mostly hard and were judged to be about seven days past peak commercial maturity. Climax was affected with the disorder although the percentage of affected heads was lower than in the October 22 planting. Also, the amount of discolored tissue in the necrotic areas was considerably less. The necrotic areas of some leaves were so small they could easily have been overlooked.

Rusty rib

Heads of all varieties from the last date of planting were stored at 35°F for seven days in an ethylene-free room so possible post-harvest defects could be observed. Tissue discolorations were scored on each head prior to storage. Some heads of Climax were included which did not show internal rib necrosis symptoms. After storage, however, all heads of Climax (regardless of original internal rib necrosis symptoms) were severely affected with a disorder generally known as "rusty rib." The other three varieties were completely free of this disorder (see cover photos). The discoloration is in the epidermal tissue only and affects the entire surface of the ribs without the pitting and the discrete or coalescing necrotic areas which occur



COLD WEATHER AND RAINFALL PERIODS FOR THE 1968–69 AND 1969–70 SEASONS AT BRAWLEY. PLANTING AND HARVEST DATES ARE SHOWN FOR THE EXPERIMENTAL PLANTINGS.

INTERNAL RIB NECROSIS AND MATURITY OF LETTUCE AS AFFECTED BY VARIETY, DATE OF PLANTING, AND IRRIGATION TREATMENT, USDA SOUTHWESTERN IRRIGATION FIELD STATION, BRAWLEY—1969-70

Variety	Irrigation treatment	Date of Planting							
		Sept 24		Oct 8		Oct 22		Nov 5	
		% Cut	% IRN	% Cut	% IRN	% Cut	% IRN	% Cut	% IRN
Climax	Normal	51.3	0	73.3	0	64.4	85.4	60.2	34.6
	Wet	62.7	0	71.6	0	50.9	59.7	62.7	38.5
Forty-Niner	Normal	83.5	0	73.4	0	76.3	0	92.8	0
	Wet	89.8	0	78.9	0	76.8	0	90.6	0
Golden State D	Normal	80.2	0	78.3	0	80.8	0	85.1	0
	Wet	75.3	0	70.6	0	80.3	0	96.1	0
Vanguard	Normal	27.3	0	55.3	0	65.8	0	83.5	0
	Wet	34.6	0	56.6	0	67.8	0	65.9	0

with "russet spotting." "Rusty rib" was a serious problem in lettuce shipments from the Imperial Valley in 1970, and the disorder was apparently confined to Climax. Thus, Climax appears to be susceptible to two different types of tissue breakdown—one which develops in the field during maturity (internal rib necrosis), and one which develops after harvest under conditions of cold storage ("rusty rib"). These two types of symptoms may be different manifestations of the same general physiological disorder.

Analysis of the data from field plots at Brawley failed to show any effect of irrigation treatment on internal rib necrosis. Even though the plants harvested from the October 22 planting seemed to develop more internal rib necrosis under the "dry" treatment, the difference between the treatments was not great enough to be statistically significant. The results indicate that the suspicion that wet soil near maturity causes an increased incidence of internal rib necrosis is unfounded.

Weather records

An examination of the records of weather prevailing during the Brawley trial provides some insight into the effects of environmental conditions on disease development. Periods of cold weather preceded the harvests of both the October 8 and October 22 plantings by two weeks, yet the plants from the October 8 planting failed to develop internal rib necrosis. Cold weather in itself, therefore, does not appear to be the cause. Rainfall preceded the harvests of the last two plantings, but, even though both plantings showed considerable internal rib necrosis, the most abundant development of the disorder was in the October 22 planting. This harvest was preceded by both cold weather and rainfall. A combination of low temperature and rainfall was thought by several observers to be the major predisposing factor for the prevalence of the disorder in the winter of 1969, and it may explain why Climax, maturing before and after these periods during both 1969 and 1970, was largely free of internal rib necrosis.

Based upon the present knowledge of internal rib necrosis, the only solution lies in planting varieties resistant to the disorder. Climax is closely related to Golden State D, Francisco, and Vanguard through the USDA breeding line parent. From the results of the present experiment, at least two of these varieties (Golden State D and Vanguard) are known to be resistant to internal rib necrosis. Breeding lines related to Climax through the parent had been observed to be segregating for susceptibility to rib necrosis in 1959 and 1960 tests at Salinas. It appears possible, therefore, that resistance also exists within present stocks of Climax. Field selection of symptomless heads might lead to establishing lines with resistance to internal rib necrosis. This process of selection will require a minimum of three years; but should be pursued because Climax has some good horticultural characters and is well-adapted to midwinter production in the desert valleys of California. In the meantime, other varieties will need to be evaluated for the purpose of finding a suitable substitute for Climax, if necessary.

Hunter Johnson, Jr. is Extension Vegetable Crops Specialist, University of California, Riverside; David R. Woodruff is Farm Advisor, Imperial County; and Thomas W. Whitaker is Research Geneticist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, La Jolla, California. Cooperating in these studies were A. J. MacKenzie, Superintendent, and R. O. Standridge, Agricultural Research Technician, both of USDA Southwestern Irrigation Field Station, Brawley, California; and Adolph Van Maren, County Director and Farm Advisor, Imperial County. Photographs were by Albert O. Paulus, Extension Plant Pathologist, University of California, Riverside.

Feedlot performance . . . STEERS vs.

GOOD TO CHOICE HEIFERS are discounted from one to three dollars per hundredweight on most U. S. markets. This is true for live weight as well as for wholesale carcasses. On the other hand, Good to Choice ewe lambs and gilts bring the same price as wether lambs and fat barrows of equal grade, for both live animals and for carcasses.

This penalty against heifer beef has been with the industry for a long time. In the early days, most of the "she stuff" on the market came from old cows far advanced in pregnancy—or over-finished, wasty animals. Historically then, there is some justification for the price differential. However, some countries—England, for example—prefer heifer beef to steer beef. They maintain that the female meat is of finer grain, more palatable and more tender than steer beef. Even in this country, most of the heifer beef sold today over the block brings the same price as steer beef of the same grade and quality.

In the fall of 1968, two ranchers, Jim Sinton of Shandon and Bert Crane of Merced, cooperated on a test to study the performance of heifers and steers. Birthdates on the calves from both herds were secured. They were weighed and one-half of each sex class implanted with stilbestrol—15 mg for the heifers and 30 mg for the steers, at approximately six weeks of age. The calves received no extra feed—just their mothers' milk and what forage they consumed. They were weaned at approximately eight months of age and weaning weights were recorded. These data show that steers on both ranches outperformed heifers in average daily gain (ADG) as well as weight per day of age (WDA). For example, Sinton steers had an ADG of 1.57 lbs and a WDA of 1.79 lbs while the heifers gained 1.41 lbs and 1.64 lbs, respectively. The Crane steers had an ADG of 1.82 and a WDA of 2.09, while the heifers recorded 1.72 and 1.98. All of these data are significant in favor of the steers. In this study the Sinton control steers had an ADG of 1.53 and WDA of 1.74. Treated steers had an ADG of 1.61 and their WDA was 1.84 (significant in favor of the treated animals).

Sinton control heifers gained an average daily weight of 1.33 and WDA of 1.57 while the treated heifers gained 1.52 and 1.73, respectively. Untreated Crane