Lima Bean Tolerant to Stem Rot

strain of large seeded lima resistant to stem disease offers possible transference of resistance to commercial varieties

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Basal stem rot of the lima bean in California is a destructive disease.

The most severe phase of basal stem rot—incited by *Rhizoctonia solani* Kuhn —occurs within the initial four weeks after emergence. Characteristic brick-red, oval, sunken lesions marked with concentric rings develop on the hypocotyls of infected plants. These lesions may ultimately enlarge and girdle the stem. Lateral roots are not extensively infected. Infected plants are often stunted, especially when subjected to water stress. Occasionally severely infected seedling plants are killed, reducing stands by 10% or more in heavily infested fields. As plants become older, development of the disease slows down and partial to nearly complete recovery is frequent.

Rhizoctonia basal stem rot is particularly serious in coastal southern California on lima beans grown for quick freezing. Besides reducing yields, it causes uneven maturity resulting in higher processing costs and lower quality.

A survey of lima bean varieties or strains has been conducted to discover sources of resistance which may be useful in the control of this disorder if it is possible to make the transfer to commercial varieties in the lima bean breeding program.

One hundred fifteen varieties or strains of lima beans were tested for reaction to basal stem rot. The majority were from the lima bean accession series maintained at Davis. The rest were supplied by the United States Department of Agriculture. The varieties or strains tested each season included the most promising material of previous tests.

All testing was conducted in commercial fields having a history of poor plant stands and severe root decay. Field plantings were arranged in randomized complete blocks with four replications. Individual plots consisted of single rows 25′ long. Approximately four to eight weeks after emergence, 10 plants were pulled from each plot and rated in one of five arbitrarily chosen classes for hypocotyl decay. Plants with no visible decay or discoloration were placed in class 0; those with superficially discolored hypocotyls, in class 25; those with definite lesions involving not more than 50% of the hypocotyl, in class 75; and those with from 75% to 100% hypocotyl decay, in class 100. A disease index was calculated for each plot as the sum of the products of the class values multiplied by the number of individuals within the class, divided by the number of individuals sampled in the plot. The predominant edible lima bean varieties of southern California, Concentrated Fordhook—for freezing—and Ventura—dry—were included as controls in all trials.

The initial test, in 1949, included 10 varieties and 22 strains of lima beans and was located in Ventura County on a sandy loam soil known to be heavily infested with *Rhizoctonia solani*. The response of the 10 varieties and one of the strains is shown in the table on page 15. The remaining seed lots tested were all highly susceptible to this disease. Of the 32 items tested in 1949, US 403A was the only one which had significantly less hypocotyl decay than Concentrated Fordhook.

Four varieties and 46 strains were tested the next season in Ventura County in another field—clay loam soil—located farther inland and subject to fewer coastal fogs. The reactions of the four varieties and two of the strains are shown in the table. The remaining 44 strains were found to be highly susceptible to basal stem rot. Both control varieties were less severely diseased in this trial than in the previous trial. Under the cir-

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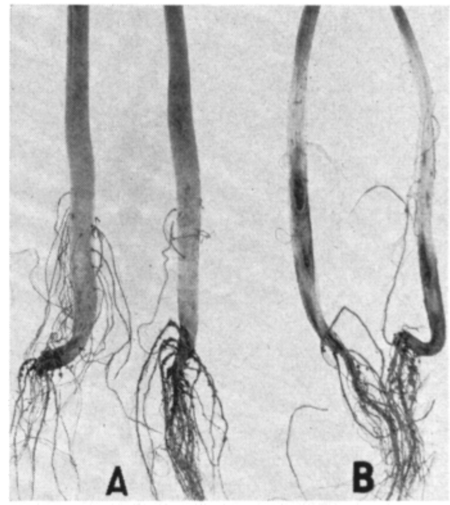

Representative roots of two strains of lima beans grown in field soils infested with *Rhizoctonia solani* Kuhn. A, Strain L-4. B, Concentrated Fordhook.

Growth of strain L-4 (row 312) compared with that of two susceptible strains in soil naturally infested by *Rhizoctonia solani*.

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cumstances of this trial, the amount of decay in Fordhook 242 was significantly less than that of Concentrated Fordhook, and plants of selection L-4 developed only superficial hypocotyl discoloration. The resistance shown by US 403A in the first trial was not evident in this test; in fact, strain 403A was more severely diseased than the control varieties. This difference in response by one variety emphasizes the necessity for testing material under a range of conditions.

Three varieties and 27 strains, including surviving material from previous trials, were tested in 1951 on a heavy loam soil in Orange County. The mean summer temperature in this trial area is higher by about 5F than that in the areas of the first two trials. Fordhook 242 was eliminated as a potential source of resistance because it did not show outstanding tolerance to decay in this test. Strain L-4, however, again exhibited a good degree of tolerance, hypocotyls of this strain being only superficially discolored at the worst. Seed was collected from 42 individual L-4 plants for further testing.

The fourth season's test—1952—was located in Los Angeles County in an area subject to coastal fogs. The sandy soil was very heavily infested with the disease-inciting organism. The trial included 42 lines derived from single plants of strain L-4 selected in the previous test, together with Concentrated Fordhook in the first three trials. The differences observed were not significant, however. Under the exceptionally severe conditions of the fourth trial, Ventura proved to be significantly more tolerant than Concentrated Fordhook. All lines of L-4 were significantly more tolerant to hypocotyl decay than the Concentrated Fordhook; five of the single plant progenies of L-4 fell in class 75, 30 in class 50, and seven in class 25. One of the seven lines with the lowest disease index was selected as the source of tolerance in a breeding program designed to improve the reaction of Concentrated Fordhook to this disease.

Strain L-4 is very similar to the Giant Calico variety which was reported to have germinated significantly better in unsterilized soil at 59F than the Fordhook, Henderson, and Jackson varieties. The superiority is attributed in a large measure to resistance of the cotyledon to infection by Rhizoctonia. The two types —L-4 and Giant Calico—may be identical. Transfer of their tolerance to *Rhizoctonia solani* into commercial varieties should prove a major step in reducing losses in yield and quality of lima beans caused by the poor stands and root destruction resulting from attacks of this organism.

Mean Indices for Hypocotyl Decay Exhibited by Some of the Lima Bean Varieties or Strains Tested in Various Southern California Areas, 1949 to 1952

Variety or strain	Location and year of test			
	Ventura County		Orange County 1951	Los Angeles County 1952
	Field 1 1949	Field 2 1950		
Concentrated Fordhook	46.5	38.8	41.3	84.4
Ventura	40.0	32.5	38.8	51.5**
Fordhook 242	35.7	30.0*	40.0	...
Regular Fordhook	54.5	...	...	...
US 403A	28.3**	47.5	...	...
Henderson	48.7	38.8	...	...
L-4	...	27.5**	26.2*	43.8**
L-4—7 best lines 1951	...	...	...	27.2**
Easy Thresh	43.3	...	...	...
Triumph	46.7	...	...	...
Westan	46.7	...	...	...
Peerless	49.8	...	...	...
Wilbur	50.4	...	...	...

* Significantly different from Concentrated Fordhook at odds of 19:1.

** Significantly different from Concentrated Fordhook at odds of 99:1.

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CONTROLS

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The diverted acres in the central San Joaquin Valley trended heavily into grain, hay, and pasture. In both these last two subareas, dairying and beef are well established, although on the Eastside dairying, in particular, tended to decline from 1947 to 1953.

The soil and water conditions on the Westside limited possible adjustments. Water costs are high; establishing and developing a well often involves investments of $35,000 to $50,000. Common practice has been to combine a winter crop—such as barley—with cotton in such an acreage ratio as to use the full capacity of the well for 10 months or more of the year. Growers have found few alternatives for cotton—as a summer crop—assuring them a net return, much less an equivalent level of earnings.

Farmers operating all farm sizes report reduction in miscellaneous crops, both in terms of number of crops and acres. The smaller farms tended to increase legumes, particularly alfalfa hay and irrigated pastures, plus feed grains —field corn, milo, barley.

There was little or no change in fallow land for farms of 80 crop-acres and under. As the size of farm increased, however, farmers tended to shift a higher proportion of diverted acres to grain and relatively less to legumes. On the Westside, farmers put about half their diverted acres into barley with two fifths being left fallow and the remainder assigned to summer crops such as alfalfa seed.

The greatest increase in inputs of resources other than land for cotton production is occurring in the more highly specialized areas such as upper San Joaquin Valley—Kern County—the Westside, and southern California. This is particularly true of materials such as fertilizers and soil conditions, and investments such as added land levelling and improved irrigation facilities.

Growers in the subareas with acceptable alternatives to cotton succeeded in maintaining gross value of farm production or, at least, in minimizing its drop.

The crops with increases of 10% or more in gross value tend to concentrate in Kern County. Many larger farms in southern California, on the Eastside, and in the central San Joaquin Valley also were able to shift into such crops.

Under-use of mechanical cotton picker capacity—resulting from the acreage cut—was followed by a drop in custom rates for mechanical picking as well as for hand picking during the 1954 cotton harvest season. The majority of California growers with 100–150 acres producing cotton in recent years equipped themselves with mechanical pickers. These farmers now find themselves with insufficient acreage following the acre cuts to utilize all their harvesting capacity.

The tendency of growers to increase capital investment in permanent improvements and equipment is most evident on the part of larger operators and of farmers who either own their land or have a long-time lease, frequently some type of development lease.

The acreage control programs have varied in effect depending on tenure. For example, a cash-lease grower—operating in a high water-cost area—might be paying $50 an acre year year for 80 acres in cotton. Under the control program he would be cut to 40 acres of cotton. Therefore, he would, in effect, be paying $100 an acre rent, and—in a high water-cost area—it is difficult to find a profitable alternative crop for cotton.

The farmer with a development lease finds himself with a similar difficulty. He has undertaken to pay for a considerable investment in farm improvements—in lieu of rent—over a period of years. He finds his financial position weakened or endangered to the degree that the control program lessens his ability to meet the fixed payments he has assumed.

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