UNIVERSITY OF IDAHO
College of Agriculture

Bean Production In Idaho

MARSHALL LEBARON
R. W. PORTMAN
C. W. HUNGERFORD
V. I. MYERS

IDAHO Agricultural Experiment Station

Bulletin No. 282
February, 1958

VARIETAL REACTIO

Field or Dry Beans

Variety	Curly Top	Common Mosaic	
		Strain VI	Strain VIA
California Pink	Resistant	Susceptible	Susceptible
Cranberry	Susceptible	Susceptible	Susceptible
Great Northern 1140	Susceptible	Resistant	Resistant
Great Northern UI-31	Resistant	Resistant	Resistant
Great Northern UI-59	Susceptible	Resistant	Resistant
Great Northern UI-123	Susceptible	Resistant	Resistant
Pea Bean Michelite	Susceptible	Resistant	Susceptible
Pea Bean Sanilac	Susceptible	Resistant	Susceptible
Pinto UI-78	Resistant	Resistant	Susceptible
Pinto UI-111	Resistant	Resistant	Susceptible
Pinto, Columbia	Resistant	Resistant	Resistant
Red Kidney (Common)	Susceptible	Susceptible	Susceptible
Red Kidney (Light)	Susceptible	Susceptible	Susceptible
Red Mexican UI-3	Resistant	Resistant	Susceptible
Red Mexican U1-34	Resistant	Resistant	Susceptible
Red Mexican UI-35	Resistant	Resistant	Resistant
Small Flat White	Susceptible	Resistant	Susceptible

Garden or Snap Beans

Variety	Curly Top	Common Mosaic	
		Strain VI	Strain VIA
Bush—Green Pod			
Bountiful	Susceptible	Susceptible	Susceptible
Blk. Val. Stringless	Susceptible	Susceptible	Susceptible
Commodore Improved	Susceptible	Susceptible	Susceptible
Contender	Susceptible	Resistant	Resistant
Cornelli 14	Susceptible	Resistant	Resistant

TO BEAN VIRUSES

Garden or Snap Beans (Continued)

Variety	Curly Top	Common Mosaic	
		Strain VI	Strain VIA
Idaho Bountiful	Resistant	Resistant	Resistant
Idaho Refugee	Susceptible	Resistant	Resistant
Plentiful	Susceptible	Susceptible	Susceptible
Ranger	Susceptible	Resistant	Resistant
Seminole	Susceptible	Resistant	Resistant
Slendergreen	Susceptible	Susceptible	Susceptible
Stringless Greenpod (Tendergreen)	Susceptible	Susceptible	Susceptible
Tendergreen Improved	Susceptible	Resistant	Resistant
Tenderlong 15	Susceptible	Resistant	Resistant
Tenderpod	Susceptible	Susceptible	Susceptible
Tennessee Greenpod	Susceptible	Susceptible	Susceptible
Topcrop	Susceptible	Resistant	Resistant
Wade	Susceptible	Resistant	Resistant
Bush—Wax Pod			
Brittle Wax	Susceptible	Susceptible	Susceptible
Cherokee Wax	Susceptible	Susceptible	Susceptible
Davis Stringless Wax	Susceptible	Susceptible	Susceptible
Golden Gem	Resistant	Resistant	Resistant
Golden Wax	Susceptible	Susceptible	Susceptible
Kinghorn Special	Susceptible	Susceptible	Susceptible
Pencil Pod Black Wax	Susceptible	Susceptible	Susceptible
Puregold Wax	Susceptible	Susceptible	Susceptible
Pole—Green Pod			
Blue Lake Stringless	Susceptible	Resistant	Resistant
Florigreen	Susceptible	Resistant	Resistant
Kentucky Wonder	Susceptible	Susceptible	Susceptible
Pole—Wax Pod			
Kentucky Wonder Wax	Susceptible	Susceptible	Susceptible

TABLE OF CONTENTS

Introduction 5
Varieties 5
Source of Seed 6
Crop Rotation 6
Land Preparation 7
- Irrigated Land 7
- Non-irrigated Land 7

Fertilization 7
Inoculation 7
Planting 8
Cultivation 9
Irrigation 10
Harvesting 11
Diseases 12
- Bacterial 14
  - Common Blight 14
  - Halo Blight 14
  - Bacterial Wilt 14
- Fungus 14
  - Root Rot 14
  - Sclerotinia Wilt 15
  - Pythium Wilt 16
- Virus 16
  - Mosaics 16
  - Curly Top 18
- Non-parasitic 19
  - Baldheads 19
  - Heat Injury 19
  - Sunscald 19
  - Alkali Injury 19

Seed Treatment 20
Insect Pests 20
- Major Pests 20
  - Beet Leafhopper 21
  - Lygus Bugs 21
  - Seed-corn Maggot 21
  - Two-spotted Spider Mite 21
  - Red-backed Cutworm 22
  - Western Bean Cutworm 22
  - Wireworm 22
- Minor Pests 22
  - Thrips 22
  - Grasshopper 23
  - White Grubs 23
  - Corn Earworms 23
  - Lima Bean Pod Borer 23
  - Cutworms 23

COVER PHOTO.—*A typical view of the bean producing area near Twin Falls, Idaho. Photo courtesy of Associated Seed Growers, Inc.*

BEAN PRODUCTION IN IDAHO

MARSHALL LEBARON, C. W. HUNGERFORD,
R. W. PORTMAN, V. I. MYERS *

Introduction

IDAHO RANKS FIRST among the states in the production of garden bean seed and second in the production of field beans. This position is possible because of Idaho's **unique geographic location** which is condusive to the production of high-quality, disease-free seed. The gross income to the farmers from beans is approximately $20,000,000 annually, placing this crop among the leaders in Idaho agriculture.

The major bean production area extends along the Snake River from southcentral to southwestern Idaho. The soils of this region are predominantly silt loams with sandy loams in some localized areas. The extent of bean production in this general region is limited only by the length of the frost-free growing season. An area of lesser importance is in northern Idaho, where beans are grown on non-irrigated farms along the ridges above the Clearwater River in Latah, Nez Perce, Lewis and Clearwater counties. The soils of this region are silt loams.

Varieties

The Great Northern, Pinto and Red Mexican varieties are the principal dry bean types produced in southern Idaho. Varieties of other types such as kidney, small white or pea bean, and cranberry are also grown in limited quantities. These varieties all have a vining growth habit, except the kidneys and Sanilac, a pea bean.

The flat, small white is the dominant type in the northern Idaho production area but a limited acreage is devoted to the production of Pinto.

Table 1 gives the relative yield and the days required from planting to maturity for representative types from each major class of dry beans. The yield averages given are: (1) for the state, (2) for the University of Idaho, Branch Experiment Station, Kimberly, Idaho.

Table 1.—Relative yield and growing season of dry beans in Idaho

VARIETY	Ave. yield (1) state	Ave. yield Exp. Sta.	Days to maturity
Red Mexican	2100	2700	110
Pinto	1950	2500	95
Great Northern	1930	2200	101
Small White	600	2100	97
Michelite (pea)	600	2100 (2)	100
Cranberry	.....	2100	101
Kidney	.....	1850	105
Sanilac	.....	2200	100

(1) Yields cited are CWT/acre.
(2) Experiment Station data limited for Michelite, Cranberry and Kidney.

*Superintendent, Twin Falls Branch Experiment Station; Professor Emeritus, Department of Plant Pathology; Extension Entomologist; and formerly Assistant Agricultural Engineer, respectively.

Many garden or snap bean varieties are produced in southcentral Idaho for seed. These varieties vary in type, yield, and maturity and are grown only under contract with a seed company. Detailed information on specific garden bean varieties is often furnished to the grower or can be obtained from seed companies. However, most of the recommended farming practices for field beans also apply to garden beans.

Source of Seed

Dry bean seed should always be of certified grade. Each bag of certified seed sold in Idaho must bear the official seal and tag of the Idaho Crop Improvement Association. This tag and seal assures the grower that the seed is of good quality, free of varietal mixtures, seed-borne diseases, objectionable weed seed and will meet the 85 percent minimum germination requirement. Foundation seed stocks of approved varieties are produced and maintained by the Idaho Agriculture Experiment Station and are distributed to warehousemen and growers through the Idaho Crop Improvement Association. Certified seed for planting may be purchased from warehouses in the production areas. The following varieties were approved for certification in 1957:

Flat, small white, U. of I. No. 1 and 2
Great Northern, U. of I. No. 123, 59, 31 and 16
Pinto, U. of I. No. 111, 78 and 72
Red Kidney—dark, light
Red Mexican, U. of I No. 34 and 3.

Seed of garden varieties is not certified but high-quality stocks are maintained and produced by the major commercial seed companies in the area.

Crop Rotation

Beans will fit into a variety of rotation plans. They will grow satisfactorily following alfalfa, clover, cereals, potatoes, peas, rye or sugar beets. Many fields have produced good bean crops for two and often many more years. However, the successive cropping of beans is not recommended. The practice of growing beans on the same field year after year multiplies the disease and insect problems and reduces soil fertility and organic matter. A crop rotation that allows 3 or 4 years between bean crops on a particular field is considered a good practice.

Many times growers experience difficulty with beans following sugar beets. The growth of the bean plant is often retarded for a few days shortly after emergence, but an early cultivation and irrigation will usually start the crop growing normally.

Winter rye plus nitrogen is very beneficial in short rotations, such as beans after beans or beans after peas. The rye will act as a winter ground cover and increases organic matter to some extent. Sufficient nitrogen (50 lbs. available per acre or more) should be applied to the rye to insure good growth and subsequent decomposition when it is plowed under.

Land Preparation

Irrigated Land

The preparation of land for beans varies with the machinery available and the preceding crop. The land is plowed either in the fall or spring. If a winter cover crop, such as rye, is to be turned under, the land should be plowed early in May. When beans are to follow alfalfa, the alfalfa may be "crowned" in the fall, followed by deep plowing in the spring. Another very satisfactory method of handling alfalfa land for beans is to spray the alfalfa with 2, 4-D at the rate of 2 pounds per acre (acid equivalent) after the last cutting of hay is removed. The alfalfa will be killed within a period of 2 weeks and may then be plowed without crowning.

It is necessary to work down the surface of the soil sufficiently to irrigate before planting. After the pre-planting irrigation, the soil is allowed to dry for approximately 10 days or until the surface is dry. The common practice is to harrow once, then work the soil with a disk or field cultivator to a depth of 3 or 4 inches. The final seedbed preparation can then be accomplished by harrowing two or three times. The seedbed should be firm but not packed hard.

Non-irrigated Land

Plowing in the fall is preferable for beans under dry land conditions. However, early spring plowing can be quite satisfactory. The soil is usually disked and then harrowed several times before planting. Proper timing of these operations can effectively control weeds as well as prepare the seedbed.

Fertilization

Nitrogen and phosphorous fertilizers are not generally recommended for beans in Idaho. It is far more economical to apply the fertilizer to other crops in the rotation. If beans are to follow a grain crop, and the stubble is not removed, then an application of nitrogen is advisable. Generally, 1 pound of nitrogen for each 110 pounds of straw turned under should be adequate. This fertilizer should be applied before plowing and should be followed by an irrigation if possible.

Barnyard manure will increase bean yields and should be applied if it is available. However, the fertilizer requirements of other crops in the rotation, such as sugar beets and potatoes, should be considered first.

Beans have not responded to applications of the minor elements, iron, manganese and zinc in southern Idaho.

If the soil is in good general state of fertility, with adequate organic matter, maximum bean yields can usually be expected.

Inoculation

The inoculation of bean seed with nitrogen-fixing bacteria has not proven to be of value, either in the irrigated or dry land bean producing areas of Idaho, except on virgin soil.

Planting

Several types of planters are used for beans and all are quite satisfactory. Beans should not be planted until the surface 6 inches of the soil has reached a temperature of 50°F. or more. The most common planting dates are from May 15 through June 7.

To insure that adequate moisture is available for the germinating seed, it should be planted at a depth of $2\frac{1}{2}$ to $3\frac{1}{2}$ inches. Deeper planting should not be made unless the moisture supply is very low. Many growers in southern Idaho make a ridge of soil over the row at planting time and harrow it off within 4 or 5 days. This procedure helps to maintain moisture around the seed and is also effective in weed control.

Rates of planting will vary with the variety, its germination, and its ability to resist disease and insect injury. The information contained in Table 2 is based on data from trials at the Twin Falls Branch Station. The spacing given is considered the optimum for best yields. If the seed tests less than 85 percent germination the rate of planting must be increased to compensate for the lower germination.

Table 2.—Recommended rates of planting in pounds per acre.

VARIETY	Germination percentage 95-100%	Germination percentage 80-85%	Spacing of plants in rows 22" apart
Dry Beans			
Pinto ..... UI 111	75 pounds	90 pounds	3
Great Northern ..... UI 123	75 pounds	90 pounds	3
Great Northern ..... UI 31	60 pounds	100 pounds	3
Red Mexican ..... UI 34	65 pounds	80 pounds	3
Small White (pea bean)	40 pounds	50 pounds	3
Snap Beans			
Topcrop	120 pounds	145 pounds	2
Bountiful	135 pounds	160 pounds	2

Figure 1.—A type of planter commonly used in the irrigated areas of Idaho.

Occasionally a farmer is faced with the problem of a poor stand of beans and he must decide whether or not to replant his crop. In making this decision several factors must be considered: (1) is there sufficient time to replant and mature the crop, (2) is there sufficient moisture in the soil surface to germinate the seed, (3) how many plants constitute a stand, and (4) is the reduction in stand uniform or spotty as in the case of frost damage? The semi-vining field beans will normally produce a good crop if the plant population is not reduced beyond an average spacing of 6 inches between plants in the row, and even greater spacings will often produce a fair yield. The garden bush beans will normally produce a good crop if the plant population is not reduced beyond an average spacing of 4 inches between plants in the row.

The most common row width for planting beans is 22 or 24 inches in the irrigated areas and 28 or 30 inches in the dry land areas of Idaho. Limited experimental data from the irrigated areas indicates that the semi-vining field bean types will yield as well when rows are planted as much as 36 inches apart. The same rate of planting in pounds of seed per acre should be used for any row width from 22 to 36 inches.

Figure 2.—A close-up of the "hiller" attachments used to ridge soil on the rows.

Cultivation

The principal reason for cultivating a bean crop is to control weeds. Excessive cultivation may result in undue injury to the root system. The cultivation should be shallow and should be started when the weeds are small. In the irrigated areas it is necessary to make corrugations between the rows for irrigation water. This is usually done simultaneously with the first or second cultivation.

The cultivators may be set up with many different combinations of tools and any combination that will till the soil surface and roll some soil around the base of the plant will be satisfactory. It is necessary to ridge some soil around the plants for two reasons: first, it will smother the small weeds in the bean row; and secondly, it will help promote the growth of secondary roots which are vital when the primary root system becomes affected by root rot.

Late-season cultivations, if necessary, should be performed with care to avoid root injury and subsequent blossom drop.

All of the annual weeds common to Idaho can be controlled quite well by cultivation, except those of the nightshade family. These plants begin to grow at the close of the cultivating season and are usually quite large and green at the time of harvest. The nightshade plants may interfere with the harvesting operation; therefore, it is often considered good economy to remove them from the fields by hand and burn them.

Pre-emergence weed control with chemicals has not proven to be a satisfactory method of controlling weeds in the irrigated areas of southern Idaho.

Irrigation

In the past, the frequency and rate of application of irrigation water has varied with the experience of the grower and local customs. Recent irrigation experiments conducted on the Twin Falls Branch Station have shown several critical aspects of irrigation as applied to the production of dry beans. It should be realized, however, that many factors must be considered in deciding when to irrigate and how much water to apply. The kind of soil, weather conditions, depth of plant roots, and other variables all influence the irrigation cycle. It is especially significant that the irrigation intervals vary throughout the irrigation season. For example, the test plots where the most water was applied (short frequency treatments) were irrigated as frequently as every 5 or 6 days during the hot part of the season, but at intervals of 11 or 12 days during the late, cooler weeks.

Applying water to every row each irrigation or in every other row (alternating rows each successive irrigation) gave the best yields.

Table 3.—Yield of dry beans for short and medium irrigation frequency using two methods of irrigation. The weights are averages of three trials.

Method of Irrigation	Yield in CWT/acre	
	Short cycle	**Medium cycle**
Every row	27.47	24.12
Every other row alternating each successive irrigation	26.39	21.78

Seed produced on plants receiving the most frequent applications of water had the highest rate of germination. This increase in germination percentage is probably due to the higher moisture content of the seed at threshing time and to less thresher injury. In the short-frequency treatment there was an application of water near the date of harvest. This

is recommended to help reduce seed injury while threshing. The frequency of irrigation did not appear to affect the severity of root rot.

Irrigation should begin before the available moisture in the root zone is more than 50 percent depleted. At this moisture level, soils of medium texture will still be somewhat crumbly, but will hold together when compressed firmly in the hand. The use of short irrigation runs is suggested to permit light applications of water which will avoid excessive deep percolation losses and reduce soil compaction.

There are instances when it is necessary to irrigate a bean crop at the time it is planted to insure sufficient moisture for germination; however, this must be done with caution. Applying irrigation water tends to cool the soil, which will retard germination, and also tends to compact it around the seedlings, which may prevent their emergence.

When the soil moisture supply is reduced, bean plants will become noticeably darker in color. This color change can often be used by an experienced irrigator to indicate the irrigation requirement of the crop.

Harvesting

Harvesting is a very important step in the production of a bean seed crop. The dry, ripe bean seed must be handled as gently as possible to prevent injury and loss of germination. The beans should be cut and windrowed when most of the pods are yellow and most of the seeds are mature. After the beans are pulled or cut, they should be raked into windrows immediately with a side delivery rake. It is advisable to make the windrows as large as can be conveniently threshed by the specific

Figure 3.—C. B. Hay bean harvester at work in southern Idaho. This is one of the more popular types of special bean harvesters used in the area. Photo courtesy Associated Seed Growers, Inc.

machine to be used, usually 6 or 8 rows. The larger windrows offer the seed more protection from injury and discoloration by the sun. The pulling and windrowing is often done at night or early in the morning when the plants are damp with dew. This will very materially reduce the loss from shattering. The windrows should be left to cure for a period of 7 to 10 days to permit complete drying of the straw and pods before threshing.

Combines of various types are used to thresh beans. Small "all-crop" type harvesters are used by many growers but a large combine developed especially for beans is commonly used in the bean-producing areas of southern Idaho. The large combines have two cylinders for threshing, whereas the small ones have only one.

The care of the seed must begin at the thresher. The cylinder speed should be reduced as much as possible and long drops in the separating and loading operations should be prevented. The cylinder speed should be between 250 and 400 RPM for most threshing conditions. There must be sufficient clearance between the cylinder and concave bar to allow the seed to pass through without injury. If there is evidence of injury or splitting in the seed, immediate adjustments should be made.

Beans produced for seed purposes are put into 100-pound bags at the combine while commercial dry edible beans are often handled in bulk bins or boxes for delivery to the warehouse. After the beans reach the warehouse, they are milled to remove all of the foreign material and small or broken beans. Commercial dry beans are prepared for sale by packaging in small packages for the grocer's shelf, in 100-pound bags or retained in bulk storage. Beans for seed are milled and picked by hand or an electric eye machine and rebagged in 100-pound units.

Diseases

Wherever beans are grown they are subject to a number of diseases which each year reduce production and lower the grade of the bean crop. Idaho growers, however, have a well-earned reputation for producing high-quality, disease-free dry and snap bean seed. In part, this reputation rests upon the fact that seed produced in the state is free or relatively free from infection by certain destructive seed-borne diseases. The comparatively dry climate in our bean-producing areas prevents the development of a number of these serious seed-borne, disease-producing organisms. The fact that varieties of beans having high resistance to some of the serious virus diseases have been successfully developed and distributed in the state has helped to establish the bean growers of Idaho as seed producers for other bean-growing areas of the West. Thousands of bags of high-quality certified bean seed are shipped to other less fortunate bean-producing areas each year.

In this brief discussion only the most important bean diseases as they occur in the state will be described. They will be listed in four classes based upon the cause of the disease: bacteria, fungi, viruses and non-parasitic abnormalities.

Figure 4.—Symptom of common blight on leaf.

Figure 5.—Symptom of halo blight on leaf.

Bacterial

Three important diseases of beans are caused by bacteria: **common blight, halo blight,** and **bacterial wilt.** All three of these diseases have been repeatedly introduced into Idaho in infected seed. None persist for any length of time under normal growing conditions here. The use of seed free from the bacteria causing these diseases is the only sure way to prevent sporadic outbreaks. A small amount of infected seed may produce a few infected plants which under moist conditions serve as a source of bacteria for general spread of the disease throughout the field.

The bacterial blights are easily recognized in the field. The water-soaked spots on the leaves, stems, and pods are very characteristic of these two diseases. Reddish brown discoloration soon develops in the infected tissues and dried bacterial exudate appears on the surfaces of the spots. In severly infested fields, areas may appear where nearly all of the plants will turn yellow or brown, drop their leaves, and finally die. Halo blight causes the leaves to turn yellow in the early stages of the disease while in common blight the leaves have a brown discoloration.

The seeds which develop in infected pods may be invaded by the bacteria at the point of attachment to the pod. The discoloration caused by infection of the seed may be so slight as to escape notice. Severe infection may cause shriveling or death of the seed.

The bacterial wilt disease may cause symptoms somewhat similar to those caused by common blight and halo blight, but more often the disease causes a typical wilting of plants. The wilt organism spreads throughout the plant, invading the pods and developing seeds. Stunting and death of the plant may result or the bacteria may girdle the stem causing a rot at the node of the stem with the plant breaking over at this point.

The bacterial blights and bacterial wilt can be successfully prevented by use of disease-free seed. Other control measures are of doubtful value. Pinto, Great Northern and Red Mexican beans are resistant to halo blight, but no variety of dry beans is resistant to common blight. Little is known about varietal resistance to bacterial wilt.

Fungus

Root rots occur in varying degrees wherever beans are grown. A number of different parasitic organisms may attack the base of the stem, the tap root, or other parts of the root system causing reduced vigor or death of the entire plant. The most common root trouble in Idaho is the dry root rot caused by a Fusarium fungus. This disease is widespread and may be quite destructive, especially on soils which have been repeatedly planted to beans without proper rotation of crops. Characteristic reddish discoloration of the tap root is the most constant symptom of the disease. The fungus parasite plugs the tubes of the root tissue, and the lower portion of the root is thus cut off. If sufficient moisture is

present in the surface soil, new roots may develop above the point of injury. More frequent irrigations are required under these conditions.

Although numerous materials have been tested as soil fumigants and as soil and seed-treating agents, none has proven to be entirely satisfactory in controlling root rots. Cultural practices which provide good conditions for plant growth and a crop rotation system wherein beans are not grown too frequently on the same ground are the best insurance against losses from bean root rots.

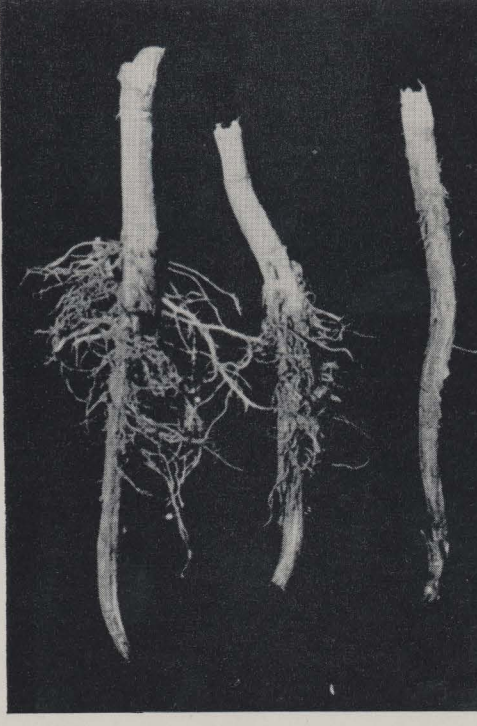

Figure 6.—Bean roots showing severe symptoms of bean root rot.

Sclerotinia Wilt (white mold) has become an important disease in Idaho in recent years. It is probably world-wide in its distribution. As the fungus causing this disease is soil-borne, Sclerotinia wilt, like the bean root rots, is usually more serious in the older bean-growing areas. The Sclerotinia fungus, however, may attack a large number of other crops and wild plants and is, therefore, usually present to some extent in most soils. The fungus may become seed-borne and infection may spread from the seed to the growing plant. Extensive experiments at the Idaho Agricultural Experiment

Figure 7.—Symptoms of Sclerotinia wilt (white mold. Photo courtesy W. J. Zaumeyer, U.S.D.A.

Station have shown, however, that this type of transmission of the disease from year-to-year and from one region to another is very rare. When discolored seeds from diseased plants were planted, less than 1 per cent of seed transmission was noted.

The Sclerotinia fungus may attack any of the parts of the bean plant, causing a rapid soft rot of the tissues under moist warm conditions. A white web of fungus growth usually covers the diseased areas. These areas gradually turn darker in color; the fungus material forms irregular shaped masses which finally turn black and form hard resting bodies of the fungus. These are called sclerotia and are the means of perpetuating the fungus over unfavorable conditions for the disease to develop.

Sclerotia may remain alive in a dry condition for years. When favorable moisture and temperature conditions again occur, a mushroom-like growth forms from the sclerotia and produces spores of the fungus. These spores are spread by wind or rain and under moist conditions may cause widespread development of the disease in the field.

When a bean field becomes infected with white mold, usually in August, the bean crop is starting to mature. The question many farmers must decide is, "Should I irrigate the crop again?" If the crop is irrigated again loss due to the disease may be severe. If the crop is not irrigated there may be loss of yield from immature beans. If the white mold appears to be spreading with each irrigation it would probably be advisable to withhold irrigation water, except when the soil is extremely dry.

Rank growth of bean plants, over-irrigation, and flooding of portions of the field provide ideal conditions for the fungus to develop and cause serious loss. Rotation, wide spacing of bean rows, and careful irrigation will tend to minimize losses.

Pythium Wilt is caused by a fungus which attacks the stem of the bean plant at the soil line. A soft slimy rot occurs which extends up into the plant but does not extend much below the soil. In southern Idaho, it usually attacks the plant during the early part of July, and affected plants wilt suddenly without noticeable loss of green color. Although this disease is ordinarily of little importance, it may cause very minor damage locally when conditions are favorable for its development. The general recommendations for the control of root rots will also apply in the control of Pythium wilt, although control of this disease is usually considered to be unnecessary in Idaho.

Virus

Mosaics.—This discussion of bean virus diseases will be limited to the three most important mosaics—common mosaic, a severe strain of common mosaic, yellow bean mosaic—and to curly top. Common mosaic and the variant strain of this disease produce symptoms in the field which are impossible to tell apart. A number of varieties of beans are susceptible to the variant but are resistant to the common form. (See table of resistant varieties.) These two mosaics are primarily leaf diseases,

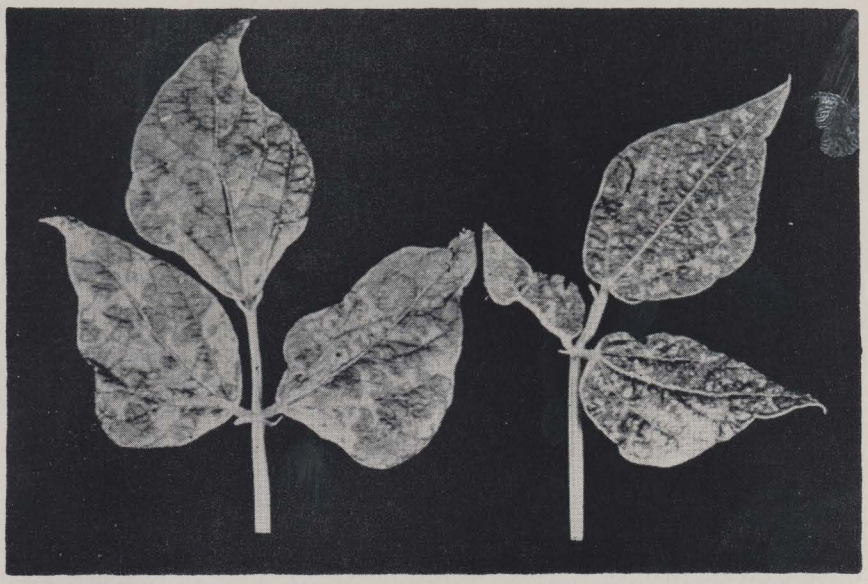

Figure 8.—Bean leaves showing symptoms of yellow bean mosaic.

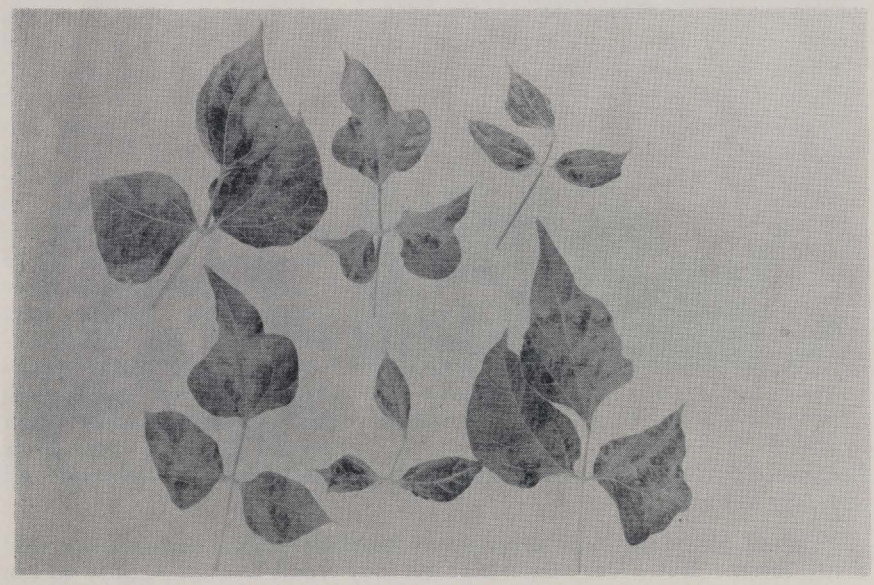

Figure 9.—Bean leaves showing variation in symptoms of common bean mosaic.

causing mottling, curling and distortion of leaf tissue. Although infected plants may be badly stunted, they are seldom killed. In yellow mosaic and in curly top, death of the plants may occur. As indicated by the name, yellow mosaic causes a yellowing of the leaves, and the contrast between the green and yellow areas of the infected leaves is more marked. There are a number of strains of yellow mosaic. The one described and illustrated here (Figure 8) is the typical strain which is common in Idaho.

The viruses of the bean mosaics are spread in the field by aphids or plant lice. Common mosaic and its variant may be transmitted through infected seed as the virus remains viable as long as the seed will germinate and develops with the young growing plant. The virus of yellow mosaic does not enter the seed and therefore is not seed transmitted. This disease over-winters primarily in sweet clover plants and is transferred to beans from infected sweet clover by aphids. Although some varieties of beans are more tolerant than others, no variety of dry or snap beans has been found to be resistant to the strain of yellow bean mosaic common in Idaho.

Curly Top.—The virus causing curly top in beans may also cause the disease on many other wild and cultivated crops. Few viruses have such an extensive host range. The disease, fortunately, is not seed-borne. It is spread in the field by the beet leafhopper or white fly, as it is often called. The amount of infection of curly top varies greatly from year to year, depending upon the population of leafhoppers, which is in turn influenced by weather conditions. Although there are certain symptoms which curly top and the mosaics have in common, it is usually fairly easy to distinguish curly top from the mosaics. When the leafhoppers carry the virus to bean plants early in their growth, the plants turn yellow and die. When infection takes place somewhat later, the leaves may first appear darker than normal in color and later become chlorotic, curl downward, and are considerably thickened and severely rolled.

Figure 10.—Curly top virus symptoms on beans. Note downward rolling of apical leaves.

The whole plant later presents a dwarfed, yellow appearance, and death often results. Very late infection may result in minor injury to the growing tips of the plant. The most satisfactory control for curly top is

growing varieties of beans which are resistant to the disease. Fortunately, there are available varieties of Pinto, Great Northern and Red Mexican beans which are resistant to curly top. It is good insurance to grow resistant varieties if you are located where curly top is a serious disease.

Table 4.—Field beans commonly grown in Idaho and their reaction to certain virus diseases

VARIETY		Common mosaic	Variant	Curly Top
Great Northern	UI 123	R	R	S
	UI 59	R	R	S
	UI 31	R	R	R
	USDA 1140	R	R	S
Pinto	UI 111	R	S	R
	Columbia	R	R	R
Red Mexican	UI 34	R	S	R
Small Flat White	UI 1	R	S	S
Kidney		S	S	S
Sanilac		R	S	S

R—Resistant
S—Susceptible

Non-parasitic Causes

There are numerous disease-like conditions in beans which are not caused by parasites. Some of these injuries may be of considerable importance when environmental conditions are unfavorable. A detailed description of this group of bean troubles is not possible in this brief discussion but a few of the more important ones will be listed.

When the new seedlings emerge from the ground, a few may be noted which have the growing point injured and the primary leaves absent from the stem. These plants have been called **baldheads.** The principal cause for this condition is injury to the growing point of the seed during handling or threshing. This type of injury is not so common in dry beans as in snap beans where it may be of considerable importance in some varieties.

Heat injury lesion may appear in the form of a constriction of the stem close to the soil line when bean plants are exposed to high daytime temperatures. This is especially true in light sandy soil.

Sunscald differs from heat injury in that it will affect all above-ground parts of older plants that are exposed to the direct or reflected rays of the sun. It is due to intense sunlight rather than heat. Sunscald on beans is characterized by the appearance of small brown patches between the veins of the leaves, often extending to make larger patches, partial defoliation or even complete loss of the plant may follow. When there is danger of injury due to sunscald it is advisable to irrigate bean fields at night, timing the application so that there will not be free water on the soil to reflect the sun's rays.

Alkali injury will appear on bean plants only when the total salts in the soil are relatively high. (**Alkali areas.**) The symptoms are yellow, stunted plants that later may actually show some corrosive action of the salts on the leaves. The leaf edges of the affected plants will be brown

and dead and often accumulations of the salt may be seen on the leaf surfaces. Other types of injury include hail damage, fertilizer injury, and injuries caused by an excess or deficiency of essential salts in the soil.

Seed Treatment

Seed treatment of field beans is of doubtful value in Idaho. When beans are planted under unfavorable soil and weather conditions, treatment with some of the newer materials may help to control rotting of the seed or damping-off of the seedlings. Treatment with insecticide-fungicide combiniations may be advisable where infestations of wireworm or seed-corn maggot are present.

Insect Pests

Several species of insects and mites attack Idaho beans and their control must be considered in bean production. The following numbers indicate the areas where these pests are found (northern Idaho 1, southwestern Idaho 2, and southcentral Idaho 3).

Major Pests

Beat leafhopper, *Circulifer tenellus* (Baker) 1, 2, 3.

Lygus bugs,*Liocoris elisus* (Van D.) 1, 2, 3.
L. hesperus (Kngt.) 1, 2, 3.
L. desertus (Kngt.) 1, 2, 3.

Red-backed cutworm, *Euxoa ochrogaster* (Guen.) 1, 2, 3.

Seed-corn maggot, *Hylemya cilicrura* (Rond.) 1, 2, 3.

Two-spotted spider mite, *Tetranychus telarius* (L.) 1, 2, 3.

Western bean cutworm, *Loxagrotis albicosta* (Sm.) 3.

Wireworms, *Limonius californicus* (Mann.) 1, 2, 3.
L. canus (LeC.) 1, 2, 3.
Ctenicera inflata (Say) 1.

Minor Pests

Thrips, *Thrips tabaci* (Lind.) 1, 2, 3.
Franklinella spp. 1, 2, 3.

Grasshoppers, *Melanoplus bivittatus* (Say) 1, 2, 3.
M. femur-rubrum (DeG) 1, 2, 3.
M. mexicanus (Sauss.) 1, 2, 3.

Lima-bean pod borer, *Etiella zinckenella* (Treit.) 2.

White grubs, *Polyphylla* 10-*lineata* (Say) 1, 2, 3.
Ligyrus gibbosus (DeG.) 1, 2, 3.

Corn earworm, *Heliothis zea* (Boddie) 2, 3.

Cutworms, *Agrotis ypsilon* (Rott.) 2, 3.
Pseudaletia unipuncta (Haw.) 2, 3.
Chorizagrotis auxiliaris (Grote) 1, 2, 3.
Peridroma margaritosa (How.) 1, 2, 3.
Amathes c-nigrum (L.) 2, 3.

Major Pests

Beat leafhopper—The beet leafhopper migrates long distances in the late spring and causes damage by transmitting curly top virus disease rather than by mass feeding. It spends the winters in vast areas of weeds that have grown up on abandoned farmlands, burned and overgrazed ranges. In the spring, when these plants mature and dry, the leafhoppers travel with the wind to summer hosts, transmitting curly top virus to all susceptible plants.

After the leafhopper moves into susceptible crops, there is no entirely satisfactory control. Planting resistant varieties, proper timing of planting dates, and treating the concentrated breeding areas with one pound of actual DDT per acre will aid in reducing curly top damage.

Lygus bugs.—These bugs spend the winter in fencerows, ditch banks, and hay fields. Their feeding may kill young bean plants or the terminal portion of the plants. Blossom-drop and malformed small pods are the result of lygus attacking the petioles. When attacking large pods with filling beans, they force their beaks through the pods into the individual beans, causing them to become deformed and "cat-faced", reducing the market value.

Lygus bugs are readily controlled with 30 pounds of 5 percent DDT dust applied per acre. In the southwestern and southcentral Idaho areas where the two-spotted spider mite is a problem, the use of 5 percent DDT plus 50 percent dusting sulphur at the rate of 30 pounds per acre will control both pests.

Seed-corn maggot—When bean seeds are planted in soil with abundant organic matter, the seed-corn maggot may seriously reduce the stand during springs characterized by cold, wet, slow-growing weather. In the spring, the over-wintering adults deposit their eggs in the soil containing an abundance of decaying humus. The tiny yellowish-white larvae burrow into the developing seeds, weakening or killing them. There are several generations each year.

Shallow planting in well-prepared seedbeds of warm soil is recommended. Seed treatments of 1 ounce actual dieldrin or heptachlor plus a fungicide per 100 pounds of seed has shown promise in seed-corn maggot control.

Two-spotted spider mite.—In southern Idaho, beans grown adjacent to alfalfa and clover fields are generally the most heavily infested. Mite feeding injury appears first as pale yellow to reddish-brown spots and later both surfaces of the entire leaf are damaged. The mites prefer the under leaf surface where they spin a fine silken web. Between the web and the leaf can be found the tiny eggs, nymphs and adults. There are many generations each year.

Early season infestations from adjacent hay fields can be prevented by applying 25 pounds of dusting sulphur per acre in a 20- to 30-foot border around the field. Later, when the first mite injury appears the entire field should be treated with dusting sulphur.

Red-backed cutworm.—The favored food of this cutworm includes a variety of broad-leaved plants. The moth deposits her eggs in mid- to late-summer. These eggs hatch the next spring, and in about 45 days the cutworms have completed their development. The cutworms' enormous appetite and rapid rate of growth is responsible for severe damage to beans.

They are readily controlled by an application of 30 pounds of 10 percent toxaphene dust. Where the ground has "crusted" and the cutworms are feeding beneath the surface, the field should be irrigated to bring the worms above ground before applying the toxaphene dust.

Western bean cutworm.—This insect is a problem where beans are grown on light, sandy soils in southcentral Idaho. Unlike other cutworms, this species is not cannibalistic, is specifically a pest of beans, and has been reported on corn and tomatoes in southcentral Idaho. The adults mature in over-wintering larval cells in the ground and emerge the latter part of July. The larvae are first found during the first week in August. As high as 25 percent injury has been noted in harvested beans. The larvae eat through the pod and into the developing bean. Occasionally a larva may tunnel through the pod, destroying all the beans in that pod.

Treat the entire field immediately on finding the tiny larvae, and before they commence to feed on the pods or beans. Apply 5 percent DDT dust at the rate of 20 to 25 pounds by ground, or 25 to 30 pounds by air per acre. Once the bean has been fed on it never recovers. Control must be properly timed and thoroughly applied for good results.

Wireworm.—When the soil is infested, bean stands will be severely damaged and many times will require replanting. Soil treatment, by thoroughly mixing 10 pounds of actual DDT in the top 8 inches of soil, will kill the wireworms and prevent them from reinfesting the soil for about 8 years. This should be done before planting of beans. DDT will not give effective control the first year under a heavy wireworm infestation; however, aldrin or heptachlor at 3 pounds per acre will protect the crop the first year.

Minor Pests

With the drying of native weed hosts, the maturing of grain and peas, and the cutting of hay crops, **thrips** are forced to move from these to other crops and often infest beans. The infestations are sporadic from season to season and from field to field. Thrips often move into bean fields in large numbers, but since beans are not a preferred host, very few remain throughout the growing season. Therefore, their injury to beans is of minor importance. They feed on the blossoms and on the underside of the leaves by rasping and puncturing the surface plant cells, causing silvering of a portion of the lower surface of the leaves. Severely injured lower leaves dry due to the loss of moisture, and by keeping the plants slightly on the wet side, the leaves do not readily dry and fall off. Since thrips feed on the lower surface of the leaves, they are very difficult to control, as the insecticides must be applied di-

rectly where they are feeding. Several insecticides are effective in killing thrips, but the coverage of the lower surface of the leaves, as well as proper timing is very important. Seldom has the control of thrips on beans justified the cost.

When **grasshoppers** are migrating into beans, the field can be bordered with aldrin, dieldrin or heptachlor sprays. This may stop the migration and save the expense of treating the entire field. **White grubs** are usually found in soil recently taken out of sod. Wireworm control is also effective for white grub control. Every 5 to 7 years, **corn earworms** are a problem in beans. About 1 week after the moths are found in the fields the larvae will be hatching from their eggs. Effective control may be obtained by applying DDT at the rate given for control of Western bean cutworm. Application should be made just as soon as the first larvae are found. The **lima-bean pod borer** on rare occasions causes some damage in southwestern Idaho. The infestations are generally light and the natural enemies of the pod borer have held it in check. Several species of **cutworms** may occasionally be found cutting off the bean plants in the spring as they emerge from the ground. Toxaphene, or other chlorinated hydrocarbon insecticides are very effective in controlling these migrating pests.

Other University of Idaho Publications that may be of interest to bean producers

Irrigation of Field Beans in Idaho. Research Bulletin No. 37.

Disease Resistant Field Beans for Idaho. Experiment Station Circular No. 118.

Farm Water Measurement. Extension Bulletin No. 170.

Use the Farm Level for Better Irrigation and Soil Conservation. Extension Bulletin No. 171.

Weed Control—Chemicals, Cultivation, Crop Rotations. Extension Service Bulletin No. 207.

Idaho Recommendations for Insect Control. Extension Service Bulletin No. 216.

Idaho Bountiful and Golden Gem Snap Beans Resistant to Curly Top. Experiment Station Bulletin No. 217.

Western Bean Cutworm . . . and Its Control. Extension Service Bulletin No. 233.

Field Beans As a Dietary Source of Protein. Experiment Station Bulletin No. 289.

Copies of these and other University of Idaho agricultural publications may be secured from county agricultural agents or by writing to the Director, Idaho Agricultural Extension Service, Moscow or Boise