Soybean Production in Michigan
Michigan State University Extension Service
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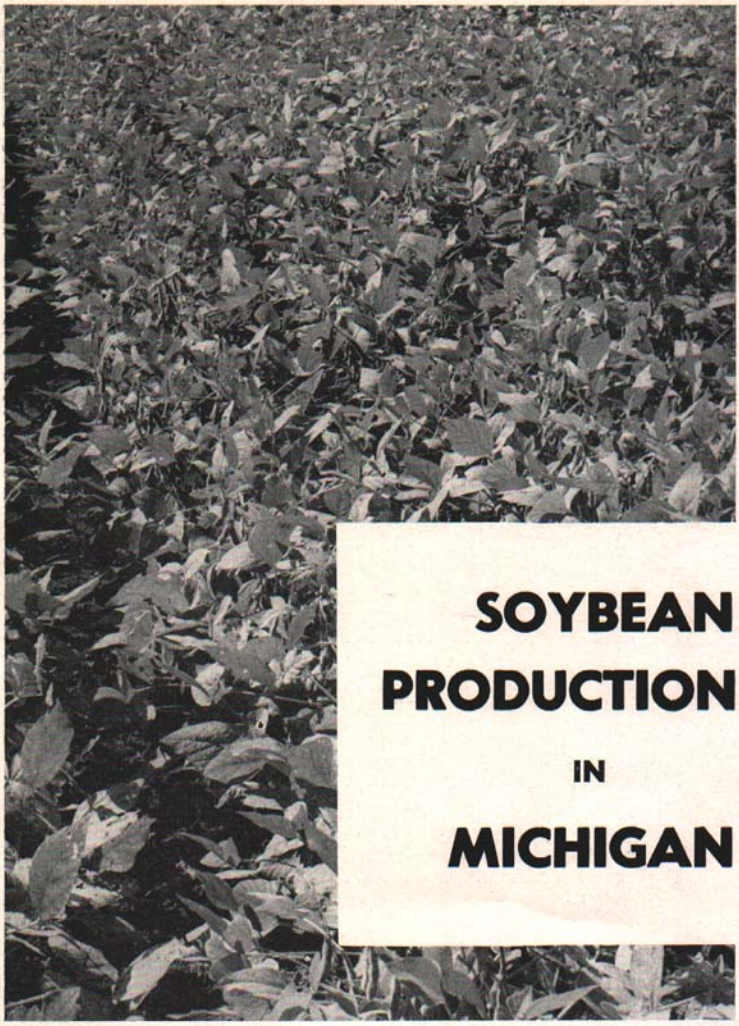

SOYBEAN PRODUCTION IN MICHIGAN

COOPERATIVE EXTENSION SERVICE

Michigan State University East Lansing

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SOYBEAN PRODUCTION IN MICHIGAN

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Soybeans are increasing in importance as a cash crop in Michigan, especially in the southeastern part of the state. In 1957, Michigan farmers produced 236,000 acres of soybeans—double the state's 10-year average of 1946-55. The average yield in 1957 was 21.5 bushels per acre and about 94 percent of the crop was produced for beans. Most of the soybeans are produced in southeastern Michigan, 50 percent of the crop being grown in Monroe and Lenawee counties.

HISTORY

The soybean is a summer annual legume, a native of Southeastern Asia. Records indicate it was extensively cultivated prior to 1800 B.C. It was introduced into the United States in 1804, and became an important crop about 1900. In 1926, there were 2 million acres produced in the United States, about 70 percent grown for hay. By 1939, soybeans were produced on over 10 million acres, with one-half the crop grown for beans. In 1957, there were 21 million acres, of which over 90 percent of the crop was grown for beans. Illinois leads the nation in soybean production with about 5 million acres in 1957.

USES

Almost all of the Michigan crop is processed, the principal products being oil and oil meal. Much of the oil is used as human food in the form of shortening, margarine, and salad oils. Oil meal is high in digestible protein and is used as a supplement in livestock feeds and in making plastics.

The composition of soybeans is shown in Table 1.

The use of soybeans for hay in Michigan is quite limited. Good yields of high protein hay may be produced but the hay is difficult to cure under normal weather conditions at harvest time. Soybeans are an excellent green manure crop but the expense of growing them for this purpose is higher than for most legumes.

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ADAPTATION

Soybeans are adapted to areas in Michigan where corn will mature. Until the past few years, the soybean varieties in use would not mature successfully north of a general line extending westward from Bay City to Muskegon. With recent development of earlier-maturing, highly productive varieties, the area of adaptation has moved farther north.

The crop is adapted to a wide range of soil conditions but does not produce good yields on light, droughty soils. In comparison with field beans, soybeans are more tolerant of droughty and imperfectly drained soils. They are best adapted to well drained, fertile soils having a pH of about 6.5. They can be grown successfully on well-drained muck soils, although early frosts and lodging are sometimes serious problems.

Soybeans leave the soil loose and friable and subject to water erosion. Therefore, they are not well adapted to land with a steep or long gradual slope. Planting on the contour is advisable if such land is used for soybean production.

PLACE IN THE ROTATION

Soybeans can take the place of any row crop in the rotation. However, they do not respond as well as corn to the plowing down of a forage legume. Usually, soybeans should follow corn, or a similar row crop, in the rotation. Soybeans may do well following soybeans on a fertile soil. However, this practice increases the possibility of disease and insect build-up. Soybeans are a good crop with which to precede a fall-sown grain if harvest is early enough to permit planting of that crop. Little or no preparation of the soil is required after the soybeans are removed.

CHOOSING THE VARIETY

The choice of a variety is one of the things which a grower can control. The following points should be considered in making the choice:

Maturity—For the highest yield per acre of top quality beans the crop should mature by the time of the first killing frost. The sooner a killing

*Table 1. Composition of Soybeans and Soybean Products.**

	Product Digestible protein %	Total digestible nutrients %	Oil content %
Soybean, seed	33.7	87.6	20 (average)
Soybean, hay (all analyses)	9.6	49.0	—
Soybean, oil meal (solvent process)	42.4	78.5	—

*From Feeds and Feeding by Morrison, 21st Edition, and U. S. Regional Soybean Laboratory, Urbana, Illinois.

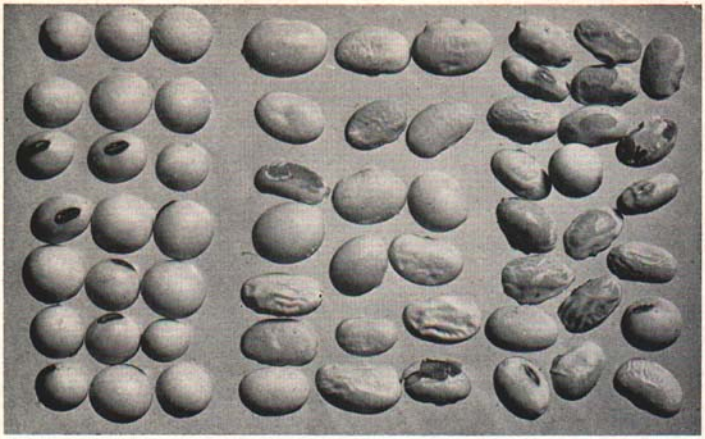

Fig. 1.—Effect of maturity on the quality of soybeans
Right—Very poor quality—immature at time of killing frost.
Center—Poor quality—partially mature at time of killing frost.
Left—Excellent quality—mature at time of killing frost.

frost occurs before maturity, the lower the quality of the beans. If a variety is of late maturity, fall weather may further delay harvest, lower seed quality, and cause higher harvest losses. Generally, the farther north soybeans are grown, the earlier the varieties must be. An exception is the Gratiot-Saginaw area where, on well drained soils, the growing season is similar to that at East Lansing. Figure 1 shows the effect of maturity on the quality of the harvested crop.

Lodging resistance and plant height—On heavy, fertile soils, some varieties stand quite well for combining, while others lodge seriously. Those which lodge on heavy soils may stand well enough for combining on the lighter, less fertile soils. When planted on heavy, fertile soils, varieties which have short stalks may make enough growth to allow successful combining. However, on lighter, less fertile soils, plant growth is so short that successful harvest is difficult. Figure 2 shows the difference in height of the short-stalked Mandarin and the taller Hawkeye variety. On the lighter soils it is difficult to harvest Mandarin.

Future use of field and acres planted—Normally one would select a variety which would use the entire growing season. However, if wheat is to be planted following soybean harvest, the variety must be early enough to permit harvesting and still allow time for planting wheat. When necessary, it might be feasible to use an earlier variety and harvest 1 or 2 bushels

of beans less per acre. On large acreages, it is best to choose two or more varieties of different maturity to stretch the harvest season, and avoid having all of the beans ripen at the same time.

Oil content—Varieties differ in oil content, and oil content varies with the season. Since most of the soybeans are grown for beans, high oil content is important. A variety is not recommended unless its oil content is satisfactory.

Disease resistance—One of the most practical and economical methods of controlling soybean diseases is the development of resistant varieties. Breeding programs emphasize resistance to those diseases which are most serious in a state or region. Of the varieties recommended for Michigan, Blackhawk has field resistance to Phytophthora blight and root rot, an important disease in northwestern Ohio which is near the main area of pro-

Fig. 2.—Difference in height of plants. Hawkeye on left—Mandarin on right.

duction in Michigan. Harosoy is one of the least susceptible varieties to stem canker, and Flambeau and Hawkeye have resistance to bacterial blight.

Yield—One should select a variety which has a high yield record and good lodging resistance, and which matures successfully. Data on yield, maturity, lodging, and other factors, are given in Extension Mimeograph, "Performance of Soybean Varieties in Michigan," which is revised each year and is on file at the county extension office. Table 2 gives the characteristics of recommended varieties of soybeans when they were grown on productive mineral soils. All of the varieties are yellow seeded, have a satisfactory oil content, and have yielded well in areas where adapted.

Table 2. Comparison of Soybean Varieties.

Variety	Maturity days	Plant Height inches	Lodging Resistance	Seed Size	Area where adapted
Norchief	110-115	29	Fair to Good	Med.	Muck soil and northern areas
Chippewa	115-120	34	Very Good	Small	Northern and central Michigan — to precede wheat in southern Lower Michigan
Blackhawk	120-125	35	Good	Med.	Central and southern Lower Michigan
Harosoy	123-128	38	Fair	Large	Southern two tiers of counties
Hawkeye	125-130	37	Very Good	Large	Southern two tiers of counties

SOIL PREPARATION

Soybeans require a seedbed similar to that for corn. It is important to kill weeds and provide a firm seedbed and a mellow rootbed. These conditions favor rapid seed germination and seedling emergence, and good root development. The most common way to get these conditions is to plow, work the soil twice or more with a disc, and harrow just before planting. This method has worked well but tends to compact the soil. Minimum tillage is another promising method of seedbed preparation. Results are encouraging for the plow-plant, and other variations of minimum tillage tried at the Ferden Farm, Chesaning, Mich. In Illinois tests in 1956 and

1957, yields per acre with minimum tillage were at least equal to those obtained by conventional preparation. Michigan trials indicate that plowing and smoothing the soil in one operation, followed by immediate planting, is preferred for soybeans. In these trials weeds were no more trouble than with conventional tillage.

The success of minimum tillage depends on plowing when the soil has good tilth and moisture, doing a careful and thorough job of plowing, and planting immediately after soil preparation. This method provides a firm seedbed (made by the planter wheels) in the row where the seed is placed, while the soil between the rows is loose. Minimum tillage saves time and money, lessens soil compaction, leaves the soil loose between the rows to absorb more water, and makes soil conditions favorable for quick germination and good root development.

Soybean growers should try this method of soil preparation in the interest of economical soybean production. For detailed information on minimum tillage see Extension Bulletin 352, Minimum Tillage, Michigan Cooperative Extension Service, August, 1958, available at your county extension office.

USE GOOD SEED

Plant high quality seed of adapted varieties. Good seed should have high varietal purity; high crop purity (98.5% or above); relative freedom from cracked and split seed, stems, and dirt; freedom from weeds and other crop seeds such as corn; uniform size for accurate planting; and a high germination (85% or above). Certified seed is the only source which always meets all of these requirements.

In selecting seed, whether it is purchased or home grown, special attention should be given to its mechanical condition. Select sound seed. Seed having a high percentage of severely cracked seed coats seldom germinates satisfactorily. Many of the plants from such seed are stunted and slow to

Table 3. Effect of mechanical condition of seed upon the stand and vigor of soybeans (average of 6 replications).

Mechanical condition of seed	Vigorous	Moderately vigorous	Weak	Stand total
	%	%	%	%
7% cracked seed coats	69	5	2	76
100% severely cracked seed coats	23	15	5	43
100% slightly cracked seed coats	41	12	4	57
No cracked seed coats	72	6	2	80

develop. Field tests were conducted in 1954 to determine the effects of mechanical condition of the seed on stand. Careful visual examination was used to decide between severely and slightly cracked seed coats. The results are shown in Table 3.

Similar results have been obtained in other states in both field and laboratory trials. Mechanical injury to the seed is most likely to occur in dry harvest years when the seed is low in moisture. Serious mechanical injury can usually be detected by visual examination of the seed and verified by laboratory germination.

SEED TREATMENT

Seed treatment with a fungicide and/or insecticide may be effective in preventing seed decay, damping-off of seedlings, and maggot injury. These occur most frequently when wet and cold weather prevail at planting time and conditions hinder quick sprouting of seed and emergence of seedlings. However, with the recommended planting rate of 50 to 60 pounds of *high quality seed* per acre, there has been no advantage in yield from seed treatment in tests at two locations for the three year period, 1956-58, inclusive. At lower planting rates the effect of seed treatment would probably be more noticeable. If *low quality seed* is used, seed treatment will likely be beneficial unless the low quality was the result of mechanical injury.

The following materials are recommended for treating bean seeds:

Thiram Tersan 75, Arasan SFX, Thiram Naugets, Thiram 75 W, Delsan A-D, I & D Seed Protectant, Panoram 75

Chloranil Spergon -SL, Geigy SP 50

Captan Captan 75W, Orthocide 406, Orthocide Seed Treatment

In treating seed, the recommendations of the manufacturer for dosage and method of application, should be carefully followed. Where it is desired to treat and inoculate the seed, treatment should be made several weeks in advance of planting time and the inoculant applied just prior to planting.

INOCULATION

The most economical way to get the nitrogen required for a soybean crop is to have the bean plants manufacture their own supply. The safest way to be sure of good nodulation on the roots and manufacture of nitrogen is to inoculate the soybean seed with the proper bacterial culture each year. It is good insurance at low cost. The directions of the manufacturer should be followed in applying inoculant to the seed.

FERTILIZING

Soybeans are not very responsive to commercial fertilizer. However, if the soil is low in phosphorus and potassium, soybeans will respond favorably to applications of these elements.

The type of soil, previous crop, and soil tests should be used to determine fertilizer needs. On heavy-textured soils (clays and loams) there is little effect from applications of fertilizer if the soil test shows high phosphorus and high potassium content. On light-textured soils, with high phosphorus and potassium, 100 to 125 pounds per acre of a 5-20-20 fertilizer have proved beneficial. General requirements for the main soil textures are as follows:

- Heavy texture—100 to 200 pounds per acre of 5-20-10*
- Medium texture—100 to 200 pounds per acre of 5-20-20*
- Light texture—200 pounds per acre of 5-10-20*

For information in detail, see Extensive Bulletin E 159 (revised), Fertilizer Recommendations for Michigan Crops, Cooperative Extension Service, available at your county extension office.

On heavy textured soils with a pH of 6.5 or higher, manganese may not be available to plants. In such cases use a fertilizer containing 1 or 2 percent manganese.

The time to apply and the amount of fertilizer to use depends to a degree on the kind of available equipment. Soybean seed is subject to injury from fertilizer placed in the row in contact with the seed. Proper placement of fertilizer is about 1 inch to the side and 2 inches below the seed. If such placement is impossible and fertilizer is needed, apply it before planting by either plowing down or drilling. Beet and bean drills allow proper fertilizer placement and attachments are now available for some corn planters.

Normally, soybeans need little nitrogen fertilizer except as part of a starter fertilizer. Trials at the Ferden Farm, Chesaning, Mich., in 1957 and 1958, show little effect from side-dressing soybeans with a nitrogen fertilizer.

*Or comparable amounts of a similar ratio

*Table 4. Effect of row spacing on the yield of soybeans in bushels per acre.**

	Row spacings (inches)				
Varieties	**18**	**24**	**30**	**36**	**42**
Mandarin (early maturity)	**32**	**30.9**	**29.3**	**28.3**	**26.2**
Blackhawk (medium maturity)	**31.4**	**29.7**	**29.2**	**28.0**	**26.7**

*From data furnished by the Minnesota Agricultural Experiment Station.

Fig. 3.—Plant in rows for better weed control and easier harvest.

PLANTING

Soybeans are usually planted as soon as corn planting is completed. A survey of soybean growers in 1955 showed that the planting date varied from May 15 to June 10. In the southern tier of counties in Michigan the best planting date is May 20 to 25 if the weather is satisfactory. Slightly later dates are preferred at more northern locations, but not later than June 5 for a normal planting. In the northern fringe areas, planting on June 10 would be too late for any of the recommended varieties.

Under most conditions, planting seed at a 1 inch depth is satisfactory. For all conditions, plant deep enough to place the seed in moist soil but not deeper than 3 inches.

For best results, plant in rows (See Figure 3). A solid planting does not allow good weed control, it requires more seed, and harvest often is more difficult. Trials conducted in the Midwest show that early varieties do best in narrower row spacings. With the later maturing varieties, the narrow row spacing becomes less advantageous. For the varieties recommended for Michigan, a 28-inch row spacing has given excellent yields, especially with early varieties such as Chippewa.

Table 4 gives a 3-year comparison in Minnesota of soybeans planted at various row spacings.

Most of the soybeans grown in Michigan are planted in 36- to 40-inch rows so that planting and cultivating equipment may be used for both corn and soybeans without making machinery adjustments for different row spacings. Several methods have been used to obtain a narrow row width and still use existing equipment with very slight changes. One method, used successfully in Iowa with a 2-row corn planter, is to alternate the regular row spacing (36 or 40 inches) with a narrow row spacing (24 inches). To do this, shorten the gauge marker on the planter to give the 24-inch row. The cultivating problem is solved by removing the outside shovels from the 2-row cultivator.

The seeding rate per acre depends on the quality, germination, and size of the seed, and the method of planting. Plant enough seed so as to have seedlings close enough in the row to help each other emerge. This means about 8 to 10 germinating seeds per foot of row and should result in a good stand. This is very important if the soil has a crust.

A study of seeding rates at the Iowa Agricultural Experiment Station showed little or no difference in yield per acre of soybeans planted in 32-inch rows, at seeding rates of 60, 84, 108, and 132 pounds per acre. However, as the seeding rate increased from 60 pounds per acre, there was an increase in lodging.

When planted in 28-inch rows, 55 to 60 pounds of seed per acre should be adequate and 45 to 50 pounds should be enough in 40-inch rows. For a solid planting, 120 pounds of seed per acre is recommended. Table 5 shows the pounds of seed per acre required for various row spacings when seeds are spaced at varying distances apart in the row. The information is based on well screened seed of the Blackhawk variety.

As seed size affects the planting rate, information is given in Table 6, on the approximate number of seeds per pound for the recommended varieties. The number will vary, depending on how the seed lot is screened.

Table 5. Seed required in pounds per acre as affected by row spacing and spacing in the row.

Row Spacing (inches)	Seed spacing in the row (inches)				
	1	1½	2	2½	3
28	77	52	38	31	26
32	68	45	34	27	23
36	60	40	30	24	20
40	54	36	27	22	18

Table 6. Seeds per pound of five soybean varieties.

Variety	Number seeds per pound
Norchief	2600
Chippewa	3000
Blackhawk	2600
Harosoy	2300
Hawkeye	2300

WEED CONTROL

The results of a survey in southeastern Michigan in 1955 showed that most soybean growers considered weed control to be an important production problem. Many growers reported losses in yield of 10 percent caused by weeds with losses ranging from none to 30 percent.

Weeds may be responsible for one or more of the following:

Delayed maturity — Shorter plants

Increased lodging — Lower yields

Increased harvest difficulties

One of the most important factors in weed control is to kill the weeds early, as they begin to sprout. After planting and before the soybean seedlings emerge, go over the field with a rotary hoe or similar equipment to break a crust and kill small weeds. Use a rotary hoe until the plants are about 6 inches tall. Start when the weeds first show and do not worry about damaging a few soybean plants. Under good conditions, 2 or 3 times with the rotary hoe may mean only one regular cultivating. If a rotary hoe is not available, it is essential to cultivate early and carefully to get the weeds and avoid covering the bean plants. Cultivating should be shallow and level, as the tendency to build a ridge may cause difficulty in harvesting if there is much lodging.

Herbicides look promising for weed control in soybeans. A pre-emergence spray over the row in a 12-inch band may help in early weed control, especially when wet weather delays cultivation and where large acreages are involved. For successful control with herbicides, soil moisture must be adequate to support good plant growth. The following materials have proved most effective and practical in Michigan trials:

Premerge or Sinox PE .....3 to 6 pounds per acre

Alanap .....5 to 10 pounds per acre

CIPC .....4 to 8 pounds per acre

The recommended time for applying Premerge is 3 to 4 days after planting, and the other herbicides should be applied at planting time. The lower rate should be used on sandy soils. All of the rates listed are amounts of active ingredients per acre for the area *actually covered.* For instance, if the distance between rows is 36 inches and the spray is applied in a 12 inch band over the row, then only one third of the area of the field is actually covered. For information in detail on herbicides, see Extension Folder F-222, Weed Control in Field Crops, Cooperative Extension Service, Michigan State University, available at your county extension office.

HARVEST

For highest quality and yield, soybeans should be harvested as soon as weather conditions permit after they reach a moisture level of 14 percent or less. Frequently, the best harvesting conditions occur just after the first frost. This frost kills the plants and weeds and causes them to dry. Further delay in harvesting may mean lower quality and higher harvest losses due to shattering and lodging. Figure 4 shows a comparison of weather-damaged, and high quality beans. Local elevators are equipped to run a moisture test on samples as a guide in determining the proper time to begin harvesting.

Common harvesting losses are as follows:

- Shattering before combining
- Beans missed, or pods cut through by the combine cutter bar
- Failure to thresh beans from pods
- Splitting and cracking of beans
- Failure to separate beans from chaff
- Beans blown over the chaffer extension with chaff.

Cylinder speeds ranging from 400 to 800 RPM are normally adequate. Cylinder-concave clearances of 5/16 to 7/8 inch usually give good results. Use only enough concave bars or teeth to thresh the beans from the pods. Considerable fan blast is necessary, and the adjustable chaffer and chaffer extension should be at least 2/3 open, with the sieve about ½ open.

An operators' manual provided with the combine gives basic information on adjustments for that particular make and model of machine. These instructions are usually for normal conditions, and cannot cover all of the varying situations which might arise. They should be used as a guide, and additional adjustments made that are necessary to solve special problems. This is very important to the grower who is producing seed for planting the next year.

Depending upon the variety, every 4 to 5 beans left in the field per square foot of land means a loss of about 1 bushel per acre. Cracked or split beans, and beans with a cracked seed coat will result in a high screening loss and lower quality.

Shattering losses occur before combining, and increase as the soybeans lose moisture and dry out. Timely harvest helps to reduce these losses.

Cutter bar losses may be reduced by selecting taller varieties (if available) and varieties with more lodging resistance; more complete weed control; and avoiding ridging of the beans when cultivating.

Cylinder losses may be held to a minimum by properly adjusting cylinder speed and cylinder-concave clearance. Use only enough concave bars

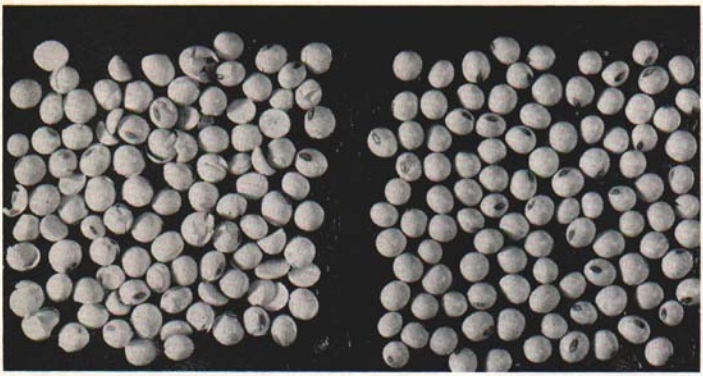

Fig. 4.—Effect of delayed harvest on quality of soybeans. Weathered, damaged beans, left. Good quality beans, right.

or teeth to thresh the beans from the pod. Over-threshing at the cylinder will result in splitting and cracking of beans, and damage to the seed coat. Use only enough threshing action to thresh most of the beans out of the pods.

Straw rack losses are usually small, but may be excessive if the proper rack speed is not maintained. Overloading of the combine, caused by excessive ground speed for operating conditions also may result in excessive losses.

Cleaning shoe losses may be held to a minimum by proper adjustment of the chaffer, the chaffer extension, and the cleaning sieve. The amount and direction of the fan blast through the cleaning shoe is also important. In general, use as much fan blast as possible without blowing beans out the back end of the machine. Direct most of the fan blast toward the forward 1/3 of the chaffer. Always use enough fan blast to maintain a "live" chaffer.

REMEMBER: a proper combine setting at 11:00 A.M., may not be correct for 2:00 P.M., of the same day. Figure 5 shows the effect of harvest on the quality of soybeans.

At times during the day the beans may be so dry, or the humidity so low that excessive cracking or damage is encountered. The usual solution is to stop combining during the hottest and driest part of the day.

Table 7. Soybean diseases, symptoms and control.

Disease and symptoms	Method of transmission and time of occurrence	Control measures
BACTERIAL BLIGHT— Bacterium *Pseudomonas glycinea*		
Small angular, brownish-black spots appear on infected leaves. Dark center of spots usually surrounded by water soaked area. Older spots have sunken appearance and are bordered by narrow yellow band most noticeable on top side of leaf. Wind whipping may cause diseased tissue to drop out giving the leaf a shot-holed appearance.	Organism is seed borne and may be soil borne. It commonly occurs early in the season especially when the weather is cool and wet. May be spread by cultivating when plants are wet with rain or dew.	Crop rotation and use of disease free seed are quite effective. Avoid spreading disease by not cultivating when plants are wet. Flambeau and Hawkeye are the only recommended varieties with resistance to blight. Sprays for control are impractical on a field scale at present. (One of the most common diseases in Michigan).
BACTERIAL PUSTULE— Bacterium *Xanthomonas phaseoli* var. *sojense*		
Small yellowish-green spots with reddish centers appear on leaves and pods. Raised pustules, which rupture, form within the spots. Most noticeable on undersurface of leaf. Similar to blight but does not have water soaked area in early stages. Late symptoms hard to distinguish from those of blight.	Organism over-winters in bean residue and to some extent on and within the seed. It thrives in warm weather. Disease seldom occurs before mid-summer.	Crop rotation and deep plow-down of bean residue. No suitable resistant varieties are available for use in Michigan.
BROWN SPOT— Fungus *Septoria glycines*		
Angular brown to reddish-brown spots on leaves are typical. With severe infection, spots join and the leaves yellow and drop prematurely. Stems and pods may show infection late in season.	Organism lives in bean residue and to some extent in soil. One of the first diseases to appear. Development favored by low temperatures and abundant rainfall.	Crop rotation combined with deep plow-down of bean residue. (This is a common fungus disease wherever soybeans are grown).

DOWNY MILDEW—Fungus *Peronospora Manshurica*

Infected leaves show distinct yellow spots on upper surface and grayish mold opposite the spots on lower surface. As spots enlarge they join, turn brown and leaves wither and die. Seed and interior of pods may be infected and covered with grayish mold.	Organism over-winters in the seed and infected bean straw. Seedling infection can occur locally and systematically from fungus spores on seed. A cool weather disease observed on heavy soils during periods of high humidity and soil moisture.	Crop rotation and deep plow-down of bean residue. Seed treatment may be effective in minimizing seedling infection. All recommended varieties for Michigan are susceptible. Harosoy appears to be the least susceptible.

BROWN STEM ROT—Fungus *Cephalosporium gregatum*

Infection usually takes place through roots and spreads to lower stem causing tissue to split open and turn brown. The lower and sometimes upper leaves yellow between veins. With severe infection leaves may wilt and die.	Organism over-winters in bean residue and soil. Occurs most frequently when the season is unseasonably cool.	Crop rotation with 3 to 4 years between soybean crops and deep plow-down of bean residue. None of the varieties available are resistant. (Plants weakened by disease produce seeds smaller than normal).

STEM CANKER—Fungus *Diaporthe phaseolorum* var. *batatitis*

Brown sunken lesions appear near base of stem and may girdle it causing death from lack of water and nutrients. More evident on young plants.	Organism is seed borne but can overwinter in bean residue. Usually appears in early July on young plants.	Crop rotation and deep plow-down of bean residue. Use disease-free seed. Seed treatment will reduce seed borne infection. Harosoy is resistant.

POD and STEM BLIGHT— Fungus *Diaporthe phaseolorum* var. *sojae*

Closely related to stem canker. Pods and stems become cankered and plants die prematurely. Numerous small black fungus fruiting bodies appear on stems and pods.	Seed and bean residue are primary sources of infection. Damage normally occurs as plants near maturity.	Crop rotation and deep plow-down of bean residue. Use disease free seed. Seed treatment will reduce seed borne infection. (Differs from stem canker in having the black fruiting bodies on stems and pods).

RHIZOCTONIA—Fungus *Rhizoctonia solani*
PYTHIUM—Fungus *Pythium ultimum*

Seed rot and damping-off of seedlings both cause rot of roots in older plants. Infected roots show lesions and have a brownish red discoloration. The root tissue rots, and much of secondary root system may be destroyed. Plants usually wilt and die while those which survive are unthrifty and yield poorly.

Both organisms are soil borne. Rhizoctonia usually occurs during warm weather and on light soil with high pH. Pythium appears favored by cool temperatures, and heavy soil with high moisture and a low pH.

Crop rotation is the only suitable control. Seed treatment beneficial in preventing seed rot and damping-off. (Root rot occurs typically in areas about 5 to 10 feet in diameter, irregularly distributed over the field. These are some of the most common diseases in Michigan. Rhizoctonia appears to be the most common).

SCLEROTIAL STEM ROT— Fungus *Sclerotinia sclerotiorum*

A cottony fungus growth on base of stem; sometimes on ground around stem. Stem tissue is destroyed and plant usually dies before pods are formed. Black, irregularly shaped bodies about ⅛ to ¼ inch in diameter are seen in the white fungus mass or within the dried stem. These are resting bodies of the fungus.

Organism is soil borne. The resting bodies of the fungus are highly resistant to heat, cold, and chemicals. Apparently the organism lives in the soil for an indefinite period.

Deep plowing is probably the most effective control measure. Germination of the resting bodies may be prevented by deep burial, thereby reducing incidence of the disease. (Disease can be very damaging. Observed at several locations in Monroe Co. in 1957 but doesn't appear a serious problem at the present).

COMMON AND YELLOW MOSAIC—Viruses

With common mosaic, leaves become distorted and may be narrower than normal with margins cupped downward. Leaves mottled, pods misshapen, and fewer seeds per pod than normal. Plants frequently stunted. Yellow type does not cause distortion and stunting. Young leaves show yellow mottling or vein banding. Rusty brown dead spots appear in mottled areas of mature leaves.

Common mosaic is seed borne. Yellow mosaic is not believed to be seed borne. Symptoms are most obvious on young foliage.

No practical means of control. Remove infected plants from seed fields. No varietal resistance to mosaic at present. (Yellow mosaic is the most common type in Michigan. The symptoms of common mosaic are similar to 2,4-D injury on soybeans.)

BUD BLIGHT—Virus (Tobacco ring spot virus)

When young plants are infected before blossoming the tip bud turns brown and dries up. Leaves below the bud have a rusty appearance. Interior of stem near nodes may be brown. Plants are stunted and without pods. Infection at blossoming time may result in poorly developed pods without seed. Later infections usually result in poorly filled pods with a distinctive purple blotching. Infected plants remain green after normal plants have matured.

Method of transmission is unknown. It has not been proved the disease is seed borne. If there is a progressive movement of the disease inward from borders of a field an insect could be the carrier.

There are no effective control measures, and no resistant varieties at the present.

(Bud blight is the most serious virus disease. It is common in small amounts in Michigan with an occasional severe infection).

ity of soybeans. Poor quality (har-
harvest).

STORAGE

tight bins at a moisture content of 14 percent or
s frequently for heating and move them to other
tected. Drying with heated air may be advisable if the
is too high. Anyone interested in drying soybeans should
with the manufacturers of drying equipment and/or the Depart-
of Agricultural Engineering, Michigan State University, for proper
drying procedures and precautions.

SOYBEAN DISEASES

Less than a dozen diseases have been observed on soybeans in Michigan. Some have caused considerable damage while others appear to have had little effect on yield. Occasional severe infections have been reported and observed. With the increase in soybean acreage and wide use of the crop, disease problems are likely to be of greater significance in the future.

Weather, soil conditions, cultural practices, and seed have an important bearing on the severity of infection and spread of diseases. Most diseases attack the above ground parts of the plant, with the symptoms being most noticeable on leaves, but sometimes on stems and pods. Certain fungi and nematodes attack and destroy the roots, thereby inducing water and nutrient deficiency symptoms on the above ground parts.

Soybean diseases can best be controlled by the use of resistant varieties. However, at present few varieties are resistant to the common diseases and none have extensive resistance. Details regarding the symptoms, method of transmission, and control measures for some of the most common soybean diseases observed in Michigan are given in Table 7.

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