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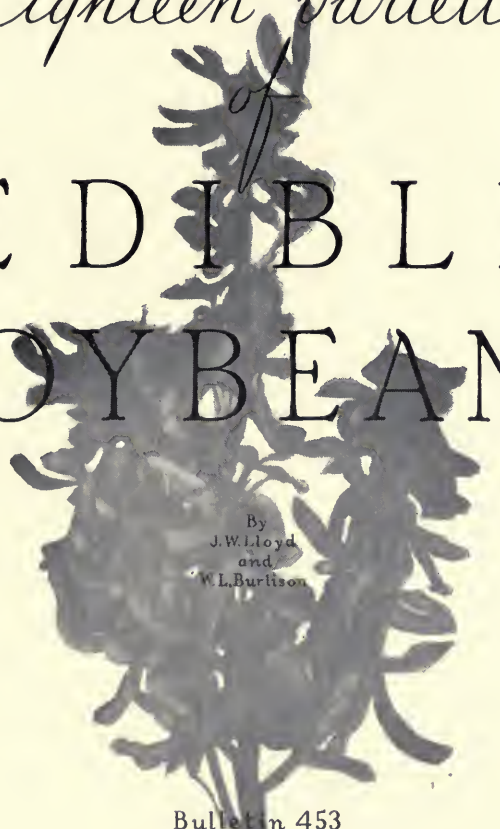
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Eighteen varieties
of
EDIBLE
SOYBEANS



By
J. W. Lloyd
and
W. L. Burlison

Bulletin 453

University of Illinois
Agricultural Experiment Station

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CONTENTS

	PAGE
DISTRIBUTION OF SEED FOR TESTS.....	386
RESULTS OF THE COOPERATIVE TESTS.....	388
Reports From Home Gardeners.....	388
Reports From State Institutions.....	391
Reports From Market Gardeners.....	392
Reports From Canners.....	393
RANGE OF ADAPTATION.....	394
Northern and Southern United States.....	394
East and Middle West.....	396
Illinois Reports Concerning Adaptation.....	397
Comparison of Adaptability in Illinois and Other States.....	399
PERFORMANCE OF 18 VARIETIES AT URBANA.....	399
Relative Earliness of Different Varieties.....	400
Duration of Edible Period.....	404
Agronomic Characters.....	407
Yields of Dry Beans.....	409
Blossom, Pod, and Seed Characters.....	412
Weights and Shelling Percentages of Green Soybeans.....	415
Yields of Green Soybeans.....	416
MARKET QUALITIES OF THE GREEN SOYBEANS.....	417
PROTEIN AND FAT CONTENTS OF THE MATURE SOYBEANS.....	421
CHARACTERISTICS OF THE DIFFERENT VARIETIES.....	422
VARIETIES RECOMMENDED.....	426
METHOD OF CULTURE.....	427
Time of Planting.....	427
Preparation of Seedbed.....	429
Distance and Depth of Planting.....	429
Equipment for Planting.....	431
Inoculation of Seed.....	432
Tillage.....	432
DAMAGE FROM RABBITS AND GRASSHOPPERS.....	433
HARVESTING GREEN SOYBEANS.....	434
HARVESTING, CURING, AND THRESHING RIPE SOYBEANS.....	435
SUMMARY AND CONCLUSIONS.....	438
DIRECTIONS FOR SHELLING AND COOKING GREEN SOYBEANS.....	439

Eighteen Varieties of Edible Soybeans

Their Adaptability, Acceptability, Culture and Characteristics

By J. W. LLOYD, Chief in Olericulture, and W. L. BURLISON,
Chief in Crop Production

WHEN soybeans were first introduced into America from the Orient, where the seed had been used as food since ancient times, only the field types were included in the importations. These were suitable primarily for the manufacture of oil and for other industrial uses, or for forage. More recently, however, seed of a different type of soybean, especially adapted to use as human food, has been brought into this country by the Bureau of Plant Industry of the United States Department of Agriculture. Small samples of seed of a large number of these edible varieties have been furnished by the United States Department of Agriculture to the Illinois Agricultural Experiment Station for testing, and a few additional varieties have been procured from other sources.

Three principal lines of study have been employed in the work on these varieties of soybeans: (1) field tests at Urbana to determine type of plant, time of maturity, relative yield, and other pertinent matters from the standpoint of production; (2) analysis of reports on cooperative tests by many gardeners to whom seed was sent for the purpose of determining the acceptability of this new vegetable as food and its adaptation for production in different localities; (3) tests in the Home Economics laboratory to determine palatability and other factors bearing upon the acceptability of the different varieties as food, whether used as green shelled beans or dry, ripe beans.

Results of the tests in the Department of Home Economics have already been reported in Illinois Bulletin 443,¹ which includes a review of literature regarding the place of soybeans in the diet. This review points out that green shelled soybeans are much richer in protein and fat than are green peas or green lima beans, and that they make a very favorable showing wherever foods are listed according to their richness in calcium and iron. The preceding statement also applies to dry mature soybeans when compared with dry lima beans and peas. Ap-

¹WOODRUFF, SYBIL, and KLAAS, HELEN. A study of soybean varieties with reference to their use as food. Ill. Agr. Exp. Sta. Bul. 443, 1938.

proximately 40 percent of dry soybeans is protein. Because of this high percentage of protein and because of a fat content of about 20 percent, soybeans yield a high number of calories per pound. They have a relatively low percentage of total carbohydrates compared with other kinds of beans and peas, and very little of this carbohydrate is starch. It has also been reported by other authors that green cooked soybeans are a very good source of vitamins A, B, and G, and a poor source of C.

The present report summarizes the results of the cooperative tests carried out by those to whom seed was furnished for the purpose of determining the adaptability and acceptability of this new vegetable; gives data regarding the field performance and characteristics of 18 superior varieties grown at Urbana; and describes methods of culture used in the production of the vegetable-type soybeans under field and garden conditions.

DISTRIBUTION OF SEED FOR TESTS

Distribution of seed samples was begun in 1935 and continued thru 1938. Previous to 1938 the distribution was principally to growers in Illinois. For home gardeners the seed was put up in packets of approximately 100 seeds each. A mimeographed letter was mailed to each gardener the same day as the seeds, giving brief instructions regarding the planting and care of the crop, and directions for harvesting the beans and preparing them for the table.

In 1935 seed samples were sent to 122 persons known to be interested in home gardens and located principally at points scattered pretty well over the state of Illinois. Two varieties—one early and one late—were sent to each person. Since the available seed supply of any one variety was very small, it was necessary to use several varieties in this distribution. Thus the test was primarily to determine the reaction of gardeners to this new type of vegetable, rather than the acceptability of given varieties. Varieties were then known chiefly by number only, but several have since been named.¹

In the spring of 1936 an abundance of one fairly early variety (Fuji, 81029) was available for distribution. There was also considerable seed of Higan (80475), a late variety, and fair supplies of two midseason varieties, Willomi (81044-1) and Hokkaido (85666).

¹The serial numbers used are those of the Division of Plant Exploration and Introduction (formerly known as Division of Foreign Plant Introduction), Bureau of Plant Industry, U. S. Department of Agriculture.

It was decided to send out small packets of three varieties to each home gardener participating in the tests, so as to cover the season more fully than was possible with two varieties. The three-package collection was sent to 176 persons. In all collections the Higan was used as the late variety; and in most cases Fuji was used as the early variety. For the midseason variety, Willomi was used in some collections and Hokkaido in others.

In addition to the small packets for home gardeners, one pound of Fuji was sent to each of nineteen state institutions in Illinois in 1936, with a view to determining the feasibility of growing this type of soybean for use at such institutions. Special requests for soybean seed in pound lots or larger quantities were received from canning companies, manufacturing concerns, the Chicago Tribune experimental farm, and county farm advisers. There was sufficient seed to satisfy all requests until the close of the planting season.

In 1937 four varieties of the vegetable-type soybeans were sent to each of 182 home gardeners. The varieties were selected on the basis of season of maturity and available seed supply. They were, in the order of earliness, Giant Green, Bansei (81031), Jogun (87615), and 80488-1-1. Fourteen other assortments were sent out in response to special requests of individuals. Nine state institutions were each furnished with 4 pounds of seed of one variety in order to produce enough beans at one time to give this vegetable a fair test at the table. Three canning companies and various other institutions were furnished seed of different varieties in quantities adapted to the tests they wished to conduct.

In 1938 seed of the vegetable-type soybeans was furnished to 205 different persons or concerns. Requests for seed this year were received from 31 states besides Illinois, and seed supplies were distributed accordingly. In addition to home gardeners, a number of market gardeners were furnished with seed to test the practicability of growing this new vegetable as a market crop in their localities. A special selection of varieties was made for testing in northern localities where the season is likely to be short. This collection consisted of Giant Green, Bansei, Fuji, and Hokkaido. For the corn belt and points farther south the collection consisted of Bansei, Willomi, Kura (81042), and Imperial (81780). All these varieties except Kura are among the 18 selected at Urbana as possessing superior qualities. Kura was included on account of the favorable reports on this variety as tested under eastern conditions, even tho its unattractive color kept it out of the selected list.

In late September or early October each year a letter was mailed to each person to whom seed had been sent the preceding spring, requesting a brief report on the success or failure experienced in the production of the crop and the honest opinion of the correspondent regarding the table quality of this new vegetable. The question was also asked whether the varieties furnished gave a good succession of harvest over a long period.

RESULTS OF THE COOPERATIVE TESTS

Reports regarding the successful production of the vegetable-type soybeans were received from 54 Illinois counties from the Wisconsin border to the extreme southern part of the state (Fig. 1). Reports have also been received from 23 other states and from the Province of Ontario and the Island of Jamaica.

Reports From Home Gardeners

Of especial importance are the reports from home gardeners, since they represent the results of direct personal contact with the growing crop and personal tests of the product. The general dependability of the vegetable-type soybeans to make a crop thruout Illinois, even under adverse weather conditions, was fully demonstrated by the results obtained by the home-garden cooperators who reported their experiences with this new vegetable in 1935, 1936, 1937, and 1938. Reports were made primarily from the standpoint of the production of the crop for use as green shelled beans.

Soybeans Proved Highly Drouth-Resistant.—Probably the most outstanding feature regarding this crop, reported by those making the tests, is its ability to resist drouth. There were serious dry periods in some parts of Illinois each year of the tests, but in 1936 drouth prevailed thruout the state most of the summer. Some of the comments in reports that fall were the following:

They do well in a dry season. . . . The soybeans produce well tho lacking in moisture. . . . Other beans planted at the same time did not come up well because of the drouth, and failed to bloom until the fall rains came, but the soybeans came up well, matured normally, and produced beans during the dry weather when there was practically nothing else in the garden for table use except Swiss chard. . . . The soybeans grew and thrived when nothing else did. . . . They stood the summer remarkably well. . . . A good crop considering the drouth. . . . Thru June, July and August we had it so dry that a good bluegrass lawn got dry enough to burn. All growing things suffered, but the soybeans in my garden came

Produced Good Yields and Steady Supply.—Most home gardeners in Illinois who tried the vegetable-type soybeans were impressed with their productiveness. Comments on this point were as follows:

Have never seen anything so prolific. . . . Heavy yield. . . . They bore heavily. . . . Three plants yielded 2½ cups of shelled beans. . . . I pulled six plants and hulled out a pint of beans. . . . They all produced good yields. . . . All four varieties produced a splendid crop. . . . The soybeans made a wonderful crop. . . . They bore abundantly, one plant furnishing enough for a very good serving.

Several gardeners reported liking the soybeans because they were available for use as a fresh vegetable at a season of the year when vegetables in the home garden are likely to be scarce. As one gardener expressed it, "We plan to include soybeans in our garden planting every year—for variety, and to assure ourselves of a fresh vegetable in times of drouth." Another said, "One nice thing about the soybeans is that they bear at a time when you are needing a variety of things to cook." Other comments were: "I shall plant them again next year as they make a vegetable to vary the menu when other vegetables are not abundant." "They come at a time when there are not so many other things in the garden to eat."

In general, gardeners who planted the collection of three or four varieties at the same time reported having a good succession and a continuous supply of fresh soybeans available for use over a long period. Representative comments were:

There was a steady succession of beans. . . . The beans gave a fine succession over a period of five weeks. . . . The four varieties succeeded each other in maturity, each variety with a wonderful production. . . . My assortment of soybeans this year furnished green beans for the table over a period of about six weeks. . . . The four varieties made a good succession over a long period. . . . Had fresh beans available from the last week in August until October 12.

Fresh Soybeans Had Satisfying Flavor.—Many favorable reports were received regarding the satisfying flavor of the fresh soybeans, tho some people did not care much for them upon first trial and seemed to have to acquire a taste for them. Representative comments follow:

We like them very much. . . . Very much relished at the table. . . . They were delicious. . . . We like them better than peas or beans. . . . I served soybeans to all guests this summer. Most everyone liked them. . . . I like these varieties better than lima beans. . . . They are a very good vegetable. . . . We all thought they were excellent. . . . Everyone who tried them said they were splendid. . . . Either the beans were better or the family have changed, for they seem to like the beans better this year

than last. . . . The quality of all the varieties was very fine. . . . For table use I found them very good. . . . I serve them frequently to guests, and the majority express surprise at how well they taste. . . . We liked the edible soybeans very much. . . . The beans were of very fine quality. . . . We were very much pleased with the flavor of these beans. . . . Of excellent flavor. . . . We had hoped to can some, but were too fond of them on the table. . . . We had never eaten any beans as good. . . . We liked their flavor better than other varieties of garden beans. . . . Some members of my family liked them and others did not care for them. . . . I gave different people some to cook and all thought they were good. They have a flavor that appeals to most people and is different from other beans. . . . I believe we liked the last variety best. Perhaps it was because we acquired the taste for them rather than because of the variety or because I learned better how to cook them. . . . The beans were delicious to eat and were universally liked by my family and our guests. In fact it took persuasion to leave any for seed. . . . We enjoyed the soybeans more than any other garden vegetable we grew this year.

Other Comments.—Not only was the flavor reported excellent, but the appearance of the beans as served at the table was also considered appealing. As one gardener commented, "Their green color makes a very pretty dish." This has been found true of both the green-seeded and the yellow-seeded varieties, since the color of the immature beans is green in both groups, and when cooked they are of a very attractive pea-green color.

A number of gardeners reported specifically that they considered the vegetable-type soybean a valuable addition to the home vegetable garden. Some of the comments on this point were:

It seems to me that they promise a very valuable addition to the farm garden. . . . I consider these soybeans a valuable addition to my garden, and believe they should be tried out wherever adapted. . . . I shall always plant them in my garden if I can obtain the seed. . . . We believe the soybeans could easily take the place of lima beans. The soybeans are much easier to raise. . . . I am sure they will prove a very valuable addition to our garden supply. . . . I think the vegetable soy will soon become a standard vegetable. . . . I think it is only a question of time until these beans will be very popular.

The esteem in which the vegetable-type soybeans were held by those who tried them is further illustrated by the large number who reported that they were saving seed for the next season's planting.

Reports From State Institutions

Reports on vegetable-type soybeans from state institutions in Illinois which had been furnished seed were quite variable. At a number of the institutions heavy yields were secured. In some instances the

dietitians were quoted as reporting that the soybeans "were consumed fairly well," but in others that they "were not liked very well."

The most serious objection to the use of the green soybean at the state institutions was the difficulty of shelling the beans in preparing them for cooking in large quantities. As stated by the managing officer of one institution, "Unless there is some way to shell these beans other than by hand, we cannot use them." Contrasted with this attitude was that at a smaller institution where a large crop had been produced and the managing officer reported, "We will have no difficulty in utilizing the entire crop, and expect to grow some next year."

It is entirely possible that at state institutions vegetable-type soybeans will be used in the mature stage during the winter months rather than as a green vegetable during the late summer and early fall.

Reports From Market Gardeners

A number of market gardeners who were furnished with one pound each of three or four varieties of vegetable-type soybeans in the spring of 1938 made tests to secure information on the acceptability of this new vegetable, from a market standpoint, in their localities. One gardener reported:

The soybeans made a wonderful crop. All four kinds were good, but the sale was poor. I think the reason was lima beans were too cheap. I gave soybeans to my customers to try and they all came back for more.

Certain other market gardeners dealing directly with consumers used the same method of introducing this new vegetable; they gave liberal samples of the soybeans to their customers making purchases of other vegetables. One report states: "All of the housewives who have experimented with soybeans from our gardens appreciated having 'something different' to serve." Another gardener reported: "I put some of the soybeans on our sales counter and found that about 80 percent of the people who tried the beans once came back for more."

One cooperator who was furnished with pound samples of seed of four varieties reported as follows:

We were so much impressed with the soybeans as a vegetable crop that we have saved most of the crop from these plantings for seed next year. Our marketing department took some of the green soybeans to two of the large chain store organizations in Chicago and inquired whether they could use any, and both told us they would take all we could supply, and were disappointed when told we did not have any for sale this year. If seed were available we might greatly increase our plantings next year. We plan to use what seed we have saved, anyway.

In attempting to introduce the green soybeans on his local market,

one gardener sold the product very cheaply and also gave several lots to his trade—both grocers and eating establishments. He reported that the grocers were rather indifferent toward the soybeans, but that the restaurants seemed to take kindly to them and gave them a fair trial. One cafeteria which served them on several occasions reported that they had several comments in favor of them, but stated that the labor involved in shelling them was against them. They also stated that they had no recipes to guide them; they just had to feel their way until they found which style fitted them best.

Another commercial grower who had developed a seed supply from previous years' plantings undertook to introduce the vegetable-type soybeans to the hotel and restaurant trade by furnishing supplies to several hotels and restaurants in Chicago and Evanston and requesting the managements to report how the customers liked this new vegetable. Most of the reports were favorable.

The same grower made arrangements with a large grocery store in the loop district in Chicago to introduce soybeans to the retail trade. Before the sale of the beans started, the sales force were given full information about the soybeans—how to prepare and serve them, their food value, etc. Several of the store clerks tried the beans in their own homes and all liked them. They were then able to recommend the soybeans to customers from personal experience. This was a big advantage in selling the new product. Also, directions for shelling and cooking the beans were mimeographed, and a copy of these instructions was furnished with each purchase.¹ As a result of this introductory campaign, sales amounting to about 1,200 pounds were made during a period of approximately four weeks.

Reports From Cannery

One of the large canning companies operating in Illinois was furnished seed of several varieties of vegetable-type soybeans in sufficient quantities to make plantings to supply material for experimental canning tests. Following preliminary tests in 1936 to work out details of processing methods adapted to this product, a definite comparison of several varieties from the canning standpoint was made in 1937. Factors involved in the rating of the canned product included color, flavor, tenderness, and "style" or freedom from defects. The clearness of the liquid in the can was considered fully as important as the color of the beans themselves.

The varieties tested were rated by this canning company in the

¹Directions for shelling and cooking green soybeans are given at the back of this bulletin.

following order, in reference to their adaptability to making an acceptable canned product: (1) Toku (86129), (2) Higan, and (3) Bansei were placed in a group ahead of the other varieties on account of the clearness of the liquor and also the small size of the beans, which was considered preferable in the canned product. Following this group were placed: (4) Jogun, (5) Hokkaido, (6) Willomi, (7) Giant Green, and (8) Funk Delicious. Fuji and Kura, which were also included in the canning tests, were rated as not at all suitable for canning on account of the bad color of the beans and the cloudiness of the liquor.

This canner stated that he would anticipate no great difficulty in manufacturing an attractive product if the right varieties were used, tho he felt that considerable promotional effort might be required to sell this new product in volume. The soybeans were shelled by means of a pea viner after making suitable adjustments.

Another company making canning tests on a few varieties in 1937 reported the making of "a very fine canned product" from Bansei and Jogun, "the appearance being very good and the flavor excellent." The same company stated that "the Fuji variety does not make a very attractive canned product" and "the flavor is not as tasteful as that of the other two varieties."

RANGE OF ADAPTATION

Northern and Southern United States

The vegetable-type soybean is essentially a warm-season crop, like the field varieties. However, it can be grown as a table vegetable to be used in the immature stage in some localities where the season is too short for maturing the seed. Early varieties are better adapted to northern localities than late varieties.

Reports from cooperators indicated that only the very earliest variety, Giant Green, matured seed at such northern points as Lesuer, Minnesota (lat. about 44° 30'); Burnett county, Wisconsin (lat. about 45° 45'); and Kamiah, Idaho (lat. about 46°, elevation 1,200 feet).

At Florence, Oregon (lat. 44°), on the Pacific coast, Giant Green was the only variety that set any pods. From seed planted May 16 the first picking of this variety was made on September 15. The cooperator remarked, "We have a very long growing season but our nights are too cool here along the coast." Farther inland in Oregon, at about the same latitude, other varieties set pods, but were very slow in developing and were not yet ready for table use on October 18, when the report was made.

At Dundee, near Portland, Oregon, Giant Green, planted May 14, was ready for use September 15, while Jogun and Willomi were ready October 1. At Kennewick and Vader, Washington, the only variety that matured seed was Giant Green. Other varieties set pods, but did not mature before frost.

At high altitudes in northern localities, even Giant Green may fail to set pods. At Bozeman, Montana, (lat. about $45^{\circ} 30'$), seed of Giant Green, Bansei, Fuji, and Hokkaido was planted May 16, at an elevation 5,000 feet above sea-level. None of the varieties set any pods. The report states:

Our cool nights and different day-night light relationship are probably responsible for this failure to develop blossoms and pods before the onset of our cool fall weather. While our long days and short nights during the growing season account for the rapid growth of seed peas, small grains, garden vegetables, etc., the climate is evidently unsuited for the growing of even the early types of edible soybeans.

At high altitudes, even in southern locations, the soybeans may fail to mature. A report from Valley Ranch, New Mexico, where Bansei, Willomi, Kura, and Imperial were planted at an elevation of 7,500 feet, stated: "The plants grew splendidly, to over three feet in height, but the season proved to be just two weeks too short to produce green beans." Evidently the pods set all right, and it is entirely possible that the Giant Green variety, if planted in this locality, might develop to edible condition. Summer days in New Mexico are much shorter than they are in Montana.

At Edgewater, Colorado, not far from Denver, at an altitude of about 5,000 feet, the four varieties tested—Giant Green, Bansei, Fuji, and Hokkaido—all matured seed.

At low altitudes in the Southeast, certain varieties that produce especially well in the corn belt did not seem to thrive. Planted in South Carolina, the Bansei, Willomi, Kura and Imperial grew only 14 to 18 inches high. One report stated that all these varieties matured at approximately the same time, while another report mentioned yields of only 3 to 10 pods per plant.

At Little Rock, Arkansas, also, these four varieties ripened very close together. At Garfield, Arkansas, a good stand of plants was secured, but very few beans were produced. At Bentonville, Arkansas, the crop was very poor, but the planting had been late. Likewise at Waurika, Oklahoma, the yields of these four varieties were not good.

At Oswego in the extreme southeast corner of Kansas the soybeans matured very rapidly, and beans were available for eating for only about a week from any one variety. Giant Green was ready for

use July 9, Bansei July 16, and Fuji and Hokkaido July 21. Giant Green yielded more than any of the other varieties, producing 15 to 30 pods per plant, while the other three varieties produced only 10 to 20 pods per plant.

At Clarksville in the northeastern part of Texas, Bansei, Willomi, Kura, and Imperial "planted a month late" (May 11) grew no more than a foot high, but "produced surprisingly well considering the late planting and the very dry season."

East and Middle West

In tests of the early-maturing varieties at two points in western New York, Giant Green, Bansei, Fuji, and Hokkaido all bore abundantly. The cooperator at Lockport stated that the plants "grew enormously," Giant Green "about 2½ feet high and the other varieties 3 feet or more." "Giant Green was ready for eating August 15, Bansei September 1, Fuji between September 1 and 15, Hokkaido about October 1. Fuji was the heaviest yielder."

Planted on Long Island, New York, the varieties Bansei, Willomi, Kura, and Imperial grew very well. The report stated: "Bansei was about twice as prolific as any of the other kinds, while Willomi ranked low in this respect. The four varieties made a very good succession, being picked respectively August 30, September 7, 14, and 21."

At Redding, Connecticut, Bansei, Fuji, and Hokkaido "seemed to do very well."

At Worcester, Massachusetts, the collection of early varieties was planted. The cooperator reported that Fuji "would appear to be a light yielder," while Giant Green and Hokkaido "appeared to be heavy yielders." He expressed doubt as to whether Hokkaido would mature seed in the short season there, and also as to the acceptability of the vegetable-type soybean in that region where the people are accustomed to shelled beans of entirely different texture, appearance, and flavor.

Reports were received from four cooperators in the soybean tests in Pennsylvania. Three reported success in the production of Bansei, Willomi, Kura, and Imperial, except that wild rabbits were a disturbing factor in one locality. The other report, from the extreme north edge of the state, said that Bansei was the only variety that matured completely so that the pods were dry. Willomi and Imperial did not produce well nor mature at that point.

At Indianapolis, Indiana, the yield of vegetable-type soybeans was reported to be exceptionally good, tho no comparisons were made of

the four varieties grown—Bansei, Willomi, Kura, and Imperial. At Whiteland, not far from Indianapolis, medium or high yields were obtained from eight varieties which had been sent out for trial by the Illinois Station. At Evansville, Indiana, an especially heavy yield of Higan was secured.

At Ovid, Michigan, Bansei and Fuji matured very nicely. Hokkaido matured about a week later than Fuji and appeared to be one of the best varieties for Michigan. Giant Green was of short growth and unusually early, but very prolific for its size. Imperial appeared to be too late a variety for that part of Michigan, altho it matured in the long season of 1938. At Battle Creek, Michigan, Bansei and Hokkaido did especially well.

At Tarkio, in the extreme northwest corner of Missouri, four varieties of soybeans were tested. Bansei seemed to be best adapted to that locality, tho Willomi and Kura were also satisfactory. Imperial did not do so well, and the cooperator expressed some doubt as to the ability of this variety to mature seed in his locality in a normal season.

All four varieties of soybeans in the collection of early kinds (Giant Green, Bansei, Fuji, and Hokkaido) matured seed at La Porte City, Iowa, near Waterloo, and all produced good crops. Bansei appeared to be best adapted to that locality. At Salem, Iowa, the same four varieties "did very well, each variety following in nice succession. However, if frost had occurred as early as usual the Hokkaido would not have ripened. That variety is a little late for this locality."

Illinois Reports Concerning Adaptation

Reports of the successful production of vegetable-type soybeans in 54 Illinois counties from the Wisconsin border to the Ohio river indicate the general adaptation of this new vegetable crop thruout the state. A relatively small proportion of the cooperators reported on the performance of particular varieties, but a sufficient number of such reports were received to be significant.

Giant Green.—The only year in which Giant Green was included in all collections it was singled out as the most satisfactory variety, in reports from counties in the north, west, east, and southern parts of the state, thus indicating its adaptation to all parts of the state. Some specific reasons given for preferring this variety, besides its good quality and extreme earliness, were that it was especially drouth-resistant, that it developed before the bad weather came, and that it was ready to use before grasshoppers arrived in destructive numbers.

Higan.—Contrasted with Giant Green as to earliness is Higan, one of the latest varieties to reach edible maturity, but which several co-operators reported to be the heaviest yielding among those tested. Such reports came from counties scattered from the north to the south ends of the state, indicating the general adaptation of this variety for the production of green shelled beans thruout the state. Higan proved especially good as a late sort in the extreme southern part of the state where the Imperial did not seem to thrive.

Fuji, Jogun, Bansei.—Fuji was reported as especially resistant to drouth in the western part of the state and as yielding very heavily in Cook county. Jogun was reported as performing well in both the north and south parts of the state. Bansei was reported as the heaviest producer at certain points in the northern part of the state (Fig. 2).

Hokkaido.—A midseason variety as grown in the central part of Illinois, Hokkaido proved especially valuable for extending the season for green beans in the north end of the state in the favorable fall of



FIG. 2.—TWO ENTHUSIASTIC COOPERATORS IN THE SOYBEAN PROJECT

The plants under observation are of the Bansei variety, grown in Kane county, Illinois. This variety is a heavy yielder and an especially good producer of ripe beans in regions where the season is rather short. (Courtesy A. E. Phelps, Mooseheart, Illinois)

1938. From Stephenson county came the report that "Hokkaido furnished green beans up to the second week in October"; while from Cook county it was reported that "even at this date (October 12), on the Hokkaido 90 percent of the pods can still be used as green shelled beans."

Comparison of Adaptability in Illinois and Other States

The reports from the different parts of the country and from different parts of Illinois indicate that some varieties of vegetable-type soybeans that are well adapted to central Illinois are of doubtful value in the south and in the southwestern plains states. The plants are small and the yields deficient.

In northern localities in the central states, as in Iowa, Minnesota, Wisconsin, and Michigan, and even in northern Illinois, the early varieties proved the most reliable, Bansei being especially productive in Iowa and northern Illinois, and Giant Green being the most suitable for localities farther north. Both high altitudes where the nights are cool and exposure to ocean influences in the northwest seem unfavorable to the normal development of the vegetable-type soybeans, tho Giant Green may produce a crop in some localities where other varieties fail.

In western New York, on Long Island, and at various points in Pennsylvania, varieties adapted to central Illinois seemed to thrive quite well, tho at some points only the earlier varieties seemed to be productive. In central Indiana conditions seem to be favorable for the same varieties as thrive in central Illinois.

PERFORMANCE OF 18 VARIETIES AT URBANA

The field tests at Urbana, begun in 1934, included a total of 466 varieties and strains of soybeans, about one-third of which were of the vegetable type. From this large number, 18 varieties were selected as most worthy of special attention for use as food. Seventeen varieties were of the vegetable type, especially adapted to use as green shell beans but highly desirable also in the ripe state; the other variety was the Illini, which was included in this select list of edible soybeans because of its special value as a dry bean.

All 18 varieties of edible soybeans included in the selected list with which this report is especially concerned have been grown on the Experiment Station plots at Urbana each year from 1936 to 1938 inclusive and a number of them were grown also in 1934 and 1935. Data

regarding various aspects of the performance of each variety have been recorded for each year the variety was grown, and data regarding certain additional aspects have been recorded for part of the varieties some years. For ease of comparison, the data are presented in tabular form.

Relative Earliness of Different Varieties

As grown at Urbana, there were marked differences in the relative earliness of the different varieties (Table 1). Three different measures of earliness were employed: (1) number of days from planting to bloom; (2) number of days from planting to edible condition as green

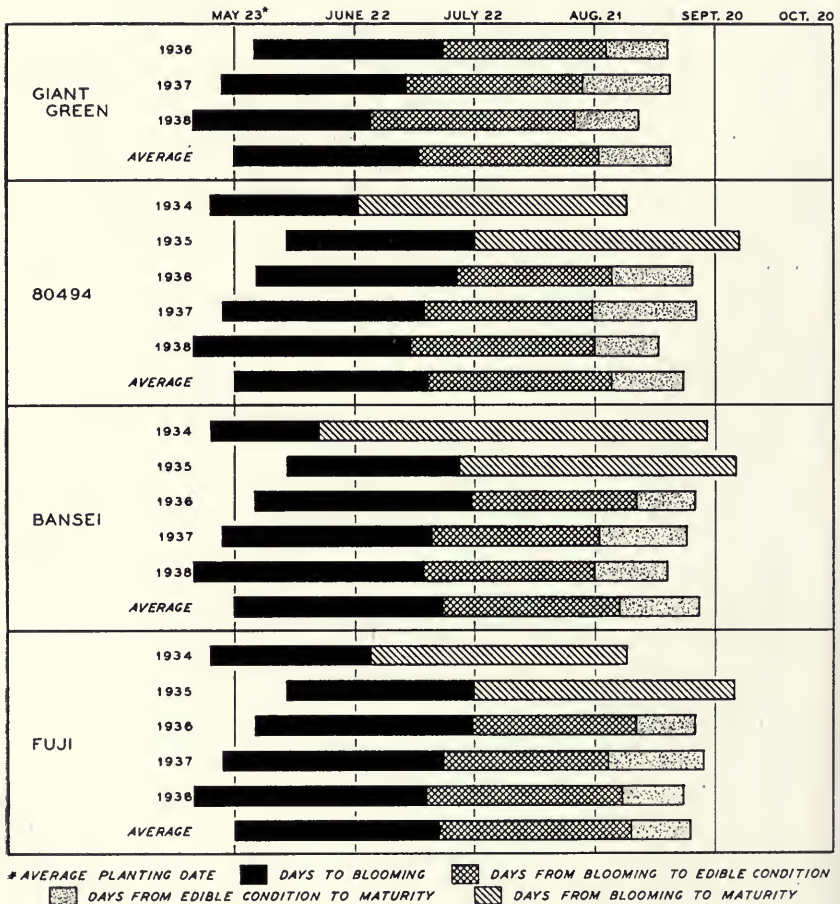


FIG. 3.—PERIODS OF DEVELOPMENT OF FOUR EARLY SOYBEAN VARIETIES

TABLE 1.—RELATIVE EARLINESS OF 18 VARIETIES OF SOYBEANS GROWN AT URBANA, ILLINOIS, 1934-1938
(Planted May 17, 1934; June 5, 1935; May 28, 1936; May 20, 1937; May 13, 1938)

Variety	Number of days to blooming ^a					Number of days to edible condition ^b				Number of days to maturity ^c						
	1934	1935	1936	1937	1938	Aver.	1936	1937	1938	Aver.	1934	1935	1936	1937	1938	Aver.
<i>Very early</i>																
Giant Green . . . . .	. . .^d	. . .	47	46	44	46	88	90	95	91	. . .	. . .	103	112	111	109
<i>Early</i>																
804941	37	47	50	50	54	48	89	92	100	94	104	113	109	118	116	112
Bansei (81031)	27 ^e	43	54	52	57	52	95	94	100	96	124	112	110	116	118	116
Fuji (81029)	40	47	54	55	58	51	95	96	107	99	104	112	110	120	122	114
<i>Midseason</i>																
Illini	55	. . .	57	57	58	57	95	100	103	99	130	. . .	122	125	126	126
Hokkaido (85666)	47	50	54	55	59	53	101	99	113	104	124	115	124	123	138	125
Jogun (87615)	47	50	50	55	58	52	98	102	107	102	124	143	118	124	134	123
Willom (81044-1)	42	51	57	55	57	52	102	102	105	103	124	125	126	123	135	127
80490-1	38	47	61	53	55	51	105	100	108	104	124	113	130	123	127	123
89162	44	. . .	54	56	57	53	99	96	106	100	125	. . .	137	125	125	128
84979	46	. . .	54	65	70	59	96	104	109	103	125	. . .	137	131	137	133
87617 . . . . .	. . .	. . .	57	55	55	56	100	96	99	98	. . .	. . .	137	120	120	126
<i>Late</i>																
Illington . . . . .	. . .	. . .	61	63	69	64	109	110	114	111	. . .	. . .	142	131	136	136
Imperial (81780)	47	52	61	61	64	57	. . .	107	114	111	124	125	145	133	138	133
87606 . . . . .	. . .	62	64	68	72	67	105	110	110	108	. . .	118	149	134	138	135
Funk Delicious . . . . .	. . .	. . .	64	61	60	62	107	110	116	111	. . .	. . .	145	133	138	139
Emperor (97155) . . . . .	. . .	62	64	67	72	66	105	111	118	111	. . .	125	154	139	145	141
Higan (80475) . . . . .	. . .	. . .	64	70	74	69	113	115	123	117	. . .	. . .	142	138	145	142
Average	44	51	57	58	61	56	100	102	108	103	121	117	130	126	131	127

^aBlooming date, when 50 percent of the plants showed some open blossoms. ^bEdible date, when about 80 to 85 percent of pods were well filled. ^cMature date, when pods had turned to their mature color and become fairly dry. ^dBlanks in these tables indicate either that the variety was not included in the tests that year, or that data on the particular point were not secured. ^eNot included in average. ^fThe serial numbers, used either alone or in parentheses following a variety name, are the designations under which the varieties were originally sent out by the Bureau of Plant Industry, U. S. Department of Agriculture. Several have since been named.

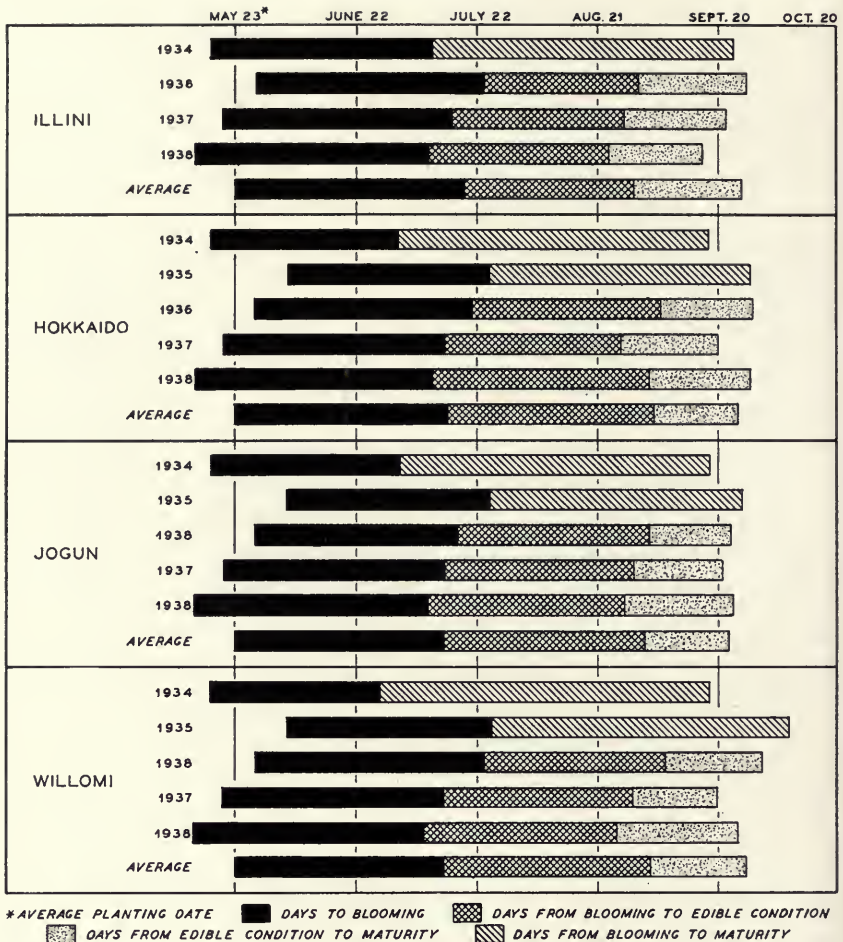


FIG. 4.—PERIODS OF DEVELOPMENT OF EIGHT MIDSEASON SOYBEAN VARIETIES
(Concluded on opposite page)

shelled beans; and (3) number of days from planting to maturity of seed. Planting dates varied from year to year, being determined largely by weather and soil conditions, but each year all varieties in the test plots from which these data (Table 1) were obtained were planted on the same day. The planting dates were as follows: May 17, 1934; June 5, 1935; May 28, 1936; May 20, 1937; May 13, 1938. The average planting date was May 23.

There was considerable variation in the rate of development of the same variety in different years, partly because of differences in plant-

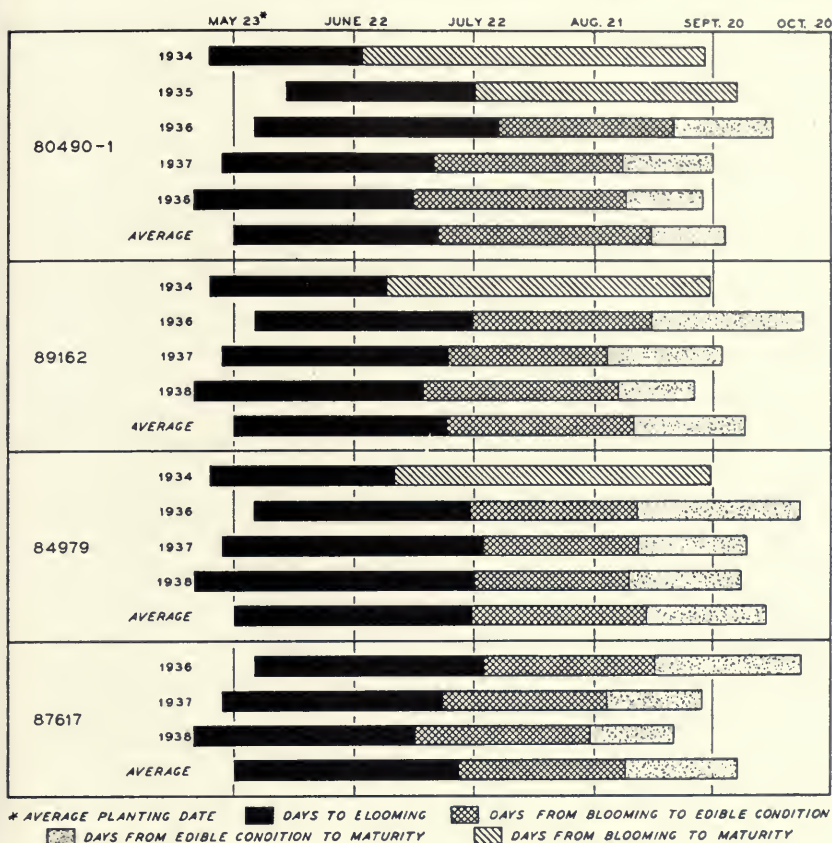


FIG. 4.—CONCLUDED

ing dates and weather conditions. However, the rate of development of each variety in relation to the others was fairly consistent, and, as grown at Urbana, the varieties may conveniently be classified into four groups; (1) very early, (2) early, (3) midseason, and (4) late (Table 1). In general the early varieties required much less time to reach the blossom stage than did the late varieties, and they developed more rapidly from bloom to the edible stage, and from edible condition to maturity, than either the midseason or the late varieties.

Giant Green was distinctly earlier than any other variety included in the tests at Urbana, and has been classified by itself as very early. It produced edible beans in 88 to 95 days from planting in these test plots during the three years that records on it were made. The group of early varieties developed to the edible stage in less than 100 days,

on the average; whereas most of the midseason varieties required slightly more than 100 days. The late varieties normally required about 110 days to reach the same condition, with an average of 111 days for most of them, altho Higan required 117 days as an average and was consistently the latest variety to reach edible condition.

In maturing seed, Giant Green was distinctly earlier than its closest rival, while the early group was approximately 10 days ahead of the midseason group and 20 days earlier than the late group.

The average number of days required for the development of all varieties to a given stage each season indicates in a general way the combined influence of time of planting and character of season on rate of development. The hot, dry weather of 1934 and late planting of 1935 apparently hastened development; while September rains in 1936 and early planting in 1938 undoubtedly prolonged the period required for reaching maturity.

The rate of development and time of reaching each of the three stages are graphically represented for each variety in Figs. 3 to 5 inclusive. Of especial interest is the date of maturity of each variety. Giant Green normally matured by September 10; Hokkaido, Jogun, and other midseason sorts usually about September 25. Some midseason varieties were delayed until about October 10 some seasons. This was especially true in 1936. The late varieties normally matured about October 5, but in 1936 some of them matured later than October 20.

Duration of Edible Period

As an aid in selecting varieties to cover the season from early to late, data were secured in 1937 and 1938 regarding the length of the period during which certain varieties remained in condition for use as green shelled beans (Table 2). These data were obtained from a different plantation than that from which the data in Table 1 were secured. Planting dates were May 19, 1937, and May 21, 1938, except for a few varieties, the planting of which was unavoidably delayed for a few days.

Nearly every variety remained in edible condition for at least 10 days both seasons, while some varieties were usable much longer, an extreme of 28 days being recorded for Emperor in 1937 and for 80490-1 in 1938. There was a marked difference in the performance of three midseason varieties (Hokkaido, Jogun, and Willomi) in the two seasons. In 1937 these varieties remained in edible condition only 11 days, whereas in 1938 they were edible for 24 days. The extremely

TABLE 2.—DURATION OF EDIBLE PERIOD OF 13 VARIETIES OF SOYBEANS GROWN AT URBANA ILLINOIS, 1937-1938
(Different plantation from that reported in Table 1)

Variety	1937				1938			
	Date planted	Date first edible	End of edible period	Duration of edible period <i>days</i>	Date planted	Date first edible	End of edible period	Duration of edible period <i>days</i>
<i>Very early</i>								
Giant Green.....	May 19	Aug. 17	Aug. 27	10	May 21	Aug. 18	Aug. 29	11
<i>Early</i>								
80494.....	May 19	.....	.....	.....	May 21	Aug. 22	Sept. 3	12
Bansel.....	May 19	Aug. 23	Sept. 3	11	May 21	Aug. 22	Sept. 6	15
Fuji.....	May 19	Aug. 27	Sept. 7	11	May 21	Aug. 29	Sept. 16	18
<i>Midseason</i>								
Hokkaido.....	May 19	Aug. 27	Sept. 7	11	May 21	Aug. 29	Sept. 22	24
Jogun.....	May 19	Aug. 27	Sept. 7	11	May 21	Aug. 29	Sept. 22	24
Willoml.....	May 19	Aug. 27	Sept. 7	11	May 21	Aug. 29	Sept. 22	24
80490-1.....	.....	.....	.....	.....	May 21	Aug. 29	Sept. 26	28
<i>Late</i>								
Illington.....	May 19	Sept. 3	Sept. 11	8	May 21	Sept. 3	Sept. 22	19
Imperial.....	May 19	Sept. 3	Sept. 24	21	May 21	Sept. 6	Sept. 22	16
Funk Delicious.....	May 19	Sept. 3	Sept. 24	21	May 25	Sept. 9	Sept. 29	20
Emperor.....	May 24	Sept. 3	Oct. 1	28	May 25	Sept. 9	Sept. 29	20
Higan.....	May 19	Sept. 7	Sept. 27	20	May 25	Sept. 12	Sept. 29	17

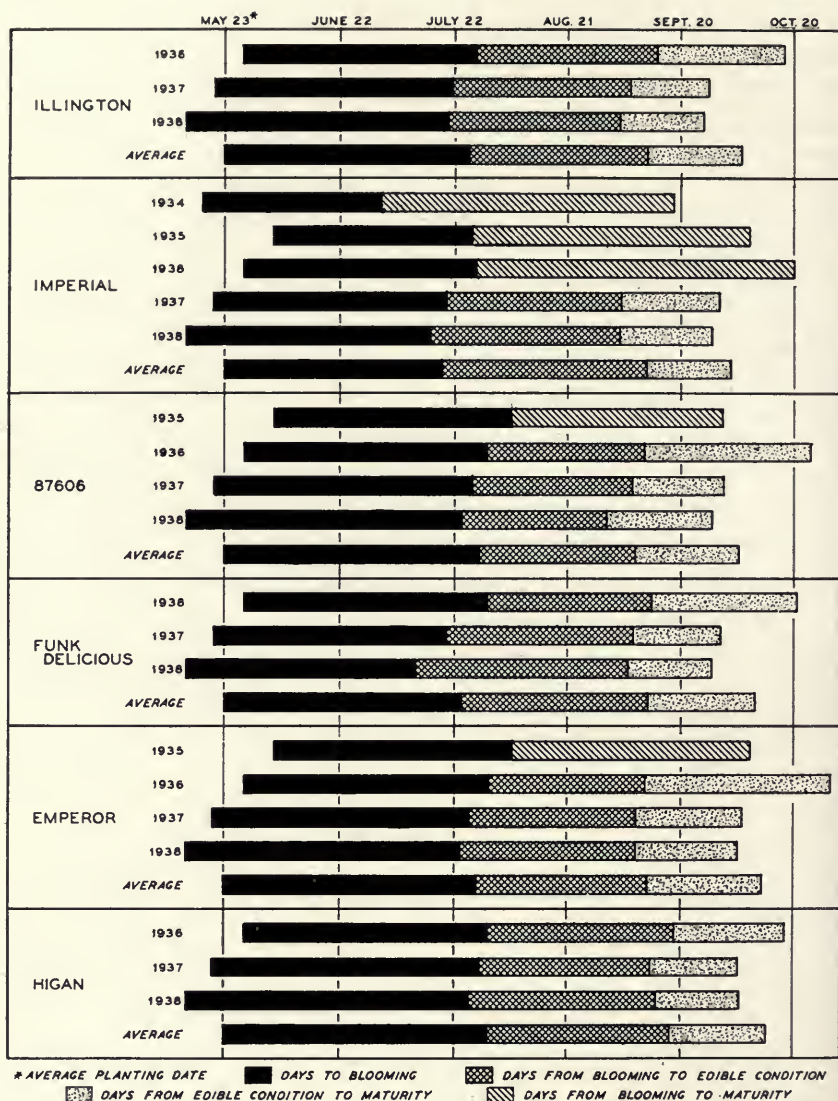


FIG. 5.—PERIODS OF DEVELOPMENT OF SIX LATE SOYBEAN VARIETIES

high temperature which prevailed during the first eight days these varieties were in edible condition in 1937 undoubtedly was an important factor in hastening them thru the edible stage. The mean daily maximum temperature from August 27 to September 3 was 90° F.¹

¹Calculated from official weather record, Urbana, Illinois.

while the mean temperature for the period was 80.7°. In 1938 much lower temperatures prevailed during the early part of the edible period of these varieties, the mean temperature for the first eight days (August 29 to September 5) being only 74.2°. The relatively low mean temperature (57.9°) during the last eight days of the edible period of these varieties in 1938 (September 15 to 22) also tended to lengthen this period. It is probable that in central Illinois 11 days is more nearly a normal period of edibility for these three midseason varieties than 24 days.

In normal seasons the later varieties tend to remain in edible condition longer than the earlier varieties, partly on account of the cooler weather likely to prevail at the time they are in the edible stage, tho the inherent character of each variety is an all-important factor. There is also evidence that the amount of moisture in the soil and in the atmosphere has some influence on hastening or retarding maturity after the beans have reached the edible stage.

Agronomic Characters

Certain characteristics of the different varieties of edible soybeans have an important bearing upon their adaptation to garden and field culture. Chief among these characters are height of plant, erectness of growth (relative freedom from lodging), and susceptibility to shattering (Table 3).

Height of Plant.—This characteristic was recorded each year for each of the varieties grown in the test plots from which the data given in Table 1 were secured. Except in 1935 the measurements were made after the plants had reached maturity and had shed most of their leaves. The measurements were made from the surface of the ground to the tip of the plant (end of the growing point, exclusive of leaves). Plants not standing fully erect were stretched up before being measured. The figures given in Table 3 represent averages of a number of measurements.

There was considerable difference in the height of plants of the same variety in different seasons, shorter plants usually being produced in dry seasons, as in 1934 and 1936. The more normal growing seasons of 1937 and 1938 resulted in much taller plants. In spite of seasonal differences some varieties normally grew much taller than others, as shown by the averages, tho these figures are not all directly comparable, since some are averages for four years and others for three years. For garden culture, especially in home gardens where the soybeans are likely to be planted next to dwarf string beans or other

TABLE 3—AGRONOMIC CHARACTERS OF 18 VARIETIES OF SOYBEANS GROWN AT URBANA

Variety	Height of plant at maturity, inches					Lodging ^b	Shattering ^b	
	1935 ^a	1934	1936	1937	1938			Average ^a
<i>Very early</i>								
Giant Green.....	...	...	14	24	18	19	Bad
<i>Early</i>								
80494.....	22	13	20	30	22	21	Medium to bad	
Bansel.....	23	18	18	30	26	23	Slight	
Fuji.....	21	12	18	32	22	21	Medium	
<i>Midseason</i>								
Illini.....	...	41	34	44	42	40	None	
Hokkaido.....	23	18	18	26	28	21	Slight to medium	
Logun.....	25	15	17	26	26	21	Medium to bad	
Willom.....	29	17	21	26	25	22	Slight	
80490-1.....	22	20	19	24	25	22	Medium	
89162.....	...	26	26	30	35	31	Medium to bad	
84979.....	...	15	20	32	25	23	Slight	
87617.....	...	...	30	40	23	31	Medium
<i>Late</i>								
Illington.....	...	...	24	30	23	26	Medium
Imperial.....	32	20	25	33	36	29	Slight	
87606.....	26	...	23	34	24	27	Medium to bad	
Funk Delicious.....	...	...	26	38	38	34	Slight
Emperor.....	28	...	27	34	29	30	Bad	
Higan.....	...	...	18	26	23	22	Slight
	...	...	...	...	...	...	Medium

^aHeight in 1935 was taken at the flowering date and is not included in the average. ^bThe amount of lodging and shattering are estimates based on data taken from 1934 thru 1938.

low-growing crops, there is an advantage in using the varieties that normally do not make a very tall growth.¹

Erectness of Growth.—Some varieties of the vegetable-type soybeans normally grow erect, while others have a tendency to sprawl over the ground and become badly lodged by the time the ripe seed is ready to harvest. Other varieties are between these extremes. The tendency of the soybean plants to stand up or sprawl is expressed in terms of extent of lodging (Table 3). Erectness of growth is particularly desirable in crops that are to be harvested by machinery as mature seed.

Susceptibility to Shattering.—In the vegetable-type soybeans shattering of the seed is much more prevalent than in the field type commonly grown in the corn belt, such as the Illini. However, some varieties of the vegetable type shatter much more than others.

Data on shattering were taken for each variety each year it was grown, and they were almost invariably taken on the day the beans were cut for seed. Harvesting for seed took place as soon as the pods on most of the plants had turned to their mature color and become fairly dry and most of the foliage had fallen; that is, at the earliest date that the maturity of the crop warranted harvesting for seed. This practice was employed in order to save as much of the crop as possible.

The records show that there was considerable difference in the amount of shattering in the same variety in different seasons, the shattering being worse when the weather was dry than when it was moist at the time the crop matured.

Yields of Dry Beans

Yield records were obtained on most of the varieties every year they were grown. In the test plots the soybeans were planted in rows exactly one rod long. Three adjacent rows were planted to each variety, and the yield record was taken from the center row. The rows were 2 feet apart, and there was no extra space between different varieties. In some years some varieties and in other years all varieties were replicated in the tests, and the average of either two or three replications was taken as the yield. However, in some instances the yield record was based on a single row.

A good stand of plants was invariably secured in the test rows. This was accomplished by heavy seeding, 150 seeds being counted out

¹The height of plant is also influenced by time of planting, very late planting resulting in much shorter growth than normal-season planting.

TABLE 4.—ACRE-YIELDS OF DRY BEANS FROM 18 VARIETIES OF SOYBEANS, URBANA, 1934-1938^a

Variety	1934	1935	1936	1937	1938	Average
<i>Very early</i>	<i>bu.</i>	<i>bu.</i>	<i>bu.</i>	<i>bu.</i>	<i>bu.</i>	<i>bu.</i>
Giant Green.....	....	....	18.0	....^b	16.8	17.4
<i>Early</i>						
80494.....	27.3	19.0	27.2	....	30.9	26.1
Bansei.....	....	24.8	25.4	....^b	41.2	30.5
Fuji.....	17.7	25.2	20.1	24.5	25.0	22.5
<i>Midseason</i>						
Illini.....	31.9	41.5	26.0	26.4	42.1	33.6
Hokkaido.....	25.2	38.2	21.4	....^b	21.2	26.5
Jogun.....	....	31.2	20.0	26.3	15.9	23.4
Willomi.....	23.0	44.2	23.6	17.4	27.3	27.1
80490-1.....	10.9	35.0	15.5	14.8	32.0	21.6
89162.....	34.9	....	25.3	12.8	40.6	28.4
84979.....	21.6	42.6	28.4	23.3	27.6	28.7
87617.....	....	....	26.9	22.9	29.8	26.5
<i>Late</i>						
Illington.....	....	25.5	21.3	27.4	22.3	24.1
Imperial.....	10.3	....	30.2	25.9	28.4	23.7
87606.....	....	35.3	16.0	26.4	24.3	25.5
Funk Delicious.....	....	....	24.7	33.9	27.9	28.8
Emperor.....	....	....	29.6	19.9	26.0	25.2
Higan.....	....	44.0	20.8	....^b	30.2	31.7

^aAcre-yields have been calculated from the yields of rod rows in test plots, counting 60 pounds of dry beans to the bushel. ^bPlants of these four varieties in 1937 were so nearly stripped to provide material for palatability tests that no yield record of ripe beans could be taken.

for the planting of each rod row. The seeds were thus spaced an average of 1.32 inches apart. Altho the stand count of plants in the test rows in 1937 and 1938 varied with different varieties, it was, with only one exception, more than 50 percent in all the rows, the range being from 53 to 89 percent. Comparable stands were procured other years. Even a 50-percent stand consisted of plants less than 3 inches apart as an average; while a 70-percent stand consisted of plants approximately 2 inches apart. The plants in the test rows were never thinned, but all were allowed to grow.

The yield records given in Table 4 have been converted to an acre basis from the data secured from the rod rows. They represent the weight of cleaned seed actually threshed and saved, with no allowance for shattering or other losses during the process of harvesting, curing, and handling. All beans were air-dried for approximately one month after threshing and before weights were taken for the yield records.

The lowest yield was secured from Giant Green. This could be expected because of the relatively small size of the plants and the bad shattering characteristic of this variety. None of the vegetable-type varieties produced as heavy an average yield as Illini, which lost no seed whatever from shattering. All the varieties produced quite consistent and satisfactory yields, even tho there was considerable varia-

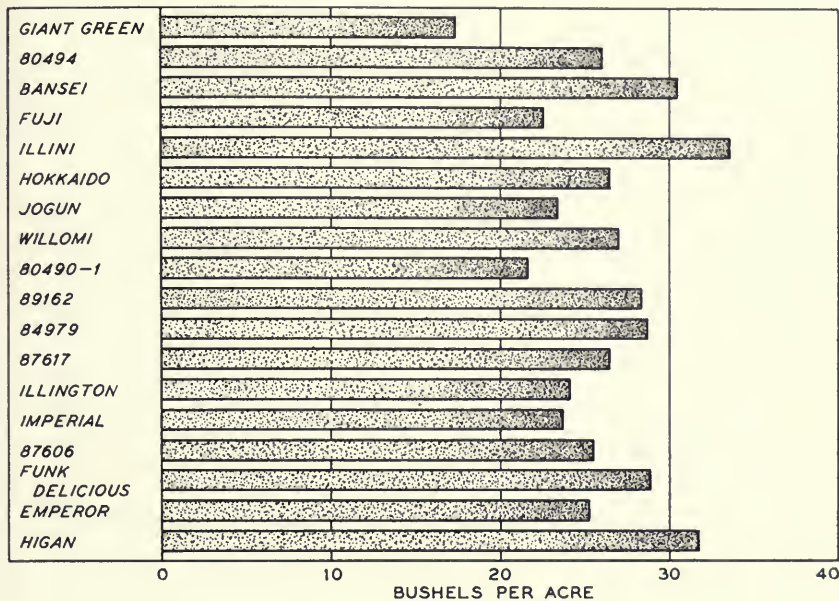


FIG. 6.—YIELDS OF DRY SOYBEANS OF 18 EDIBLE VARIETIES

All these varieties gave quite consistent and satisfactory yields. Of the vegetable type, Bansei, Hokkaido, Willomi, 89162, 84979, Funk Delicious, and Higan produced especially well.

tion in the relative yield of the different varieties from year to year. Particularly good yields were secured from Bansei, Hokkaido, Willomi, 89162, 84979, Funk Delicious, and Higan (Fig. 6).

Of especial importance is the fact that the vegetable-type soybeans were able to produce satisfactory crops each of the five years of the test, in spite of wide variations in seasonal conditions (Table 5). The five-year period covered in these tests included two years (1934 and

TABLE 5.—TEMPERATURE AND RAINFALL DURING GROWING MONTHS FOR SOYBEANS, URBANA, 1934-1938^a

	Mean temperature, °F.					Rainfall, inches				
	1934	1935	1936	1937	1938	1934	1935	1936	1937	1938
May.....	70.5	58.1	67.4	64.8	63.7	.53	6.93	3.94	2.59	4.97
June.....	80.8	69.4	72.8	72.4	72.6	5.33	3.64	.47	5.43	5.67
July.....	83.6	79.1	80.5	77.5	77.9	2.09	4.12	1.35	2.43	6.45
August.....	75.0	74.8	81.1	78.4	77.4	4.87	2.36	3.54	.80	4.28
September.....	63.7	67.3	70.7	66.6	69.1	6.99	3.94	5.83	5.34	.88
For the 5 months.....	74.7	69.7	74.3	71.9	72.1	19.81	20.99	15.13	16.59	22.25

^aData from official weather record.

TABLE 6.—YIELDS OF SOYBEAN SEED FROM MULTIPLICATION PLOTS,^a 14 VARIETIES, URBANA, 1938

Variety	Yield per acre ^b	Variety	Yield per acre ^b	Variety	Yield per acre ^b
<i>Very early</i>	<i>bu.</i>	<i>Midseason</i>	<i>bu.</i>	<i>Late</i>	<i>bu.</i>
Giant Green	18.3	Illini	39.3	Illington	27.6
<i>Early</i>		Hokkaido	21.6	Imperial	26.9
80494	32.8	Jogun	25.2	Funk Delicious ^c	30.3
Bansei	33.8	Willomi ^c	19.2	Emperor	24.1
Fuji	31.5	80490-1	33.3	Higan	37.9

^aEach plot consisted of $\frac{1}{4}$ to $\frac{1}{2}$ acre of a given variety. ^bYields calculated on basis of 12 percent moisture. ^cAverage of two plots.

1936) which were extremely unfavorable for the production of farm and garden crops in general on account of poor distribution of the moisture supply and excessive heat thru long periods. Yet several of the varieties produced good crops both these years.

In seasons of either excessive or deficient rainfall the crop was able to thrive. With 21.37 inches of rainfall in four months from May to August in 1938, the soybean plants were not drowned out, but produced abundantly. At the other weather extreme in 1936, with a rainfall of only 1.82 inches for the two months of June and July combined, nearly all the varieties produced very satisfactory yields.

Supplementary to the yields based on rod rows, as given in Table 4, the yields from multiplication plots of 14 of the varieties in 1938 are given in Table 6. These plots consisted of an area of $\frac{1}{4}$ to $\frac{1}{2}$ acre devoted to each variety. Yields of more than 30 bushels to the acre were produced by six of the vegetable-type varieties—Bansei, 80494, Fuji, 80490-1, Funk Delicious, and Higan. The yield of Higan (37.9 bushels) was especially conspicuous, even tho slightly less than that of the field variety, Illini.

Blossom, Pod, and Seed Characters

Certain plant and seed characters, besides aiding in the identification of the soybean varieties, also have an important bearing upon the adaptability of a given variety to particular uses.

The color of the blossom and of the pubescence on the pods aids materially in the proper roguing of a crop being grown for seed. The blossoms of the varieties in this test were either purple or white and the pubescence tawny or gray (Table 7).

Seed color is extremely important in soybeans to be used as a table vegetable. Varieties in which the mature seed is yellow or green are an attractive pea-green color when cooked at the green shell stage.

TABLE 7.—BLOSSOM, POD, AND SEED CHARACTERS OF THE 18 VARIETIES OF SOYBEANS TESTED

Variety	Color of blossom	Color of pubescence	Color of seed	Color of hilum	Shape of seed	Weight of 100-dry beans
<i>Very early</i>						
Giant Green.....	Purple	Tawny	Green	Black	Flat	grams 29.43
<i>Early</i>						
80494.....	Purple	Gray	Yellow	Colorless	Intermediate	22.24
Bansei.....	Purple	Gray	Yellow	Colorless to light brown	Intermediate	21.24
Fuji.....	White	Tawny	Green	Black	Flat	25.87
<i>Midseason</i>						
Illini.....	White	Gray	Yellow	Brown	Round	13.87
Hokkaido.....	White	Gray	Yellow	Colorless	Intermediate	31.88
Jogun.....	White	Gray	Yellow	Colorless	Intermediate	29.93
Willoml.....	Purple	Gray	Yellow	Light brown	Round	31.07
80490-1.....	Purple	Gray	Yellow	Colorless	Intermediate	25.02
89162.....	Purple	Gray	Yellow	Colorless	Flat	24.99
84979.....	White	Gray	Yellow	Colorless	Intermediate	26.68
87617.....	Purple	Tawny	Yellow	Colorless	Flat	23.61
<i>Late</i>						
Illington.....	White	Gray	Yellow	Colorless	Intermediate	25.94
Imperial.....	Purple	Gray	Yellow	Colorless to light brown	Intermediate	28.35
87606.....	Purple	Gray	Yellow	Colorless	Intermediate	27.10
Funk Delicious.....	Purple	Gray	Yellow	Light brown	Intermediate	31.65
Emperor.....	Purple	Gray	Yellow	Colorless to light brown	Intermediate	29.66
Higan.....	Purple	Gray	Yellow	Light brown	Flat	23.36

*The weight of 100 dry beans is an average figure, computed from weights of these beans for the years 1934 thru 1938.



FIG. 7.—CHARACTERISTIC SHAPES OF MATURE SOYBEANS

These varieties illustrate what is meant by the terms used in Table 4 and elsewhere to describe the shape of the soybean seed.

Yellow varieties are more attractive than green for use as food in the mature stage. All varieties included in the tables in this report are either yellow or green. Varieties with black, brown, mottled, or variegated seed were necessarily omitted from the select list of edible varieties on account of their less attractive appearance as a cooked vegetable.

The color of the hilum also influences the acceptability of the beans for table use. A light brown or brown hilum does not impair the attractive color of the cooked product, whereas a black hilum is conspicuous and undesirable, especially in the ripe product.

The shape of seed is not of great importance except as an aid in identifying certain varieties. The seeds of the 18 varieties tested were either flat, intermediate, or round (Fig. 7).

Size of seed is of primary importance in varieties of soybeans to be used in the green shell stage, since it has a definite relation to the

TABLE 8.—WEIGHT OF 100 DRY SOYBEANS, 18 VARIETIES, URBANA, 1934-1938

Variety	Sample from crop of year					Average
	1934	1935	1936	1937	1938	
<i>Very early</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>
Giant Green.....	.....	.....	29.50	25.83	32.95	29.43
<i>Early</i>						
80494.....	23.20	.....	.....	20.78	22.75	22.24
Bansei.....	.....	.....	19.91	19.46	24.34	21.24
Fuji.....	.....	.....	22.35	23.95	31.32	25.87
<i>Midseason</i>						
Illini.....	.....	12.23	15.89	12.93	14.42	13.87
Hokkaido.....	.....	30.92	31.57	32.42	32.60	31.88
Jogun.....	.....	32.29	25.89	26.63	34.89	29.93
Willomi.....	.....	30.30	30.65	29.93	33.39	31.07
80490-1.....	.....	26.36	.....	23.27	25.42	25.02
89162.....	28.19	.....	.....	19.80	26.99	24.99
84979.....	27.44	.....	.....	23.83	28.77	26.68
87617.....	.....	.....	.....	22.70	24.51	23.61
<i>Late</i>						
Illington.....	.....	24.75	27.60	22.50	28.92	25.94
Imperial.....	.....	26.10	29.92	24.82	32.56	28.35
87606.....	.....	.....	.....	27.28	26.92	27.10
Funk Delicious.....	.....	.....	33.39	28.72	32.85	31.65
Emperor.....	.....	.....	.....	28.11	31.21	29.66
Higan.....	.....	22.12	26.56	22.14	22.62	23.36

time required to shell and prepare these beans for the table. Large-seeded varieties are preferred for this purpose, provided other qualities are adequate. In Table 7 size of seed is expressed in terms of weight of 100 dry beans. The figures given represent averages based on weights of air-dry samples taken from the crops produced each year from 1934 to 1938. Usually these data were taken in December for the crop of the current year. Detailed data for the different years are given in Table 8.

Varieties in which 100 seeds weighed 28.35 grams (one ounce) might be classified as *large*. These are: Giant Green, Hokkaido, Jogun, Willomi, Imperial, Funk Delicious, and Emperor.

Varieties in which 100 seeds weighed more than 21 grams (approximately $\frac{3}{4}$ ounce) but less than 28.35 grams might be designated as *medium* in size. This group would include all the varieties in Table 7 not classified as large, except the Illini, which is less than half the size of the large varieties, and is not suitable for use as a fresh, green shell bean on this account, tho well adapted to use as a dry bean threshed out by machinery.

Weights and Shelling Percentages of Green Soybeans

Data were secured on certain representative varieties in the 1936 crop showing the weight of 100 pods of green beans; the percentage

TABLE 9.—WEIGHTS AND SHELLING PERCENTAGES OF SEVEN VARIETIES OF GREEN SOYBEANS, URBANA, 1936

Variety	Weight of 100 pods of green beans	Weight of shelled beans from 100 pods	Shelling percentage	Average number of beans per pod	Weight of 100 green shelled beans	Ratio of weight of 100 green shelled beans to weight of 100 dry beans
	<i>grams</i>	<i>grams</i>			<i>grams</i>	
Giant Green.....	252.0	150.0	59.5	1.78	84.2	2.67:1
Fuji.....	237.5	126.8	53.3	2.05	61.8	2.30:1
Hokkaido.....	270.6	144.0	53.2	1.86	77.4	2.50:1
Willomi.....	267.2	133.0	49.7	1.85	71.8	2.37:1
Funk Delicious.....	306.0	172.5	56.3	2.10	82.1	2.20:1
Emperor.....	230.6	126.7	54.9	1.62	78.8	2.25:1
Higan.....	214.0	124.0	57.9	2.24	55.8	2.83:1

of green shelled beans procured from shelling a given weight of pods; the weight of 100 green shelled beans (indicating the relative size of the green beans of different varieties); the ratio of the weight of 100 green beans to the weight of 100 dry beans of the seed planted that season; and the average number of beans to the pod (Table 9).

Each 100-pod sample of green beans was taken from a freshly picked lot in prime condition for table use. The weight of 100 green shelled beans was calculated from the weight and count of the beans shelled from the 100-pod sample. While there was some variation in the shelling percentage of different varieties, it was in most of these varieties well above 50 percent, and that percentage would be a convenient basis for calculating the weight of shelled beans that could reasonably be expected from a given weight of green beans in the pod.

The ratio of weight of green beans to dry, ripe beans of the same variety varied among the different varieties. This ratio would undoubtedly vary also with different samples of the same variety, depending upon the moisture content of the dry beans when weighed and the exact stage of development of the green beans. However, the average ratio of the six varieties on which data were secured was 2.44 to 1. Roughly, it may be said that green beans weigh about 2½ times as much as the same number of dry beans of the same variety.

Yields of Green Soybeans

No records were kept of the yields of soybeans picked in the green shell stage from the test plots at Urbana. However, repeated observations when picking the beans for palatability tests and for market

TABLE 10.—YIELDS OF GREEN SOYBEANS SHELLED FOR CANNING, 1937
(Reported by a canning company)

Variety	Yield per acre	Variety	Yield per acre
	<i>lb.</i>		<i>lb.</i>
Giant Green.....	7 100	Hokkaido.....	6 100
Bansei.....	6 800	Jogun.....	5 300
Fuji.....	6 760	Willomi.....	6 000

indicated that with a normal crop of most varieties one bushel of soybeans in the pod was usually harvested from less than 100 feet of row. With rows 2 feet apart, one bushel from 100 feet of row would be at the rate of 217.8 bushels of pods to the acre.¹

A report from one of the canning companies showed yields of six varieties in 1937 ranging from 5,300 pounds to 7,100 pounds of green shelled beans (ready for canning) to the acre (Table 10). Assuming that green soybeans weigh $2\frac{1}{2}$ times their equivalent yield of dry beans, these yields would be at the rate of 35.33 bushels to 47.33 bushels to the acre. Because of no shattering during the harvest, the net yields of green shelled soybeans are likely to be larger than corresponding crops of dry soybeans, where considerable loss from shattering may occur. It is worthy of note that the yield of Giant Green was larger than that of any other variety here reported, even tho the yields of ripe beans of this variety are often low on account of excessive shattering.

MARKET QUALITIES OF THE GREEN SOYBEANS

Size and color of pods, size of beans, ease of shelling, yield of shelled beans, and table quality—all have an important bearing upon the introduction of soybeans as a standard fresh vegetable on the market. Only varieties possessing all the desirable features to a marked degree are likely to help build up the popularity of this new vegetable.

Pod Color

Among the 18 varieties of soybeans tested at Urbana, the pod color in the green shell stage differed widely, especially as the end of the edible period approached (Table 11). Some remained quite green until the brown tinge that indicates approaching maturity developed. Others turned from a green to a clear yellow, and remained an attrac-

¹Green soybeans in the pod weigh approximately 32 pounds to the bushel.

Green Soybeans of Three Superior Varieties and One Row of Mature Beans

(Actual size)

Upper group: F.P.I. 81780 (Imperial)

Center group: F.P.I. 85666 (Hokkaido)

Lower group: F.P.I. 87615 (Jogun)

Pods of the Imperial variety show the characteristic green color of the vegetable type of soybeans at the beginning of the edible period. Pods of Hokkaido and Jogun show the yellowish-green color which is characteristic of soybeans in prime edible condition.

Shelled Beans

Left row: as they come from the pod

Center row: green color intensified by cooking

Right row: mature beans



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TABLE 11.—MARKET QUALITIES OF THE 18 VARIETIES OF GREEN SOYBEANS TESTED AT URBANA

Variety	Color of pods toward close of edible period	Size of pods	Size of green beans	Weight of shelled ^a beans from 100 grams pods	Shelling ^a time for 1 pound of pods	Quality ^a rating
				grams	minutes	
<i>Very early</i>						
Giant Green.....	Green, turning brown	Large	Large	47	8.5	Good
<i>Early</i>						
80494.....	Yellow, turning light brown	Medium	Medium	49	13	Good
Bansel.....	Yellow, some black tinge	Medium	Medium	49	15	Good
Fuji.....	Yellow, turning light brown	Medium	Medium	55 ^b	10	Good
<i>Midseason</i>						
Illini.....	Tinged with black	Small	Small	50.5 ^b	21	Good
Hokkaido.....	Clear yellow, till past edible	Large	Large	49 ^a	8	Very good
Jogun.....	Clear yellow, till past edible	Large	Large	49	8.5	Very good
Willom.....	Yellow, purplish blotches	Large	Large	49 ^a	8.5	Very good
80490-1.....	Clear yellow, till past edible	Medium	Medium	49	15	Good
89162.....	Yellow	Medium	Medium	49	16	Good
84979.....	(No record)	Medium	Medium	52	12	Good
87617.....	(No record)	Medium	Medium	50	11.5	Good
<i>Late</i>						
Illington.....	Clear yellow, then straw color	Large	Medium	47	10	Good
Imperial.....	Yellow, purplish tinge	Large	Large	47 ^b	9.5	Very good
87606.....	(No record)	Large	Large	36	8.5	Good
Funk Delicious.....	Purple on exposed side	Large	Large	50 ^d	8	Very good
Emperor.....	Yellow	Large	Large	47	10.5	Very good
Higan.....	Clear yellow, then straw color	Medium	Medium	50.5 ^b	11	Good

^aData furnished by Department of Home Economics, University of Illinois. ^bAverage of 2 samples. ^cAverage of 3 samples. ^dAverage of 4 samples.

tive yellow until the beans were past the edible stage. Still others developed a black or purplish tinge, or large blotches of purple or black early in the edible period, and were much less attractive in appearance than the varieties with clear green or yellow pods.

Pod Size

At best the pods of soybeans are not large enough to make the strongest appeal to the purchasing public. The largest-podded varieties are of course likely to be the most salable, provided they are attractive in color. Nine of the 18 varieties had large pods, eight had medium-sized pods, and one, Illini, had a small pod.

Size of Beans

Size of beans is also an important market consideration, particularly as it is closely associated with the ease or tediousness of shelling. All 18 varieties had large or medium-sized beans except Illini. The small size of that bean and the long time required to shell a pound of pods preclude the use of this variety as a green shell bean even tho it is of good table quality and well adapted to use as a dry bean threshed out by machinery.

Shelling Time

Tenacity of pods and number of seeds per pod, as well as size of pods and size of beans, affect the shelling time. Tests made by the Department of Home Economics indicate that several of the large-podded, large-seeded varieties can be shelled at the rate of one pound of pods in 8 to 8.5 minutes, while 21 minutes were required to shell the same quantity of the Illini. Other varieties were between these extremes (Table 11).

The facility with which green soybeans can be shelled by the method found most expeditious by the Department of Home Economics (page 439) is definitely influenced by the number of seeds per pod. Two-seeded pods were found to lend themselves best to this method of shelling. Counts made on eighteen samples representing five varieties showed that, as an average for all the samples, 73.4 percent of the pods contained two beans each, 19.5 percent contained one bean each, and 7.1 percent contained three beans each.

Ratio of Shelled Beans to Pods

The weight of shelled beans obtained from a given weight of pods, as determined in tests by the Department of Home Economics in 1937,

varied somewhat between varieties, and between different samples of the same variety, but usually represented about 50 percent of the original weight of pods and beans (Table 11). These data corroborate the findings by the Department of Horticulture for a smaller number of varieties in 1936 (Table 9). All samples represented beans in a satisfactory stage of development for use as green shell beans.

Table Quality

Fortunately most of the varieties rated "very good" in table quality have large pods and are among the most easily shelled (Table 11). Some of them—especially Hokkaido, Jogun, and Emperor—have pods of attractive color as well as size. Some of the early varieties of medium size have attractive pods.

PROTEIN AND FAT CONTENTS OF THE MATURE SOYBEANS

Determinations of the protein and fat contents of the 18 varieties of edible soybeans were made from samples of the 1938 crop grown at Urbana (Table 12). For ease of comparison, the results of the analyses were calculated on a water-free basis.

TABLE 12.—PROTEIN AND FAT CONTENTS OF THE MATURE SOYBEANS OF THE 18 VARIETIES TESTED AT URBANA, CROP OF 1938

Variety	Protein N x 6.25	Fat
<i>Very early</i>	<i>perct.*</i>	<i>perct.*</i>
Giant Green.....	39.34	22.39
<i>Early</i>		
80494.....	38.50	21.13
Bansei.....	36.43	21.61
Fuji.....	39.62	21.41
<i>Midseason</i>		
Illini.....	38.66	21.44
Hokkaido.....	40.38	20.80
Jogun.....	40.69	19.88
Willomi.....	42.34	19.44
80490-1.....	38.23	21.83
89162.....	41.01	21.58
84979.....	44.13	18.05
87617.....	39.84	22.42
<i>Late</i>		
Illington.....	42.85	18.55
Imperial.....	40.96	20.45
87606.....	42.53	20.45
Funk Delicious.....	42.33	19.97
Emperor.....	42.16	19.86
Higan.....	41.04	18.12

*Water-free basis.

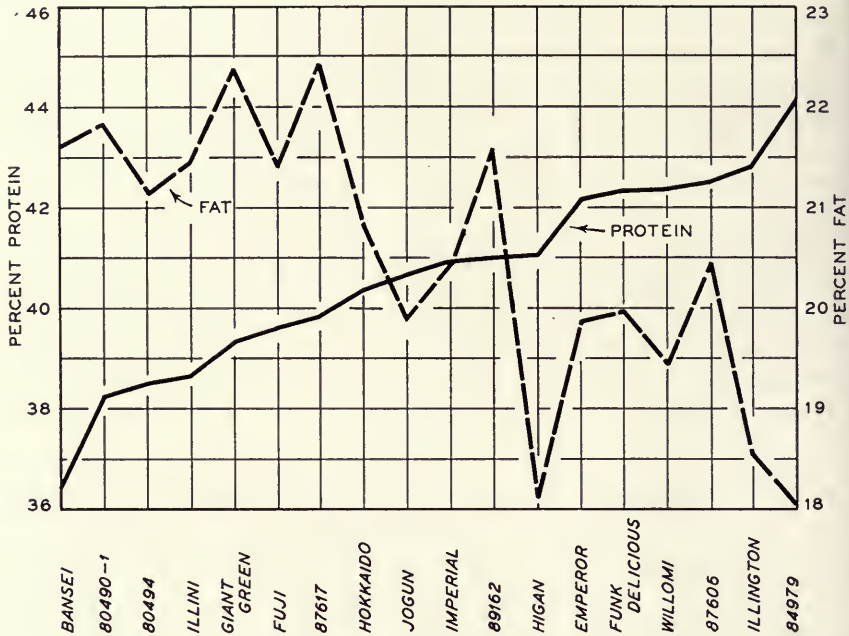


FIG. 8.—PROTEIN AND FAT CONTENTS OF 18 VARIETIES OF EDIBLE SOYBEANS

The varieties low in protein were high in fat, and with a few exceptions those high in protein were somewhat low in fat.

The protein content ranged from 36.43 percent in Bansei to 44.13 percent in 84979, a difference of 7.70 percent. All the vegetable types except 80494, Bansei, and 80490-1 were higher in protein than Illini.

The fat content of the different varieties ranged from 18.05 percent in 84979 to 22.42 percent in 87617, a difference of 4.37 percent. Five of the vegetable-type varieties were as high in oil as Illini: Giant Green, Bansei, 80490-1, 89162, and 87617. Fuji lacked only .03 percent of being as high as Illini.

The varieties low in protein were high in fat, and with a few exceptions those high in protein were somewhat low in fat (Fig. 8).

CHARACTERISTICS OF THE DIFFERENT VARIETIES

As grown at Urbana, the outstanding characteristics of the soybean varieties in the select list of eighteen are as indicated in the following descriptions. (Varieties are arranged in same order as in Tables.)

Giant Green. The very earliest variety of all those tested at the Illinois Station. Plant short and erect. Seed large and green. Pods large and attractive at the green shell stage. Yield, especially of ripe seed, usually smaller than that of the later varieties on account of the pronounced tendency to shatter badly. Much better adapted for use in the green shell stage than as a dry bean. Especially desirable for home-garden culture and for planting in northern localities.

80494. A few days later than Giant Green. Plant erect and of medium height. Seed yellow and of medium size. Pods of medium size and attractive color, turning from green to yellow, then to light brown as maturity approaches. Yield usually good, tho shattering is sometimes bad. A good early bean where yellow color is desired.

Bansei. Much the same season as 80494 but usually slightly later. Plant erect and of medium height. Seed yellow and of medium size but rather tedious to shell in the green stage. Pods yellow but with some black markings that detract from their appearance. Yield heavy. Shattering slight. Especially adapted to production for ripe beans in regions where the season is rather short.

Fuji. Usually a few days later than Bansei, but somewhat variable in time of reaching edible maturity. Plant erect and of medium height. Seed green and of medium size but distinctly larger than Bansei or 80494 and more easily shelled in the immature stage. Altho pods are covered with tawny pubescence, they have an attractive yellowish color, turning to light brown without any dark blotches as maturity is approached. Yield is usually good, tho the tendency to shatter is sometimes quite marked. Adapted especially to use as a green shell bean; color in ripe stage is unfavorable to use as a dry bean.

Illini. The most prominent commercial field variety of soybean grown in Illinois. Included in the select list of edible varieties on account of its good qualities for table use as a dry bean. The small size of the seed and consequent tedious shelling preclude its use as a green shell bean even tho its quality in the green state is good. Plant tall and usually erect. Midseason in time of maturity. Yield is large and there is no tendency to shatter even tho the beans are left standing in the field long after they are mature. Worthy of extensive use as human food, especially in regions where regularly grown as a field crop.

Hokkaido. One of the best of the midseason varieties for use either green or ripe. Plant erect and of medium height. Seed yellow and consistently large. One of the easiest varieties to shell. Pods large and attractive, remaining clear yellow until the beans are past the immature edible stage. Yield good, tho there is some tendency to shatter.

Jogun. Practically the same season as Hokkaido. Plant erect and of medium height. Seed yellow and large, tho averaging slightly smaller than Hokkaido. Pods large and attractive, clear yellow in color until past edible maturity. Yields good tho somewhat variable. Shattering sometimes bad.

Willomi. Placed by the Department of Home Economics at top of entire list on basis of quality for table use both as a green shell bean and as a dry ripe bean. Practically the same season as Hokkaido but some-



FIG. 9.—MATURE PLANTS OF THE WILLOMI, a MIDSEASON VARIETY

Willomi produced consistent yields of beans of exceptionally high table quality both green and ripe.

times slightly later. Plant fairly erect and of medium height. Seed yellow and large but usually slightly smaller than Hokkaido. Pods turn from green to yellow but show some purplish blotches that detract from their appearance. Less tendency to shatter than Hokkaido or Jogun (Fig. 9).

80490-1. A midseason variety of erect growth and medium height. Seed yellow and of medium size, distinctly larger than Bansei tho about as tedious to shell. Pods retain a clear yellow color until past the stage for green shell beans. Remains long in edible condition. Yields variable. Many pods too close to the ground for convenient and effective harvesting of the ripe crop. Some tendency to shatter.

89162. A rather tall midseason variety, fairly erect. Seed yellow and flat and average about the same weight per 100 as 80490-1. Average yield good in spite of bad shattering some seasons.

84979. A midseason variety of medium height and fairly erect. Seed yellow, somewhat larger than 80490-1 and more easily shelled. Yield consistently good even tho there was a medium amount of shattering.

87617. A midseason variety of rather vigorous growth, that tends to sprawl over the ground. Seed yellow, flat, and smaller than most mid-season varieties tested. Pods of medium size and covered with tawny pubescence. Yield consistently good; shattering medium.

Illington. A late variety of fairly erect growth and somewhat above medium height. Seed yellow and somewhat smaller than most of the other varieties in the late group. Pods of good size; clear yellow until nearly mature, then turning straw color. Yields quite consistently good, shattering medium.

Imperial. A rather tall late variety, fairly erect. Seed yellow and large. Pods large, but with a purplish tinge that detracts somewhat from their appearance when offered for sale. Yield usually good, and shattering slight.

87606. A late variety of somewhat more than medium vigor with a tendency to sprawl. Seed yellow and of slightly larger average size than Illington. Yield variable, tho the average was good. Shattering slight.

Funk Delicious. A tall late variety, fairly erect. Seed yellow and large. One of the easiest varieties to shell. Pods large, but with purple coloration on the exposed side, which detracts seriously from their appearance as a market product in the green shell stage. Yield heavy; shattering slight.

Emperor. A late variety of vigorous growth, with strong tendency to branch and sprawl. Seed yellow and large. Pods large, yellow, and attractive; devoid of blotches or discolorations. Slightly more tedious to shell than some of the other large-seeded varieties. Yield good; shattering slight.

Higan. A late variety of medium height. Plant very erect. Seed yellow and of medium size. Pods of medium size, turning from green to clear yellow, then straw color as maturity is reached. Very attractive in appearance. Has been consistently the latest of the 18 varieties to reach edible condition, but ripens its seed suddenly as the season draws to a close. The yield is heavy, but the seed must be harvested promptly to avoid loss from shattering. Shatters worse than the other late varieties except Illington.

VARIETIES RECOMMENDED

Undoubtedly some of the varieties under consideration need further testing before their relative merits are fully disclosed. Some have been under test only three years of the five, while others have been subjected to intensive field observations only the past two seasons, even tho included in the general tests for a longer time. Nevertheless, some general recommendations in reference to selection of varieties to meet given conditions seem warranted at this time.

Green Shell for Home or Market

For a home garden or a market garden where a supply of green shell soybeans is desired over a long season, either three or four varieties should be planted. These should include one variety from each group—very early, early, midseason, and late—except in northern localities where the season may be too short for the proper development of the later varieties.

Central Illinois.—A good selection for central Illinois would be Giant Green (extra early), Bansei (early), Hokkaido, Jogun, or Willomi (midseason), and Imperial, Funk Delicious, or Emperor (late). Because of the tedious shelling of Bansei, Fuji might be substituted as the early variety, but Fuji is sometimes delayed in development until the normal time for the midseason varieties to be ready for use.

Southern Illinois.—For southern Illinois the same selection of varieties for extra early, early, and midseason as recommended above for central Illinois would be applicable, but Higan should probably be used as the late variety since it seems to thrive especially well in that region.

Northern Illinois.—For northern Illinois Giant Green and Bansei are especially adapted. One of the three midseason varieties—Hokkaido, Jogun, or Willomi—should also be included in all northern Illinois plantings where a succession of green soybeans is desired. In most seasons the late varieties also will develop to usable condition before frost in the northern part of the state; and if desired, one of the three large-seeded varieties—Imperial, Funk Delicious, or Emperor—may be included in plantings in that region.

Ripe Beans for Table Use

For the production of ripe beans in areas where the season is short, Bansei is especially recommended. In central Illinois where soybeans

are extensively grown as a field crop, the field variety Illini is particularly recommended for production as a ripe bean to be used as a table vegetable. In southern Illinois Higan is well adapted to production as a ripe bean.

Any of the vegetable-type soybeans of yellow color may be grown for use as ripe beans, but their susceptibility to shattering makes them less reliable producers than the Illini in regions where that variety is well adapted. However, for superior table quality and for certain other purposes, such as the manufacture of specialty products, some of the large-seeded yellow varieties are especially desirable. The adaptability of particular varieties for the making of each specific product can undoubtedly be worked out by the manufacturers of the various specialties.

Green Shell for Canning

Limited tests by commercial canners indicate that Bansei and Higan are especially worthy of recommendation for canning as green beans, on account of the clear color of the canned product. Jogun is also well adapted to canning, altho the product is somewhat cloudy.

Tests to determine the adaptability of different varieties of vegetable-type soybeans for preservation by the quick-freezing process are included in a research problem now in progress, but no recommendations regarding specific varieties for this purpose are available at this time.

METHOD OF CULTURE

The vegetable-type soybeans have been found to respond well to methods of culture generally applicable to the field type of soybean as produced in the corn belt. Slight modifications to meet special conditions, however, have sometimes seemed warranted, such as shallower and thinner planting and more careful attention to cultivation both before and after the plants are up.

Time of Planting

In tests with vegetable-type soybeans at Urbana, it has been the practice each year to make the principal planting of all varieties about May 15, or as soon thereafter as soil and weather conditions permitted. Actual planting dates of the main test crop have been given on page 400.

In addition to the general plantings made at the season apparently most favorable to the normal development of this crop, earlier and

TABLE 13.—VARIATION IN RAPIDITY OF DEVELOPMENT OF GIANT GREEN SOYBEANS PLANTED AT DIFFERENT DATES AT URBANA

Date planted	Date edible	Days to edible condition	Production
<i>1936</i>			
May 15.....	Aug. 19	96	Good
June 3.....	Aug. 30	88	Good
<i>1937</i>			
April 12.....	July 29	108	Good
May 10.....	Aug. 9	91	Good
May 19.....	Aug. 9	82	Good
June 24.....	Sept. 3	71	Fair
<i>1938</i>			
May 3.....	Aug. 5	94	Good
May 21.....	Aug. 18	89	Good
June 9.....	Sept. 1	84	Good

later plantings of the Giant Green variety were made in certain years in an effort to determine the feasibility of providing a succession of green beans by successive plantings of the one variety, and also to determine how early in the season this product might be made available for table use by the early planting of a very early variety.

In 1936 only two plantings of Giant Green were made, one on May 15 and the other on June 3. Beans in prime condition for table use were picked from the first planting on August 19, 96 days after planting (Table 13). Beans in prime condition from the second planting were first available on August 30, only 11 days later than those from the first planting, even tho there was a difference of 19 days in the time of planting. Both plantings produced very satisfactory yields.

In 1937 plantings of Giant Green were made on April 12, May 10, May 19, and June 24. The original plan was to make the first three plantings as near April 15, May 1, and May 15 as conditions of soil and weather would permit. Conditions were favorable for planting when the first seed was put in on April 12, but the weather was cold and wet following this planting and only a few plants came up. They were left, however, to determine time of edible maturity. Wet weather in early May delayed the second planting until May 10. In order to avoid having the second and third plantings made too close together the third planting was delayed until May 19.

On July 29 a small picking of beans from the planting of April 12 was made for test purposes, tho these beans had barely reached edible condition at this date. The beans from this planting were still in edible condition on August 9, at which date picking of both the May 10 and 19 plantings could have been started. A large production *per plant* resulted from each of these three plantings.

The plants from the seed planted June 24 were quite small but were well filled with pods and produced a fair crop. The beans were at the beginning of the edible stage on September 3.

In 1938 plantings of Giant Green were made May 3, May 21, and June 9. Good crops were produced from all these plantings.

In each of the three years, 1936, 1937, and 1938, beans from the later plantings reached edible maturity in a shorter time than beans from the earlier plantings (Table 13). A wide range of possible planting dates for vegetable-type soybeans is indicated by the results of these tests. Extremely late planting, however, is likely to result in reduced yields.

Preparation of Seedbed

The vegetable-type soybeans may advantageously be planted on land plowed either in the fall or early in the spring. Repeated disking at intervals during the spring has been found to be an effective means of insuring favorable soil conditions for the final preparation of the seedbed just before planting. The disking not only keeps the soil in friable condition but also kills many weeds.

In the tests at Urbana preparation of the seedbed consisted of thoro harrowing immediately following the last disking. Sometimes the spike-tooth harrow was followed with a Meeker harrow. The aim has been to have an especially well-prepared seedbed and to plant the seed the same day that the seedbed was prepared.

Reported failures to secure a stand of the vegetable-type soybeans or to produce a crop have doubtless been due in many instances to failure to prepare a suitable seedbed.

Distance and Depth of Planting

Experience in growing the vegetable-type soybean at Urbana has indicated that these beans respond well to the allowance of sufficient space between the rows to permit cultivation of the growing crop (Fig. 10). Except for some of the shortest varieties under garden culture, it has been found that a minimum space of 2 feet between rows is needed for handling this crop whether grown for green shell beans or mature seed; and even more space is desirable for harvesting the green beans, especially from tall plants. Three feet between rows has been found to be a convenient distance, tho some growers have reported planting the rows as far apart as 42 inches.

In the test plots at Urbana the depth of planting was $1\frac{1}{2}$ to 2 inches. Under favorable soil conditions this depth has proved to be satisfactory, but some growers have reported difficulty in securing a



FIG. 10.—SOYBEANS GROWING ON THE UNIVERSITY FARM AT URBANA

These soybeans were drilled in rows 2 feet apart to permit tillage with a beet-and-bean cultivator. Thoro tillage is an important step in obtaining good yields.

stand of some of the large-seeded varieties when planting at this depth was followed immediately by heavy rains that packed the soil.

A rate of planting that will place the seeds from $1\frac{1}{3}$ to $1\frac{1}{2}$ inches apart in the row has been found to be most satisfactory where an ample supply of seed is available. The amount of seed required to plant an acre will vary with the size of the seed and the distance between rows. When planted in 2-foot rows, about 120 pounds of a large-seeded variety¹ would be needed for an acre, while 90 pounds of a variety with seed classified as the smallest of the medium size² would be sufficient. The quantity of seed required for varieties between these sizes would vary proportionately. These rates of planting almost invariably result in good stands if soil and weather conditions are reasonably favorable.

If only a small supply of seed is available, thinner planting is advisable, in order to produce as large a crop as possible. Spacing the seeds 3 to 4 inches apart in the row results in a thin stand but a high production *per plant*. In a thin stand the plants of many varieties of the vegetable-type soybeans branch freely and produce phenomenal yields.

¹Varieties in which 100 seeds weigh an ounce or more.

²Varieties in which 100 seeds weigh $\frac{3}{4}$ of an ounce.



FIG. 11.—PLANTING SOYBEANS WITH A BEET-AND-BEAN DRILL

This implement is especially well adapted to planting soybeans of all sizes. It is much superior to an ordinary grain drill for handling the large beans of the vegetable type. Four rows are planted at a time.

Equipment for Planting

For field planting of the multiplication plots of vegetable-type soybeans at Urbana, a beet-and-bean drill was employed (Fig. 11). Four rows 2 feet apart were planted each trip across the field. The rate of discharge of seed was adjusted for each variety and size of seed. In the absence of such equipment a regular grain drill might be made to serve the purpose by stopping up part of the holes and inserting guides in the hopper to insure proper feeding of the beans into the holes that are left open. However, in planting the large beans, a grain drill is likely to crack many of the seeds, and some other method of planting should be employed if possible.

A few growers who have desired to plant the rows more than 3 feet apart have found a two-row corn planter well adapted to the purpose. By the use of proper plates for the different varieties, the desired rate of seeding was readily obtained, and cracking of the seed was largely avoided.

For planting small areas in home or market gardens, a regular garden seed drill has proved very satisfactory. Adjustments are



FIG. 12.—BREAKING A BAD CRUST WITH A ROTARY HOE

This operation is often necessary before the soybeans come up, if seeding is followed shortly by a dashing rain.

readily and quickly made for accommodating the different-sized seeds of the different varieties of table-type beans.

In the absence of any seeding equipment, small test lots of seed or a row or two in a home garden may be planted by hand in drills made with a hoe, as garden peas are planted under similar conditions. To insure accuracy in spacing the seed in the test plots, the rod rows were planted by this method.

Inoculation of Seed

In localities where soybeans of the field type have been grown extensively for a number of years, there is little need of inoculating seed of the vegetable type or the soil in which it is to be planted, for the same bacteria are effective on both types of soybeans. In areas where soybeans have not recently been grown, there is usually some advantage from inoculating the seed, even tho, on good soil and in a favorable season, the vegetable-type soybeans generally produce satisfactory crops without inoculation.

Tillage

For breaking up any crust formed on the soil as the result of heavy rains immediately following planting, and for early tillage soon after the plants straightened up, a rotary hoe (Fig. 12) was used to great



FIG. 13.—BEET-AND-BEAN CULTIVATOR OF THE TYPE USED ON THE SOYBEANS AT URBANA

Four rows can be cultivated at a time, thus resulting in rapid tillage.

advantage in the care of the experimental plots of vegetable-type soybeans at Urbana. In the absence of this special tool, a spike-tooth harrow could be used for the same purpose.

Later tillage consisted of three cultivations either with a four-row beet-and-bean cultivator (Fig. 13) in plantations with rows 2 feet apart, or with a one-horse cultivator in plantings where the rows were $2\frac{1}{2}$ or 3 feet apart. Plantations with rows $3\frac{1}{2}$ feet apart would most readily be cultivated with regular corn-tillage tools (Fig. 14).

DAMAGE FROM RABBITS AND GRASSHOPPERS

Reports from a number of cooperators have mentioned that, especially in dry seasons, there has been considerable damage to small plantings of vegetable-type soybeans by rabbits and grasshoppers, tho the soybeans were sometimes unmolested until every other green thing in the garden had been killed by drouth. Except in years of heavy infestation, grasshopper damage does not seem to have been severe.

Up to the present time, no evidence of damage to the vegetable-type soybean by fungous diseases has been apparent in the experimental plots at Urbana, or reported by cooperators.



FIG. 14.—VEGETABLE-TYPE SOYBEANS IN NORTHERN ILLINOIS

Soybeans make good use of the distance allowed between rows. Planted 42 inches apart, the above beans left no open space between rows. The small plants at the left are ordinary string beans, also planted 42 inches apart. Both crops were cultivated with corn-tillage tools. (Courtesy A. E. Phelps)

HARVESTING GREEN SOYBEANS

As already mentioned (page 404), soybeans of the vegetable type remain in edible condition as green shelled beans for quite a long period. They are ready to use as soon as the pods are plump and the seeds are nearly full size. They remain usable until the pods show signs of beginning to ripen and just before the seeds begin to shrink. At the beginning and end of the usable period they are less acceptable to most people than when in prime condition between the two extremes. At the best stage for picking, the pods are green or yellowish-green (*see colored plate opposite page 418*), tho some varieties become quite yellow while still in very acceptable condition.

In harvesting small lots of green beans for table use, the plants can be pulled up or cut off near the surface of the ground, and carried to the kitchen or some shady place, where the pods can be removed by hand.

Another way of gathering the green beans for table use is to pick the pods from the plants in the field, leaving the stalks to be plowed under for humus. In this way harvesting is completed in one operation—a decided advantage to the market grower.

For commercial canning, green soybeans could be harvested and handled with the equipment usually employed in the handling of the Henderson Bush lima for canning.

HARVESTING, CURING, AND THRESHING RIPE SOYBEANS

Harvesting and Curing

For table use as dry beans or for seed purposes the vegetable-type soybeans should be harvested as soon as the pods have turned to their mature color and become fairly dry. With most varieties nearly all the leaves will be off at that time. If the plants are cut earlier, the beans will usually wrinkle some during the curing process, will appear inferior, and might be difficult to keep from molding. However, the harvesting must be done promptly when the beans reach the right stage, in order to avoid excessive loss of seed from shattering, especially in some varieties.

In harvesting the crops from the multiplication plots, use was made of an ordinary grain binder equipped with extra guards, or "fingers," for picking up branches or vines grown close to the ground or lodged. All varieties in the tests at Urbana were sufficiently tall to be handled readily with a binder. If plants are too short to harvest with a binder, a self-rake reaper or a clover buncher can be substituted.

After cutting with the binder, the soybeans were handled practically the same as any grain crop. In order to facilitate curing, the bundles were made comparatively small and were not bound very tightly. The bundles were set up in small shocks and allowed to cure in the field (Fig. 15).

The practice at the Illinois Experiment Station has been to thresh the soybeans directly from the shocks after they have become sufficiently cured. However, where threshing equipment is not available when desired, and the soybean field needs to be cleared for fall plowing or for the seeding of fall grain, the bundles of cured soybeans may be hauled in and stacked in the same manner as wheat or oats.

Small lots of soybeans from test rows were harvested by cutting the plants off close to the ground with a corn knife or a pair of pruning shears and tying them in bundles. Shattering was found to be

much less severe when the pruning shears were used and when the cutting was done early in the day while the plants were still wet with dew. Sometimes, in handling particularly choice small lots, instead of cutting the plants and shocking them in the field, the ripe pods were picked off by hand and spread out in shallow wooden trays for drying.

Threshing the Seed

In threshing the soybeans at Urbana, an ordinary grain separator was used, tho special adjustments had to be made and special attention given to the speed of operation. For threshing dry beans, the first concave was always taken out of the separator and a wood blank substituted. When threshing beans that were somewhat damp, all the concaves were left in, but many of the teeth were removed, leaving only one-third to one-half the usual number. By setting the concave far enough away from the cylinder, the cracking of the beans was reduced to a minimum. Whether threshing damp or dry beans, the speed of the cylinder was reduced to approximately one-half the normal threshing rate for grain. To avoid slowing down the other working parts of the separator, a large pulley was put on the cylinder shaft and the speed of the remainder of the machine thus kept at its normal rate.¹

Some cooperators used a flail to thresh out small lots of edible soybeans from garden plots. Others placed small quantities of the dry pods in a gunny sack and pounded them lightly to shell out the beans.

For harvesting and threshing commercial soybeans at one operation in the principal producing areas of Illinois, the combine has been adopted as standard equipment and is well adapted to handling non-shattering varieties like the Illini. However, attempts to use this method of handling a seed crop of the vegetable-type soybeans have sometimes met with disaster, on account of severe shattering of the beans before they were dry enough to combine. Losses as high as one-half the crop have been reported. One grower, however, reported successful combining of the Higan variety in 1938. It is possible that further experience may lead the way to successful use of the combine for harvesting seed of the various varieties of vegetable-type soybeans, but at present it seems much safer to cut and shock the beans before they are dry enough for harvesting with a combine.

¹Special pea and bean hullers, where available, afford a satisfactory means of threshing the edible soybeans.



FIG. 15.—SOYBEANS CURING IN THE SHOCK AFTER BEING HARVESTED WITH A BINDER

For handling a mature crop of the vegetable type of soybeans, this method results in much less shattering than when a combine is used.

Handling the Threshed Beans

At time of threshing in 1938, some of the 18 varieties of vegetable-type soybeans contained from 17 to 20 percent of moisture. Previous experience has shown that soybeans which test more than 12 percent moisture at threshing time need to be examined frequently if stored in large lots, and that when the moisture exceeds 15 percent, the beans need to be spread out so that they may be frequently stirred, or else put in loosely woven burlap sacks which are set up in rows so that air can circulate about them. The beans are stirred by moving and inverting the sacks from time to time.

In these tests special care was taken in handling the seed beans of high moisture content to insure their proper curing after threshing. All lots which by test showed over 17 percent moisture when threshed, were spread out about 4 inches deep on tables and trays in a dry building, and were stirred with a garden rake twice a day for five or six days. Handled in this way, the seed was sufficiently cured for sacking in about a week. One lot which contained 17.4 percent moisture when threshed, was tested again on December 8, and at that time showed only 8.45 percent moisture. After they were thoroly cured, the seed beans were stored in sacks in a dry building.

SUMMARY AND CONCLUSIONS

1. Reports of cooperative tests in 54 Illinois counties indicate the adaptation of the vegetable type of soybeans to production thruout the state and also the acceptability of the green shell beans as a home garden vegetable.

2. Market gardeners who supplied purchasers with information on the preparation and cooking of soybeans met with some degree of success in introducing this new product on their markets.

3. Tests by canners indicate the feasibility of processing an acceptable product from certain varieties of green shelled soybeans.

4. Seed of vegetable-type soybeans, furnished upon request, was planted in a number of different states. Reports indicate that the varieties well adapted to central Illinois also thrive in other midwestern states, but that for northern Illinois, Iowa, and localities farther north, the early varieties are most reliable.

5. The 18 superior varieties of edible soybeans tested at Urbana showed wide differences in earliness, duration of edible period, height of plant, erectness of growth, and tendency to shatter.

6. All these varieties yielded well, but some were heavier producers than others. The yield of green shelled soybeans was about $2\frac{1}{2}$ times the yield of dry, ripe beans.

7. The 18 varieties varied widely in appearance of pod. Those which were most attractive in color and size of pod and size of beans, rated very good in table quality also.

8. Analyses of the 1938 crop showed that the protein content of the 18 varieties of edible soybeans varied from 36.43 to 44.13 percent, and the fat content from 18.05 to 22.42 percent.

9. Most of the varieties in the select list of 18 edible sorts are suitable for use not only as green shell beans but also as dry beans. For a succession of green soybeans in Illinois one variety should be selected from each group—very early, early, midseason, and late.

10. The method of growing vegetable soybeans was practically the same as that for growing the field type, except that they were always planted in rows far enough apart to permit cultivation.

11. For use as green shelled beans, harvesting may begin as soon as the beans attain nearly full size and the pods appear well filled. The color of the pods at this time is green or yellowish green.

12. Mature soybeans should be harvested promptly to avoid excessive shattering, and should be properly cured before threshing.

13. If soybeans contain more than 15 percent moisture at time of threshing, they require special handling to prevent spoilage.

DIRECTIONS FOR SHELLING AND COOKING GREEN SOYBEANS

*(Prepared by Department of Home Economics,
University of Illinois)*

Shelling. To make shelling easier, pour boiling water over the soybean pods (about $1\frac{1}{2}$ quarts to 1 pound of beans) and let them stand in the hot water for 5 minutes. Drain.

The shelling operation is different from that of peas and lima beans; the pod cannot be split open and the beans brushed out with the finger. The best procedure is to hold the pod with both hands over the container which is to receive the shelled beans. With one motion break the pod across the middle and squeeze out the beans. Only 9 to 12 minutes are required to shell a pound of vegetable-type soybeans in this manner.

Cook as follows: To one pint of hulled beans add one cup of boiling water and $\frac{3}{4}$ teaspoon of salt. Cover and cook for 10 minutes after boiling starts. Drain, and season with butter or in any other manner desired. *Avoid overcooking.*

Soybeans of the vegetable type should be a bright green color after cooking and will have a nutty texture. They do not soften like green peas. They can be used in any of the ways that green peas or lima beans are used.

(It is suggested that market gardeners and retail dealers may wish to print or mimeograph the above directions and furnish them to each purchaser of green soybeans.)

Recipes for serving green soybeans (and also dry soybeans and for using soybean flour) have been issued under the following titles:

Ways of Using Soybeans as Food. Department of Home Economics, University of Illinois. (Mimeographed, free on request).

Soybeans for the Table. Leaflet 166, Bureau of Home Economics, U. S. Department of Agriculture. Can be procured from Superintendent of Documents, Washington, D. C. 5 cents.

SMALL PACKETS OF VEGETABLE-TYPE SOYBEANS

. . . . for home garden planting will be furnished
on request, as long as the supply lasts.

Address: 208 Vegetable Greenhouse, Agricultural
Experiment Station, Urbana, Illinois

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