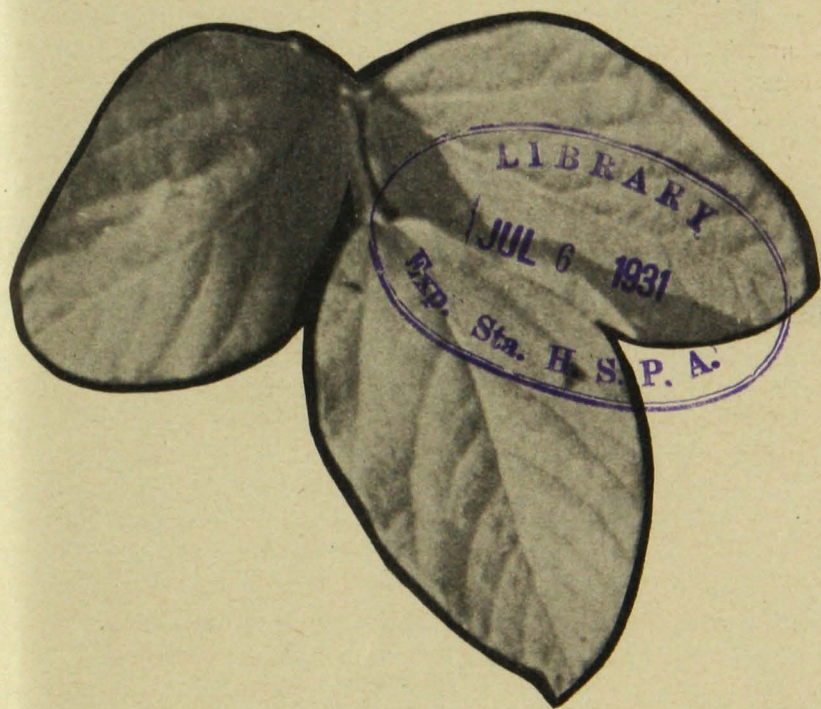


# Grow More SOYBEANS in Minnesota

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## WORLD PRODUCTION

The soybean is an annual leguminous plant, native to Asia. It has been grown in China, India, and Japan for more than 5,000 years. Manchuria produces more soybeans than all the other countries together. In Manchuria the total acreage in 1921 was estimated as 7,000,000 and the yield per acre as 22 bushels. In these countries the soybean is used extensively as a food; the oil, for lubrication and for lighting purposes; but there are still large amounts of soybeans for export.

Export of the beans from China began in 1907 and has increased steadily since. In 1927, 1,688,395 tons were exported. Germany, Denmark, and England were the largest importers, together with Japan, from which country large exports have been made also. In that year, China exported 329,000,000 pounds of oil, Japan 33,000,000, and Denmark 11,000,000 pounds, most of it going to the Netherlands, the United Kingdom, and Germany. The United States imported 5,500,000 pounds of soybean oil that year.

## PRODUCTION IN THE UNITED STATES

Soybean seed was introduced in the United States in 1804. Since 1900, seed of a large number of varieties have been brought in, but the crop was not important, except in limited areas, until about 1912. With the introduction and development of varieties maturing in from 90 to 160 days, production of soybeans became practical in the United States, as it requires almost the same climate and soil as corn.

At first the crop was grown largely for seed, for hay, and in combination with corn for silage. During the last few years, the growing of soybeans with corn as a silage crop has decreased materially, whereas their production for planting as hay and pasture crops and for seed from which oil is extracted has increased rapidly. The states leading in soybean production, with acre yields, December price per bushel, and value per acre at December farm prices are given in Table 1.

Soybean acreages in 1929 were: Illinois, 240,000 acres; North Carolina, 162,000; Missouri, 161,000; Indiana, 100,000; and Ohio, 49,000. This is a marked increase in each state over the six-year average. Values of corn per acre for the period, 1924-29, at December prices were: Illinois, \$24.80; North Carolina, \$20.60; Missouri, \$20.80; Indiana, \$22.70; and Ohio, \$26.80.

In these states the values of soybeans per acre have compared favorably with those for corn, and the cost of production per acre is not far different. Considering all this, there are advantages in favor of growing soybeans, one of which is the effect on crops that follow.

Table 1

Acreage of Soybeans, Yield per Acre, December 1 Farm Price, and Value per Acre for the Period, 1924-29, in the States Leading in the Production of Soybeans

State	Acreage	Yield per acre	Dec. 1 farm price	Value per acre, Dec. 1 farm price
		bu.		
Illinois .....	158,000	14.0	\$1.52	\$21.20
North Carolina .....	106,000	13.6	1.82	25.20
Missouri .....	97,000	10.4	2.12	22.00
Indiana .....	66,600	12.3	1.75	21.50
Ohio .....	28,000	13.4	2.05	27.50

## COMPOSITION AND USES OF SOYBEANS

Soybean seed contains from 15 to 19 per cent of oil. The cake, or meal, which is the residue after the extraction process has been completed, contains from 4.5 to 8 per cent.

The oil is semi-drying and consequently can be substituted for linseed oil in paints, to about 25 per cent. It is satisfactory in the manufacture of linoleums, enamels, and soaps. In refined form, the oil is suitable for human consumption.

Being a legume, the hay, seed, and cake or meal are high in protein content. Table 2 gives the digestible nutrients in 100 pounds of various high-protein concentrates and in alfalfa and soybean hay.<sup>1</sup>

Table 2

Comparison of Pounds of Digestible Nutrients in 100 Pounds of Soybean Seed and Meal and Other High Protein Concentrates and in Soybean and Alfalfa Hay Together with Their Nutritive Ratios

Feed	Crude protein	Carbo-hydrates	Fats	Total	Nutritive ratio
	lb.	lb.	lb.	lb.	
<b>Concentrates</b>					
Soybean seed.....	33.2	24.7	16.1	94.1	1:1.8
Soybean meal.....	39.7	34.7	4.5	84.5	1:1.1
Linseed meal.....	30.2	32.6	6.7	77.9	1:1.6
Cottonseed meal..... (Prime)	33.4	24.3	7.9	75.5	1:1.3
<b>Hays</b>					
Soybean hay.....	11.7	39.2	1.2	53.6	1:3.6
Alfalfa hay.....	10.5	38.5	0.7	50.6	1:3.8

Soybean seed averages approximately the same in pounds of digestible crude protein per 100 pounds as prime cottonseed meal and more than linseed meal. Soybean meal is higher in crude protein content than soybean seed, linseed or cottonseed meal. Soybean hay is

<sup>1</sup> Figures are taken from "Feeds and Feeding" by Henry and Morrison.

similar to alfalfa hay of like quality in digestible crude protein content and somewhat higher in digestible fat content.

By "nutritive ratio" is meant the pounds of digestible crude protein in relation to the total number of pounds of digestible carbohydrates together with the pounds of fat, multiplied by 2.25. Soybean seed averages one pound of digestible crude protein for each 1.8 pounds of carbohydrates. It is similar to linseed meal in this respect. Soybean meal and prime cottonseed meal have more digestible crude protein in relation to the carbohydrates than soybean seed and linseed meal and therefore are richer in protein. The relation of the digestible crude protein to the other constituents in soybean hay is very similar to that of alfalfa hay of approximately the same quality.

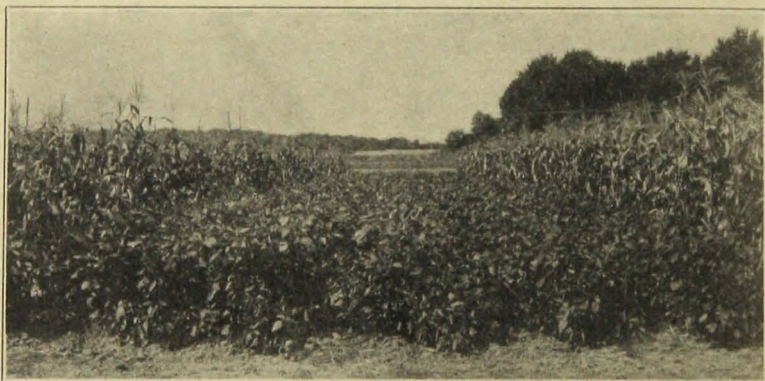


Fig. 1. Soybeans for hay growing alongside of corn. This is the preferable way to plant soybeans for silage.

From the composition of soybeans as compared with those of linseed and cottonseed meal, it appears that they might serve the same purpose as a feed for farm animals. When there is a shortage of alfalfa hay, soybean hay can be substituted.

### RESULTS FROM FEEDING TRIALS

At the Minnesota Agricultural Experiment Station, feeding ground soybeans proved, for all practical purposes, equal pound to pound to linseed meal in the dairy ration. Butterfat from the milk from the group of cows fed linseed meal averaged 3.82 per cent and from the group fed ground soybeans, 4.01 per cent. Feeding soybean hay reduced the expenditure for mill feeds by 93.6 per cent compared to feeding timothy hay.

At the Iowa Experiment Station, cracked soybeans were found to be worth \$60 per ton as compared with \$45 per ton for linseed meal



Fig. 2. A mature soybean plant of the Chestnut variety

as a feed for dairy cows. At the South Dakota Experiment Station, ground soybeans, used as a high protein supplement for dairy cows, produced 20 per cent more milk and 18 per cent more butterfat than linseed meal.

Based on feeds consumed, soybean hay proved less valuable at the Indiana Experiment Station than alfalfa hay for milk production. However, the milk contained more butterfat.

In a feeding test at the Indiana Experiment Station, ground soybeans were less satisfactory than cottonseed meal as a high protein supplement for steers.

At the Ohio Experiment Station, ground soybeans proved as efficient as linseed meal as a supplement along with tankage in feeding hogs having access to green forage. In dry-lot feeding, the ground soybeans were somewhat less efficient than linseed meal for this purpose.

The results of the feeding trials indicate that cracked or ground soybeans may replace linseed or cottonseed meal as a high protein feed for cattle and hogs. Grinding soybeans fine enough is difficult in an ordinary feed mill, but a mixture of corn, barley, or oats with 50 per cent soybeans grinds well. At the Waseca Station, mature soybeans in the bundle fed to dairy cows and hogs has proved satisfactory, thereby eliminating both threshing and grinding expense. A number of bundles were threshed by hand and the seed from each weighed to obtain an average yield per bundle. In computing the rations, a pound of soybeans was

fed in place of a pound of linseed meal. Soybeans fed to livestock in the bundle are thoroly digested, whereas threshed seeds fed without grinding often pass through the digestive tract whole. Soybeans may also be hogged off to advantage. If used for this purpose, planting corn and soybeans in alternate rows instead of together is preferable. Growing soybeans eliminates the purchase of high protein concentrates so necessary in efficient feeding.

When there is a shortage of alfalfa hay, soybeans may be grown to provide the needed high protein roughage. Soybean straw makes good feed for sheep. At the Waseca Station, the breeding flocks of registered Shropshire ewes have been wintered on a ration of two pounds of corn silage per head a day and an amount of soybean straw that could be consumed. Horses relish soybean straw and consume it more completely than do sheep.

## GROWING SOYBEANS

### Varieties and Yields per Acre

In the southern and central parts of the state, Manchu, Habaro, and Chestnut soybeans are satisfactory for both seed and hay production. Minsoy is a high-yielding seed variety in central Minnesota but is too short for hay production. In northern Minnesota the earliest varieties, Wisconsin Black and Minsoy, should be used for seed production. They mature as a seed crop only in favorable years. The field pea is more satisfactory than the soybean for hay production in the northern part of the state.

Seed of Manchu is yellow with black eyes; Habaro, yellow; Chestnut, brown; Minsoy, yellow with brown eyes; and Wisconsin Black is black.

Northern grown seed is preferable when it can be obtained. When northern grown seed is scarce, however, it is necessary to use that produced in sections farther south, particularly for hay production. Soybean crops grown for hay need not be completely mature. Seed of Manchu, produced in Illinois, Indiana, Ohio, or Missouri has been satisfactory in Minnesota for hay production. Seed of other varieties requiring about the same number of days to mature as Manchu can be used.

When seed of adapted varieties is planted in Minnesota, yields averaging from 10 to 20 bushels of seed per acre have been obtained. The average yield for Minnesota should compare favorably with those given in Table 1. The legal weight of the seed is 60 pounds per bushel. Yields of hay varying from 1½ to 2 tons per acre have been obtained in Minnesota.

The germinating ability of soybean seed often lowers rapidly after the first year. Soybean seed should always be tested for germination before being planted.

### Soil for Soybeans

Only well-drained soil that will produce good yields of corn and clover is suitable for soybeans. Soils that are too acid to produce

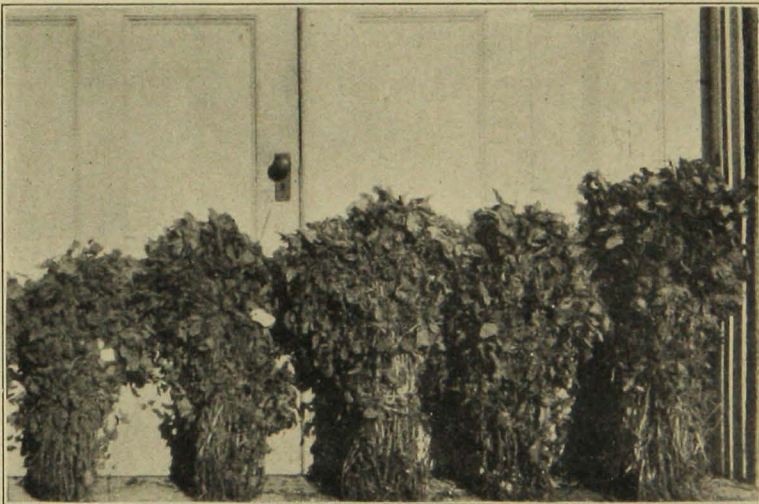
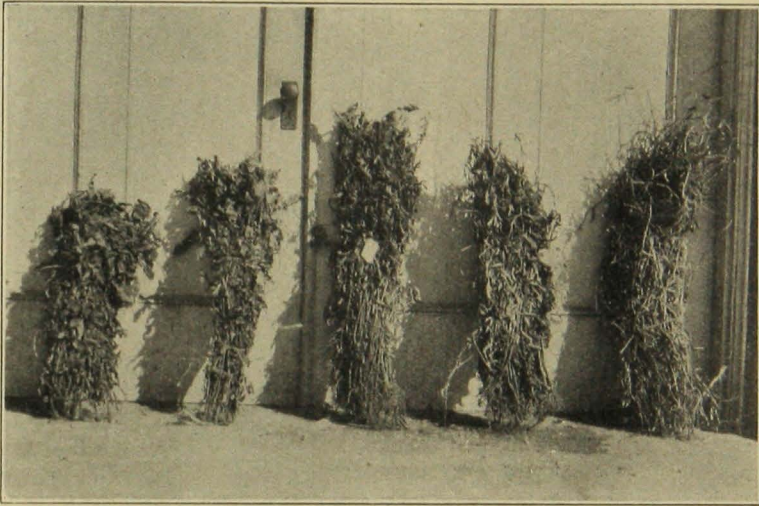


Fig. 3. Above. Samples from plantings drilled solidly. Many of the leaves have dropped off.

Below. Samples from plantings in cultivated rows. There are more leaves, with many low down on the stems.

alfalfa or sweet clover to advantage are satisfactory for soybeans. Loam, clay, and peat soils produce higher yields of soybeans than light sandy soils.

### Preparation of the Seedbed

The preparation of the seedbed and the time of planting are the same as for corn. A weed-free, mellow seedbed at the time of planting lessens the amount of cultivation necessary to keep the crop reasonably clean. Fall-plowed lands, disked early and as often as needed to keep the land free from weeds up to planting time, provides a good seedbed.

### Method of Planting and Amount of Seed per Acre

Best results have been obtained for both seed and hay production from drilling soybeans in rows and cultivating like corn. When grown in rows from 20 to 42 inches apart and cultivated, larger yields of better quality hay have been obtained than from those drilled like grain or broadcast. Soybeans drilled like grain or broadcast lose many of the lower leaves before they are mature enough to cut for hay. Grain drills have been used to plant the crop. Enough of the cups have been stopped up to space the rows the desired width apart. If beet drills and cultivators are available for planting and caring for the crop, the rows may be spaced the same distance apart as for beets.

Seed planted in the drill row at the rate of one bean every 2 inches or slightly less has proved satisfactory for seed production. For hay production, beans may be planted as close as one inch apart in the row. This requires from 30 to 50 pounds of seed per acre, depending on the width of the rows and the size of the seed. The seed of the different varieties are of different sizes. Usually ~~35 to 40~~<sup>30-60</sup> pounds per acre of Manchu or Chestnut seed are adequate, whereas ~~50 to 60~~<sup>33-40</sup> pounds of Minsoy or Wisconsin Black are required.

### Inoculation

The soybean is still a comparatively new crop in the state and as yet the required bacteria are not generally present in the soil. Bacteria that work on red clover, alfalfa, and other legumes are not capable of inoculating soybean plants. Commercial inoculation for soybeans may be purchased at seed stores at small expense. The directions on the container should be followed carefully. Soil from a field that produced well-inoculated soybeans the previous year, sifted and mixed with the moistened seed, is satisfactory for inoculation. Abundance of nodules on the roots of plants indicates the presence of adequate numbers of the proper bacteria. The root of a well-inoculated soybean plant is shown in Figure 4.



### Time and Depth of Planting

Planting at the same time as corn has given higher yields of seed and hay than earlier sowing. Plantings for both seed and hay production may be made 20 to 30 days later than the average corn planting without much reduction in yield. Later plantings usually result in marked reductions. Depth of planting depends upon the kind and condition of the soil. On clay and clay loams, on which a crust usually forms after rains, shallow planting is more essential than on lighter soils. Have conditions as favorable as possible for germination of the seed and growth of the plants, and plant as shallow as possible and still have the seed covered. Planting at a depth of from one to 2 inches is usually satisfactory.

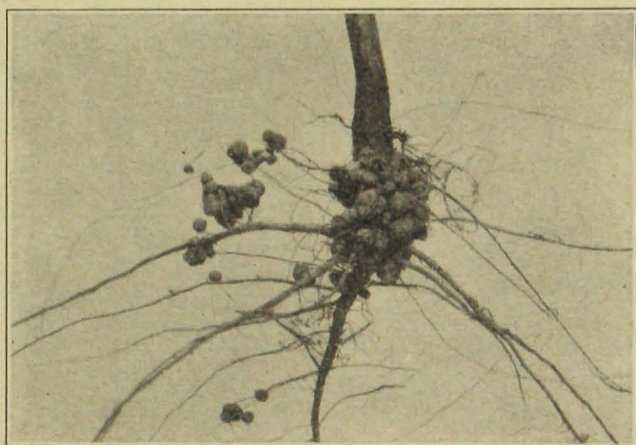


Fig. 4. Numerous large nodules occur either grouped around the upper part of the tap root or well distributed over the entire root system of well inoculated plants. The nodules shown are approximately one fourth actual size.

### Cultivation

If, after the soybeans have been planted, heavy rains occur and a crust forms on the surface of the soil, the smoothing harrow should be used crosswise of the rows to let the seedlings come through. Small weeds in the rows may be destroyed by harrowing crosswise on sunny afternoons when the young soybean plants are not easily broken. Use of the rotary hoe for early cultivation is increasing. Cultivation of soybeans is essentially the same as for corn.

### Harvesting the Soybean Crop for Hay

When the lower leaves begin to turn yellow is time to cut the soybean crop for hay. The pods are then well filled with beans and the largest yield of hay of the highest feeding value is obtained. When

such medium maturing varieties as Manchu and Chestnut are used, from three and one-half to four months are required for the crop to reach this stage of maturity. The crop is cut with the mower any time in the morning after the dew is off. Leaving the crop in the windrow in sunny weather until the leaves are well wilted, but not brittle, hastens the drying. Raking and cocking should be done before the leaves become brittle. Cocks made before the leaves become brittle will shed light rains after they have settled. If wet weather prevails for some time, the cocks should be moved to dry ground to avoid mold on the bottom.

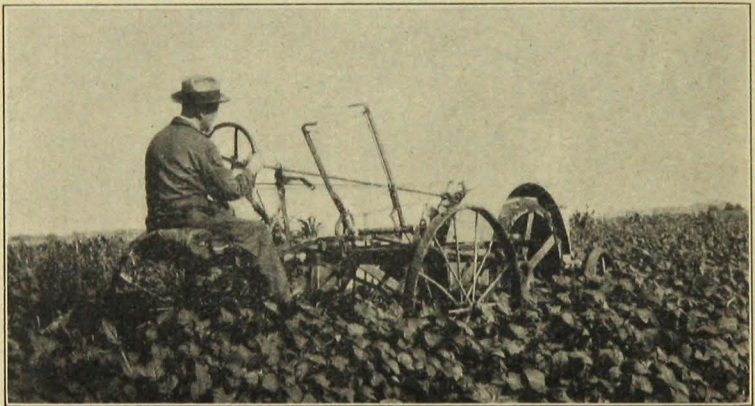


Fig. 5. A two-row tractor outfit cultivating soybeans

### Harvesting for Seed and Stacking

For seed production, soybeans are usually left standing until thoroly mature and the majority of the leaves have dropped. After the leaves have dropped, the air circulates more freely and the seed dries out more rapidly on both the standing plants and in the shocks. The varieties, Chestnut and Minsoy, drop their leaves and shatter seeds from the pods less readily than some other varieties.

After most of the leaves have dropped, the crop is usually cut with the binder. This should be done during the early part of the day when the pods are damp in order to avoid shattering. With some varieties, harvesting may be started after the dew is off in the morning and continued throughout the day without much loss from shattering. The bundles are set in small shocks to allow further drying.

Soybeans in bundles may be stacked or put in barns a considerable time before the beans are ready to thresh without danger of heating or molding.

### Threshing and Drying the Seed

In states where large acreages of soybeans are grown, the combine is used, harvesting and threshing the crop in one operation. In this method the beans must be left standing longer in the field than when they are harvested with the binder to allow the drying to take place that ordinarily occurs in the shock.

When soybeans are harvested with the binder, the ordinary grain separator is used for threshing the crop. The cylinder is run at approximately 300 to 400 revolutions per minute without checking the speed of the other parts of the separator. In addition to this, it may be necessary to remove the concaves in order not to crack the seed that is to be used for planting.



Fig. 6. Soybean hay built into narrow cocks as soon as the leaves are wilted will settle and dry out gradually. Such cocks will shed considerable rain.

The threshed seed should be spread two to four inches deep or less on the floor of a well ventilated room and shoveled over as needed to prevent any heating or molding. It usually takes several weeks of favorable drying weather for the seed to reach the air-dry condition. Under no circumstances should the seed be stored in sacks until it has become air-dry.

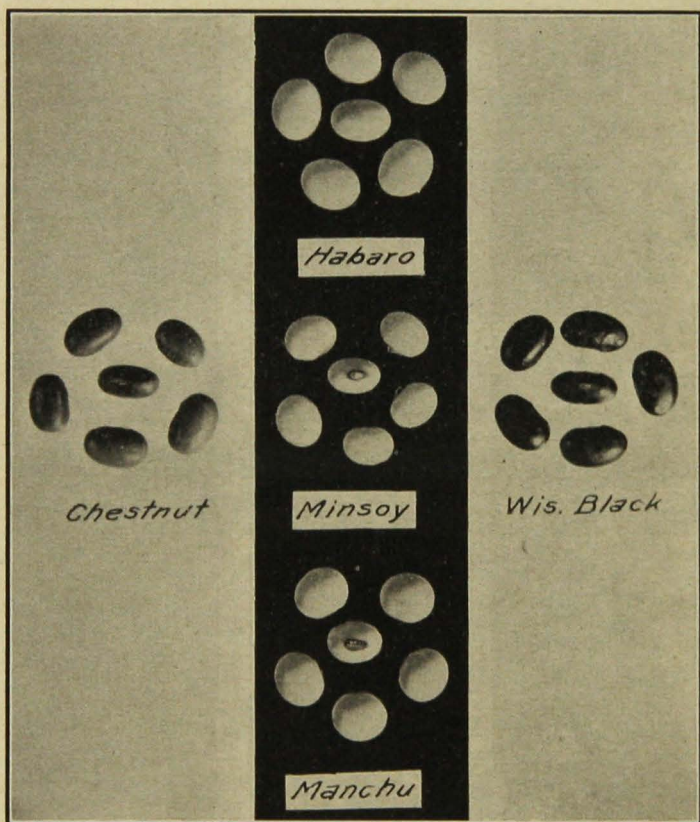


Fig. 7. Seeds of Recommended Varieties of Soybeans

The seeds of Chestnut are brown and those of Wisconsin Black are black with hilums of the same color. Habaro seeds are yellow with hilums of the same color. The seeds of Minsoy are yellow with brown hilums and those of Manchu yellow with black hilums.