

Studies on Soybeans in Sind

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Introduction The Soybean, *Glycine max* L. is a native of Eastern Asia. The culture and use of the Soybean are recorded in the ancient Chinese literature and undoubtedly date from a period long before the time of written documents. It is the most important legume in China where it is one of the most essential articles of food.

There is sufficient evidence to show that soybean has also been cultivated in Northern India and Burma since a long time. Major T. E. T. Aitchison (1881) found the soybean largely cultivated in the Kuram valley, North-west Frontier Province, especially in the Kuram district, occasionally in Hariab and also frequently as a weed in the cultivated fields. Hooper (1911) in his investigations on soybeans has recorded seeds aggregating perhaps into nine distinct varieties, collected from Burma and from places situated on the lower slopes of the Himalayas extending from Kashmir to Darjeeling. Woodhouse and Taylor (1913) describe nine Indian varieties secured from Darjeeling, Bankipur and Bhagalpur. Most of the Indian varieties have slender twining stems, small pods and small seeds. They resemble the wild soybeans much more closely than do the varieties of China and Japan. The existence of different local names for soybeans in Bengal, Assam, Nepal and the North-west Frontier Provinces is also an evidence of its ancient culture in India.

With the opening of the Lloyd Barrage in Sind, investigations into the possibilities of cultivation of soybean in Sind under the perennial irrigation system, were started at the Agricultural Research Station, Sakrand, in the year 1929; but all attempts failed until 1931 when for the first time a successful crop was grown for seed. Several varieties of soybeans obtained from abroad and from various provinces of India have been tested. The small seeded and late-maturing varieties have succeeded fairly well under the Sind conditions. It has been found difficult to establish foreign big-seeded varieties as their germination when sown in beds is very low and besides they are subject to white ant attack which does the most damage.

Cultivation method Soybean has been found to succeed on a variety of soils varying from sandy loam to loamy soils. The crop is rather sensitive to *Kalar* (alkali soils) and cannot be grown in stiff soils. In the United States of America, artificial inoculation of the land that has not previously grown soybean has been found necessary, while under the Sind conditions

the inoculation of land has not been found to result in any extra advantage. The last fortnight of June has been found to be the suitable time of sowing as nothing is gained by sowing the crop earlier. The crop whether sown early or late matures at the same time, *i. e.* in December. A spacing of 3 to 4 ft. between rows and 6 to 9 in. between plants has been found to give high yields. When the crop is grown for fodder purpose, the distance between the rows should be $1\frac{1}{2}$ to 2 ft. Under the Sind conditions, an average yield of 825 lb. of seed per acre has been obtained. The soybean crop was grown for fodder and it yielded on an average 10,300 lb. of green fodder in a single cutting, and did not give further cuttings. The yield of fodder when compared to that of *Jowar* (*Andropogon sorghum*) which yields about 20,500 lb. in one cutting, is very poor.

Description of varieties tested Twenty one varieties of soybeans obtained from different provinces of India and the foreign countries, viz. U. S. A. United Kingdom and South Africa have been tried at Sakrand. These varieties for the sake of convenience have been classed into two groups, Indian (obtained from different provinces of India) and exotic, as they form two distinct groups. The Indian varieties have small seeds with oil content varying from 13 to 16 percent while the exotic varieties have big seeds with oil content varying from 16 to 21 percent. The word Indian does not necessarily imply that the origin of the varieties which fall in this group is in India. The history of these varieties is not known and some of these viz. Behrum and Mir-John-Hat which resemble foreign varieties in their habit of growth may have been originally imported from abroad.

(i) **Indian varieties.** The following eight Indian varieties, the first six of which have a spreading habit of growth and the last two with bunch habit, have been tried at Sakrand.

Variety	Source from where obtained	Variety	Source from where obtained
<i>Spreading types</i>			
1. Pusa Yellow	Pusa	5. Burma Yellow	Rangoon
2. Pusa Chocolate	"	6. Pengype	Madras
<i>Bunch types</i>			
3. Pusa Black	"	7. Behrum	do.
4. Punjab Yellow	Punjab	8. Mir-John-Hat	Ranchi

(a) **Spreading varieties** The basal portion of the stem is stout and upright and the other portion weak; the branches specially the elongated terminals are more or less twining and are usually weak. The leaves are trifoliate and the leaflets are ovate lanceolate in shape and pale green in colour. The stem, leaves and pods are pubescent and the pubescence is found in two colours, whitish (termed as grey by Piper and Morse) and light fawn to tawny. All the varieties grown at Sakrand have purple flowers. The pods form in clusters of 2 to 3, and on account of long internodes, they appear scattered. These are small in size and have 2 to 3

seeds. Three seed colours, greenish yellow, chocolate and black were noted among the varieties tested. These varieties take 180 to 190 days, to ripen when sown in June.

(b) *Erect varieties* There are only two Indian varieties, viz. Mir-John-Hat and Behrum which come under this class. The stem of these is stout, upright and branching. The leaflets are ovate and big and they vary in number from 3 to 5 per leaf. The stem and leaves have dirty white (termed as greyish by Piper and Morse) pubescence. The flowers are purple and slightly bigger than those of the spreading varieties. The pods are formed in clusters of 3 to 5 and are slightly bigger, and the seeds slightly heavier than those of the spreading varieties described above. The ripening period of these beans is about 160 days when sown in June.

(ii) *Foreign varieties* Thirteen samples of soybeans, listed below, were obtained from abroad and tried at Sakrand.

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|-----------------------|----------------|-------------------------|
| 1. Shangai | 2. Larido | 3. Chinese White |
| 4. Dalny | 5. Vilamskot | 6. White Morse |
| 7. Mommoth Yellow | 8. A. K. White | 9. Haberlandt |
| 10. Barchet | 11. Ootootan | 12. South African Brown |
| 13. American Eye brow | | |

The habit of growth of all the varieties, except Barchet and Ootootan, is erect and branching with a well defined main stem. In Barchet and Ootootan varieties, the plants are slender and bushy and have a tendency to lodge. In erect as well as slender varieties, the leaves are trifoliate and the leaflets are usually ovate lanceolate in shape. All the varieties are pubescent. The erect types have the habit of fruiting in clusters while the slender types have the pods scattered. The pods are also pubescent and the pubescence occurs in two colours, light fawn and dirty white. All the varieties, except American Eye brow, have unicoloured seeds of straw yellow, black or brown. The American Eye brow variety has black seeds with brown saddle. The maturity period of these foreign varieties varies from 90 to 155 days. Almost all the imported varieties have well developed big seeds except Barchet and Ootootan varieties which have comparatively smaller seeds.

Acclimatization The foreign varieties gave very poor germination in the first year. The stand and the growth of the crop were not satisfactory. The small seeded varieties, viz. Barchet and Ootootan, had better germination and stand and seemed to be hardier types than the others. The seed obtained from the foreign varieties with straw yellow colour was smaller in size than the originally imported seed. In most of the plants, the seed was shrivelled. All the varieties were subject to white ant attack. The following statement shows the incidence of white ant attack, the percentage of plants with plump seed and the acclimatizing capacity of the different varieties.

Variety	No of plants soon after germination	Mortality		Final stand		Plants with plump seeds % (P)	Acclimatizing capacity seeds of variety (F x P)/100
		No. of plants	Percent	No. of plants	% (F)		
<i>Yellow coloured seeds</i>							
Shanghai	805	606	75	199	25	23.2	5.8
Chinese White	155	121	78	34	22	82.3	18.1
Haberlandt	191	46	24	145	76	61.5	46.74
A. K. White	396	164	41	232	59	38.0	22.42
Mammoth Yellow	212	130	62	82	38	30.5	11.59
<i>Other seeds</i>							
Ootootan (black)	291	160	55	131	45	100.0	45.00
Barchet (brown)	289	183	37	106	63	100.0	63.00
South African Brown	172	60	35	112	65	89.3	58.04

It will be seen from the above table that the black and brown seeded types are comparatively hardier and have better acclimatizing capacity than the yellow seeded types. Among the yellow seeded varieties Haberlandt has behaved comparatively better.

Maturity The observations made by Woodhouse and Taylor (1913) at Sabour, India, show that newly imported American varieties take a considerably shorter time to mature at Sabour than in America, but the plants from acclimatized seed mature somewhat later than those from freshly imported seed. Our observations recorded at Sakrand confirm the first statement of Woodhouse and Taylor, *i. e.*, the plants raised from the newly imported seed take considerably shorter period to flower and mature than that taken in the original home. The observations do not corroborate the second statement of the above authors. The data obtained here shows that in the subsequent years, the flowering and the maturity period has not been necessarily greater than that of the first year and in certain cases the period is even shorter. Probably the variation in flowering and maturity period is due to season and varieties. In almost all the varieties, the time taken to flower and to mature in different years is never more than that taken in their original home. A statement of the observations recorded at Sakrand is given in the following table. These varieties were sown in the beginning of June in all the years.

Variety	Days taken to flower					Days taken to mature				
	In U. S. A. ^o	At Sakrand				In U. S. A. ^o	At Sakrand			
		1933-34 Freshly imported seed	1934-35 Acclimatized seed	1935-36	1936-37		1933-34 Freshly imported seed	1934-35 Acclimatized seed	1935-36	1936-37
A. K. White	50-55	40	37	49	50	110	101	110	120	112
Haberlandt	50-55	45	40	47	46	125	103	101	121	108
Mammoth Yellow	85-90	55	52	63	54	145	138	126	125	128
Ootootan	90-95	65	92	78	90	170	151	155	148	142
Barchet	80-85	65	87	79	89	160	151	155	144	139
Morse White	50-55	40	51	40	..	130	100	115	108	..
American Eye brow	35-40	40	..	..	..	110	98	..	..	..
Larido	75-80	50	..	..	..	140	127	..	..	..

^o Data from Piper and Morse (1923).

Natural cross pollination Piper and Morse (1923) conclude from the observations at the Arlington Experiment Station that even when the test rows of several varieties are grown side by side, the percentage of hybrids is perhaps not one individual in two hundreds. They also find that the hybrid seeds can be recognised by the presence of peculiar markings on the seed. Heterozygous plants can be distinguished by the appearance of the pods at the top of the branches; such pods are more tumid, less hairy and of thinner texture. Woodhouse and Taylor (1913) conclude from the observations made at Sabour that natural crosses do not occur on the plains of India to such an extent as in America, and that the crossing occurs more frequently in the more temperate climate of America and the Darjeeling Himalayas.

At the Agricultural Research Station, Sakrand, Indian varieties of yellow, black and chocolate seeds were grown in consecutive rows in the first year. In the year 1932, a few plants (3 plants in a bed with a population of about 500 plants) were found in Pusa yellow variety which had oddly coloured seeds such as smoky yellow and yellow with brown bands. The number of such plants compared with total number of plants was very small. The seeds were grown separately next year and were found to segregate into pure yellow and other shades of yellow which were similar to a natural hybrid.

The foreign varieties tried at Sakrand, were impure in flower character and consisted of both white and purple flowers. Thirty-six single plants with white and purple flowers were selected from three varieties, viz. (1) Haberlandt, (2) A. K. White and (3) Mammoth Yellow and sown during the year 1934-35. Out of these 36 single plant cultures, 30 (13 white flowered and 17 purple flowered) bred true, while six (all purple flowered), showed segregation. During the next season, i. e. 1935-36, further selection of single plants was made from the cultures which had bred true to type. In all, 29 single plants were selected which were outwardly pure for flower character. The behaviour of these single plants is shown in the following table.

Variety	Behaviour of the selected plants							
	No. of single plants selected and sown in 1935-36			No. of cultures which bred true				Total
	White flower	purple flower	Total	For white flower	For purple flower	White flower	Purple flower	
Haberlandt	7	2	9	5	—	2	2	9
A. K. White	8	2	10	8	—	—	2	10
Mammoth Yellow	—	10	10	—	10	—	—	10
	15	14	29	13	10	2	4	29

It was seen that out of 29 cultures which were pure for flower character, 23 bred true and 6 showed variation. These results clearly show that the exotic types are more subject to natural cross pollination than the Indian varieties.

Genetic behaviour of the flower colour. Piper and Morse (1923) found that the mode of inheritance of flower colour is in accordance with the simple Mendelian type and that the purple colour of the flower is dominant over white colour. Woodworth (1923) reported that the purple colour was dominant to white and segregated in the F_2 in a 3:1 ratio. At Sakrand, segregations in the progenies of natural crosses found in the pure strains which were isolated from foreign varieties were recorded. The number of plants under observation was less as there was considerable mortality due to white ant attack. The goodness of fit has been worked out.

Variety & strain no.	Character of flower	F_1 phenotype obtained by natural crossing	Segregations in F_2		Goodness of fit
			Purple	White	
A. K. White—86	Purple	Purple	40	11	$\frac{1.75}{2.08} = 0.84$
Haberlandt—15	Purple	Purple	21	4	$\frac{2.25}{1.46} = 1.54$
		Total	61	15	
		Expected on 3 : 1	57	19	$\frac{4}{2.53} = 1.57$

In the F_3 the following segregations were observed.

No. of cultures	Nature of parent	Behaviour of progeny	Frequency	
			Observed	Expected
4	Purple } flower }	Pure	1	1.5
		Segregating	3	3.0
2	White flower	Pure	2	1.5

In F_3 the phenotypes segregated as under :—

Phenotype like F_2	Purple	White
1	5	3
2	44	11
3	11	7
Total observed	60	21
Expected on 3 : 1	60.75	20.25
Dev. 0.75		
P. E. = $\frac{0.75}{2.63} = .29$	The fit is good.	

The behaviour of F_3 confirms the mode of single factor inheritance of flower character.

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References.

1. Du Toit F. M. (1932) *Dept. Agric. Union S. Africa Bull. 107.*
2. Ferree C. J. (1929) *The Soy Beans and the New Soya Flour. William Limited, London.*
3. Hawkins L. A. *Soya bean a valuable legume crop. International Harvester Company Agric. Extension Dept. Chicago U. S. A.*
4. Hayes, H. K. and Garber R. G. (1927) *Breeding crop plants. McGraw Hill Book Company, N. Y.*
5. Hooper, D. (1911) *Glycine hispida (Soy bean), Agric. Ledger No. 3 (original not seen.)*
6. Morse W. J. (1927) *U. S. Dept. of Agric. Farmers Bull. 1520.*
7. Piper, C. V. and Morse, W. J. (1923) *The Soy bean. McGraw Hill Book Company N. Y.*
8. Woodhouse E. J. and Taylor C. S. (1913) *India Dept. Agric. Mem. Bot. 5 (3)*
9. Woodworth, C. M. (1923) (Original not seen) Quoted from Hayes and Garber, p. 210 (loc. cit).

Sorghum Grain for Food

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Sorghum (*Cholam, Jola or Jonna*) is the second important grain crop in the Madras Presidency. It is grown annually on an area of about five million acres in this Province and on about 36 million acres in India. The sorghum grain is the main article of food of the rural population in the dry areas. It is used extensively as human food in Africa, Asia Minor and China also. It is the chief diet of the natives in Africa. It is reported that sorghum grain is the most important source of flour in Egypt and is used in bread-making mixed with wheat, barley and fenugreek or beans.

Now that there is scarcity of rice in many parts of the Province and the people have to manage with available substitutes an attempt is made in this brief note to indicate the common methods of utilizing sorghum. There may be slight variations or modifications in the different processes involved in preparing the same or similar product in different localities. The object of this note is only to present an idea of how sorghum can be prepared for food.

The Sorghum grain is a naked grain. That is, the grain obtained on threshing the earheads and which is sold in the market has no protective covering of husk as in rice. Threshing separates the grain from the husk. The colour of the grain may be white, yellow, red or rarely brown. The colour is confined only to a thin outer layer of the grain which is the seed coat. In all the grains the inner portion, called the endosperm, is white.

In food value the sorghum grain is superior to rice though only second to wheat. It is richer than rice in protein content and richer than wheat and infinitely richer than rice in fat content. The protein content of sorghum grain varies from 8 to 12 per cent and the fat (oil) content from 1.5 to 5 per cent in the different South Indian varieties. The analyses of samples of