

## Preliminary Studies on *Bhendi* (Syn. Lady's fingers, Gumbo, Okra)—*Hibiscus esculentus* Linn.

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Classed as one of the most popular vegetables of South India, the *bhendi* has appealed to the home and market gardener as a hardy plant adaptable to almost every part of the Province with the exception of the hills roughly above 4,000 feet from the mean sea level. Though primarily grown for its green fruits it is reported that fibre of a moderate quality can also be extracted from the plant. Although several varieties are under cultivation, information as to the suitability of variety to each region, and varietal peculiarities are yet to be known accurately.

To gather some information on the present position and to assess the immediate problems for improvement a study was undertaken at the Agricultural College, College Orchards, Coimbatore towards the end of 1942. The observations and data collected so far are given in this paper with the hope that the information presented will be of some value to the scientific worker and to the large scale *bhendi* farmers whose attention towards the crop has been diverted in the wake of the stimulus given to vegetable cultivation under the present emergency period.

**Review of Literature.** From the meagre literature on the subject it is only possible to glean some information of practical value and interest. So far no study on the improvement or on the varieties of *Hibiscus esculentus* has been reported in India. In 1934 Saran (6) reported on some anatomical deformities in the root tissue of *bhendi* brought about by the infection of eel-worms and their bearing on the growth of the plant. Singh (7) made a comparative study of the respiratory index, water content, and the rate of mechanical wounds in this plant. Pure line selection work in this vegetable was carried out in Ceylon by Lord and Wickramasekera (2). In 1938, Singh *et al* (8) reported on the hybridisation in the genus *Hibiscus*.

In America, McGinty and Barnes (3) studied the flower bud and pod development in *Okra*. In the Louisiana Experimental Station the problem of breeding *Okra* has been undertaken and in 1937 Miller and Wilson (4) have given a preliminary report on *Okra* breeding in Louisiana. Further information on their achievements have not so far been made available. Often leaflets on vegetable growing have been published by the Agricultural Department of the United States of America, and Beattie (1) has published a bulletin on the culture and uses of this vegetable. According to Beattie this vegetable has no great food value and it is not likely that it will ever become a very important crop commercially there. There are three general types of this vegetable, viz., Tall Green, Dwarf Green, and Lady Finger. Each of these is again divided according to the length and colour of the pods, making in all six classes of varieties. Description of all these

types are also given, and this is followed by a note on the various recipes. The author has not dealt with the improvement of the crop.

Popoff (5) has studied the varieties of *Okra* found in Bulgaria. Having discussed the nomenclature of this vegetable, the distribution of certain types in Bulgaria and in other countries, its uses and the paucity of literature on this plant in European countries, the author stresses the importance of studying the forms in Bulgaria, and of formulating descriptions of the existing types. The morphological features of the different varieties are recorded by him. The botanical classification of this plant according to the material studied by various authors is briefly reviewed by him. The plants from Bulgarian sources come under four botanical varieties viz, *elongatus*, *sanguineus*, *vulgaris*, and *Zhukowskii*, and their relation to Asiatic forms is considered by the author. Unfortunately his publication, which appears to be a mine of information on the subject, is not available for reference and consultation.

### Observations and Results.

**Materials.** For a study of the varieties as well as for assessing the present problems a collection of seed was attempted at the very outset from all possible sources. In all 34 samples were collected of which 26 were from within the province, 4 from the Bombay presidency, and one in each from Baroda, Aurangabad, Bihar and U P. These seeds were utilised for four successive sowings at the College Orchards. The observations reported in this represent those collected on the crops raised from 1943 to 1944.

**Purity and germination.** In an open-pollinated crop like the *bhendi* crops of mixed inheritance are bound to result under the system of uncontrolled seed production. This has been unfortunately a marked feature of the seed collections made for the purpose of the present study. No less than 14 samples out of the 34 samples collected were found to be distinctly impure. Whether the purity in the other samples is due to self-pollination or due to the raising of the mother seed crops away from possible foreign pollen contamination is a point difficult to explain. However, the cumulative loss as the result of wide-spread distribution of impure seeds which form about 41 per cent of the available seed supply is obvious and this should point out the need for the establishment of a more satisfactory method of seed production and distribution than is at present.

The position reveals itself even in worse lights when the germination capacity of the seeds is examined. One sample from Tanjore failed to germinate totally, while in others the range of germination was from 20 to 80%. As the grower is not supplied seeds with a guaranteed certificate of purity and germination, he has to meet this loss from both sources for no fault of his. Controlled and regulated seed supply seems, therefore, an urgently needed work of improvement.

**Seasons and sowing.** Observations collected on the crop sown in the four seasons, viz, January, April, August and November, show that April is

the most favourable, having produced the maximum yield. The crops failed miserably in the other seasons mainly due to the attack of jassids. The yield from the April crop was as high as 4,348 lb. of pods per acre, while in other seasons the yields ranged from 500 to 825 lb.

**Pollination.** Preliminary observations on the pollination of the *bhendi* show that although from the very nature and structure of the flowers they appear to be ideally suitable for open pollination, self pollination is by no means absent. The flower opens usually in the mornings and by the evening the corolla withers, twists and closes over the staminal column. Before the corolla sheds on the following morning scope exists for the self-pollination. This perhaps explains the reason why a fairly large number of samples of seed in *bhendi* is more pure than in the case of entirely open pollinated plants like the Cucurbits and Cruciferous vegetables. This also further discloses the ease with which purity in the *bhendi* can be ensured by such simple methods as bagging the flowers before the corolla opens or by raising the mother seed crop far away from the other varieties.

**Varietal study.** A detailed study of plant characters was deemed necessary in the varieties which were received in the pure form to bring out some orderly basic knowledge from the existing chaos in the nomenclature and classification. The data collected in this study are presented in Table No. 1 (vide appendix I).

The standards adopted for the various quantitative plant characters are briefly explained below with illustrations of the more important characters associated with varieties.

**Observations made** (1) *Height of plants.* The height of the plant was measured when the plant was in its full bearing. The average height of the plant varied from 20 to 65 inches. According to the plant height the different varieties can be grouped under two heads, viz., (1) Tall plants and (2) Dwarf plants.

(2) *Plant spread and branching habit.* To a slight extent the spread also varies from one variety to another. According to this character two general types are met with, viz., spreading and much branched, and (2) branches few and stems erect.

(3) *Colouration and hairiness of stem.* The colour of the stem met with in the different varieties are, (1) light green, (2) reddish brown and (3) green with red patches.

With regard to hairiness two classes of plants are met with, viz., (1) plants with soft stems, and (2) plants with prickly hairs.

(4) *Leaf.* The leaf is uniformly dark green in all varieties, and it is simple and lobed, the nature of the lobes varying slightly in some varieties. In some the lobes are deeply cleft and in some others the leaves are slightly lobed.

(5) *Inflorescence.* The flower is solitary, axillary. There is but very little difference with regard to this character in the various varieties studied.

In one instance an abnormal flower with the staminal column producing stigma-like structures was met with, and in another case a flower with a secondary, small ovary lobe was observed details of which are presented elsewhere.

(6) *Earliness of flowering.* It has been observed that most of the varieties begin to flower at almost the same period, i. e., after 30 days of growth. The varieties Long Green, and Poona Bulk were the earliest, and the varieties White Velvet, Soft Bhandi, Bendakai from Tiruttani, and the varieties from Ranipuram and Gobichettipalayam were the late maturing ones. The others were intermediate between these early and late types.

(7) *Fruit.* The different varieties are easily distinguished with the help of the fruit characters alone. According to the length of the fruit two kinds are met with, viz., (1) Long-fruited plants, and (2) Short-fruited ones. The different colours of the fruit met with are, (1) Light green, (2) Dark green, (3) White, and (4) Reddish green.

The number of ridges or ribs in the fruit also varies but slightly from one variety to another. In one case there are no ridges at all. In some cases as the White Velvet and the Long Green variety the fruits are smooth to touch, while in certain types as the Hairy variety, the fruits are beset with prickly hairs.

In some cases as in the American Long Green and White Velvet the apex is long and sharp, while in the dwarf podded types the apex is not significant.

The length of the fruit in general varied from 5.5 to 11.0 inches; the width from 0.7 to 1.5 inches, and the number of ridges from 5 to 9.

(8) *Yield.* The yield of fruit per plant is too small and hence when taking this data into consideration the yield per plot was considered for each sample, and from the readings obtained the average yield per acre was calculated. In the table this yield is given. These readings were obtained from the April to August crop of 1943. The yield of the different varieties range from 3,000 to 7,000 lbs. per acre.

**Classification.** A provisional classification based on the foregoing varietal studies may be useful and has been accordingly attempted. The characters found useful for the tentative classification are primarily: (1) The height of plants, (2) Length of fruit, (3) Spread of plants, and (4) Colour of fruit.

In the case of the first character the plants are considered "tall" if they are 36 inches and above in height; they are considered "dwarf" if they are below 36 inches in height. The fruits which are 3 inches and longer when quite tender are considered "long", and those which are below 3 inches when tender are termed "short".

With the help of the characters studied the different forms could be classified as under:—

**I. Plants Tall:****A. Fruits Long—****B. Dark green in colour**

- 1) Plants branched and spreading and leaves deeply lobed—Type 1.
- 2) Plants erect, few branches —Type 2.

**B1. Light green in colour :**

- 1) Fruit hairy with prickles —Type 3
- 2) Fruit smooth without prickles —Type 4

**B2. Reddish green :**

- Fruit slightly prickly and reddish when mature —Type 5

**B3. White, i. e., green with ashy bloom :**

- Fruit cylindrical without ribs —Type 6

**A1. Fruits short—****B. Dark green in colour :**

- 1) Fruit slender and tapering and erect —Type 7
- 2) Fruit very short & thick, ridges very prominent —Type 8

**B1. Light green :**

- Fruit smooth and tapering, ridges 5 to 6 —Type 9

**II. Plants Dwarf :****A. Fruits Long—****B. Dark green :**

- Plant spreading, leaves small, fruit thin and horizontally disposed —Type 10

**B1. Light green :**

- 1) Greenish white, 5 ribbed and smooth hairs all over —Type 11
- 2) Fruits long and erect, leaves deeply lobed —Type 12
- 3) Leaves broad, slightly lobed ; fruit long and thick, apex not sharp—Type 13

**A1. Fruits short—****B. Dark green :**

- Fruit short, erect and 5 to 7 ribbed ; leaves small and deeply lobed, erect—Type 14

**B1. Light green :**

- 1) Same as type 14 except in colour —Type 15
- 2) Leaves very broad, slightly lobed and borne on short petioles ; fruit erect—Type 16

The key for the identification of the numerous varieties as given in this paper is admittedly open to criticism from certain stand-points. Differences in the habit of the growth of a plant and size of the various plant parts are generally found to be affected by environment, but to an extent they can be relied upon. Such imperfections in a system of classification are not limited to this alone. Despite the obvious limitations it is believed that the key as

worked out at present may be useful in attempts to list and describe the large number of forms with some sort of grouping of the related ones

**General description of the varieties** (1) *Tall plants*. Height of plant 3 to 6 feet; habit of growth upright, sometimes branching near the ground; leaves borne on long petioles; pods in axils of leaves

(a) Long-fruited forms:—Pods 3 to 5 inches long, and 8 to 12 inches when mature; 0.6 to 1.25 inches in diameter; 5 to 9 ribbed.

(b) Short podded forms:—Pods 1.5 to 2.5 inches when tender, and 3 to 6 inches long when mature; 1 to 2 inches in diameter; 5 to 9 ribbed.

(2) *Dwarf plants*. Height 20 to 36 inches; habit of growth bushy and spreading from the ground, leaves small and on slender petioles.

(i) Long-fruited forms:—3 to 5 inches long when tender and 6 to 10 inches when fully mature; 0.6 to 1.3 inches in diameter; 5 to 7 ribbed. Leaves deeply lobed.

(ii) Short-fruited forms.—2 to 4 inches long when tender and 3 to 7 inches when mature; 1 to 2 inches in diameter when fully grown; 5 to 9 ribbed; leaves large and on short petioles.

**Insect pests.** The only important insect pest met with was the jassid. The others such as the fruit and stem borers did not cause any appreciable damage. The jassids—small, very active green leaf-hoppers—infested the young plants in swarms and they were found resting on the under-surface of the leaves. They suck up the plant sap causing leaf curls. When badly affected the leaf curls very much and assumes the shape of a cup, and gradually it dries up exhibiting a burnt up appearance. On account of this the pods do not develop normally and hence the reduction in the yield of fruits.

The infection was found to be appreciably smaller during the months April to June 1943 than in the other months. It had been observed that from among the varieties studied, the varieties Soft Bhendi, Hairy variety and Bendakai from Tiruttani were to an extent resistant to the attack of jassids. Some varieties were planted in January 1944 and the plants grew well, and at the time of flowering, i. e., by the end of January the plants of most of the varieties were infested by jassids. The plants began to bear and they gave a poor performance. All the varieties except the Soft Bhendi and Bendakai from Tiruttani soon failed to keep up to the mark. The varieties Soft Bhendi and Bendakai from Tiruttani recovered from the attack of jassids and they began to bear pods. The variety from Tiruttani showed this resistance to the jassids in the previous crops in 1943 also. This shows that these two varieties are to an extent resistant to this insect pest. Since no regular experiment was conducted with due care nothing can be said definitely except that there is an indication of a few varieties being resistant to the attack of jassids to a little extent.

**Summary.** (1) Thirty-four samples of the cultivated varieties of *bhendi* were collected from various sources for a comparative study of their performance under Coimbatore conditions.

(2). With the help of the plant characters studied, a key for the identification and classification of the different types has been attempted. Out of the 34 samples studied 16 different forms could be isolated.

(3) The plant characters of the different types have been detailed in the text. The yield ranges from 3,000 lb to 7,000 lb.

(4) It has been incidentally observed that some varieties are resistant to the attack of jassids at least to some extent. The observations made are but mere indications.

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### APPENDIX I.

Table No. 1. Showing the fruit characters and yield of 16 types of Bhendi.

| Type No. | Name of the variety. | Average plant height | Fruit    |         |        | No. of ribs. | Calculated Approx. Yield per acre. |
|----------|----------------------|----------------------|----------|---------|--------|--------------|------------------------------------|
|          |                      |                      | Colour.† | Length. | Width. |              |                                    |
| 1.       | Greenish Bhendi      | 48"                  | D. G.    | 8.0"    | 0.9"   | 6-9          | 7050 lbs.                          |
| 2.       | American Long Green  | 54                   | do.      | 10.0    | 1.0    | 5-6          | 4000 ..                            |
| 3.       | Hairy variety        | 65                   | L. G.    | 8.0     | 1.1    | 5-7          | 5025 ..                            |
| 4.       | Soft Bhendi          | 60                   | do.      | 8.0     | 1.0    | 5-7          | 4200 ..                            |
| 5.       | Reddish Bhendi       | 63                   | R. G.    | 8.6     | 1.2    | 6-8          | 4250 ..                            |
| 6.       | White Velvet         | 56                   | White    | 8.5     | 0.9    | nil          | 6000 ..                            |
| 7.       | Soona Bulk           | 40                   | D. G.    | 6.0     | 0.7    | 5-6          | 3000 ..                            |
| 8.       | Dwarf ribbed         | 54                   | do.      | 3.5     | 1.4    | 5-8          | 4000 ..                            |
| 9.       | Lady's Finger        | 42                   | L. G.    | 4.5     | 1.0    | 5-7          | 3200 ..                            |
| 10.      | Podugu Benda         | 24                   | D. G.    | 10.0    | 0.7    | 5-6          | 5000 ..                            |
| 11.      | Green White          | 30                   | L. G.    | 5.0     | 0.7    | 5-7          | 6000 ..                            |
| 12.      | Long Green           | 32                   | do.      | 11.0    | 1.0    | 5-7          | 7000 ..                            |
| 13.      | Koma Benda           | 28                   | do.      | 8.0     | 1.1    | 5-7          | 3075 ..                            |
| 14.      | Dwarf Green (a)      | 26                   | D. G.    | 4.0     | 1.0    | 5-6          | 3500 ..                            |
| 15.      | Dwarf Green (b)      | 20                   | L. G.    | 4.0     | 1.0    | 5-6          | 4000 ..                            |
| 16.      | Akasa Benda          | 28                   | do.      | 4.5     | 1.0    | 5-7          | 3000 ..                            |

\* The names used here are as given by the seed suppliers.

† L. G. : light green; D. G. : dark green; R. G. : reddish green