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OKRA



Store No : 626316

OKRA

Common name : Okra, Bhindi, Lady's finger, Gumbo.

Botanical name : *Abelmoschus esculentus*

Family : Malvaceae

Chromosome no. : $2n=130$



INTRODUCTION :

Okra is fast growing annual herb the young seed pods of which are commonly used as vegetable.

- It is an important fruit vegetable crop of the tropical and subtropical regions of the world.
- It is commonly grown through the warmer parts of temperate Asia, Southern Europe, Northern Africa, the United States and in all parts of the tropics.
- It is adopted to climates with relatively short rainy seasons, hence its special acceptance in North-east Brazil.
- ▶ India ranks first in world in okra production.
- ▶ In India, okra is commercially grown in the states of Gujarat, Maharashtra, Assam, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, West Bengal, Assam, Rajasthan, Tamil Nadu, Karnataka, Haryana and Punjab.



ORIGIN:

- ▶ According to Zeven and Zhukovsky (1975), okra is believed to have originated in the Hindustani Centre of Origin, chiefly India, Pakistan and Burma.
- ▶ However according to some other authors, okra originated in India (Masters, 1875), Ethiopia (de Candolle, 1883, Vavilov, 1951), West Africa (Chevalier, 1940, Murdock, 1959) and Tropical Asia (Grubben, 1977)

TAXONOMY:

- ▶ The genus *Abelmoschus* is small and consists least 6 species (Borssum Waalkes, 1966)
- ▶ These are native to the Hindustani Centre or to south-east Asia, and are closely related to each other.
- ▶ West African okras are characterised by many morphological and physiological differences from the normal okra.



- West African okra's have less epicalyx segments, very red leaf veins, late flowering when planted in the summer, pods mounted at right angles to the stem, and large numbers of seeds per pod.
- In addition, pods of the East African type tend to be short, with a relatively long sterile tip.



BOTANY

- ▶ Okra is a erect, herbaceous annual.
- ▶ Stem : green with or without reddish tinge.
- ▶ Leaves : alternate, 3-7 lobed palmate, hirsute and serrate.
- ▶ flowers: solitary, axillary having epicalyx (up to 10)
- ▶ There are five yellow patterns with crimson spot on claw.
- ▶ Staminal column consist of numerous stamens which are united to the base of petal.
- ▶ Stigma is 5-9 lobed.
- ▶ Fruit is capsule.
- ▶ Flowering starts below to upwards.
- ▶ Dehiscence: occurs around 8-10 am, about 20minutes after anthesis.
- ▶ Flowers remain open for shorter duration and wither in afternoon.
- ▶ Stigma receptivity: during anthesis hence pollination is not very successful at bud stage.



The species of *Abelmoschus* L. (Martin, 1982)

Sr. No.	SPECIES	SPECIAL CHARACTERISTICS	CHROMOSOME NUMBER
1.	<i>A angulosus</i>	Epicalyx bracts 4-8 and persisting, as long as capsule	-
2.	<i>A crinitus</i>	Epicalyx bracts 10-16 and 25-50 mm long, capsule usually shorter, mature capsule fusiform.	-
3.	<i>A esculentus</i>	Epicalyx bracts 6-10 , lanceolate	72, 124, 130
4.	<i>A ficulneus</i>	Epicalyx bracts 4-8 , lanceolate, ovoid capsule	72
5.	<i>A. glutino-textile</i>	Combines characteristics of <i>A. esculentus</i> and <i>A. manihot</i>	-
6	<i>A manihot</i>	Epicalyx bracts 4-8 free, much shorter than capsule.	60, 68
7	<i>A moschatus</i>	Epicalyx bracts 6-10, lanceolate , capsule ovoid to oblong	72
8	<i>A speciest</i>	Epicalyx bracts 5-8 , free, broad	194
9	<i>A tetraphyllus</i>	Epicalyx bracts , soft hairs	130
10	<i>A tuberculatus</i>	Fruit with bristly hairs from a tubercular base	58
11	<i>A tubercular esculentus</i>	Combined characteristics of <i>A. tuberculatus</i> and <i>A. esculentus</i>	182

BREEDING OBJECTIVES:

- ▶ High pod yield.
- ▶ Dark green , tender, thin, medium long, smooth, 4-5 ridged pods at marketable stage
- ▶ Pods free from conspicuous hair. Seed bulging and yellow ring at base.
- ▶ Early and prolonged harvest.
- ▶ Short plant with more number of nodes , short internodes.
- ▶ Optimum seed yielding ability.
- ▶ Pods suitable for processing industry and export market.
- ▶ Resistance to diseases like yellow vein mosaic virus, fusarium wilt, cercospora leaf spot.
- ▶ Resistance and tolerance to insect like fruit and shoot borer, jassids and whitefly.
- ▶ Tolerance to abiotic stresses like low temperature, excessive rains, saline and alkaline soils.



Inheritance of principal characteristics of okra

Characteristics	Inheritance
Plant height	Height heritability (79%) Medium heritability (49%), Non-additive gene action
Internode length	Height heritability (79%)
Dark red stem	Simple inheritance, purple dominant over green
Pubescence of foliage	Incomplete dominance
Light red petiole	Simple inheritance
Degree of leaf lobing	Simple inheritance Incomplete dominance
Resistance to yellow vein mosaic	Height heritability (70%)
Earliness	Simple inheritance
Days to flowering	Height heritability (65%) Non-additive gene action

Calyx colour	Simple inheritance (dominance)
Petal blotch	Simple inheritance (dominance)
Outer side, petal colour	Simple inheritance (dominance)
Base colour	Simple inheritance (dominance)
Petal venation colour	Simple inheritance (dominance)
Pod colour	Simple inheritance (multiple alleles), Two genes, dominant
Pubescence of pod	Complex/simple inheritance, complete dominance
Length of fruit	High heritability (84%)
Diameter of fruit	High heritability
Weight of fruit	Average heritability (48%)
Vitamin C content of fruit	High heritability
Fiber content of fruit	High heritability
Pods/plant	Additive gene action, average heritability (40%)
Seeds/pod	Very high heritability (94%)
Seed weight	High heritability (77%)
Yield	High heritability (63%)

Selfing and crossing

Selfing

Cover unopened bud with half length white pollination paper bag and staple or clip the bag securely along peduncle. Put a thread ring at the peduncle. The pod will come out piercing through the bag. The thread ring acts as identification mark for selfed pods during harvesting.

Tie circular thread around pedicel and put a knot around the unopened flower petals with the same piece of thread .the petals shall bulge out below the tied thread during the flower opening and the stigma inside remain protected from unwanted pollen grains. The thread tied at pedicel is the identification mark for selfed pod at harvesting

Emasculation

The flower in okra start from below to upwards.

Dehiscence of anthers about 20 minute after anthesis flower remain open for the 3-4 day and wither in the afternoon. Stigma receptive during anthesis hence pollination is not very successful at bud stage.

Emasculation is done in the late afternoon. Big size unopened flower is selected. Two long and opposite silts are made on the calyx with forceps. Both the halves of sepal are pulled downward and removed. Now entire corolla and anthers are removed and the emasculated bud is covered with paper bag which is secured with U clip on the pedicel.

Pollination:

Flower just to open fully are collected. Calyx and corolla are removed and the dehiscing anthers are brushed over stigma of the buds emasculated on perceeding afternoon. One male flower can be used to pollinate 3-4 flower . After pollination the buds are again covered with pollination paper bag and a label having name of male parent along with date of pollination is tied at the pedicel of the pollinated flower bud.



Breeding Methods:

Okra is considered both as self pollinated and as an often cross pollinated vegetable due to protogyny and male sterility in a few varieties.

INTRODUCTION:

A cultivar from Africa known as *Abelmoschus manihot* spp *manihot* introduced into India has been successfully used as source of resistance to YVMV in breeding of Prabhani and Punjab Padmani

Clemon Spineless

Perkin Long Green.

PURE LINE SELECTION:

An elite single plant is identified from the population based on the desirable characters. Controlled selfing is done to ensure self pollination.

Variety develop through this method:

- ❖ Pusa Makhmali
- ❖ CO-1 from Red Wonder
- ❖ Gujarat Bhendi 1

Mass selection

This method is follow only to purify the existing variety. Sometime only one generation of mass selection would purify variety, if variation in the original population is due to physical mixture or similar reasons.

BACKCROSS METHOD

This is followed to transfer a few gene to a desirable variety lacking the particular gene. The receptor parent may be a popular variety and the donor parent may be another variety , breeding line or wild related species.

Pedigree method

This method is applicable to the segregating generation after hybridization between desirable promising donors. The individual plant selection starts in F2 and continue till F5. or F6.

VARITY DEVELOPED BY THIS METHOD

Pusa Sawani

Varsha Uphar

Hisar Unnat

Azad kranti

Punjab Padmani

Prabhani Kranti

P 7

Arka Anamika

Arka Abhaya

Company name	variety
mahyco	MH 10, MH 64
Nunhems	Sonal
Syngenta	Syn 16, 152
Bioseeds	avantika
Krishdahan seeds	Hyb 215 and 577

Mutation breeding

This has been employed to evolve early yielding varieties.

Gamma radiation affected qualitative and quantitative character of interspecific hybrids and thus created wide variability.

Variety developed by mutation;

MDU1

MDU2

POLYPLOIDY BREEDING

Colchicine induced polyploids have showed smaller, thicker, darker leaves than untreated control. Polyploids have inhibited growth and retarded flowering. A few fruits formed were small and irregular. Amphidiploids were obtained from interspecific crossing with related wild species. Amphidiploid was resistant to yellow vein mosaic virus. Amphidiploid was highly fertile due to its meiotic stability and hybrid could exist as a new synthetic species.

INTERSPECIFIC HYBRIDIZATION

It is resorted to transfer disease resistance gene from related species to *A. esculentus*

Interspecific hybridization in *Abelmoschus*

Cross	Results
<i>A. esculentus</i> x <i>A. tuberculatus</i> $2n = 130$ x $2n = 58$	Positive
<i>A. esculentus</i> x <i>A. manihot</i> $2n = 72$ x $2n = 60$	Positive
<i>A. esculentus</i> x <i>A. manihot</i> $2n = 130$ x $2n = 66$	Positive
<i>A. esculentus</i> x <i>A. feculneus</i> $2n = 130$ x $2n = 72$	Negative
<i>A. esculentus</i> x <i>A. moschatus</i> $2n = 130$ x $2n = 138$	Negative
<i>A. esculentus</i> x <i>A. tetraphyllus</i> $2n = 130$ x $2n = 138$	Positive
<i>A. esculentus</i> x <i>A. tetraphyllus</i> $2n = 72$ x $2n = 130$	Positive
<i>A. esculentus</i> x okra from Ghana $2n = 130$ x $2n = 194$	Positive

Interspecific hybrids in okra

- A. esculentus x A. manihot var. medicus
- A. esculentus x A. manihot var. adotachtylus
- A. esculentus x A. tetraphyllus
- A. esculentus x A. manihot var. manihot
- A. esculentus x A. manihot sp. tetraphyllus

Vegetable crop varieties developed by hybridization and selection from advanced generations

Variety	Organization	Parents	Feature
Punjab Padmini	PAU, Ludhiana	A. esculentus x A. manihot sp. manihot	It is resistant to YVMV, jassids and cotton ball worm.
Parbhani Kranti	MAU, Parbhani	A. esculentus cv. Pusa sawani x A. manihot sp.	It is resistant to YVMV.
Arka Anamika	IIHR, Bangalore	A. esculentus (IIHR 20-31) x A. tetraphyllus	Average yield is 11 t/ha. It is resistant to YVMV.
Varsha Uphar	CCSHAU, Hisar	Lam Selection-1 x Parbhani Kranti	Average yield is 10 t/ha. It is resistant to YVMV and leafhopper.
Hissar Unnat	CCSHAU, Hisar	Selection 2-2 x Parbhani Kranti	It is tolerant to YVMV and leafhopper. Average yield is 14 t/ha.

F₁ hybrids in Okra

F ₁ hybrids	Features
Hybrids from crosses between Pusa Sawani and Pusa Makhmali (male parent) and H 398 (female parent)	Early flowering, early maturity, higher fruit weight and yield
Local 5 (Malaysian) x Emerald (American) , Local 7 (Malaysian) x Gold Coast (American) , Local 5 (Malaysian) x Gold Coast (American), Local 7 (Malaysian) x Emerald (American)	Higher germination, early flowering, more plant height and higher yield
Pusa Sawani x Smooth Long Green	More fruits/plant and higher yield
American seven Ohari x Pusa Sawani	More plant height and higher yield
New Selection x AE 91	Heterosis for yield
Balady x Gold Coast	Heterosis for plant height, fruits/plant and fruit weight
Seven Leaves x Pusa Sawani	Yield and fruits/plant

DISEASE RESISTANT BREEDING

YELLOW VEIN MOSAIC (Gemini virus)

- ✓ Most devastating disease of okra.
- ✓ First reported by C. S Kulkarni in 1924 followed by B.N Uppal, P.M Verma and S.P Capoor and P.M Verma in 1950
- ✓ Transmitted by white fly (*Bemisia tabaci*)
- ✓ Arka Anamika, Arka Abhay and Prabhani Kranti were initially highly tolerant.
- ✓ *Abelmoscus manihot* accession have shown resistance to YVMV.

Crosses of cultivated okra with *A. manihot* under BC2/BC3 followed by pedigree method of breeding are expected to give YVMV resistant segregants.

VENATION LEAF CURL OF OKRA

- ✓ First observed at IHR hessarghatta Bangalore in 1924 by S.J Singh and 1986 by S.J Singh and O.P Dutta.
- ✓ Virus transmission is by grafting, natural transmission by white fly.
- ✓ No resistant source is reported.

Sources of resistance

Disease/Insect	Resistance donors
Yellow vein mosaic	IC 1542, <i>A. manihot</i> , <i>A. manihot sp. manihot</i> , Parbhani Kranti, Punjab Padmini
Damping off, <i>Rhizoctonia solani</i>	Red Ghana, Sel. 7-1, BH 27, IC 12096, IC 17252
Powdery mildew	Nigeria (R), EC 32598, IC 8248
Cercospora blight	Sel. 7-1, Round Selection, EC 32598, IC 10238, IC 8248, IC 1542
Fusarium wilt	IS 9273, IS 9857, IS 6653, Pusa Sawani, Pusa Makhmali
Nematode	Long green Smooth
Jassid	IIHR 21, AE 15, AE 30, IC 7194, IC 8899, Crimson Smooth Long, IC 7194, IC 8899, <i>A. manihot sp. manihot</i>
Fruit/shoot borer	Red I, Red II, Red Wonder I, Red Wonder II, <i>A. manihot</i> , Pusa Sawani, Long Green

IMPORTANT VARIETIES

1. Pusa Makhmali

- ▶ Developed by H.B. Singh and S.M. Sikka in 1955 as a result of selection from the local material collected from West Bengal.
- ▶ It is an early variety; Pods smooth, straight, 5-edged, attractive, light green, slender, 15-20 cm long.
- ▶ Yield potential is 100 q/ha.

2. Pusa Sawani

- ▶ Bred by H.B. Singh (1957-58), derived from a cross of IC-1542 (field resistance to YVMV) and Pusa Makhmali.
- ▶ Plants are 120-180 cm tall in rainy season; Pods smooth, 5-edged, dark green and 18-20 cm long.
- ▶ It is distinguished by the presence of a purple patch at the base of the yellow petal on both the sides whereas in most okra varieties the patch is present only in inner side.
- ▶ At present it has found to be susceptible to YVMV; yield potential is 150 q/ha.

3. MDU 1

- ▶ Evolved by TNAU, Coimbatore in 1978. It is an induced mutant, isolated from 'Pusa Sawani'.
- ▶ On an average there are 13 nodes/plants; fruiting begins from 4-5th node.
- ▶ It takes 33 days to first flowering and 43 days to first picking, fruits are light green about 20 cm long.
- ▶ It has been notified by the central seed committee in 1985.

4. Punjab Padmini

- ▶ Evolved by B.R.Sharma at the PAU, Ludhiana from a cross between *Abelmoschus esculentus* and *A. manihot* ssp. *Manihot*.
- ▶ F1 plant of a cross *A. esculentus* cv. 'Reshmi' x *A. manihot* ssp. *manihot* cv. Ghana was hybridized with an F2 (OP) plant of a cross *A. esculentus* cv. Pusa Sawani x *A. manihot* ssp. *manihot* cv. Ghana.
- ▶ Continuous selection for resistance to YVMV and desirable horticultural traits in the subsequent generations led to the isolation of Ludhiana Sel-1 in the F8 generation which was later named as 'Punjab Padmini'.
- ▶ It has field resistance to YVMV and tolerance to jassids and cotton boll worm.
- ▶ yield potential is 100-125/ha q green pods and 12.5 q/ha seeds.

5. Harbhajan

- ▶ The original 'Perkins Long Green' or Sel-6 has been named as Harbhajan in memory of Dr. Harbhajan Singh of IARI by T.A. Thomas and R. Prasad.
- ▶ Plants are very tall, thick and prolific bearer. Leaves are large, moderately lobed with rough surface and prominent veins.
- ▶ Fruits are long tapered, bright green, spineless and mostly 8-edged.
- ▶ Notified by the central variety release committee.

6. Parbhani Kranti

- ▶ It is a YVM resistant variety evolved by N.D. Jambhale and Y.S. Nerkar in 1985 from an interspecific cross between *A. esculentus* cv. 'Pusa Sawani' and *A. manihot*, an African species carrying resistance to YMV.
- ▶ BC2 with Pusa Sawani was subjected to selfing and selection upto F8.
- ▶ Plants are tall, leaves are deeply lobed; first fruit borne on 5-6th node.
- ▶ Marketable fruit size (8-9 cm) is attained 7-8 days after anthesis.
- ▶ On an average green fruit yield is 85-90 q/ha during summer and 115 q/ha during rainy season.
- ▶ Seed yield of 10 q/ha from rainy season crop and 5-6 q/a from summer crop is possible.

7. Sel 10 (Arka Anamika)

- ▶ It is YVM virus resistant variety, an interspecific origin between *A. esculentus* and a wild species *A. manihot* ssp. *tetraphyllus*.
- ▶ Plants are medium tall (about 100 cm), leaves are green, small; fruits are medium green, rough. 5-ridged and start after 5-6th node onwards.
- ▶ Yield potential is 115 q/ha of green pods.

8. EMS-8 (Punjab 8)

- ▶ It is an induced mutant derived from Pusa Sawani treated with 1% EMS. The final selection was made in the M8 generation.
- ▶ Plants are tall. Stem, petioles have splashes of purple pigmentation.
- ▶ It has field resistance to YVMV and tolerance to fruit borer
- ▶ On an average, it gives 95 q/ha marketable yield of green pods.

9. Arka Abhay (Sel 4)

- ▶ Released by IIHR, Bangalore as resistant to YVMV.
- ▶ It is a sister line of Arka Anamika.
- ▶ The plants resemble Arka Anamika in appearance as well as YVMV resistance.
- ▶ It carries tolerance to fruit borer and may suit pruning for a ratoon crop.

SALIENT BREEDING ACHIEVEMENTS

- ▶ Variety Pusa Sawani a selection from Pusa Makhmali X IC1542 was first YVMV resistant variety released in India.
- ▶ High yielding variety Lam Selection , Sel 2 , Vaishati Vadhu , Lam hybrid , R 7 , EMS 8, CO 1, Beltes
- ▶ *A.manihot* var. *pungens*, *A.crinitus*, *A.panduraeformis* and *A. vitifolius* and variety Sel 4 and Arka Anamika and Arka Abhay were observed resistant to YVMV.
- ▶ Kiran and Salkeerthi are light green types and Aruna is a red fruited type variety Long Green show resistance to nematode.
- ▶ Line AE22, AE79, Red wonder II , Red I, Red II and AE52 have shown resistance to fruit borer and lines IC 18960, IC15055, Round selection Walgaon, EC41292 to leaf spot.
- ▶ CO3 is high yielding F1 hybrid (Prabhani Kranti X MDU 1) from TNAU 16-18t/ha, Azad Bhindi 1 (Pusa Sawani X Prabhani Kranti) exhibit higher yield 10-12.5t/ha. F1 hybrid Vijay, Varsha, Panchali, Ever Green, Karishma developed by private seed companies.

Prospectus

The yellow vein mosaic disease is the most serious disease in okra. There is a need for combination breeding program to evolve resistant lines. Cultivation of okra during summer has been problematic and less economic so there is need to evolve resistant and suitable variety for summer cultivation. Recombination DNA technology needs to be employed for evolving stable YVMV resistant types. Hybrid technology in okra needs to be popularized.