

# KARONDA

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## 1. INTRODUCTION

The karonda (*Carissa carandas* L.), belongs to the family Apocynaceae, Eng.-Karonda; Hindi-Karaunda, Karumcha, an evergreen diffuse, spiny shrub, occurring throughout India. It is suitable for arid tropics and sub tropics and grown for its attractive colored edible fruits. It also grows successfully on marginal and wastelands. It thrives well as a rainfed crop, the plant hardly needs any care and gives yield with the minimum management. It is a sprawling

semi vine shrub native to India. It is used as live fencing around the orchards besides providing fruits. Ripe fruits are sub-acidic to sweet in taste with peculiar aroma. The fruits are eaten as a dessert when ripe. Mature fruits contain high amount of pectin and are used for preparation of different products such as jelly, jam, squash, sauce, syrup, etc., which are of great demand in the international market. The unripe fruits are sour and astringent and can be used for pickles and chutney. The dried fruits may become a substitute for raisins (Cheema and Cheema, 1971). The fruits can be candied just like cherry. The wine prepared from ripe fruits contains about 14.5 to 15% alcohol and is very much liked by wine fanciers (Nalawadi and Jayasheela, 1975). The fruits are rich in protein (1.1-2.25%) vitamin C (1.6-17.9 mg/100g) and minerals especially iron (39.1mg/100g), calcium (21mg/100g), and phosphorus (38mg/100g) (Anon., 1950; Anon., 1979; Kumar and Singh, 1993).

The fruits are traditionally used in the treatments of malaria, epilepsy, nerve disorder, relieve of pain and headache, fever, blood purifier, myopatic spasms, dog bite, cough, colds, itches and leprosy (Rahmatullah *et al.*, 2009). The roots are used as anthelmintic, stomachic and antiscorbutic agents and for the treatments of intestinal worm, scabies and pruritus

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(Warrier *et al.*, 1993). The plant extract of *C. carandas* has been reported to possess cardioprotective, antipyretic and antiviral activities (Taylor *et al.*, 1996; Rajasekaran *et al.*, 1999). The wood of the karonda plants is white, hard and smooth. It is used for making spoons and combs. The plants can be trained as a strong hedge.

Karonda is suitable for growing throughout sub tropical and tropical climatic zones of India. Major natural areas of occurrence of karonda have been observed in the states of Maharashtra, Bihar, West Bengal, Chhattis Garh, Orissa, Gujarat, Madhya Pradesh, Rajasthan and in the Western Ghats. In Maharashtra, the major area under this crop is scattered in sub-mountain area like Kolhapur, Ratnagiri and Pune district (Sawant *et al.*, 2002).

## 2. OBJECTIVES OF CROP IMPROVEMENT

- i. To develop a cultivar with high yield potential and producing big sized fruits with attractive skin colour.
- ii. To develop a cultivar producing fruits of good quality having higher pulp content, less number of seeds, high TSS with low acidity and high in ascorbic acid.
- iii. To develop a cultivar of dwarf stature with less spine intensity and higher fruit yield.
- iv. To develop a cultivar having drought resistance/free from major diseases and pests.

## 3. CYTOGENETIC

Chromosome number  $2n = 22$ . It is highly heterozygous, cross-pollinated fruit crop. Cook (1904) described that the *C. carandas* is a large, ever green, branched, spinous shrub or small tree. The fruit is a berry and shape of fruit is ellipsoid and pointed or globose or oval or round; 1.8 to 2.5cm long, green in colour when unripe and turn to red and finally black or dark purple on ripening, containing 1-4 flat brown seeds, but up to 16 in some species.

## 4. INHERITANCE PATTERN / LINKAGE

In karonda, inheritance linkage of different economical characters has not been studied in detail. The efficiency of selection as a breeding tool depends on the knowledge of genotypic and phenotypic coefficient of variation, heritability, genetic gain and genetic advance. Based on work done by various scientists, the following conclusions can be drawn regarding the inheritance pattern of certain characters.

- i. The magnitude of phenotypic coefficient of variation (PCV) was slightly higher than the genotypic coefficient of variation (GCV) for all characters. The PCV and GCV were more than 100% for pomace per fruit while it ranged from 60 to 90% for seed weight per fruit, acidity, non-reducing sugar and average fruit weight. Heritability was very high (above 90%) for average fruit weight bearing potential, non-reducing sugar, reducing sugar, acidity, total soluble solids and pomace content, while genetic advance in terms of percentage mean was high for pomace, fruit weight, acidity, seed weight per fruit and non-reducing sugar. These estimates indicate the scope for karonda by selection (Sawant *et al.*, 2002).

- ii. The magnitude of variation was maximum for total soluble solids followed by pulp weight. The characters, equatorial diameter, polar diameter, individual fruit weight, pulp weight and total soluble solids were less affected by environment, which showed close correspondence between Genotypic Coefficient of variability and Phenotypic coefficient of variability, while characters such as seed weight per fruit and number of seeds per fruit were most affected. High heritability estimates with low genetic advance was observed for TSS implying less genetic gain if selected upon while, selection for equatorial diameter, polar diameter, individual fruit weight and pulp weight with high heritability, high genotypic coefficient of variability and high genetic advance in the material is expected to result in considerable genetic gains. Lowest value of Genotypic Coefficient of variability, heritability and genetic advance were observed for number of seeds per fruit suggesting this character can not be effectively improved effectively by selection (Athani, *et al.*, 2005).
- iii. Fruit setting was correlated with the umbel segments. The plant having higher number of umbel segments was associated with higher yields (Karale *et al.*, 1990).

## 5. FLORAL BIOLOGY

### 5.1. Flower Structure

Flower pentamerous, white coloured star shaped. Inflorescence terminal corymbose cyme.

#### 5.1.1. *Calyx*

Pink coloured, sepals, 5 almost fused from base around the corolla tube showing separation at the tip.

#### 5.1.2. *Corolla*

Petals 5 in number, white in colour, fused at the base forming about 1.5 cm long pink coloured corolla tube.

#### 5.1.3. *Androecium*

Anthers very small, 5 in number, bilobed, filaments fused with corolla tube all along its length.

#### 5.1.4. *Gynoecium*

Single style of about 1 cm long, stigma just below the anthers favours self pollination.

### 5.2. Flowering

Flowering and fruiting takes place twice a year. The main flowering season is during the month of March-April with fruit maturing during August-September which enables the

plants to make best use of monsoon rain. The second flowering season is during October-November. The fruits from first flowering are mature in the month of August-September. However, in accession No.CZK2011 flowering takes places only during March April with very heavy fruiting. The varieties/ accessions which bear flowers and fruit twice a year generally have sparse fruiting. Variability in floral morphology and fruit set studies in seedling population by Karale *et al.* (1990) revealed variation in number of flower buds (14.6-22.6) per umbel, petal number (4-6) and number of umbel segments (1-6).

### **5.3. Anthesis**

Variable percentage of anthesis was registered in different genotypes. Peak period of anthesis was recorded from 3-6 P.M. or 8 to 10 P.M. depending on the locality, cultivar and atmospheric temperature.

### **5.4. Dehiscence**

Dehiscence of anthers takes place before anthesis between 12 noon and 4 P.M. The dehiscence takes place in the longitudinal fashion and complete within an hour. Atmospheric temperature and humidity influence the time and duration of dehiscence.

### **5.5. Stigma Receptivity**

The maximum receptivity of stigma is found two days before anthesis and two days after anthesis.

### **5.6. Mode of Pollination**

Mostly self pollination as evidenced by floral structure which favours self pollination.

### **5.7. Fruit Set**

The initial fruit set by self pollination was 73.06% which reduced to 24.24% at last. The initial fruit set was highest in plants with most number of umbel segments. Hence number of umbel segments could therefore be used selection criteria for higher fruit yield.

## **6. DIFFERENT SPECIES**

The genus *Carissa* to which karonda belongs is a member of the family Apocynaceae. The genus has nearly 30 species originating in South Africa, Australia, tropical Asia and Malaysia. Different species of *Carissa* are grown for their small berry like edible fruits and closely branched spinous hedges. Some species are also cultivated for ornamental purposes in the gardens. Important different species are:

### 6.1. *Carissa carandas* L

A large evergreen shrub with a short stem grows to a height of 3-6 meters, glabrous except the inflorescence, generally with milky latex, bark light-grey, scaly, branchlets usually alternate with twin stout sharp horizontal glabrous spines 2.5-3cm long at their base, branches usually without spines. Leaves are simple opposite, dark green, coriaceous, elliptic or obovate, obtuse, often shortly mucronate, glabrous and shining, base subacute, petioles 0.6 cm long, tan red at opening later leaves turn dark green in color. In the leaf axils slender to stout spines are present.

Flowers are white fragrant, tubular, regular bisexual, complete and epigynous, solitary or in cymose clusters, scarcely odorous in pubescent terminal corymbose cymes, pedicels very short, bracts linear, pubescent. Calyx pubescent, lanceolate, very acute, ciliate. Sepals 4-5, green in color almost free to the base, imbricate persistent ovate in shape. Petals are as many as sepals, lobes contorted in bud; the corolla often has hairy or scaly appendages or outgrowth of various kinds. Corolla-tube about 1.5 cm long, Stamen as many as petals and alternate with them in one whorl, filaments short, anthers yellow and inserted on the corolla tube interpose, arrow shaped, often free or united in a cone. Disc often present, entire lobed or scaly. Stamens included within the corolla-tube; anthers linear-oblong. Style long simple, stigma thickened two lobed yellow colored and hairy below. Carpels usually 2, very rarely more than 2, united (connate) or united by styles or stigma's only, but free at ovary. Ovary superior 2 celled, glabrous; ovules 4 in each cell; stigma slightly penicillate at the apex.

Fruit is a drupe, ovoid to ellipsoid, 2-5cm long, colored with reddish pulp at skin, and lighter near the seed. Calyx persistent, latex present, flavor pleasant. Seeds 3-4, dark brown in color and hard, flat sometimes with endosperm and sometimes without endosperm.

### 6.2. *Carissa spinarum* L

Hindi-Karanda. This species bears slightly larger juicy and sweet fruits. It is native of India. This is the hardiest species of *Carissa* and is known to thrive in poor and rocky soil. A suberect or sometimes prostrate evergreen shrub; young parts and inflorescence pubescent; bark light-coloured; branches rigid, often zigzag, terete, divaricate; spines 1.5-3cm long, horizontal, very sharp, often bifurcate. Leaves coriaceous, elliptic, acute or obtuse, shortly mucronate, glabrous or pubescent. Flowers white, sometimes tinged with pink, scented, in few-flowered pubescent corymbose usually terminal cymes, very often in threes on the top of short pubescent peduncles; pedicels short; bracts linear, pubescent. Calyx divided almost to the base; lanceolate, very acute, ciliate. Corolla tube 0.5cm long, lobes slightly shorter than the tube, lanceolate, acute, spreading. Ovary 2-celled; ovules 2 in each cell. Berry 0.5 cm in diameter, subglobose, usually 4-seeded, dark purple. It is cultivated throughout the country, particularly in Punjab and Kashmir. It is grown in hedges for its fragrant flowers. Leaves are considered to be a rich source of tannin.

### **6.3. *Carissa inermis***

A large climbing shrub or small tree occurring in West Coast; quite glabrous except the puberulous inflorescence. Spines are stout, dark-brown, decurved, simple, 2.5-3.5 cm long. Flowering branches spineless. Leaves are coriaceous, drying dark-brown, elliptic or elliptic-lanceolate, acute or acuminate, glabrous, base acute. Flowers are white, in terminal corymbose puberulous cymes; peduncles 1-1.5 cm long; pedicels short; bracts subulate. Calyx pubescent, lanceolate, very acute, ciliate. Corolla 2.5-3 cm long; in appearance like a plum, purple when ripe.

### **6.4. *Carissa suavissima* Bed**

A lofty climber quite glabrous. Spines decurved. Leaves broadly ovate, acuminate, glabrous, base usually rounded. Flowers white, in terminal corymbose glabrous cymes. Calyx glabrous, very acute. Berry with much milky juice, 2.5-4.00cm long, ellipsoid, edible, black when ripe.

### **6.5. *Carissa arduina***

A dwarf glabrous shrub with twice-forked spines, subsessile cymes, pale-pink sepals, a white corolla and a scarlet berry.

### **6.6. *Carissa acuminata* DC**

Resembles closely to *C. bispinosa*, spines not stout, or rather weak, leaves are ovate, sub cordate, peduncle short, forked and axillary. Calyx lobes lance-acuminate in form, corolla twisted to right in the bud.

### **6.7. *Carissa bispinosa* Desf**

An ever green shrub, hardy, possess strong spines with thick glossy leaves, ovate or subcordate, glabrous and entire. Flower white in color twisted to the right is the bud very large and fragrant, bears regularly and abundantly. Fruit is dark red as the size of cherry.

### **6.8. *Carissa congesta***

Distributed in Western Ghats. Fruits are used for preparing jam.

### **6.9. *Carissa edulis* Forssk**

Native of tropical Africa. It has been introduced in India from the USA (Singh *et al.*, 1982). It is a straggling bush about 10ft tall, spines simple or branched, leaves ovate to sub lanceolate, about 2 inch long, apex acute or mucronate. Flower white inside and purple to red outside, scented, small about half inch across, lobes acute, corolla tube about ¾ inch long. Fruit is a berry globose small in size, red to purple in color smooth 2-4 seeded fruit is edible.

### 6.10. *Carissa ibispinosa*

The flowers are small and fruits are borne in clusters. The fruits resemble with that of *C. grandiflora*.

### 6.11. *Carissa grandiflora* D.C.(Syn. *Arduina grandiflora* E.Mey.)

Eng.- Natal plum, came to India from South Africa. A large, spiny shrub; native to South Africa but cultivated in Maharashtra and Baroda for fruits which are eaten fresh or used in salad, jelly and sauces. The fruits are dark red with papery skin and a few small seeds. Fruits are a rich source of vitamin C.

### 6.12. *Carissa ovata*

Fruits are small and are used for jam making. The origin of this species is said to be Australia.

### 6.13. *Carissa macrophylla* Wall

Native to India found growing in plenty in Western Ghats. A large shrub spine s large about 1.5 inch long and leaves glossy on drying become dark brown, 2-4 inch long, apex sharp pointed. Corolla tube nearly 1 inch lobes ½ inch long. Berry about 1 inch long, ellipsoid.

### 6.14. *Carissa paucinerria* A.D.C.

Shrubby erect, quite glabrous except the puberulous cymes, leaves 5-10 cm, ovate or elliptic ovate, acute or acuminate, many nerved, thorns are vey strong, curved. It is found in Deccan Peninsula.

## 7. BREEDING METHODS

### 7.1. Improvement by Selection

Karonda is such an underutilized plant that not much research work has been done on varietal improvement. Whatever work that has been reported as far is based on the selection either from naturally growing population or by evaluation of seedling population on their performance over certain period of time. A survey of this fruit crop growing in eastern Uttar Pradesh identified 4 types of fruit, viz. green, white with pink blush, green with purple blush and maroon (Kumar and Singh,1993). Average fruit weight ranged from 1.6 to 4.7g and average number of seeds per fruit from 5 to 11. Wide variation was also observed in the biochemical composition of the fruit, with total soluble solids ranging from 3 to 4.5%, ascorbic acid from 10.26 to 17.94 mg/100g, reducing sugars from 0.93 to 2.4% and non-reducing sugars from 0.57 to 1.33%.

Mishra *et al.* (2007) developed three varieties by selection viz., Pant Manohar, Pant Sudarshan, and Pant Suvarna. At Central Arid Zone Research Institute Jodhpur, the work on survey, collection, conservation, characterization and evaluation of germplasm was initiated during 2000-2001 which resulted in collection of wide ranging genotypes and a variety from Pant Nagar (Anon., 2010,). Subsequently three genotypes were identified to be the high yielding varieties to be released shortly (Anon., 2011).

## **Cultivars Developed through Selection**

### **7.1.1. *Pant Suvarna***

It was developed by selection and released from G.B. Pant University of Agriculture and Technology, Pant Nagar in 1986. Plants are upright growing and sparse, leaf size-2.41 × 1.41cm. The fruit length is 2.25 cm, fruit diameter 1.67cm, fruit weight 3.63 g. It contains 88.25 % flesh with 5.89 seeds / fruit. Fruit colour is green purple. Fruit contains TSS 3.83%, total titrable acidity 2.30% and yield 22 kg per plant.

### **7.1.2. *Pant Manohar***

It was developed by selection and released from G.B. Pant University of Agriculture and Technology, Pant Nagar in 1991. Plants are medium-sized dense bushed with leaf size, 2.35x1.36 cm, having fruits of 2.13 x 1.69 cm, dark pink blush on white background. The fruit length is 2.14 cm, fruit diameter 1.70 cm, fruit weight 3.95 g with 3.95 seeds / fruit. It contains 88.28% flesh, TSS 3.92%, total titrable acidity 1.82% and yield 27 kg per plant.

### **7.1.3. *Pant Sudarshan***

It was developed by selection and released from G.B. Pant University of Agriculture and Technology, Pant Nagar in 1991. The fruit length 2.17 cm, fruit diameter 1.96cm, fruit weight 3.47g. It contains 88.48 % flesh, TSS 3.45%, total titrable acidity 1.89% with 4.68 seeds / fruit. Fruit colour is white pink and yield 29kg per plant.

### **7.1.4. *Konkan Bold***

It was developed by Fruit Research Station, Vengurla, Maharashtra. It is sweet type variety. It has large fruit size weighing 16.23g, better pulp content (92%) and low acidity. (Salvi *et al.*, 2006).

### **7.1.5. *CHES-K - 2***

It is promising genotype developed at Central Horticultural Experiment Station, Godhra. Peak period of flowering was recorded in the month of March. It recorded 10.00 kg fruit yield/plant, fruit weight 5.10 g and TSS 6.10<sup>0</sup> Brix at the time of maturity.



### 7.1.6. CZK-2011

It is a selection, to be released by Central Arid Zone Research Institute, Jodhpur, Rajasthan (Anon., 2011). Fruit size-21.79x16.35mm, elongated ovoid, green with purple blush coloured fruit, mean fruit weight-3.74g, TSS-9.4%, acidity-2.82% flesh dry matter 12.85%, vit. C-35.88mg 100<sup>-1</sup>g.

### 7.1.7. CZK - 2022

It is a selection, to be released by Central Arid Zone Research Institute, Jodhpur, Rajasthan (Anon., 2011). Fruit size-22.47x19.14mm, ovoid white with pink coloured fruit, mean fruit weight-4.18g, TSS-8.5%, acidity-2.14%, flesh dry matter-12.77%, vit. C-37.80mg 100<sup>-1</sup>g.

### 7.1.8. CZK - 2031

It is a selection, to be released by Central Arid Zone Research Institute, Jodhpur, Rajasthan (Anon., 2011). Fruit size is 22.66 × 19.57mm, ovoid half white half pink coloured fruit, mean fruit weight-5.01g, TSS-8.7%, acidity-2.95% flesh dry matter-12.96%, vit. C-37.4 mg 100<sup>-1</sup>g.

### 7.1.9. CISH Kr-11

It is a superior genotype selected from Central Institute of Subtropical Horticulture, Lucknow. Fruit weight is 6.0 g, length 2.3 cm, pulp 4.6g, seed 1.4g, TSS 6.10<sup>0</sup> Brix, ascorbic acid 16.8 mg /100g and antioxidant 189.89 µg/100ml AEAC unit.

At Rahuri some promising types No. 3, No.12, No.13 and No.16 have been identified (Karale *et al.*, 1989).

## 7.2. Hybridization

To develop high yielding variety having large size, bright red coloured fruits, crossing between two desirable parents may be done. There is genetic diversity with respect to morphology and qualitative characters which can be exploited through clonal selection and hybridization. Crossing between the varieties like Konkan Bold and Pant Manohar may result some positive traits in the progenies.

### 7.2.1. Procedure for Hybridization

Flowers buds of the cultivars should be emasculated a day prior to anthesis and covered with butter paper bags. Next morning, emasculated flowers should be pollinated with the pollen of desired cultivars, after pollination, it should be covered again. These bags should be removed after ensuring that the fruit set is taken place.

## 8. FUTURE THRUST AREAS

A rich genetic diversity is available throughout the country especially in the states of Gujarat, U.P., Bihar, Uttarakhand, Jharkhand, Chhattisgarh, M.P., etc. which should be exploited for selection of better genotypes. It is not a table fruit hence more emphasis on post harvest technology should be given for value added and export oriented processed products while selecting the genotypes. Establishment of small scale processing units should be promoted. Screening of genotypes/cultivars for problematic soils is also essential.

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## VARIETY OF KARONDA



CZK2022



CZK2011



CZK2031

