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Ker

P.R. Meghwal
Principal Scientist, Division of Integrated Farming System(Div. II)
ICAR-Central Arid Zone Research Institute, Jodhpur, Rajasthan

Ker (*Capparis decidua* (Forsk.) Edgew, (synonym *Capparis aphylla,* Roth) is a multipurpose, perennial, woody shrub or small tree found growing naturally in hot arid regions and semi-arid subtropics in various parts of the world. In India, it is known by different names in different parts of the country. In Rajasthan, it is generally called Kair or Ker while in Haryana it is known as Teent or Dela. Some more synonym by which ker is known are Caper, Karyal, Hanbag, Cari, Karira *etc* while in English, it is known as Caper berry. This species is an important constituent of arid ecosystem and plays significant roles in sustaining the ecosystem. The peoples of Indian Thar desert have known the importance of this shrub for long back. On account of its acquired xerophytic adaptive characteristics, it is capable of growing in various kinds of habitats including wastelands. It is also suitable for stabilizing sand dunes and controlling soil erosion by wind and water. Due to its xerophytic adaptive nature, the plant grows successfully under harsh climatic conditions of arid regions. Berry-shaped unripe fruits are rich in carbohydrates, proteins and minerals. It was abundant about five decades back, but, with increase in populations of humans and livestock and more demand of land for agricultural purpose, it has been over-exploited and eliminated by tractor ploughing and excessive browsing pressure from livestock. This has resulted in significant reduction in plant population of ker, but people still try to retain some plants on farm boundaries as this also prevent soil erosion which is quite high due to wind.

Origin and Distribution

The precise origin of ker is not well understood, and in fact, the range of the fruit's native habitat is wide. Many variants of capers are native to the Mediterranean basin in the western parts of North Africa, and as far east as Central Asia. It is also considered native to desert and arid regions of Indian sub-continent, Africa and Saudi Arabia. It is also found grown in dry sub-tropical Africa, Tibesti (West Chad), Sudan except in extreme south, Arabian Peninsula, Egypt, Iran, India, Jordan, Pakistan and Mascarene (Abra and Ali, 2001). In Indian sub-continent it is found almost everywhere in dry places of Sindh, Baluchistan, North Western Rajasthan, Deccan Central India, Punjab, Gujarat and Tinnevelly (Chishty and Monika, 2016). As a condiment, capers date back over 5,000 years. *Capparis decidua's* native region is a bit more limited, even though

several countries including Chad, Egypt, Ethiopia, India, Iran, Jordan, Mauritania, Niger, Nigeria, Pakistan, Senegal, Somalia, South Africa and Sudan can be considered the native region of ker. The natural habitat of ker is on the lower pediment and pediment plains all over the dry regions (Pareek 1978). It is also found in the very dry plains, semi stabilized sand dune fringes and in undulating and deeply dissected areas up to 1200 m in altitude. Ker is widely distributed in fellow lands with intense solar radiation with an altitude range of 300–1200 m, mean annual rainfall of 100–750mm and temperature range of 18–48 °C (Chishty and Monika).

Area and Production

Although, the species is found growing extensively as naturally grown, the exact area in India is not known. Rich variability under natural population can be seen with regards to fruit size, bearing habit, fruit color, pulp content *etc*. Germplasm has been collected by NBPGR from Rajasthan, Haryana and Gujarat in collaboration with CCS, HAU, regional station Bawal. CIAH Bikaner has also collected 65 collection and elite types has been identified. At Central Arid Zone Research Institute, Jodhpur, some 25 accessions have been collected and maintained in field gene bank. Enormous diversity has been reported in growth habit, spininess, branching pattern, foliage color and number of seeds per fruit. There is need to collect the genotypes with higher fruit yield, large fruit size and high protein and mineral content from western Rajasthan and adjoining areas where rich diversity of natural population exists. However, the lack of availability of faster clonal propagation technology dilutes the efforts because in the want of this conservation and multiplication of desired genotypes has not been possible so far in spite of several efforts in this direction.

Nutritive Value and Uses

The immature fruits are rich in carbohydrates, proteins and mineral elements. The bio-chemical analysis of mature fruits indicated that they are highly nutritious with 14.88% crude protein, 7.43% ether extractives, 5.96% total mineral matter,12.32% crude fibre and 59.41% digestible carbohydrate on dry weight basis (Chouhan *et al.,* 1986). The fruits were also found to be rich in dietary fibre (Agarwal and Chouhan 1988). Unripe fruits are traditionally used in vegetable curries and also made into good quality pickles by the local inhabitants of the Thar desert, with any surplus produce being sun dried for future use. The green immature fruit is the main ingredient of the popular "*panchakuta* " delicacy - a mixture of dry vegetables of Rajasthan. The sweet, pulpy, ripe fruits are eaten by birds and sometimes consumed by children in rural areas. The young twigs serve as fodder especially for goats and camels. The fruits and other plant parts are reported to have different medicinal properties in cardiac, gastric and diabetic troubles (Anonymous, 1950). The importance of the plant is known in all traditional system of medicine such as Ayurveda, Unani *etc*.(Chopra *et al*., 2006, Gupta, 2010). The plant is traditionally used for the treatment of many diseases such as rheumatism, asthma, cough, lumbago, toothache, pyrrhea, descentry, liver infection, febrifuge, cardiac troubles, constipation, ulcers, piles, renal disorders and skin diseases (Singh and Singh, 2011, Haq *et al*., 2011, Mann *et al.,* 2013). Tender branches and leaves are used as plasters for boils and swellings and when chewed they

relieve toothache. The bark is acrid, laxative, diaphoretic and alexeteric, anthelmintic and useful for coughs, asthma and inflammation (Kirtikar and Basu, 1935). Roots and root bark are pungent and bitter and are given in treatments for intermittent fever and rheumatism (Dalziel, 1948). The bark of the species has also been reportedly used as cure for asthma, inflammation and gout (Ahmed *et al.,* 1989). The wood is light yellow to pale brown smooth, moderately hard and heavy (wt. 620–770 kg/m3) and resistant to termite attack (Anonymous 1950). Mature wood is used for making tool handles, boat knees, *etc*., (Singh *et al.,* 1983).

Taxonomy

Ker (*Capparis decidua* (Forsk.) belongs to the family Capparaceae, comprises of 650 species of trees and shrubs which are found mostly in tropical, subtropical and warm temperate regions. Twenty-six species are reported to occur in India (Hewood, 1978). The somatic chromosome number is 26(2n = 2x), type of fruit is berry and edible portion is epicarp and mesocarp. Ker is a spiny, much branched, green twiggy looking shrub or small tree (sometimes up to 7m height) growing gregariously with dense spherical crowns. The stem bark is smooth, green when young and turns grey upon aging. Leaves are small caducous, succulent and appear for a short period, maximum of one month, on new shoots which later modify into spines to reduce the transpirational losses. Branches have stipular spines (up to 5mm in length) as a protective mechanism against the browsing animals. The tap root system enables the plant to extract moisture from deeper layers of soil profiles up to 4 m. The presence of fine secondary roots near soil surface help to absorb even the little rainfall. Inflorescences are both lateral and terminal fascicles or corymbose racemes of pink, scarlet red or, rarely, creamish white pentamerous flowers about 2–2.5 × 2.5 cm in size. During a recent survey, some naturally growing plants with yellow flowers have been observed near Jodhpur and on Jodhpur - Jaisalmer highway in Rajasthan (Meghwal, 2016, unpublished data). Deora and Shekhawat (1995) have also reported the existence of yellow flowers on ker. Fruits are globose, borne on a long stalk, green when immature and red or pink when ripened. Ripe fruits contain a sweet pungent yellow pulp with many seeds.

Climate

It is an extremely drought hardy species adapted to the harsh climatic conditions of hot arid regions. Its deep tap root system, scanty foliage and tough conical spines are special xerophytic adaptive mechanisms to survive under the harsh edapho-climatic conditions of arid areas of occurrence. The natural habitat of ker is reported on the lower pediment and pediment plains all over the dry regions (Pareek 1978). It is well adapted to regions having rainfall as low as 150mm but does increasingly well with increasing rain fall up to 600mm. The plants not only survive but also flowers and set fruits under extreme summer months when temperature rises up to 50°C in the Thar desert.

Soil

It prefers alkaline sandy and gravely soil with pH 6.5–8.5. Ker also thrives well on shallow hard soils and rocky outcrops but not on shifting sand dunes or water logged

areas (Muthana, 1993). It has wide ecological amplitude as it grows on all types of waste lands in arid zone as well as other soils. Kalyan-Singh and Singh (1994) reported that ker grows well on soils with lower sodicity (pH < 9, ESP < 35% and ECe < 4d Sm^{-1} m). It thrives well on sandy soil with poor organic matter content including saline and alkali soils.

Propagation

Natural regeneration occurs through seeds and root suckers thrown up to 4–5 m from mother plants (Pareek 1978; Vashishtha 1987). Ripened fruits available during the month of May-June are eaten by birds and in the process, seeds are dispersed to distant locations through their excreta. The seeds so dispersed germinate during rainy season which immediately follows after fruit ripening period that results in new plantation. However, the survival of such seedling under the inhospitable environmental conditions of the *Thar* desert and other arid regions of the country limit the establishment of new seedlings and only few seedlings succeed to establish and survive under natural conditions. The Seedlings can be raised with carefully controlled nursery schedules, but post germination mortality is very high. Seeds are extracted from well ripened fruits after clearing off the pulp and dried in the shade. The seeds being recalcitrant loose viability with loss of moisture and cannot be stored for long. The seeds can be sown in polyethylene tubes (200 gauge, I 0 × 25 cm size) filled with a mixture of sand, clay and powdered farmyard manure (FYM) in 5:1:1 proportion. Germination starts after about 15–20 days; and continues up to 40 days. The per cent seed germination is quite high even up to 70–80, but post germination mortality poses threat to seedling survival therefore, water logging should be avoided as it results in collar rot. The best way to avoid water logging is to apply water through sprinkling with a water cane in the nursery. Occasional drenching of nursery beds with fungicides can help in reducing the mortality of seedlings due to collar rots. The initial growth of seedlings is quite slow and they require one year in the nursery; only then the seedlings become ready for planting in the field just prior to the onset of the next rainy season. The plants have to be irrigated every 15 days except during the rainy season for two years after planting out. Some sort of protection from hot winds during April to June should be given for two years for proper establishment of the seedlings. After that they become well established in the soil and do not require more irrigation, though they need to be protected from browsing animals. Vegetative propagation through hardwood cuttings has been done using a quick dip treatment with IBA (1000 ppm) in the month of July but success rate was again very poor (Vashishtha 1987; Meghwal and Vashishtha 1998). The Artificial propagation by root suckers can be done but, often, with little success. The main consideration during propagation through root suckers is time of planting. The naturally established old plants throw root suckers which get sprouted with many new shoots. Such rooted suckers may be carefully detached from mother plants with some fine roots during rainy season for establishment of new orchard. At CAZRI Jodhpur over 95% success in root sucker establishment could be achieved by planting of carefully detached root suckers during the month August (Meghwal, 2018 unpublished data). Micropropagation could be an

effective means of mass propagation. Deora and Shekhawat (1995) obtained multiple shoots from nodal explants on Murashige and Skoog (1962) medium supplemented with 0.1 mg l^{-1} NAA + 5.0 mg l^{-1} BAP. The regenerated shoots rooted best in 100 mg l^{-1} IBA on half strength M.S. liquid medium followed by transfer to hormone free half strength M.S. agar gelled medium containing 500 mg l^{-1} activated charcoal. Tyagi and Kothari (1997) also reported in vitro clonal propagation of ker using nodal explants from mature trees as well as from seedling derived cotyledonary node, cotyledon and hypocotyl explants. Murashige and Skoog medium enriched with 5 mg l^{-1} BAP showed maximum shoot bud proliferation from nodal explants of seedling and mature plants. Maximum rooting occurred on half strength MS medium supplemented with 1 mg l^{-1} IBA.

Planting

Pits of 2 × 2 × 2 feet size should be dug at 4–5 m spacing during summer and refilled with about 10 kg FYM mixed with top soil after exposing the pits to sun for about 15 days. One-year-old seedlings raised in nursery can be transplanted in the field during July-August. The seedlings need to be taken care in the first year by irrigation and protection from stray animals. They may also require staking initially for upright growth. From third year onwards the bushes can survive under rainfed condition, however, they may require protection from browsing animals.

Training and Pruning

Under natural conditions, plants spread horizontally due to continuous sprouting from root suckers and remain as multibranched bush. Under the systematic plantation, plants may be trained on single stem keeping the main stem free of side branching up to 50 cm. After this, plants make natural canopy by spreading uniformly on all direction. No regular pruning is practiced since there is no regular orcharding of ker established artificially exist except at research institutes. The flowering and fruiting take place on older shoots (6–12 month) mostly but it can also occur on new growth of current seasons. Therefore, thinning out of some branches to open up the centre of the bushes and heading back of terminal shoots after fruit harvest *i.e*., in the month of June may induce more vegetative growth in next fruiting season.

Irrigation

Irrigation during the first two years is essential for proper establishment of bushes**.** During rainy season not, many irrigations are required except just after transplanting and long gaps in monsoon rains. Irrigation at 15 days interval during winter and 7–10 days interval during summer may be given up to two years. Thereafter, the plants may be maintained as rainfed as in the case of natural conditions.

Nutrition

No systematic studies have been done on ker nutrition, however application of FYM @10–15 kg per plant per year may help the plant in replenishing the nutrient removed through growth and fruit production. The FYM should be applied in the tree basins during July-August every year for its proper utilization by plants.

Flowering and Fruit Set

Plants raised through seeds start bearing fruits at 6 to 7 years of age, whilst vegetative propagated plants may start fruiting after four years. Flowering occurs on 6–12 month old shoots of the current year as well as previous year's growth. New growth starts at the end of the monsoon season *i.e*., during the onset of autumn (October) and continues until the end of June *i.e*., the beginning of the next monsoon season. The peak flowering season is February-March (the spring season) and that of fruiting is in March-April (late spring to early summer). There is wide variability in flowering pattern between the plant and within the same plant over the years. Shekhawat (1999) also reported that flowering in ker occurred thrice in a year *i.e*., February-March, August-September and October-November. In some trees flowering continues from March to November in varying intensity on different direction of the same plant as reported by Singh *et al*. (2005). This appears to be a physiological adaptation since ker being grown under rainfed condition without addition of nutrient from external source, the plants cannot afford to flower at a time. The flowering and fruiting, though take place in other season such as in August-September and October November, but commercially the fruits obtained from the February-March flowering are important as maximum fruiting occurs in this season and also fruit quality is better. Fruits obtained from later flowering are not of good quality and generally not used for vegetables or pickling. The fruits set during August-September or October-November may be left on the plant till full ripening and may be used for extraction of seeds to multiply the plants. Even though, ker produce leaves, flowers and fruits two three times a year but peak flowering occurs during summer months and maximum ripened fruits are available just before onset of monsoon. Apparently, it looks paradoxical that plants produce flower and fruits during the driest period when there is maximum water stress. Singh *et al.* (2005) gave an excellent explanation of this situation that this is an important adaptation for continuity of the race. By producing flowers about 1–2 month prior to rainy season, the species ensures that the seeds are available in ground when rainfall season starts. The plant can afford this behaviour because of its ability to draw moisture from deeper soil layers.

Pests and Diseases

Naturally established ker bushes are very hardy and seldom affected by major pest or diseases. However, attempt to establish ker artificially poses several problems particularly during establishment phase. Attack of *Fusarium solani* and *Rhizoctonia* root rot have been recorded in seedlings raised in polybags (Bhansali,2002). Termite attack can be observed on old and week trees but actively growing trees are seldom affected by termites. Association of web of spider (*Stegpduphus sarasinorum*) with ker plant has been observed.

Harvesting and Post-harvest Management and Yield

Immature green fruits are available for harvesting during March-April, while fruit ripening takes place during May-June which are harvested for extraction of seeds for raising nursery. The harvesting of the fruits is done manually. The fruits should be

harvested at green tender pea grain size for pickling, vegetable or for drying purpose. The stage can be judged by size of the fruits and also by pressing the berries. Meghwal (2002) suggested that the fruits should be harvested after 7–10 days of fruit setting with 5–8mm diameter during March-April. After maturity, the seeds in the fruits become hardened and no longer remain suitable for vegetable. It has been observed that fruits set early in the season remain tender even when they are of bigger size, while those harvested late in season *i.e*., after middle of April even smaller sized fruits turn harder with mature seeds. The fruits of second flowering are available in September-October are of inferior quality with less crop load and generally not harvested.

The yield of green immature fruits is about 2–3 kg per plant in the beginning which increases with the age of the plant. A full-grown plant (>8 years old) can give as much as 10–15 kg of fruits. The thorny nature of the plant poses great difficulty for hand picking the fruits and villagers often collect the fruits by beating the crown with wooden sticks. The fruits are generally sold fresh in the local markets. The fresh fruits are astringent due to the presence of tannins and phenolic substances (Methyl isothiocynate). The astringency can be removed by immersing the fruits in a 5% solution of common salt, or in butter milk, for 4–5 days in an earthen pot (Meghwal and Tewari, 2002). After the removal of astringency, the green fruits can be made into a vegetable, good quality pickle or they can be preserved by sun drying/dehydration. The ker fruits make excellent quality pickle. After curing the fruits, the stalks are removed and they are blanched in water. Generally raw mango slices of one fourth the weight of the ker fruits are added with usual spices and mustard oil in the pickle. For drying, the cured fruits are first destalked and then blanched in water. After draining the water, the fruits are mixed with ash and dried in Sun or in mechanical drier at 60°C to a final moisture content of 5–7%. At this moisture content, the fruits can be preserved for 2–3 years in airtight containers and can be marketed when the prices are high. Huge potential exists for its marketing in urban and national markets. The dried fruits are sold in the market @Rs.500–1000 per kg depending upon the size, the smallest sized fruits fetch the highest price.

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