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## Review on Reproductive Biology of Caster Bean (*Ricinus communis* L.)

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### Abstract

Castor belongs to the genus *Ricinus*, a member of the Euphorbiaceae, which contains a vast number of plants mostly native to the tropics. The genus *Ricinus* is considered to be monotypic and *R. communis* is the only species, which includes many polymorphic types. The cultivated types are dwarf annuals. Castor plants have well developed root system with thick horizontal roots. Tap root looks like extension of the stem below the soil. The stem is erect, circular in section, partially hollow, glabrous, and smooth with good branching. Stem is either red or green or with shades of both. The stem is marked by well-defined nodes from each of which a leaf is arises. The lower internodes are shorter and their length increases with height. Leaves are alternate, large, and palmate with 5-11 lobes acuminate margins notched, serrate or indented. They are carried on long stout petioles. The inflorescence is borne terminally on the main and lateral branches. Flowers are large, in terminal sub paniced racemes, monoecious, apetalous, the upper portion of the raceme being occupied by the female flowers and the lower by male flowers. The whole inflorescence may reach a length of 90 cm. The flowers are wind and insect pollinated and from 5 to 46 % natural pollination occurred. The fruit is round glaucous capsules with three projecting sides covered with tough spines or smooth, 3 loculed and three seeded. Seeds are albuminous, anatropous, broad, oval, compressed with a marked caruncle and longitudinal raphe. The testa is thin, brittle, varying in color and mottling. Below the testa is thin legmen, covering a whitish oily endosperm containing the embryo.

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*Ricinus communis* L, flower, fruit, stem, leaves, reproduction.

### Introduction

Flowers occur most of the year in dense terminal clusters (inflorescences), with female flowers just above the male flowers. This species is clearly monoecious, with separate male and female flowers on the same individual. There are no petals and each female flower consists of a little spiny ovary (which develops into the fruit or seed capsule), and a bright red structure with feathery branches (stigma lobes) that receives pollen from male flowers. Each male flower consists of a cluster of many

stamens which literally smoke as they shed pollen in a gust of wind.

In angiosperms, the flowers are the reproductive structures which are most varied physically and show a correspondingly great diversity in the methods of reproduction. It reproduces by following a mixed pollination system, which prefers selfing by geitonogamy and, at the same, outcrossing by anemophily and entomophily. Under natural condition more than 80% cross-pollination occurs.

Flowering may occur within 6 months after seed germination. The flowers of castor are normal monoecious, i.e., it bears pistillate flower on the upper part of the raceme and staminate on the lower part (Rizzarda *et al.*, 2012). The proportion of pistillate and staminate flowers among racemes can vary both within and among genotypes and also influenced by the environment. The percentage of pistillate flowers in normal monoecious varieties is highest on the first racemes and decreasing subsequently on developed racemes. The number of staminate flowers is proportionally increased with the decrease in pistillate flowers (Zimmerman and Smith, 1966). The probable cause of this variation is mainly temperature in different season. Moderate temperature in spring and early summer promotes female flower, while high temperature in mid and late summer promotes male flower. Femaleness is highest in young plants with a high level of nutrition, and maleness is highest in older plants with a low level of nutrition (Shifriss, 1960).

After opening, a male flower releases viable pollen grains for 1–2 days, and shedding of pollen occurs in the morning. The temperature between 26 and 29°C and relative humidity of 60% is the best environmental conditions for pollen dispersal which may vary according to cultivar. Before the opening of the female flowers, male flowers reach its maturity, and anthesis usually occurs in a short period of time (Brigham, 1993).

Therefore, the pistillate flowers that open and become receptive get a large source of pollen. After the opening of the flower, the stigma remains fully receptive for few hours, but there is a difficulty for pollination to occur promptly after the opening of the flower. Depending on the environmental condition, the stigma may remain receptive for 5–10 days (Moreia *et al.*, 1996).

### Description

Castor bean, *Ricinus communis*, is a perennial or annual crop which is grown throughout tropical and sub-tropical regions of the world. It is grown under varied climatic conditions viz., tropical, sub-tropical and temperate. However, its cultivation is largely confined to the countries lying between 52° N to 40° S latitude.

The tall, branched shrub produces seeds (8-15mm long, 6-9mm wide and 4-8mm thick) containing 35-55% oil (depending on variety), which may be extracted by a range of/or combination of processes, such as hydrate presses, continuous screw presses and solvent extraction.

The castor plant (*Ricinus communis* L.), also called castor bean plant or castor oil plant, is a shrub or small tree cultivated in tropical and temperate regions for its seeds rich in an oil valued for its many industrial applications. The plant and particularly its seeds, contain several toxic and even lethal substances. While castor plant foliage is less harmful than the seeds, its utilization as fodder is limited due to its potential toxicity, and it should be used carefully.

### Morphology

*Ricinus communis* is a very versatile species with different colors, sizes, shapes and seed colors depending on the cultivar, growth conditions and climate (Maroyi, 2007). The castor plant is a glabrous, soft-woody shrub or small tree, up to 7 (-10) m high, grown as an annual in temperate zones and as a perennial in the tropics. It is strongly tap rooted with prominent lateral roots. The stem and branches have conspicuous nodes and ring-like scars and glands often present at nodes. The shoots are usually glaucous, green or red in color. The leaves are spirally arranged, borne on 3.5- 50 cm long petioles. The leafblade is large (up to 50 (-70) cm in diameter), palmately compound with 5-12 acuminate lobes, median one up to 8(-20) cm long. The leaf margins bear glandular teeth. The inflorescence is an up to 40 cm long, erect terminal panicle becoming lateral as the plant develop new branches (due to indeterminate growth habit). The flowers are unisexual, regular, 1–1.5 cm in diameter; the male flowers are borne towards the base of the inflorescence, with many stamens in branched bundles and the female ones, towards the top of the inflorescence, with early caducous sepals, red or green in color. The fruits are spiny or smooth ellipsoid to globose, slightly 3-lobed capsules, 1.5-2.5 cm long, brown in color. Ripening of fruits within an infructescence is uneven, the lower fruits maturing before the upper ones. At maturity, the fruit is dehiscing in 3 cocci each opening by a valve and 1-seeded. The seeds are ellipsoid, 9–17 mm long, compressed, with a brittle, mottled, shining seed coat and with distinct caruncle at the base (Salihu *et al.*, 2014; Maroyi, 2007).

### Botany and reproductive biology

#### Botany

Castor plant, *Ricinus communis* L. is a species of flowering plant in the spurge family; Euphorbiaceae, which contains a vast number of plants mostly native to the tropics (Moshki, 1986). It belongs to a monotypic

genus *Ricinus*. The name *Ricinus* is a Latin word for tick. The plant is named probably because its seeds have markings and a bump at the end that resemble certain ticks (CABI, 2016).

### **Castor Leaves**

The long-stalked and simple glazing leaves are 15–45 cm long; alternate and palmate with 5–12 deep lobes with serrate leaf margins, lobes acuminate, membranous, oblong to linear; 1–3-cm-long stipules united to a sheathing bud, deciduous; and petiole 3.5–50 cm long, round (CABI, 2016). Different leaf colors are observed in castor, which start off as dark reddish purple or bronze when young and turn into dark green, sometimes with a reddish tinge as they mature. In some varieties, the leaves are really green from the start, whereas in others, a pigment suppresses the green color of all chlorophyll-bearing parts, leaves, stems, and young fruits so that they remain a dramatic purple to reddish brown color throughout the whole life of the plant. Flower: The flowers are borne in an erect terminal panicle-like inflorescence, which consists of cymes, usually glaucous, later-appearing lateral by overtopping, up to 40 cm long. The flowers are unisexual, regular, with short pedicel, 1–1.5 cm in diameter; the calyx with 3–5 lobes; corolla absent; male flowers toward the base of the inflorescence with many stamens in branched umbels; and female flowers relatively few in number and remain toward the apex of the inflorescence with early caducous sepals, three-celled superior ovary, usually soft spiny, style 3, red or green, 2-cleft (CABI, 2016). Fruit: Fruits are ellipsoid to sub globose, usually three-lobed smooth or spiny capsule, 1.5–2.5 cm long, brown, dehiscent in three cocci each opening by a vulva and one-seeded (Maroyi, 2007).

### **Reproductive biology of Castor**

#### **Castor Flower**

Castor can produce flowers over a long period, especially under natural condition when climatic condition is favorable. Castor is naturally a cross – pollinated plant and wind is the major agent of pollination. The castor flowers are borne on inflorescences, which forms a pyramidal raceme also known as spikes, terminally on main and lateral branches. The flowers may be monoecious (male and female), pistillate (female only) or interspersed (arranged intersperse) on the inflorescence (India, 2004). The male flowers occupy the upper portion of the spike. They have no corolla but have a green calyx deeply cut into three to five segments

enclosing numerous branched yellow stamens. The female flowers occupy the lower portion of the spike and have likewise no corolla. The three narrow segments of the calyx are, however, of a reddish color, and the ovary in their center is crowned by deeply divided red thread-like styles. The inflorescence can reach a length of 100cm, but since there is wide variation in distance between the flowers, ratio of male to female flowers and number of fertile female flowers, the yield is not necessarily correlated with the length. In most castor varieties, female flowers open before the male while in others male open first (NCRI, 2013). The male flowers shed most of the viable pollens between 1 to 2 days after opening. The pollens normally shed from 2 - 3 hours before sunrise until late afternoon, and there is frequently a peak at midmorning. The pollen is shed readily between 26 – 29°C with a relative humidity of 60 percent. The stigma can remain receptive for period of 5 to 10 days after opening (Christopher, 1996). Days between the opening of female flowers and that of male may vary from 3 to 7 days depending on genotypes.

#### **Castor Fruit**

The fruit is a globular spiny capsule which becomes hard and brittle when ripe. The Castor fruit is usually a schizocarp, typical regma; a capsular fruit with three cells each of which splits open at maturity into separate parts and then breaks away explosively, shattering the seeds. However, some castor varieties produce capsules with rudimentary spines, some produce soft, flexible and non – irritant spiny capsules while other produce spiny irritant capsules. After fertilization, the formation of capsule commenced 3 to 7 days (NCRI, 2013). Racemes can be conical, cylindrical or oval in shape with different capsule arrangements. The capsule arrangement may be compact, semi-compact or loose (Salihu *et al.*, 2013). The distance between the capsules reduces the damages caused by the borers. The capsule may vary in color from light green to wine and every gradation can be found.

The period from seedling emergence to capsules' maturity varies with genotypes. On average, it varies from 140 – 160 days. The lowest flowering racemes usually mature first, the others following in sequence up to the stem. Ripening of fruits along the racemes is sometimes uneven and in some wild varieties the period between first and last mature fruits may be several weeks. The capsules of some varieties shatter at maturity while some do not. In some, the whole capsule falls from desiccated raceme with the seed remaining enclosed. In

others, the capsule split to release seeds. The degree of hardness of capsule wall is varieties characteristic. Consequently, strong capsules tend to preclude mechanical hulling while very soft capsule may be difficult to hull without damaging the seeds (Salihu *et al.*, 2013).

### Castor Seed

The capsule contains three seeds which may be elongated, oval or square in shape. The seed has a tiny and brittle testa (seed coat) enclosing a white kernel. The seeds may be colored white, dark brownish-red, brown, dark chocolate, red or black but usually several colors occur as very attractive mottle on the testa.

The seeds vary greatly in size, from a few millimeters to nearly 250mm long and in breadth from 5 to 16mm. 100 seeds varies in weight from 9 to 100g (Salihu *et al.*, 2013). The variation is not only among varieties but from different racemes. In general, the seed weight increases as the total number seeds produced per plant decreases (Salihu *et al.*, 2013).

In some varieties, castor seeds may have a dormancy period of several months while freshly harvested seeds of some can germinate without special treatment. However, large seeded castors often germinate earlier compared with tiny seed (NCRI, 2014). The dormancy in some castor can be broken by soaking for 24hr in water or removing the caruncle and pierce the testa at the site. Germination is epigeal with the cotyledons coming out above the soil and expands as green leaves.

Castor varies greatly in its growth and appearance. The leaves are large, often dark glossy green with long petioles. The flowers are borne on inflorescence which forms a pyramidal raceme known as spikes or candle. The racemes are borne terminally on main and lateral branches. The fruit is usually as chizocarp; a spiny capsular fruit with three cells each of which splits open at maturity. Castor plant grows naturally over a wide range of geographical regions and similarly can be cultivated under a variety of physical and climatic regimes.

Castor plant is seen as an ideal candidate for agricultural revenue generating produce which has the potential to become the premier vegetable oil for industries across the country. The high potential yield and unique fatty acid composition allow castor oil to produce economically competitive feedstock needed for

production of premium quality biodiesel, short chain aviation fuels, derived fuel lubrication additives and very high value biopolymers.

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