

Botany of Chickpea

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Abstract

Chickpea is one of the important food legumes cultivated in several countries. It originated in the Middle East (area between south-eastern Turkey and adjoining Syria) and spread to European countries in the west to Myanmar in the east. It has several vernacular names in respective countries where it is cultivated or consumed. Taxonomically, chickpea belongs to the monogeneric tribe Cicereae of the family Fabaceae. There are nine annuals and 34 perennial species in the genus *Cicer*. The cultivated chickpea, *Cicer arietinum*, is a short annual herb with several growth habits ranging from prostrate to erect. Except the petals of the flower, all the plant parts are covered with glandular and non-glandular hairs. These hairs secrete a characteristic acid mixture which defends the plant against sucking pests. The stem bears primary, secondary and tertiary branches. The latter two branch types have leaves and flowers on them. Though single leaf also exists, compound leaf with 5–7 pairs of leaflets is a regular feature. The typical papilionaceous flower, with one big standard, two wings and two keel petals (boat shaped), has 9 + 1 diadelphous stamens and a stigma with 1–4 ovules. Anthers dehisce a day before the flower opens leading to self-pollination. In four weeks after pollination, pod matures with one to three seeds per pod. There is no dormancy in chickpea seed. Based on the colour of chickpea seed, it is desi type (dark-coloured seed) or kabuli type (beige-coloured seed). Upon sowing, germination takes a week time depending on the soil and moisture conditions.

3.1 Introduction

Chickpea (*Cicer arietinum* L.) is believed to have originated in the area between south-eastern Turkey and adjoining Syria (van der Maesen

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1987) for the fact that three closely related wild annual species of chickpea, *C. bijugum*, *C. echinospermum* and *C. reticulatum*, are found there. Of the three, *C. reticulatum* is considered to be the progenitor of the cultivated chickpea (*Cicer arietinum*). Holm (1920) reported that the generic name was proposed by Pliny and the specific name by Dodonaeus which were accepted by Linnaeus. The Latin words *Cicer* and *arietinum* were derived from the Greek words *Kikus* meaning ‘force of strength’ and *Krios* referring to ram, respectively, because of the similarity between seed shape and the head of a ram (*Aries*) (van der Maesen 1987).

Common names: From its place of origin, chickpea spread in both directions—European countries in the west and up to India, later to Myanmar in the east. Several of the vernacular names were derived from its generic name, *Cicer*, the exceptions being *garbanzo* and *garabanzo* (Spanish), *garvanche*, *garvance* and *garavane* (French) and *Garabanze* (German). These vernacular names include *pois chiche*, *pois ciche*, *ciche*, *césé*, *céséron*, *cicérole*, *ciserolle*, *seses* (French); *Kicherebse*, *Kicher*, *Chicher*, *Chichina*, *Chichuria*, *Cicererbis*, *Cisa*, *Cyfer*, *Czycke* and *Keicheren*, *Kekeren*, *Keyker*, *Kicher(n) kraut*, *Kicherling*, *Sisern*, *Sekern*, *Venuskicher*, *Ziesererbsen*, *Zisererwedsen*, *Ziser* and *Ziserbohne* (German); and *Keker*, *kekererwt*, *kicher*, *kikkererwt* and *cicererwt*, *citsers*, *sisser* and *sissererwt* (Dutch) among others. The English word, chickpea, was actually derived from *chich-pea*, referring to *Cicer-pea*. Chickpea was also described as a variety of pea which included *pois bécu*, *pois blanc*, *pois de brebis*, *poisbreton*, *pois chabot*, *pois citron*, *pois cornu*, *pois gris*, *pois pontu*, *pois tete de belier* (French); *Egyptian pea* (English); *hamoos pea* (Arabic); *Fontanellerbse*, *graue Erbsen*, *Malagaerbsen* (German); and *ovetche harokh* or *puzirnyi gorokh* (Russian). Some of the names refer chickpea as ‘coffee pea’ because of its use in preparation of coffee which includes *Kaffeerbse deutsche* or *franzosische Kaffebohne*, *deutscher Kaffee* (German); *pois cafe* (French); *kahviherne* (Finnish) and *Kaffeart* (Swedish). Chickpea is called as *nakhut*, *nohut* or *nut*, *naut* or *nohot* in Turkey, Romania, Bulgaria,

Iran, Afghanistan and in parts of Soviet Union. The Sanskrit name for chickpea is *chennuka*, and hence, the name *chana* in the Sanskrit-derived languages such as Hindi (van der Maesen 1987).

3.2 Taxonomy

Initially, chickpea was a part of the tribe Viciae, but due to its distinct characters, it was included in a new monogeneric tribe Cicereae later (Kupicha 1977). The detailed taxonomic information on chickpea (<http://plants.usda.gov/core/profile?symbol=CIAR5>) is given below:

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosida
Order	Fabales
Family	Fabaceae (Leguminosae)
Subfamily	Faboideae (Papilionaceae)
Tribe	Cicereae
Genus	Cicer

The genus *Cicer* has 9 annuals and 34 perennial species. Based on the morphology, geographical distribution and lifespan, the genus *Cicer* was divided into four sections (van der Maesen 1987 & <http://www.nipgr.res.in/NGCPCG/Taxonomy.html>).

Section	Species included	Lifespan	Morphology
Monocicer	<i>C. arietinum</i>	Annual	Firm erect or horizontal stems Branching from base or middle
	<i>C. reticulatum</i>	Annual	
	<i>C. echinospermum</i>	Annual	
	<i>C. pinnatifidum</i>	Annual	
	<i>C. judaicum</i>	Annual	
	<i>C. bijugum</i>	Annual	
	<i>C. yamashitae</i>	Annual	
	<i>C. cuneatum</i>	Annual	
Chamaecicer	<i>C. chorassanicum</i>	Annual	Thin stem Creepers with small flowers
	<i>C. incisum</i>	Perennial	

(continued)

Section	Species included	Lifespan	Morphology
Polycicer	<i>C. anatolicum</i>	Perennial	Leaf rachis ends in a tendril or a leaflet. Again divided into two subsections: Nano-polycicer and Macro-polycicer. Members of Nano-polycicer subsection have creeping rhizome, short stem, imparipinnate leaves, weak and short arista. Species in Macro-polycicer subsection have non-creeping short rhizome, stems growing to 75 cm, firm arista which is longer than pedicel
	<i>C. atlanticum</i>	Perennial	
	<i>C. balcaricum</i>	Perennial	
	<i>C. baldshuanicum</i>	Perennial	
	<i>C. canariense</i>	Perennial	
	<i>C. fedtschenkoi</i>	Perennial	
	<i>C. flexuosum</i>	Perennial	
	<i>C. floribundum</i>	Perennial	
	<i>C. graecum</i>	Perennial	
	<i>C. grande</i>	Perennial	
	<i>C. heterophyllum</i>	Perennial	
	<i>C. isauricum</i>	Perennial	
	<i>C. kermanense</i>	Perennial	
	<i>C. korshinskiyi</i>	Perennial	
	<i>C. microphyllum</i>	Perennial	
	<i>C. mogoltavicum</i>	Perennial	
	<i>C. montbretii</i>	Perennial	
	<i>C. multijugum</i>	Perennial	
	<i>C. nuristanicum</i>	Perennial	
	<i>C. oxydon</i>	Perennial	
<i>C. paucijugum</i>	Perennial		
<i>C. rassuloviae</i>	Perennial		
<i>C. songaricum</i>	Perennial		
<i>C. spiroceras</i>	Perennial		
<i>C. subaphyllum</i>	Perennial		
Acanthocicer	<i>C. acanthophyllum</i>	Perennial	Branched stems with woody base Persistent spiny leaf rachis Spiny calyx teeth Large flowers
	<i>C. incanum</i>	Perennial	
	<i>C. macracanthum</i>	Perennial	
	<i>C. pungens</i>	Perennial	
	<i>C. rechingeri</i>	Perennial	
	<i>C. stapfianum</i>	Perennial	
	<i>C. tragacanthoides</i>	Perennial	
	<i>*C. laetum</i>		

*Details are not available at present

3.3 Morphology

Plant: *Cicer arietinum* is a short annual herb, attaining a height of less than a metre. Depending on the angle of the branches and the soil surface, the plant assumes ‘erect, semi-erect, spreading, semi-spreading and prostrate’ growth habit. Branching starts from the base at ground level giving plant a bushy appearance (Fig. 3.1).

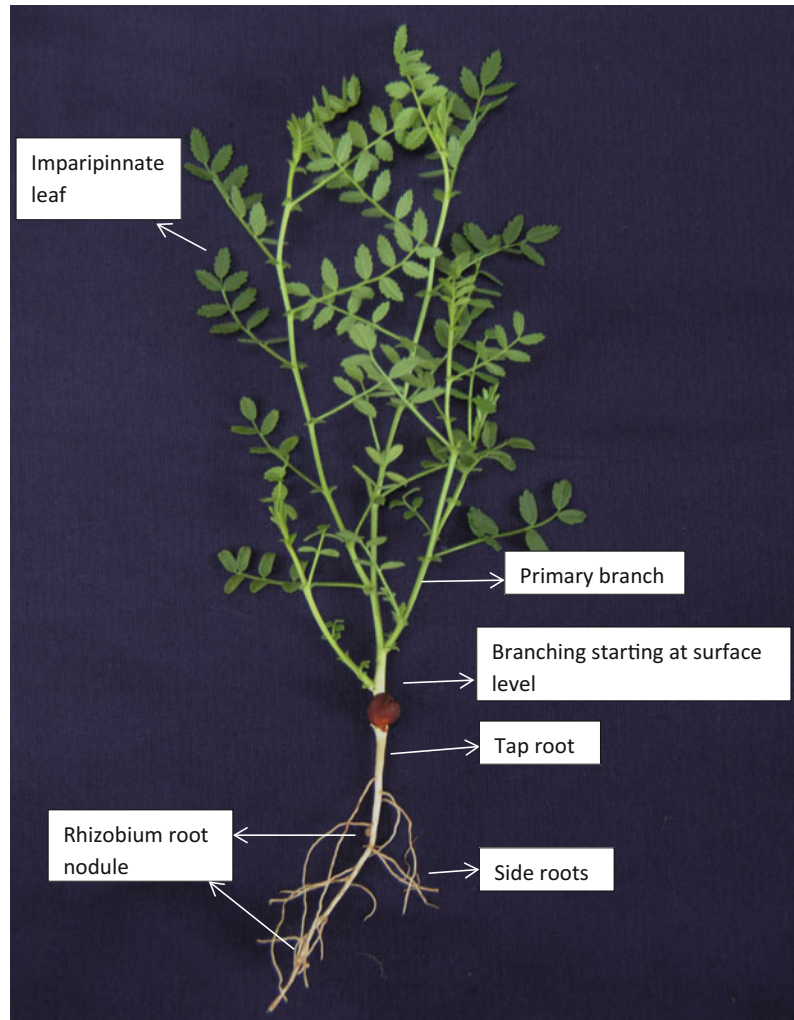
The plant surface including roots, stem, leaves and pods are pubescent, covered with glandular and non-glandular hairs. The glandular hairs secrete a mixture of acids containing malic, oxalic and citric acids. This acid mixture acts as a defence mechanism against sucking pests. The exudation from the roots helps in solubilizing the soil nutrients (Fig. 3.2).

Stem: The stem is firm due to hypodermal collenchyma, angular with ribs, straight or flexuous and pubescent. The plant produces three types of branches—primary, secondary and tertiary. The lowest nodes of the plant produce 1–8 primary branches. Alternately, the primary branches may arise from seed shoot as well. The primary branches are thick, woody with thick cuticle, and often mistaken for the main stem. The secondary branches arise from the buds on the primary branches and are comparatively thin. These branches bear the leaves and flowers. Depending on the genotype and growing conditions, tertiary branches may or may not be present. The plant grows to a height of up to 100 cm generally and occasionally reaching 150 cm depending on the growing conditions.

Leaf: The compound leaves contain 5–7 pairs of hairy leaflets per leaf, opposite or alternate, and the rachis ends in a leaflet (imparipinnate). The leaflets are oval or elliptic in shape with serrated margins. Simple leaf types also exist (Fig. 3.3).

Root: The root system is characterized by a thick tap root with several side roots developing into a robust system. The epidermis is hairy,

Fig. 3.1 Chickpea plant at 30 days after sowing



exodermis is absent, and endodermis is thin. The presence of nodules on roots indicates symbiotic relationship between chickpea and the Rhizobium bacteria (*Mesorhizobium ciceri*) leading to biological nitrogen fixation. The tap root system is so robust that it reaches more than 3 m in soil favouring the plant to survive in moisture stress conditions (Fig. 3.4).

Inflorescence: The inflorescence is an axillary raceme with generally a single papilionaceous flower though two to three flowers were also reported to occur rarely at the same node. The peduncle is 6–30 mm long, while the pedicel is 6–13 mm long. Both the peduncle and pedicel look like a single part because they are straight in

line up to fertilization, and then the pedicel bends down (Fig. 3.5).

Flower: The flower can be described as regular, bisexual, with five fused hairy sepals in a single whorl which form a calyx tube, five petals (pink, white, purple or blue in colour) in a typical papilionaceous arrangement with a big standard, two wings and two keel petals which form a boat shape, ten stamens in a diadelphous arrangement (9 stamens fused and a free 10th stamen) with orange-coloured pollen grains, linear style with globose stigma, sessile pubescent ovary containing 1–4 ovules (Cubero 1987) (Fig. 3.6).

Flowering: Commencement of flowering in chickpea is dependent on the duration of the

Fig. 3.2 Pubescence on stem, leaves, calyx of flower and pods of chickpea



genotype and the environment including soil and weather (Gaur et al. 2012). Generally, flowering starts in the range of 24 days (Kumar and Rao 1996) to 80 days after sowing and continues till the depletion of moisture owing to the indeterminate growth of chickpea. When moisture levels go down significantly, plants which bear pods and leaves start to senesce reaching maturity. Chickpea is a highly self-pollinated crop. The anthers dehisce one day before the flower opens ensuring self-pollination. Anthesis continues throughout the day.

Pod: Pods start appearing about six days after fertilization and may take up to four weeks for completing seed development. Initially, the pod wall starts to grow followed by the seed. The number of pods per plant depends on the

genotype and the environmental conditions, especially availability of moisture. The pod size is generally in the range of 15–20 mm and may go up to 30 mm depending on the genotype, especially in kabuli types. Each pod contains generally one to two seeds and rarely three (Fig. 3.7).

Towards the end of the seed development, leaves start to turn yellow first and then the whole plant dries up indicating maturity (Fig. 3.8).

Seed: The shape of the seed generally resembles a ram's (Aries) head, hence the name '*arietinum*', while other shapes do exist such as globular or quasi-spheric with a characteristic beak. The surface of the seed coat may be smooth or tuberculate. Endosperm is absent. Seed size and colour is a varietal character and



Fig. 3.3 Leaf types in chickpea: compound leaf and simple leaf (centre)

highly influenced by environmental conditions, especially moisture availability and heat. There are two types of cultivated chickpea based on seed size and colour—desi and kabuli.

Desi type: The seeds are generally small (around 0.2 g per seed); seed coat is thick with varying colours such as cream, yellow, brown, black and green. The stem and leaves may contain anthocyanin pigmentation.

Kabuli type: The seeds are generally large (around 0.3–0.5 g per seed) to extra large (more than 0.5 g per seed); seed coat is thin and mainly cream or beige coloured, sometimes white. The plants will not have anthocyanin pigmentation (Fig. 3.9).

Seed colour in desi types assumes different shades of brown, black and green depending on the genotype, while the kabuli types have mainly

beige-coloured seed. Cotyledons are mainly in three colours: cream, green or orange (Cubero 1987). Seed size exhibits huge variation starting from 0.08 g to nearly 0.8 g per seed. Generally, the kabuli types have larger seed size compared to the desi types (Fig. 3.10).

Germination: Seeds of cultivated chickpea do not exhibit any dormancy period. Seeds start to germinate within a week after sowing depending on the moisture level of the soil, temperature (28–33°C) and sowing depth (two inches). The germination is hypogeal with no hypocotyl. Plumule gives rise to a shoot bearing leaf-like scales at first and then true leaves (two pairs of leaflets and a terminal leaflet). Root growth from the radicle is much faster than above-ground shoot growth in initial stages of plant development (Fig. 3.11).



Fig. 3.4 Robust root system of chickpea with tap root and side roots

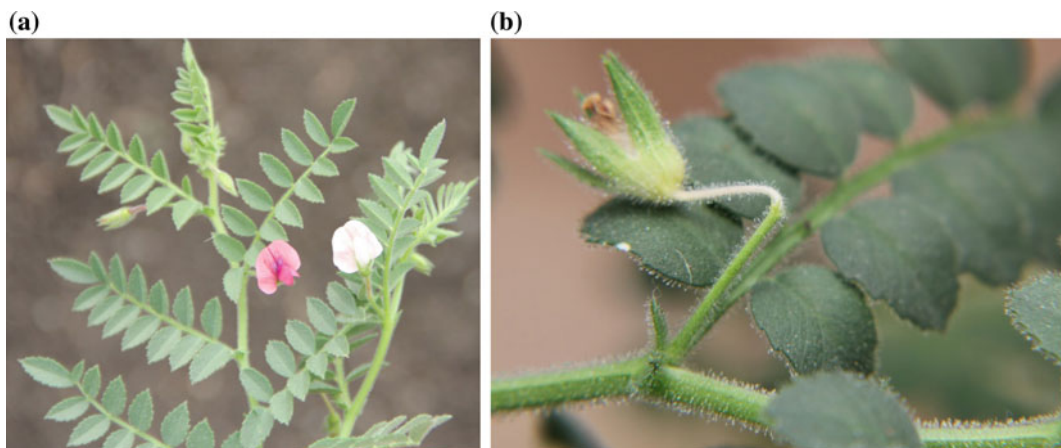


Fig. 3.5 a Major flower colours in chickpea: pink (left) and white (right). b Pedicel bending after fertilization

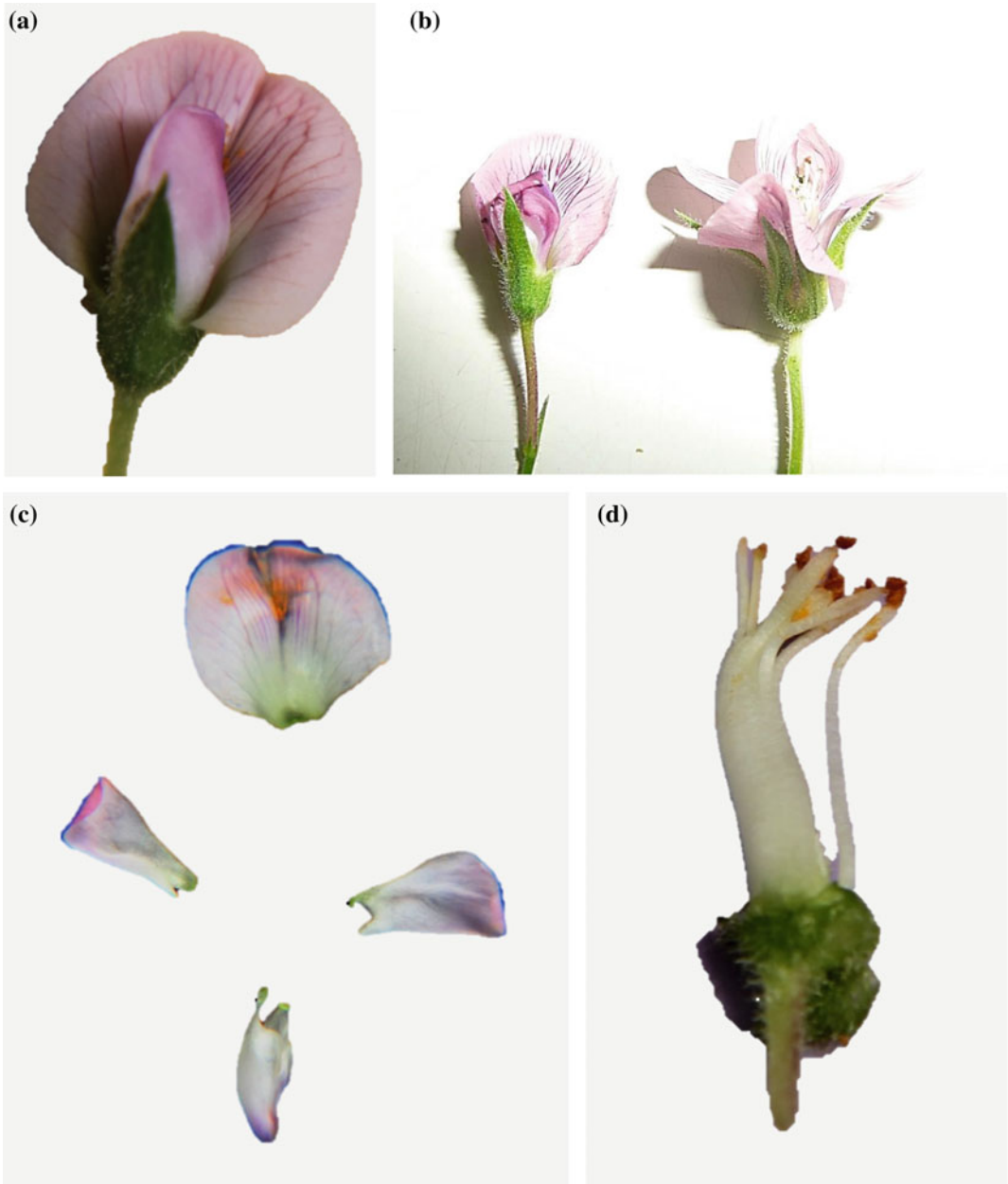


Fig. 3.6 a Papilionaceous flower of chickpea. b Normal flower (left) and open-type flower (right). c standard, wing and keel petals. d Diadelphous stamens (9 + 1)

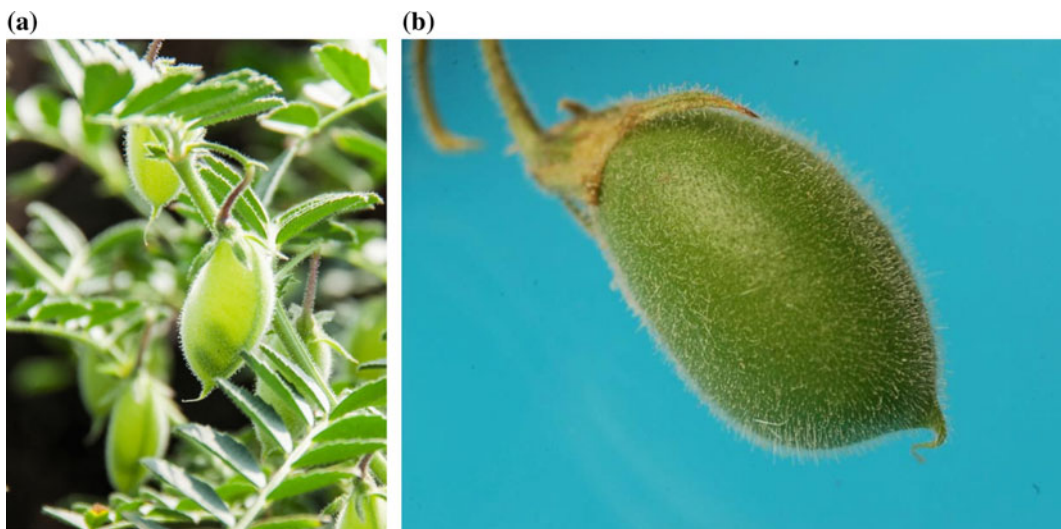


Fig. 3.7 (a and b) Immature chickpea pod



Fig. 3.8 Chickpea plants at maturity



Fig. 3.9 Desi (left) and kabuli (right) seed types

Fig. 3.10 Variation for seed size and colour in chickpea





Fig. 3.11 Seed germination, progressively, in chickpea

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