

Cultivation Technology of Chick Pea

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SUMMARY

Gram commonly known as 'chick pea' or Bengal gram is the most important pulse crop in India. Chick pea occupies about 38 per cent of area under pulses and contributes about 50 per cent of the total pulse production of India. It is used for human consumption as well as for feeding to animals. It is eaten both whole fried or boiled and salted or more generally in the form of split pulse which is cooked and eaten. Both husks and bits of the 'dal' are valuable cattle feed. Fresh green leaves are used as vegetable (sag). Straw of chick pea is an excellent fodder for cattle. The grains are also used as vegetable (chhole). Chick pea flour (besan) is used in the preparation of various types of sweets. Chick pea is considered to have medicinal effects and it is used for blood purification. Chick pea contains 21.1 per cent protein, 61.5 per cent carbohydrates, 4.5 per cent fat. It is rich in calcium, iron and niacin.

INTRODUCTION

Chickpea [*Cicer arietinum* (L.)] belongs to genus *Cicer*, tribe Cicereae, family Fabaceae, and subfamily Papilionaceae. It originated in southeastern Turkey. The name *Cicer* is of Latin origin, derived from the Greek word 'kikus' meaning force or strength. Traced the origin of the word to the Hebrew 'kirkes', where 'kikar' means round. The word *arietinum* is also Latin, translated from the Greek 'krios', another name for both ram and chickpea, an allusion to the shape of the seed which resembles the head of a ram (Aries). Chickpea is also called garbanzo (Spanish), pois chiche (French), kichar or chicher (German), chana (Hindi), and gram or Bengal gram (English). In Turkey, Romania, Bulgaria, Afghanistan, and adjacent parts of Russia, chickpea is called 'nakhut' or 'nohut'.

Origin and History

Chick pea has been known in this country for a long time. It is said to be one of the oldest pulses known and cultivated from ancient times both in Asia and in Europe. Its probable place of origin lies in south western Asia, which is in the countries lying to the north-west of India such as Afghanistan and Persia. According to the centre of origin of chick pea is eastern Mediterranean. According to De Candolle, the fact that gram has a Sanskrit name would indicate that the crop has been under cultivation in India longer than in any other country.

Area and Distribution

Chick pea is one of the important pulse crop of the world cultivated over an area of 12.0 million hectares with a production of about 9.2 million tones of grain (1999). The important gram growing countries are India, Pakistan, Ethiopia, Burma and Turkey. India ranks first in the world in respect of production as well as acreage followed by Pakistan.

It is the most important pulse crop of India occupying an area of 6.3 million hectares with production of 5.1 million tones. The average yield of chick pea is only 806 kg per hectare. The major chick pea production areas are situated in Madhya Pradesh, Rajasthan, Uttar Pradesh, Haryana, Maharashtra and Punjab.

Classification

The Indian grams have been classified into two broader groups:

Desi or Brown Gram (*Cicer arietinum* L.): In this group the color of the seed ranges from yellow to dark brown. Seed size is usually small. It is the most widely grown group. Plants are small with good branching ability. Chromosome number is $2n = 14, 16$.

Kabuli or White Gram (*Cicer kabulium*): In this group the color of the seed is usually white. Grains are bold and attractive. Yield potential of this group is poor as compared to desi or brown gram. Plants are generally taller than the desi gram and stand more or less erect. The chromosome number is $2n = 16$.

Botanical Description

Plant Habit

Chickpea is a herbaceous annual plant which branches from the base. It is almost a small bush with diffused, spreading branches. The plant is mostly covered with glandular or nonglandular hairs but some genotypes do not possess hair. Based on seed size and color, cultivated chickpeas are of two types

Seed and Germination

1. Macrosperma (kabuli type). The seeds of this type are large (100-seed mass >25 g), round or ramhead, and cream-colored. The plant is medium to tall in height, with large leaflets and white flowers, and contain no anthocyanin.

2. Microsperma (desi type). The seeds of this type are small and angular in shape. The seed color varies from cream, black, brown, yellow to green. There are 2-3 ovules pod⁻¹ but on an average 1-2 seeds pod⁻¹ are produced. The plants are short with small leaflets and purplish flowers, and contain anthocyanin.

Chickpea seeds have a seed coat, two cotyledons, and an embryo. The seed coat consists of two layers, the outer testa and the inner tegmen, and a hilum. The hilum is the point of attachment of the seed to the pod. There is a minute opening above the hilum called the micropyle, and a ridge formed by the funicle called the raphe. The embryo consists of an axis and two fleshy cotyledons. The pointed end of the axis is the radicle and the feathery end the plumule. Chickpea seeds germinate at an optimum temperature (28-33°C) and moisture level in about 5-6 days. Germination begins with absorption of moisture and swelling of the seed. The radicle emerges first followed by the plumule. The portion of the axis above the cotyledon called the epicotyl, elongates and pushes the plumule upward. The growth of the plumule produces an erect shoot and leaves, and the radicle grows to produce the roots. The first true leaf has 2 or 3 pairs of leaflets plus a terminal one. The plumular shoot and lateral branches grow continuously to develop into a plant .

Root: Chickpea plants have a strong taproot system with 3 or 4 rows of lateral roots. The parenchymatous tissues of the root are rich in starch. All the peripheral tissues disappear at plant maturity, and are substituted by a layer of cork (Cubero 1987). The roots grow 1.5-2.0 m deep. Chickpea roots bear *Rhizobium* nodules. They are of the carotenoid type, branched with laterally flattened ramifications, sometimes forming a fanlike lobe.

Stem: The chickpea stem is erect, branched, viscous, hairy, terete, herbaceous, green, and solid. The branches are usually quadrangular, ribbed, and green. There are primary, secondary, and tertiary branches.

- **Primary branches** arise from the ground level as they develop from the plumular shoot as well as the lateral branches of the seedling. They are thick, strong, and woody, and may range from one to eight in number.
- **Secondary branches** develop at buds located on the primary branches. They are less vigorous than the primary branches. Their number ranges from 2 to 12. The number of secondary branches determines the total number of leaves, and hence the total photosynthetic area.
- **Tertiary branches** arise from the secondary branches. The primary branches form an angle with a vertical axis, ranging from almost a right angle (prostrate habit) to an acute angle (erect). Generally stems are incurved at the top, forming a spreading canopy.

Leaves: Chickpea leaves are petiolate, compound, and unimpinnate (pseudoimpinnate). Some lines have simple leaves. The rachis is 3-7 cm long with grooves on its upper surface. Each rachis supports 10-15 leaflets each with a small pedicel. The leaflets do not end at the true terminal position (the central vein continuing the rachis) but at the subterminal position (the central vein oblique to the rachis). This indicates the presence of two terminal leaflet buds, one of them being aborted or transformed into a mucro or foliar shoot which is sometimes quite large. The leaflets are 8-17 mm long and 5-14 mm wide, opposite or alternate with a terminal leaflet. They are serrated, the teeth covering about two-thirds of the foliar blade. The shape of the leaflets is obovate to elliptical with the basal and top portions cuneate or rounded. Leaves are pubescent.

Stipules: The stipules are ovate to triangular in shape and serrated (2-6 teeth). They are 3-5 mm long and 2-4 mm wide. The longest margin is toothed and the smaller one entire.

Pubescence: The external surface of the chickpea plant, except the corolla, is densely covered with glandular or nonglandular hairs. The hairs vary in form and dimension: short stalked, multicellular stalked (both glandular and nonglandular), and unicellular. Some genotypes, however, do not possess any hair.

Inflorescence: The solitary flowers are borne in an axillary raceme. Sometimes there are 2 or 3 flowers on the same node. Such flowers possess both a peduncle and a pedicel. The racemose peduncle is 6-30 mm in length. At flowering, the floral and racemal portions of the peduncle form a straight line, giving the appearance that the flowers are placed on the leafy axil by a single peduncle. After fecundation the raceme is incurved. The bracts are 1-5 mm in length.

Flowers: Chickpea flowers are complete and bisexual, and have papilionaceous corolla. They are white, pink, purple or blue in color. In colored flowers, the peduncles may be of different colors, the floral part purplish and the racemal green. The axillary inflorescence is shorter than the subtending leaf.

Calyx: The calyx is dorsally gibbous at the base. There are five sepals with deep lanceolate teeth. The teeth are longer (5-6 mm) than the tube (3-4 mm) and have prominent midribs. The five sepals are subequal. The two dorsal (vexillar) sepals are closer to each other than they are to the two lateral ones in the ventral position. The fifth calyx tooth is separate from the others. The peduncles and the calyx are glabrous. The calyx tube is oblique.

Corolla: Chickpea flowers have five petals which are generally celeste and purplish red or light pink in color. The petals are polypetalous i.e., consisting of standard (vexillum), wings, and keel. The vexillum is obovate, 8-11 mm long, 7-10 mm wide, and either glabrous or pubescent with no glandular hair on its external surface. The wings are also obovate with short pedicels (nails). They are 6-9 mm long and about 4 mm wide with an auriculate base. The auricula are over the pedicel and form a pocket in the basal upper part, which is covered by the vexillum. The keel is 6-8 mm long, rhomboid, with a pedicel 2-3 mm long. Two-thirds of the frontal side of its ventral face is adnate. The wings do not show concrescence with the keel.

Androecium: There are 10 stamens in diadelphous (9)+1 condition. The filaments of nine of the stamens are fused, forming an androecial sheath; the tenth stamen is free. The staminal column is persistent. The fused part of the filament is 4-5 mm long and the free part 2-3 mm, upturned, and dilated at the top. The apex of the sheath is oblique. The stamens facing the petals are a little longer than the others. The anthers of these stamens are bicelled, basifixed, and round. The other anthers are dorsifixed, ovate, and longer than the basifixed ones at flowering. The anthers burst longitudinally. The pollen grains are orange.

Gynoecium: The ovary is monocarpellary, unilocular, and superior, with marginal placentation. It is ovate with a pubescent (glandular hairs predominate) surface. The ovary is 2-3 mm long and 1-15 mm wide. There are 1-3 ovules, rarely 4. The style is 3-4 mm long, linear, upturned, and glabrous except at the bottom (Fig. 3c). The stigma is globose and capitate. Sometimes it may be of the same size as the style.

Developmental Stages of the Bud and Flower

- **Closed bud:** At this stage, the stigma is immature and the anthers are still at the base of the bud.
- **Hooded bud:** The corolla has elongated, and the anthers are about half the height of the style. The stigma is receptive. Emasculation is done at this stage.
- **Half-open flower:** At this stage the anthers attain the same height as the stigma, and the pollen mature just before the dehiscence of the anthers. Self-pollination takes place at this stage while the keel petal remains closed, preventing the entry of foreign pollen. For crossing, pollen are collected at this stage.

- **Fully open flower:** The anthers become shrivelled, while the standard and wing petals are fully expanded. Fertilization takes place 24 h after pollination.
- **Fading flower:** This is the post fertilization stage during which the ovary begins to elongate. Chickpea being a highly self-pollinated crop, selfing is not required.

Anthesis: Anther dehiscence takes place inside the bud one day before the opening of the flower. When pollen are first liberated, the stigma is still above and quite free from the base of the anthers. The filament gradually elongates to carry the anthers above the stigma. This process is completed before the flower opens, thus facilitating self-pollination. Anthesis in chickpea is throughout the day.

Pod and Seed Development: Pod formation begins 5-6 days after fertilization. The pod is typically inflated, ending in a mucro and sometimes looking like a thorn. The number of pods plant⁻¹ varies between 30 and 150, depending on the environmental conditions and the genotype. The pod wall is 0.3 mm thick with three layers-exocarp, mesocarp, and endocarp. The exocarp is hairy and glandular. The mesocarp has 6-8 layers of parenchyma. The endocarp consists of 3-4 cell layers with fibers in its outermost region and 5-6 layers of parenchyma. Pod size ranges from 15 to 30 mm in length, 7-14 mm in thickness, and 2-15 mm in width. Depending on the basal and apical zones as well as the dorsal and ventral regions, pod shape varies from rhomboid, oblong to ovate. The number of seeds pod⁻¹ ranges from one to two, with the maximum being three. The seeds are ramhead or owl's-head shaped, and the surface may be smooth or wrinkled. The two cotyledons are separated by a groove in highly wrinkled seeds. The beak above the micropyle is produced by the tip of the radicle. The shape of the cotyledons varies from semispherical to oviform. The length of the seed ranges from 4 to 12 mm and its width from 4 to 8 mm. The seed mass varies from 0.10 to 0.75 g seed⁻¹. The seed color ranges from whitish (even chalky) and cream to deep black. Many other colors like red, orange, brown, green, and yellow may be found. The cotyledons are cream, green, or orange colored.

Climatic Requirements

Chick pea is a winter season crop but severe cold and frost are injurious to it. Frost at the time of flowering results in the failure of the flowers to develop seeds or in the killing of the seeds inside the pod. It is generally grown under rainfed conditions but gives good returns in irrigated conditions as well. Excessive rains soon after sowing or at flowering and fruiting or hailstorms at ripening cause heavy loss. It is best suited to areas having moderate rainfall of 60-90 centimeters per annum.

Soil : Chick pea is grown on a wide range of soils in India. In the north, gram is generally grown on moderately heavy soils. In Maharashtra and on the Deccan plateau, black cotton soils are used. Light soils, mostly sandy loams are preferred in Punjab, Uttar Pradesh, Haryana and Rajasthan. Though gram is grown on all kinds of soils, sandy loam to clay loam is considered to be most suitable. The best type of soil for chick pea is one that is well drained and not too heavy. On dry and light soils, the plants remain short while on heavy soils having high water retention capacity, the vegetative growth is abundant, light becomes limiting and fruiting is retarded. The soil chosen for its cultivation should be free from excessive soluble salts and near neutral in reaction. However, it is not suited to soils having a pH higher than 8.5.

Varieties

Unlike cereals high yielding photo-insensitive cultivars are not available in pulses and this appears to be the most important reason for low productivity of pulse crops in the country. However, several improved varieties of chick pea have been evolved in different chick pea growing states.

High Yielding Varieties of Chick Pea Recommended For General Cultivation in Different States

- Andhra Pradesh ICCV-2, ICCV-37, ICCV-4, ICCV-10
- Assam KWR-108, BG-256, L-550, KPG-59
- Gujarat Pusa-319, Vijay, ICCV-4, Pusa-240, GG-1, Pusa-1053

- Haryana : Haryana Chana-1, GNG-469, Pusa-362, Gora Hisari, Karnal Chana, Gaurav, H-208, H-335, Pusa-1053
- Himachal Pradesh: BBG-1, Haryana Chana-1, L-550
- Jammu & Kashmir : GNG-469, L-550, PBG-1, Haryana Chana-1
- Karnataka: BDN 9-3, ICCV-10, ICCV-2 Annegiri-1
- Punjab : PBG-1, GNG-469, Haryana Chana-1, Gaurav, L-550, C-235, G-543, Pusa-1053, GPF-2, PDG-3
- Rajasthan : GNG-416, GNG-469, GNG-663, PBG-1, L-550, Pusa-256, RSG-44, Pusa-1053, PDG 84-1
- Tamil Nadu : ICCV-10, BDN 9-3, CO-3, CO-4
- Uttar Pradesh: KWR-108, Avrodhi, BG-256, K-850, Pant G-186, Pusa-372, Radhey, JG-315, Uday (KPG-75), Pusa-1003, Pusa-1053
- Madhya Pradesh : JG-74, JG-315, Vijay, Pusa-256, Phule G-5, Pusa-1053
- Maharashtra : Vijay, Digvijay, Vishal, Jaki-9218, Phule G-5, Vishal, ICCV-10, Pusa-1053
- Orissa : Radhey, ICCV-10, L-550, Pusa-372, Pusa-1003
- West Bengal: Pusa-372, KWR-108, KPG-59, BG-256, Pusa-1003
- Bihar: KWR-108, Avrodhi, BG-256, Pant G-114, Pusa-209, L-550, Pusa-1003
- North Eastern States: KWR-108, Avrodhi, KPG-59, BG-256

Field Preparation

Chick pea is highly sensitive to soil aeration. This imposes a restriction for its cultivation on heavy soils and calls for special care in seedbed preparation. A rough seedbed is required for chick pea. In case the chick pea crop is taken after a kharif fellow, it would be desirable to go for a deep ploughing during the monsoon as the same would help in larger conservation of rain water in the soil profile for subsequent use by this crop. Very fine and compact seedbed is not good for chick pea. It requires a loose and well aerated seedbed.

Seed and Sowing: Use of good-quality seed in optimum quantity, proper seed treatment, and sowing ensure good germination, optimum plant stand, and high yield. The seed requirement depends on the seed mass, the germination percentage of the seed-lot, and plant population ha⁻¹.

Temperature and Moisture Requirement: A viable chickpea seed with an initial moisture content of 10% may germinate when it has imbibed sufficient water to reach a moisture level of more than 80%. Faster germination occurs at a temperature range of 31.8°C to 33°C. In a controlled environment, chickpea can germinate over a wider range (10°C to 45°C) of temperature.

Seed Treatment: To protect the crop from seedling diseases, it is recommended to treat seeds of *kabuli* cultivars with captan (Orthocide® 50 W) at 1.0 g kg⁻¹ seed. The *desi* types can be treated with carbendazim (Bavistin®) at 1.5 g kg⁻¹ seed. Chickpea seed treated with a combination of quinterozone and thiram, each at 1.5 g kg⁻¹ seed, improved germination and seed yield without any adverse effect on nodulation.

Seed and Sowing

Date of sowing has been recognized as single non-monetary input affecting most the yield of chick pea in all chick peagrowing areas. Experiments conducted under the All India Co-ordinated Pulse Improvement Project at different Centres overlast several years have amply demonstrated that second fortnight of October is the optimum time for sowing chick pea in most of the chick pea growing areas of northern India. For peninsular India, first fortnight of October is the best time for chick pea sowing. Delay beyond this period results in conspicuous reduction in yield. Under humid sub-tropical conditions of *Tarai*, which are characterized by shallow water table and relatively more winter rainfall, first fortnight of November is most suitable. Early sowing of chick pea results in excessive vegetative growth and poor setting of pods. The early sown crop suffers more from wilt to wilt at high temperature at that time. The crop may be sown by seed drill or local plough at a row spacing of 30-40 centimeters. A seed rate of 75-100 kg per hectare depending upon seed size may be sufficient for one hectare. The

seed should be placed 8-10 centimeters deep because the shallow be treated with 0.25 per cent. Thiram or Carbendazim (Bavistin) before sowing.

Manures and Fertilizers

Chick pea being a leguminous crop fulfills the major part of its nitrogen requirement (about 75%) through the process of symbiotic nitrogen fixation which works effectively from three to four weeks after sowing. However, soils with low organic matter and poor nitrogen supply may require 20-25 kg per hectare of nitrogen as starter dose which can meet plant requirement before the formation of nodules. Besides nitrogen, pulses respond very favourably to phosphorous application if the soils are deficient in phosphorous supply. If both nitrogen and phosphorous are required to be supplied then diammonium phosphate (18-46-0) at the rate of 100 to 150 kg per hectare should be applied uniformly before the last discing/ploughing. Responses to potassium application have been inconsistent. It is better if all the fertilizers are drilled in furrows at a depth of 7-10 centimeters.

Water Management

Chick pea is mostly sown as a rain fed crop. However, where irrigation facilities are available, give a pre-sowing irrigation. It will ensure proper germination and smooth crop growth. If winter rains fail, give one irrigation at pre-flowering stage and one at pod development stage. In no case first irrigation should be given at flowering time of gram crop. A light irrigation should be given because heavy irrigation is always harmful to gram crop. Excess of irrigation enhances vegetative growth and depresses chick pea yield.

Weed Control

Chick pea being a stature crop suffers severely by infestation of weeds. One hand weeding or inter culture with hand hoe or wheel hoe after 25-30 days and second if needed after 60 days of sowing may take care of weeds. Fluchloralin (Basalin) 1 kg per hectare in 800-1000 liters of water as pre-planting spray may be used as an effective herbicide. It should be well incorporated in the soil before sowing. In case Basalin is not available use Metribuzin or Prometryn at the rate of 1.0-1.5 kg active ingredient in 800-1000 liters of water per hectare as pre-emergence spray. Hand weeding or inter culture with the help of hoe is always better than herbicides because inter culture operations improve aeration in the soil.

YIELD

Chick pea has the potential to yield far higher than the national average. A well managed crop yields about 20-25 quintals of grain per hectare which is about three to four times higher than the national average.

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