

Pulses

Bengal Gram

Origin

Distribution Of Species

Wild Relatives And Forms Breeding

Objectives

Major Breeding Procedures For

Development Of Hybrids / Varieties



Introduction :-

Scientific Name :- *Cicer arietinum L.*

It is also known as chickpea or gram in English and chana in India.

- ▶ It is the largest produced food legume in south Asia.
- ▶ Third largest produced food legume globally, after common bean and field bean.

Origin

- ▶ Western Asia (Eastern Turkey)
- ▶ Progenitor of chick pea is *Cicer reticulatum* & *Cicer echinospermum* is a close relative.

Distribution :-

- ❖ From west Asia it spread to Europe and then to Tropical Africa, America and Australia.
- ❖ Introduction of chick pea in India appears to be independent.
- ❖ The earliest record of chick pea in India is from Atranji Khera in Uttar Pradesh and this dates back to 2000 BC.

Area , Production & Productivity :-

- Chickpea is grown in more than 50 countries (89.7% area in Asia, 4.3% in Africa, 2.6% in Oceania, 2.9% in America and 0.4% in Europe).

	world	India	Andhra Pradesh
Area (M.ha)	10	7.5	0.12
Production (M.t)	7.5	6.1	0.09
Productivity (kg/ha)	750	810	750

- The major chickpea growing countries India, Pakistan, Turkey, Mexico, Burma & Ethiopia.
- India is accounting for 77% of the total area & production.
- In India **Madhya Pradesh** ranks 1st in area (2.6 m.ha), production (2.4 m.t), with a productivity of 930 kg/ha.
- Then followed by **Rajasthan**.
- The three states Madhya Pradesh, Rajasthan, Uttar Pradesh accounts for 84% of area, 86% production in the country.

▶ Soils :-

- ▶ It can grow on from medium to heavy black soils.
- ▶ Optimum P^H for crop growth is 6.0-7.5
- ▶ It does not withstand water logging, saline & alkaline conditions.

Climatic conditions :

- ▶ It is highly sensitive to excess soil moisture, cloudy weather and high humidity.
- ▶ Chickpea is highly sensitive to frost.
- ▶ Optimum temperature regime for chick pea is 24-30⁰c.

Growth and development :-

▶ Seed germination and seedling growth :-

- ▶ Hypogeal type of germination.
- ▶ Contains tap roots and lateral roots well branched , grows to 1-2 m depth.
- ▶ Lateral roots are well developed at upper layers.

Seed germination



FACTORS INFLUENCING SEED GERMINATION AND SEEDLING GROWTH :-

1) Soil moisture :-

- Around field capacity is adequate for seed germination.

2) Temperature :-

- Temperature requirement for germination is 20-30°C.



3) Oxygen :-

- Oxygen is essential for seed germination.
- Several other gases like CO_2 , CO , N_2 , H_2S affects germination.

4) Inhibitors :-

- These include phenols, cyanides, alkaloids, herbicides, fungicides, salts of some metals, diverse acids, etc.



5) Light :-

- Light may inhibit seed germination.
- Canopy development is very slow in bengalgram.
- Early sowing in the season is desirable for obtaining adequate leaf area.

6) Age :-

- The age of seeds is important factor in germination.



Bengalgram growth stages



Growth stage	Description
1) Seedling	First leaf open, second leaf attaining full size, vegetative nodes 1-2.
2) Primary & Secondary Branching	4-6 leaves opened, primary & secondary branching starts, vegetative nodes 5-6, height 6-7 cm
3) Tertiary Branching	Ninth leaf opening, vegetative nodes 8-9, height 10-12 cm.
4) Flowering	10-15 leaves, 1-2 flowers, first two leaves yellowing, vegetative nodes 11-19, reproductive nodes 1-2
5) Early Pod Formation	Flowering on five nodes, 1-2 nodes with pods, lower 1-2 leaves fallen.
6) Mid-pod Formation & Seed Filling	Flowering on 10-12 nodes, fast seed formation, active seed filling, primary branch with 4-6 pods and 3-4 flowers, senescence of lower 3-4 leaves.
7) Late Pod Formation	Flowering on 10-12 nodes, 8-9 nodes with pods & flowers, terminal pod formed, 30% senescence, 95% pods brown

Seedling stage



Primary & Secondary Branching



Flowering



Pod formation & seed filling



Branching:

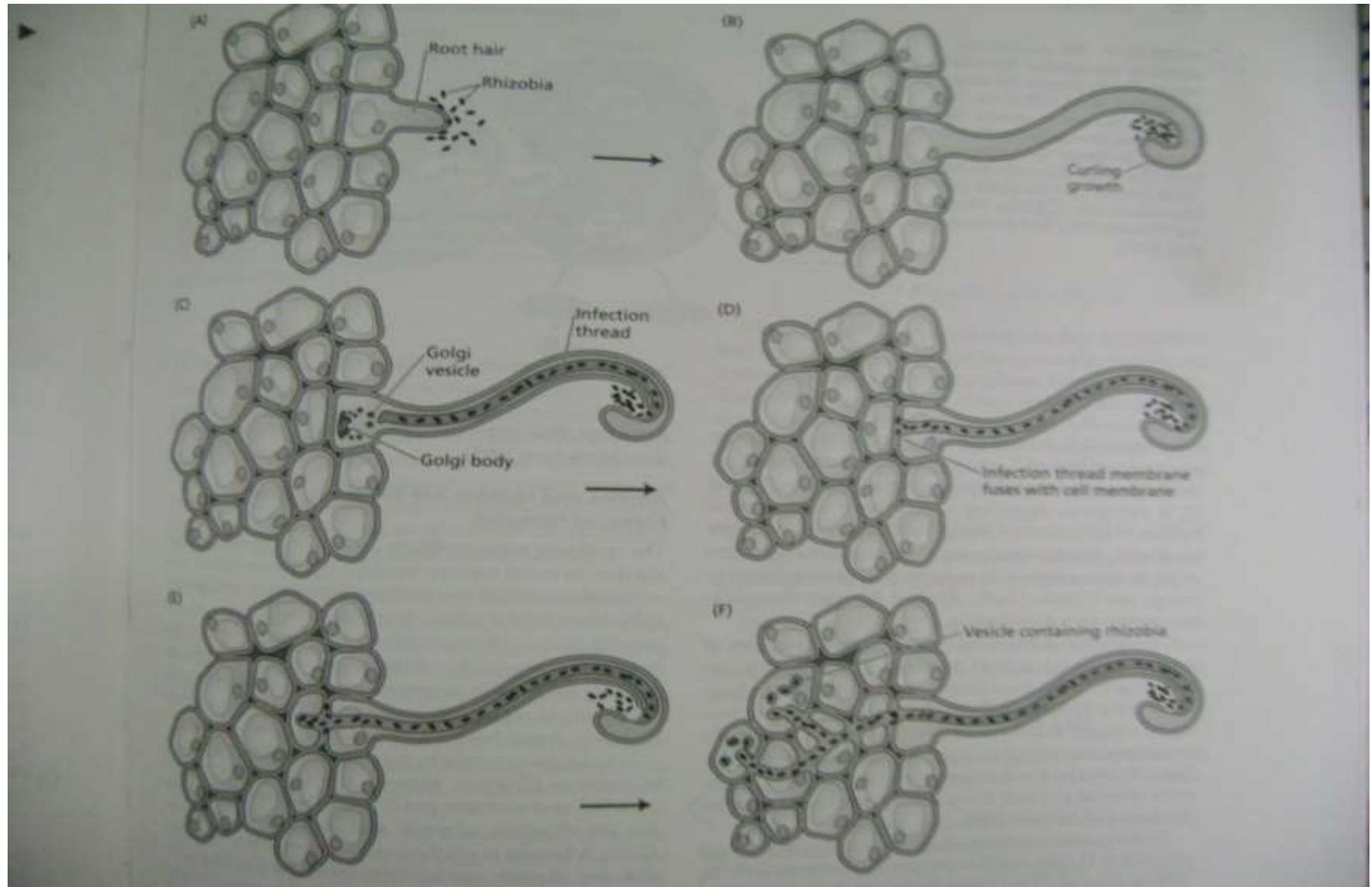
- ❖ It is a small herbaceous plant rarely exceeding 2 feet in height.
- ❖ It has spreading type and profusely branching habit.
- ❖ Stems are covered with glandular hairs.
- ❖ Short days (11 hours) and warm temperature was found to be restricting secondary branching.
- ❖ Trails carried out in India reported Varieties with basal branching shows high yields than central branching.

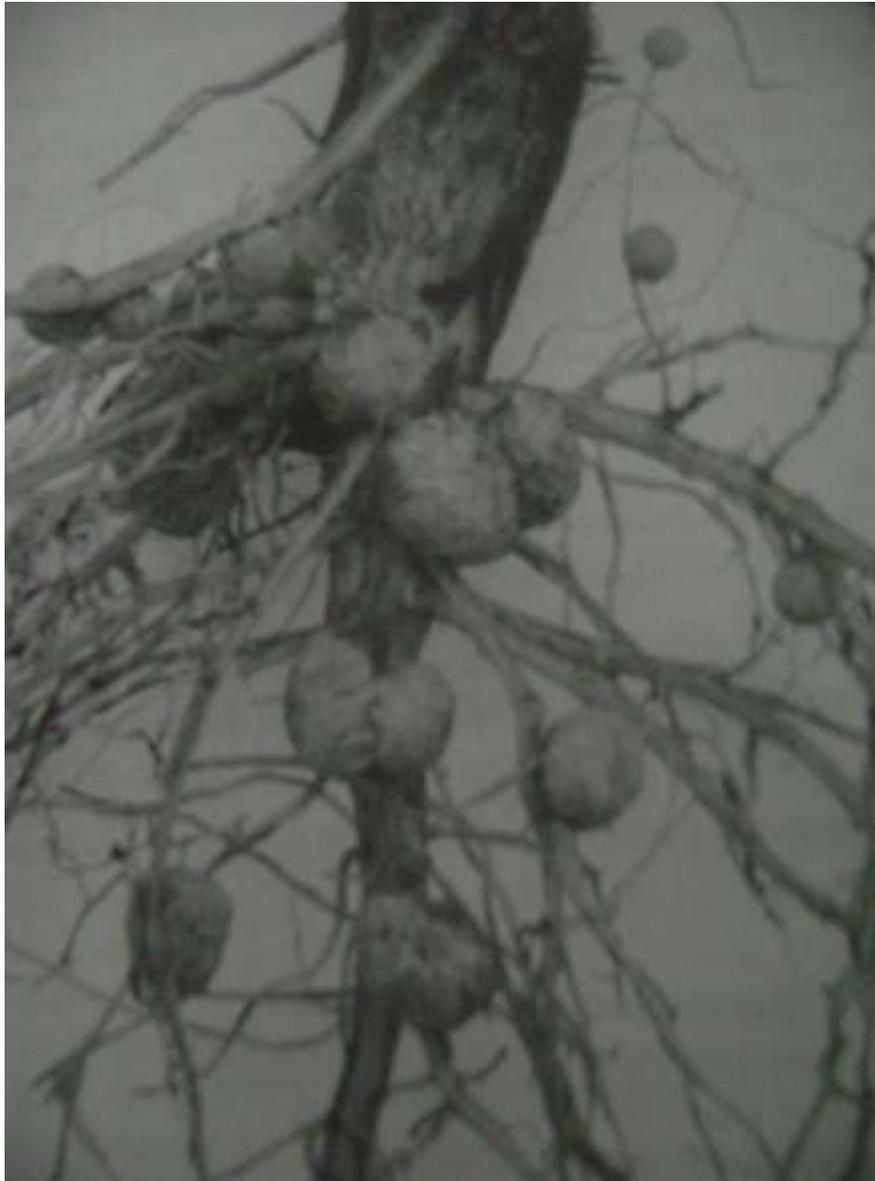
- ▶ **Malic acid** is found in leaves and stems of Bengal gram.
- ▶ The acid exudates provides resistance of crop to many potential insects and pests.
- ▶ Malic acid, oxalic acid are used in the preparation of drugs, prescribed for intestinal disorders and blood purification.

Physiology of nodulation :-

- ▶ First step is the formation of a substance which attracts *Rhizobium* bacteria.
- ▶ Then a material rich in hormones is secreted which causes curling of root hair.
- ▶ Formation of Infection thread.
- ▶ Bacteria destroy the cell walls by secreting some enzymes and enter the cortex.
- ▶ The cortical cells are stimulated, divide and become polyploidy

PHYSIOLOGY OF NODULATION

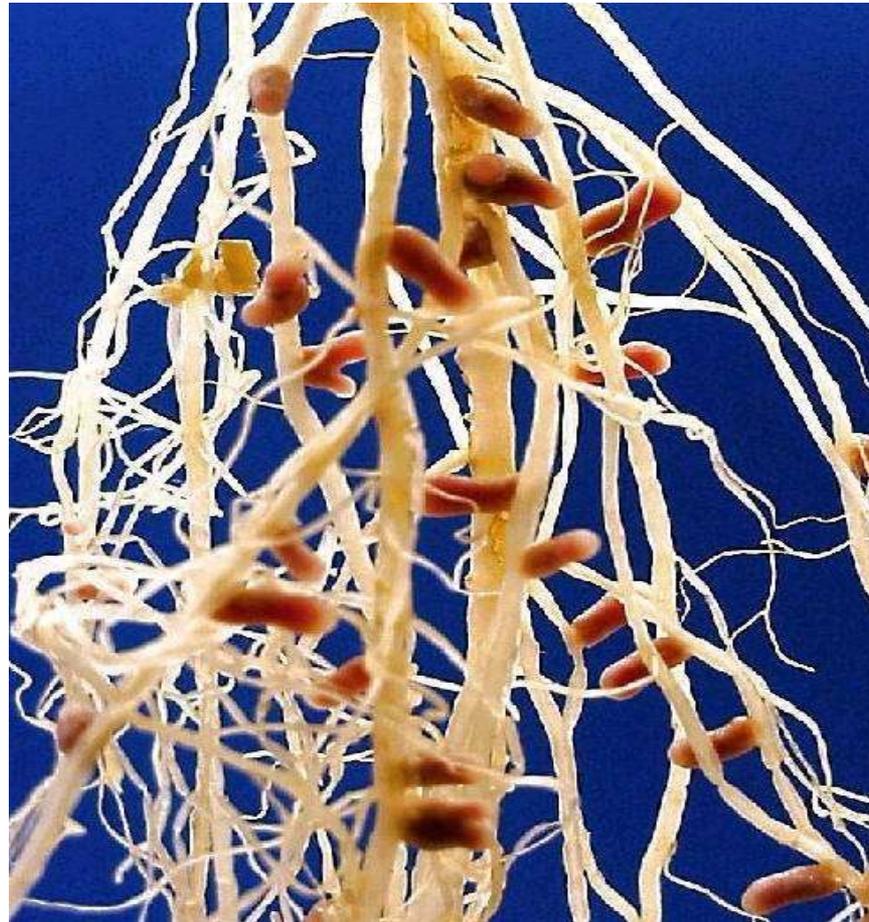




NODULE FORMATION
OVER BENGALGRAM
ROOT

NODULE

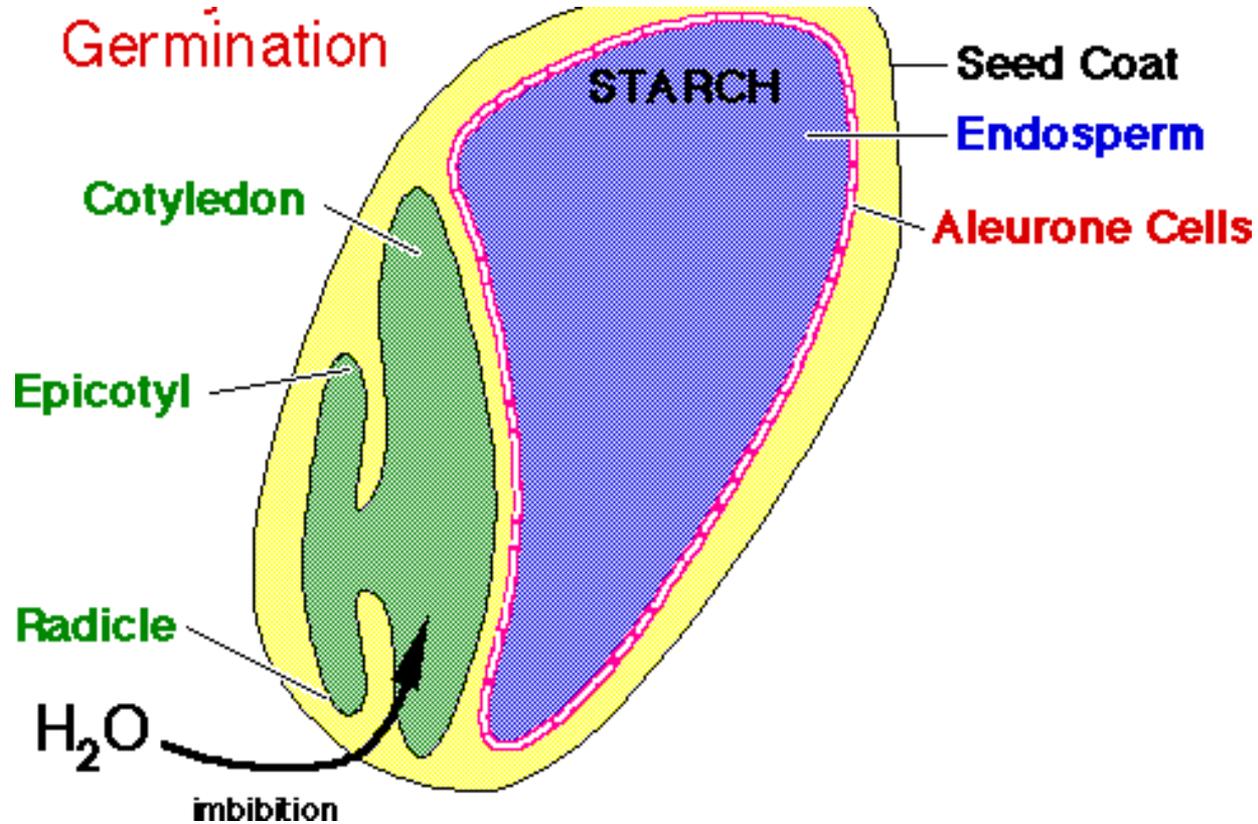
FORMATION OVER
BENGALGR
AM ROOT



Mobilization of seed reserves:

- ▶ In legumes endosperm contain largely the stored carbohydrates & proteins.
- ▶ GA produced by coleoptile migrates into the aleurone layer, where hydrolytic enzymes are synthesized & released.
- ▶ These enzymes serve to hydrolyze the endosperm reserves, producing solutes functions to nourish the growing embryo by getting translocated to it.

Mobilization of seed reserves:



Photosynthesis:

- Chickpea is a C_3 plant.
- The photosynthetic rate vary between 15 and 40 mg $CO_2/dm^2/hr$.
- Pandey et al (1976) reported a difference of 12.4% between cultivars with highest and lowest photosynthetic rate.
- The differences are especially, large between cultivars of different geographic origin.

- CO₂ fixation by leaves decreased from flowering to pod formation.
- Nitrogen applied in the form of 1% KNO₃ solution during pod development.
- Both pods and stems contribute to total photosynthesis in chickpea.
- Maximum photosynthetic rate was observed at a light intensity of 0.5cal/cm²/min.

Crop growth rate , Leaf area duration and dry matter production in chickpea:

- ▶ The rate and duration of growth of chickpea are greatly influenced by climatic conditions.
- ▶ In India the adaptations of early cultivars at Hyderabad and late cultivars at Hissar is an example.
- ▶ The growth and developing pattern of cultivars G0130 (Hissar) and JG-62(Hyderabad) are illustrated by the changes in CGR , DM and LAD.

- ▶ CGR values in early stages (50 DAS) are higher at Hyderabad (9.0 g/m²/day) than at Hissar (2g/m²/day).
- ▶ There after at Hissar CGR increased exponentially until 150-160 DAS, During this period maximum CGR ranged from 20 to 34g dry matter /m²/day.
- ▶ Then the crop abruptly stopped growing as the plants prematurely senesced because of the sudden rise in temperature, which normally occurs at this time of the year.

- ▶ In contrast at Hyderabad the CGR increases gradually, reaches a maximum of 8-14 g dry matter /m²/day and then declines as gradually at later growth stages.
- ▶ Where maximum values ranged from 8 to 12 g dry matter /m²/day.

Leaf area duration :

- At Hyderabad, LAD ranged between 29 and 62 days and it is correlated positively with grain yield, and the relation was not very close.
- In contrast, at Hissar , the LAD was very high and was positively correlated with average growth rate but was negatively correlated with grain yield

DRY MATTER ACCUMULATION :

- At Hyderabad the crop accumulates almost all of its dry matter by 85 DAS and senescence , where as at Hissar it accumulates only a fraction of dry matter at harvest.
- At both locations most of the dry matter accumulation occurs after flowering, reflecting the indeterminate nature of the crop.

Translocation of photosynthates and partitioning

- ▶ Translocation to the nodules generally stops at flowering and nodule disintegration begin.
- ▶ The developing pods receive photosynthates from its subtending leaf.
- ▶ When there is no auxiliary pod the photosynthates are diverted to other actively growing sites.
- ▶ Lower leaves supply 36% of their photo assimilates to stems and developing pods.

Reproductive growth :-

- ⦿ Flowering begins in warm environment.
- ⦿ It blossoms intensively between 20-23⁰C and RH of 60% .
- ⦿ Late sown crop does not yield well because at its full bloom stage the min RH goes down.

- ⦿ Cultivars differ in the effect of cold on time to flower and on yield.
- ⦿ Flowering begins sooner in warm environments than in cool environments and sooner in photoperiods of 15 hrs than in 11 hrs.
- ⦿ Management practices can also influence the time to flower. Flowers appear 3-5 days earlier in unirrigated crop and in close spacing.
- ⦿ Flowering may continue for 20-30 days in crop on stored moisture but with irrigation, the period extends by 10-15 days

▶ Physiology of flowering :-

- ▶ Flower initiation takes place by the transformation of vegetative apex into a reproductive structure.
- ▶ Flower initiation has two phases.
- ▶ They are 1) flower induction
2) flower differentiation.

❖ The flower induction implies all the cells of shoot meristem instead of giving rise to leaves are turned towards the formation of floral organs.

❖ Differentiation step leads to flower formation.



VERNALIZATI

ON :

- ▶ Vernalization activates a plant hormone called florigen present in the leaves which induces flowering at the end of the chilling treatment.
- ▶ Many biennial species have a vernalization period, which can vary in period and temperature. Typical vernalization temperatures are between 5 and 10°C

- ▶ *C. arietinum*, *C. yamashitae*, and most *C. judaicum* accessions were unresponsive to vernalization, whereas *C. echinospermum* and *C. reticulatum* were intermediate.
- ▶ Since both *C. echinospermum* and *C. reticulatum* are commonly used in chickpea improvement programs this has important ramifications for breeders.

Types and varieties of chickpea :-

Two types

1) Desi type &

2) Kabuli type



Kabuli chickpea



Desi chickpea



Green desi



Black desi

CHARACTERS	DESI TYPE	KABULI TYPE
1) Area under cultivation	More area	Less area
2) Colour of seed	Yellow to dark brown	White or pale cream
3) Size of the seed	small	Large, bold & attractive
4) Shape of seed	Irregular & wrinkled	smooth
5) Plant structure	Small & bushy	Taller & erect
6) Percentage of production	85%	15%
7) Yield potential	High yielders	Low yielders
8) Adaptation	Mostly to winter climates	Mostly to spring
9) Test weight	17-26 g/100 seeds	>26 g /100 seeds
10) Varieties	Annegiri	Kranthi, Swetha

- ✓ Wilt tolerant varieties – Vishal, Vijay, Avarodhi
- ✓ Varieties recommended for A.P –Annegiri, BDN 9-3, ICCCC-4, Bharathi, JG-62, JG-11, Swetha, Jyothi, Kranthi
- ✓ Popular varieties grown in A.P –Annegiri, Kranthi, Jyothi, Swetha.

Photoperiodism :-

- ▶ The response of the plants to the relative lengths, and alterations of light and dark periods with regard to the initiation of flowering is called **photoperiodism**.
- ▶ Chickpea is a long day plant requiring 12-16 hrs bright sunshine per day.
- ▶ Cooler temperatures with short days delays flowering further where as warmer days with longer photoperiods hasten flowering.

Seed maturation :

- ▶ According to varma et al, 1969

On fresh weight basis, the nutrient value increased. On dry matter basis mature seeds contains more carbohydrates, Ca

- ▶ With maturity the % of total acid soluble and inorganic P in seeds declines , while phytin phosphorous increases three folds.

- ▶ At various stages of seed development- lysine, Histidine , Arginine ,Aspartic acid, serine, Glutamic acid , Proline, Glycine , Alanine, Cystine , Valine, Methionine , Isoleucine , Phenyl alanine and Tryptophan.
- ▶ Total N , Ca, Mg, K, Fe increased with the maturity and Na, Cu ,Mn, Zn decreased.

POD MATURATION



Matured pods



● **Reasons for poor fruit-set or flower drop :-**

1) Limitation of photosynthesis :-

- The rates of photosynthesis decline once fruit development commences.

2) Limitation of nitrogen availability :-

- On the commencement of fruit setting under rainfed conditions, there was a sudden decline in the number of nodules. Alternatively, the nodules turned green indicating that they had become ineffective.

3) Reduced light

intensity :-

- Reduction of light intensity in bengalgram resulted in decrease of pod setting.

4) Canopy temperature :-

- pod set is inhibited at temperatures below 5⁰c. High mean temperatures of 28⁰-33⁰c prevents flowering of chickpea in summer.

5) Hormonal factors :-

- Whether poor fruit-set is caused by hormonal imbalance or because of the deficiency of any particular hormone is not known.
- Sinha & Ghildiyal (1973) reported increase in the yield of bengalgram by the application of 75 to 300 ppm TIBA

6) Soil & water factors :-

- Under soil-water stress as well as atmospheric water stress, there is drop of flowers & fruits.

▶ **YIELD, YIELD COMPONENTS AND HARVEST INDEX.**

- ▶ The average yield in India varies between 0.4 to 0.8t/ha but potential yields are much higher.
- ▶ Under well managed experiments, yields as high as 4t/ha are obtained in Hissar and 3t/ha with irrigation at Hyderabad.
- ▶ At ICRISAT center , early duration cultivars are better adapted yield more than the late cultivars which performs very poorly.

- ▶ In chick pea the number of pods per plant has the highest correlation with yield.
- ▶ Pod number per plant is closely correlated with the number of secondary branches .
- ▶ Grain yield has a low positive correlation with 100 grain weight but is negatively correlated with number of grains per pod .

Harvest index:

- ▶ **Harvest index** values are higher at Hyderabad than at Hissar because of greater vegetative growth at Hissar.
- ▶ Also at Hissar , the H.I is higher in late sown crops , than crops sown at the normal time .
- ▶ H.I values observed with a number of cultivars ranged from 20 to 47% .

Constraints in bengalgram production & yield :-

A) Agronomic constraints :-

1) Improper sowing time :-

- ▶ Normal time of sowing –middle oct to first fort night of November

2) Low seed rate:-

- ▶ Desi type- 65-70 kg/ha
- ▶ Kabuli type- 80-90 kg/ha

3) Insufficient irrigation:

- ▶ one or two protective or life saving irrigations are required, particularly in rabi crop.

4) Poor management conditions:

The concept that crop can grow and produce better yields on marginal lands without any inputs and management is not correct.

5) Weed infestation:

- ❑ Because of their inherent slow growth rate at the initial stage, pulse crops suffer due to infestation of weeds.

6) Losses due to diseases and insects pests:

- ❑ Pulses in general are susceptible to a large number of diseases and insect pests, which cause heavy losses.
- ❑ The major diseases are wilt, blight and grey-mould in chickpea.

B) Genetical constraints :

- 1) Lower productivity.
- 2) Non synchronous flowering/fruiting.
- 3) Non-responsiveness to good management.
- 4) Complete or partial absence of genetic resistance to major diseases and pests.
- 5) Indeterminate growth habit of most of the pulses.
- 6) Instability in performance.
- 7) Lack of good and quality and certified seed.
- 8) Non-availability of drought and water logging resistant varieties.

C) Physiological constraints:

Plays a major role in the low production and productivity of Bengalgram Some of the physiological constraints are:

- ▶ Low harvest index
- ▶ Low sink potential [source=leaf, dry matter; sink=seed]

- ▶ Flower drop is another physiological problem in Bengalgram. This results in poor pod setting and consequently low yield.
- ▶ Non-responsiveness to fertilizers.
- ▶ Photo and thermosensitive phenomenon.
- ▶ Lack of short duration varieties i.e. long duration gives low per day production.



- **STRATEGIES FOR IMPROVING THE PRODUCTIVITY OF PULSES:**

- 1) Evolution, multiplication and use of improved hybrid seeds.
- 2) Adoption of efficient plant protection measures.
- 3) Basal placement of phosphatic fertilizers and treating the seeds with Rhizobium culture.
- 4) Growing pulses on relatively fertile lands rather than growing them on marginal and sub marginal lands.

5) Evolution of better plant-types

- a) Thermo and photo insensitive.
- b) Early maturing.
- c) Responsive to applied inputs with high yield potentials.
- d) Fairly resistant to water logging, insect pests and diseases.
- e) Resistant to drought and frost.
- f) High nutritional qualities.

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