CAULIFLOWER

BOTANICAL NAME : ***Brassica oleracea var. botrytis L.***

COMMON NAME : **Phool Gobhi**

CHROMOSOME NUMBER : **2n=18**

FAMILY : **Cruciferae**

ORIGIN:

- The name cauliflower has originated from the Latin word “Cauli” meaning cabbage, “floris” meaning flower and „botrytis' meaning budding.
- It is said that the cauliflower has originated around the Mediterranean Sea from the wild cliff cabbage, *Brassica oleracea* var. *sylvestris* a native of coastal region of Europe and Africa.
- It was introduced in India during the Mughal period.
- Cauliflower is one of the most important vegetable crops of India.
- It is grown in winter season for its white tender curds formed by the pre floral fleshy apical meristem.
- It is used as vegetable in curies, soups and for pickling.
- The area under this crop in India was 369 thousand ha having a production 6745 thousand tonnes with a productivity of 18.93MT/ha (NHB, 2011).

AREA AND PRODUCTION

- The area under this crop in India is 369 thousand ha having a production 6745 thousand tonnes with a productivity of 18.3MT/ha (NHB, 2011).

CLIMATIC REQUIREMENTS

- Climatic factors play important role during transformation from vegetative to curding and curd development stages.
- Temperature 10-21^{o}C is good for germination.
- It is thermo-sensitive i.e. temperature influences growth stages from vegetative to reproductive.
- Transformation from vegetative to curding take place from 5^{o}C to nearly 28-30^{o}C, depending on the cultivar of a particular maturity group.
- Certain amount of vegetative growth is necessary to pass over juvenile phase of plant.
- Four weeks in mid-late group and 5-6weeks in late group would be sufficient for transformation from vegetative to curding phase.
- Optimum temperature for growth of young plant is 23^{o}C in initial stages while growth in later stages is more favourable at 17-20^{o}C.

- The tropical cultivars can grow even at 35°C or more.
- Plant will go on putting vegetative growth without forming any curd if temperature remains higher than optimum for curding.
- Late group cultivars require 15-20°C for optimum growth but the same temperature would cause curd formation in the early cultivars.
- Therefore, when tropical cultivars are grown at lower temperature, they form button and show severe riceyness to typical green bud formation.
- Temperature should not fluctuate too much during curd initiation phase, otherwise curd quality deteriorates.
- Temperature higher or lower than optimum for curding results in physiological disorders like riceyness, leafyness, blindness, loose and yellow curd.

VARIETIES

Varieties have been divided into four different maturity groups (I-IV) for north Indian Plains

Maturity group	Nursery sowing	Transplanting time	Optimum temp. range for curding	Varieties
Extra Early: May maturity (May-June)	End of February	March	24°C-30°C	Pusa Meghna, DC 23, Pusa Kartik Sankar
Early I (A) Sept. maturity (mid Sept-mid Nov.)	Mid May	July beginning	20-25°C	Early Kunwari, Pusa Early Synthetic, Pant Gobhi-3, Pusa Meghna, Pusa Kartik Sankar
I (B) Oct. maturity (Mid Oct-mid Nov)	May end to Mid June	Mid July	20-25°C	Pusa Katki, Pusa Deepali, Pant Gobhi-2
Mid Early (II) Nov. maturity (Mid Nov-mid Dec)	July end	Sept beginning	16-20°C	Improved Japanese, 12-C, Pusa hybrid-2, Pusa Sharad, Pant Gobhi-4
Mid late (III) Dec maturity (mid Dec mid Jan)	Aug end	Sept end	12-16°C	Pusa Synthetic, Pusa Subhra, Palam Uphar, KT-25, Pant Subhra, Pusa HimJyoti, Pb Giant 35, Pusa Paushja, Pusa Shukti
Late (IV) Snowball (Jan-March)	Sept end to mid Oct	Oct end-mid Nov	10-16°C	Snowball 16, Pusa Snowball-I, Pusa Snowball K-1, Dania, Ooty-1,

Cauliflower cultivars grown in India can be classified into two broad groups:

1. Indian Cauliflower/tropical/hot weather/heat tolerant.
2. European types/ early temperate types known as Snowball or late cauliflower

Indian Type	**European Type**
Tolerant to heat	Not tolerant to heat
Curd formation at and above 20°C.	Curd formation at 5-20°C
Yellow to creamish curds, loose with strong flavour.	Snow white curds with very mild or no flavour (better quality curds).
Plants are short having long stalk and loosely arranged leaves.	Steady plants and long leaves giving protective jacket to curd.

Early in maturity	Late in maturity
More variable (heterozygous)	Less variable (homozygous)
More self-incompatible.	Less self incompatible.
Small juvenile phase.	Long juvenile phase.
No need of vernalization but needs cold treatment at 10-13^{o}C.	Needs vernalization at 7^{o}C for 8-10 weeks.

The varieties can be grouped as early, mid early, mid late and late season varieties on the basis of maturity groups.

Early Varieties:

• Early Kunwari
• Pusa Early Synthetic
• Pant Gobhi 3
• Pusa Deepali
• Pant Gobhi 2.

Mid Early Varieties:

• Improved Japanese
• Pusa Hybrid- 2
• Pusa Sharad
• Pant Gobhi- 4

Mid Late Varieties:

• Pusa Synthetic
• Pant Shubhra
• Pusa Shubhra
• Pusa Himjyoti
• Punjab Giant 35

Late Varieties:

• Pusa snowball-1
• Pusa snowball K-1
• Ooty-1

Description

Dania:

- It is developed from IARI, Regional Station, Kalimpong for eastern hilly area.
- Plants are strong having medium sized curds.
- This variety is tolerant to stress conditions.

Early Kunwari:

- It is an early variety suitable for growing in Punjab, Haryana, Himachal Pradesh and Delhi.
- It is released by Punjab Agricultural University, Ludhiana.
- The leaves are bluish green.
- Curds are semi-spherical with even surface and ready for harvesting from mid September to mid October.

Pant Gobhi-2:

- It is a composite variety released by GB Pant University of Agriculture and Technology, Pantnagar.
- Curds become ready for harvesting from October onwards.

Pusa Deepali:

- This has been developed at IARI, New Delhi.
- Plants are medium tall.
- Curds are compact, self blanching, white and medium in size.
- Riceyness is almost absent.
- Curds are ready in late October when the average temperature is around 20-25^{o}C.

Pusa Himjyoti:

- It is released from IARI, Regional Research Station, Katrain (HP).
- Plants are straight.
- Curd is quietly white, solid and round.
- It is early in maturity, having curds of 500-600g in weight.
- Yield of this variety is 160-180q/ha.
- The only variety which can be grown from April - July in the hills.

Pusa Hybrid-2:

- First public sector hybrid of cauliflower developed by crossing a self-incompatible line and selection 1-3-18-19.
- It is recommended from IARI, New Delhi.
- Plants are erect and medium tall with bluish green upright leaves.
- Curd is creamy-white and highly compact.
- The yield potential of this variety is 230-250q/ha.
- It is resistant to downy mildew.

Pusa Snowball:

- It is derivative of the cross between EC-12013 x EC-12012 and released from IARI, Regional Station, Katrain (Kullu Valley).
- It is a late variety and suitable for cool season.
- Curds are very compact, medium in size and snow white in colour.

Pusa Snowball K-1:

- This is also developed at IARI, Regional Station, Katrain (Kullu Valley) and is tolerant to black rot.
- Amongst the snowball types, it has the best quality of snow white curds.

Swarna:

- It can be grown from September-December.
- Curds are white, compact and ready for harvesting within 80-85 days after transplanting.
- On an average, it yields 1.0-2.5kg curd weight.

SOIL

- The mid season and late crop will grow very well in medium, medium heavy and heavysoils.
- For early crop, a light to light medium soil should be preferred so that the drainage is easier in the rainy season.
- The water stagnation checks the growth, which leads to disappointment to the growers.
- It prefers a soil reaction ranging from pH 6 to 6.5.
- The deficiency symptoms of Mg may quickly appear in acidic soils while pH higher than 7 reduced the availability of boron causing browning.

SOWING TIME

Maturity Group	**Sowing time**	**Transplanting Time**
Extra Early	End of February	March
Early I (A)	Mid May	July beginning
Early I (B)	May end-June end	Mid July
Mid early	July end	Sept. beginning

Mid late	Aug. end	Sept. end
Late	Sept. end – mid Oct.	Oct. end –mid Nov.

SEED RATE

Early varieties	600-750g
Mid-Early season varieties	500g
Mid-late varieties	400 g
Late varieties	300g

SPACING

• Early crop : 45 x 30 cm

• Mid and Late crop : 60 x 45 cm

NUTRITIONAL REQUIREMENT

- Apply FYM @250-300q/ha, Nitrogen @100-150kg/ha, Phosphorus @ 60-80kg/ha and Potassium @ 80kg/ha.
- Half quantity of N and entire quantity of P and K are applied to the soil at the time of field preparation.
- The remaining half quantity of N is top dressed four weeks after transplanting.

USE OF PLANT GROWTH REGULATORS

PGR	**Method of application**	**Attributes affected**
IBA@ 10ppm	Seedling treatment	Increase in yield
GA@ 100ppm +NAA@120ppm +Mo@ 2%	Foliar spray	Increase in yield
GA@ 50ppm +Urea @1%	Foliar spray	Increase in yield
GA3 @50ppm	Foliar spray	Increase in yield
NAA 10ppm	Seedlings treatment	Plant stand in the field and vegetative growth.
GA4 + GA7 @ 80 mg/l	Foliar spray	Shortens the period from transplanting to the harvest

INTERCULTURAL OPERATION

- Cauliflower is a shallow rooted crop, so do shallow hoeing to remove weeds and to avoid any injury to the roots.
- Regular hoeing operations keep crop weed free and provide aeration to the root system.
- Crust formation in medium heavy and clay soils hinder water and air penetration in root system and should be broken otherwise adversely affect plant growth.
- Earthing up is important in rainy season as roots get exposed after every shower and should be done 4-5weeks after transplanting.
- Critical period for crop- weed competition is between 30-50days after transplanting.
- Use herbicides in initial stages followed by hand weeding in later stages of plant growth along with fertilizer top dressings.

- Application of Alachlor (Lasso) @2kg a.i. /ha before transplanting is beneficial for controlling annual and broad leaved weeds.
- Pendimethalin (Stomp) @1.2kg a.i. /ha or Oxyflurofen (Goal) @ 600ml/ha can also be used before transplanting if there is problem of annual weeds only.

IRRIGATION

- First irrigation should be given immediately after transplanting.
- Being shallow rooted crop, it requires frequent and light irrigation.
- Early season crop require irrigation at an interval of 5-7days while mid and late sown crop require irrigation at an interval of 8-12 days.
- Curd development is the critical stage.
- Heavy irrigation is avoided at the time of maturity of heads.
- Optimum moisture level at the time of curd formation is very essential.

BLANCHING

- An important operation to protect the curds from yellowing due to direct exposure to sun.
- The curds may also loose some of their flavour because of this exposure.
- This problem generally occurs in varieties of early and mid maturity group, which have spreading and open plant type.
- In Snowball group and some of hybrids of early and mid maturity groups, curds remain naturally protected and surrounded by inner whorls of leaves.
- This may be done by drawing and tying of leaves when curds are fully developed. Sometimes, a leaf of cauliflower is kept over the curd 4-5 days prior to harvesting.

HARVESTING

- The harvesting of curds is to be done as soon as the curds attain prime maturity and compactness.
- It is better to harvest little early than late if there is any doubt about the maturity.
- Delayed harvesting leads to the elongation of flower stalk and loose, over matured curds, deterioration of quality and turns into loose, leafy, ricey and fuzzy. Such curds should be eliminated from the consignment to be sending to the markets as they wilt rapidly and spoil the appearance of the consignment.
- The curd should be cut-off with stalk along with sufficient number of jacket leaves to protect the curd.
- Severe trimming of leaves is to be done after unloading or before marketing.

YIELD (q/ha)

- Early varieties 100-150.

- Mid and late season varieties 150-225.
- Snowball group may produce upto 500 q/ha.

PRE AND POST HARVEST HANDLING

- Harvesting should be done preferably in the late evening or early morning so that the product remains turgid and fresh.
- The freshly harvested plants should be put in the truck or cart in such a way that the bruising of the curd is minimum.
- These bruised portions of the curd become blackish and unattractive for the fresh market.

STORAGE

- Most of cauliflower grown in India is harvested and used for fresh consumption.
- In general, it is not stored in the cold storage because of lack of capital to erect and run the cold storage by farmers.
- Snowball cauliflower can be stored for 7days at 0oC-1.7oC and RH between 85-95%.
- Cauliflower with intact leaves and head size 25-30cm diameter are the most suitable for long-term storage.

PACKING AND PACKAGING MATERIAL

- Generally packaging material is not used for transportation or storage of cauliflower in India.
- Freshly harvested plants with most of the leaves intact are loaded in cart/truck keeping the curd downward so that they are not exposed to the sun and the leaves protect the curd from bruising and impact damage.
- This practice is for the market situated nearby.
- They are sent in gunny bag packing or in crates to distant markets.
- Cling wraps may be used for packing in which only the curd portion is kept.

VALUE ADDED PRODUCTS

- In India, cauliflower is mainly dried or processed into mixed vegetable pickles.
- In the glut season, cauliflower can also be preserved in chemical solution containing 3%salt + 0.3%potassium metabisulphate + 0.8% glacial acetic acid in glass jars for 6-8months for culinary purpose and for pickling.
- **Frozen cauliflower**: The curds are washed, cut into pieces, blanched, packed in poly bags of the desired size and then marketed in the lean period.
- **Dehydrated Cauliflower**: Cauliflower buttons are separated and cut into small pieces. These pieces are blanched for 4-5 minutes in boiling water, steeped in 0.5% SO2 solution for about an hour, then drained and washed. These are then dried at

60oC for about 10-12 hours. The dry matter content is 7 and 8-10% in snowball and tropical cauliflower, respectively.

- **Canning**: Canning is also done on limited scale in India. Compact curds are cut into small pieces of suitable size. These are then blanched for 5-6minutes in boiling solution of 0.1%citric acid or titaric acid and subsequently cooled in 2%brine to prevent discolouration. Blanched material is filled in plain cans containing 2%brine, then they are sealed and sterilized. Pink colouration in the canned product is a problem.

SEED PRODUCTION

- Periods of low temperature (chilling) is not essential, but cool conditions are required for seed production.
- Seed production of late varieties can only be taken up in hilly regions of the country.
- Himachal Pradesh has emerged as the major producer of quality cauliflower seed of late varieties.

Methods of Seed Production

- There are two methods of seed production:

1. In-situ method (Seed-to-Seed method)
2. Replanting method (Head-to-Seed method)

For seed production, seed to seed method is recommended, since the head to seed method in India has not been very successful. In seed to seed method, crop is allowed to over winter and produce seed in the original position, where they were first planted in the seedling stage.

Cultural practices/production technology

Time of sowing and transplanting

- For seed production purpose, the sowing time of cauliflowers should be so adjusted in such a way that the plants put up the maximum leafy growth by the second week of December, when the temperature goes down and the plants become almost dormant.
- The first week of September is the optimum time of sowing for the seeds in the nursery beds.
- Transplanting of seedlings should be completed by the end of September.
- The mean temperature of 6.5-110Cduring February to March is very conducive to curd formation.

- Early sowing done in June to July, results in curd formation during October to November.
- The curds, being very susceptible to cold injury, rot during winter and hence fail to flower the following summer.
- If sown late, the crop starts curd formation late in the spring and consequently flowering is delayed.

Method of seed sowing

- Method of seed sowing and raising of healthy nursery is same as that of cabbage.

Preparation of land for transplanting

- The field should be prepared well to fine tilth by one deep ploughing followed by 3 to 4 harrowing and plankings/levelings.

Nutrient management

- The cauliflower seed crop requires heavy manuring as it removes large quantities of major nutrients from the soil.
- For good seed yield, 20-30tonnes of farmyard manure are applied per hectare.
- Apply 50 kg/ha nitrogen, 60kg/ha phosphorous and 60kg/ha potassium per hectare before transplanting.

Transplanting

- Transplant the seedlings when 12 to 15cm long, preferably in the evening time, and irrigate immediately after transplanting..

Spacing

• Row to row : 60-90cm

• Plant to plant : 45-60cm.

Irrigation

- Irrigate the crop according to the soil type and climatic conditions.
- A crop after transplanting may need irrigation twice a week and later once in a week.
- Adequate moisture supplies during flowering and seed formation are necessary to obtain high yields.

Interculture

- Frequent shallow cultivation should be given to the soil to kill weeds and provide soil mulch.
- Four to five weeks after transplanting, earthing up of plants is highly desirable.

Early Varieties (Seed Production in Plains):

- Most of the cultural practices for seed production of early varieties in the plains are same, except for the time of sowing (June to August) as it varies with the varieties

and a little closer spacing (60 x 45cm) is adopted and scooping if curds is normally not required.

Isolation distance

- The seed field must be separated from fields of other varieties, fields of the same variety not confirming to varietal purity requirements of certification, and from all other kinds of cole crops at least 1600 meters for foundation and by 1000 meters for certified seed.

Pollination

- It is a highly cross-pollinated crop.
- Honey bees are the usual pollinating agents, though bumble bees and house flies may also be responsible for pollination.
- It has been found that stigma of *Brassica* spp. is receptive even 5days before and 4days after anthesis.
- The period from pollination to fertilization generally takes about 24-48hours, depending on temperature.
- The ideal temperature has been found to be 12 to180C for seed production in hills.
- The seeds are globular, smooth and dark brown in colour.
- The fruit is often called as siliqua and popularly as pod.

Roguing

- Selection of curds is done when the curds are well developed.
- Off type plants and those not confirming to varietal characteristics should be removed at this stage.
- Subsequently roguing for off types, diseased plants and infected with phyllody should be done from time to time.

Harvesting and threshing

- Harvesting is done when majority of pods turn brown.
- Overripe pods dehisce, hence harvesting may be done in lots.
- Generally, the early plants are harvested first when about 60-70per cent of the pods turns brown and rest of the crop changes to yellowish brown.
- After harvesting, it is piled up for curing.
- After 4-5days, it is turned upside down and allowed to cure for another 4-5days in the same way.
- Threshed is done with sticks and sifted with hand sifters.
- After thorough drying of seed in the sun (up to 7 % moisture content) it is cleaned and stored.

Seed Yield

- Average seed yield varies from 400-500 kg per hectare

SEED CERTIFICATION STANDARDS

A. Fields Standards

A. General requirements

Isolation:

- Seed fields should be isolated from the contaminants shown below:

Contaminants	**Minimum distance (Meters)**	
	Foundation	**Certified**
Fields of other varieties	1600	1000
Fields of the same variety not conforming to varietal purity	1600	1000

B. Specific requirements

Factors	**Maximum Permitted (Per cent)**	
	Foundation	**Certified**
Off types	0.10	0.20
Plants affected by seed borne diseases	0.10	0.50

C. Seed Standards

Factors	**Standards for each class**	
	Foundation	**Certified**
Pure seed (minimum) %	98	98
Inert matter (maximum) %	2.0	2.0
Other crop seeds (maximum) Number/kg	5	10
Weed seeds (maximum) Number/kg	5	10
Germination (minimum) %	65	65
Moisture (maximum) %	7.0	7.0
For vapour-proof containers (maximum) %	5.0	5.0