

# **College of Agriculture, Baramati**

**Course No.: AGRO246**

**Course Title: Crop Production  
Technology-II (Rabi Crops)**

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## Wheat

B.N: *Triticum aestivum* L (soft/sarbati),  
*Triticum durum* L. (Macaroni hard/ Bansi)  
*Triticum dicoccum* L. (Amber/ Emmer wheat)

Family: gramineae  
Origin: North-East Asia

### **Economic Importance:**

1. World's mostly widely cultivated food crop
2. In, India it is a second imp staple food crop ( rice being first )
3. Eaten in the form of, chapatis, upma, parisi ,
4. Preparation of baked bread cakes biscuits etc
5. Straw source of feed for cattle
6. Wheat protein more than other cereals
7. Wheat protein provides characteristic substance gluten which is very essential for bakers as it provides structural framework for the spongy cellular texture of bread & other baked products

### **Area & distribution:**

In world-Max area – china followed by India, Production – china followed by India, Productivity –UK followed by France

In India-Max area - U.P, Production – Up, Productivity- Punjab followed by Haryana

### **Classification**

87% *triticum aestivum* – Common bread wheat, 12 % *T .durum* – Macaroni wheat, 1 % *T. dicoccum* – Emmer wheat

### **Botanical description**

#### Root system

- 1) Primary / roots / temporary roots
  - Forms at germination absorbs nutrients & water for seedling growth & dies as growth progresses & replaced by secondary roots
- 2) Secondary / roots / permanent roots
  - It arises 21-25 days after sowing acts as principle organ of absorption it is permanent roots system
  - Inflorescence of wheat botanically called as spike

- Wheat kernel is canyopsis type of fruit

### **Climatic requirement:-**

Temperate crop, but grown in tropical & subtropical zone. Cool, dry & clean weather. Critical growth stages-Germination temp:-20-25°C, **Tillering stage:-16-20°C**, **Grain devotement stage:-less than 25°C**. **Most ideal condition:-** cool & moist weather for vegetative growth. Warm & dry weather for grain formation

### **Soil requirement:-**

Well drained, clay loam soil & moderate water holding capacity is ideal for wheat. Irrigated –Deep black alluvial soil. PH range:-6-7

### **Seedbed preparation:-**

- Wheat require compact seedbed for good & uniform germination
- Ploughing -15-20cm deep.
- Harrowing-2-3
- Collecting stubble & weed.
- Leveling of land.
- Add FYM compost @ 10-15ton/ha before last harrowing.

### **Seeds & sowing:** Use certified seeds.

1. Seed treatment- Fungicide @ vitavex / thirum / agrosan @ 2.5 /kg of wheat seeds. Biofertilizer Azotobacter and PSB @ 250 gm each/ 10kg of seeds
2. Sowing time: Irrigated – 1<sup>st</sup> fortnight of November, Rainfed – 2<sup>nd</sup> fortnight of october, After 15<sup>th</sup>nov each fortnight delay causes reduction in yield upto25 q/ha
3. Seed Rate: Irrigated timely sown – 100-125 kg /ha  
Irrigated late sown - 125-150 kg /ha , Rainfed - 75 – 100 kg/ha
4. Spacing: Row to row – 22.5 cm timely sown, 18cm late sown  
20- 22 lakh plants should be maintained to get a good yield
5. Drilling is ideal method of sowing.

**Varieties:** Irrigated timely sown- NIAW-301(Traymbak) , NIAW-917 (tapowan) , NIAW – 295 ( godawari)

Late sowing- NIFAD – 34 (NIAW -34), AKAW – 4626

Rainfed: NIDW-15 (panchwati), AKDW- 2997-16

New Varieties: Netrawati, Phule Samadhan

**Nutrient management :**FYM@ 10-15 T/ha

RDF:

Irrigated (timley sown)- 120:60:40-60 Kg NPK/ha

Irrigated (Late sown)- 80:40:20 Kg NPK/ha

Rainfed - 40:20:00 Kg NPK/ha

Nitrogen is given in split, half nitrogen and full dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O is given at the time of sowing and remaining half dose of N is given at the time of first irrigation i.e. 18-21 DAS. Whole dose is

### Water management

- Total water requirement- 40 hacm. Crop requires 5 to 6 no. of irrigations.
- Critical growth stages
  - Crown root initiation (CRI)- 18-21 DAS
  - Tillering stage- 40-42 DAS
  - Flowering stage- 60-65 DAS
  - Grain filling stage- 90-95 DAS

It limited irrigation is there,

For 1 irrigation, - given at 42 DAS ( i.e. at tillering stage)

For 2 irrigations- at 21 DAS and 64 DAS( At CRI and flowering)

For 3 irrigations- at 21, 42 and 65 DAS( i.e. at CRI, tillering and flowering stage)

### Weed management

- Hand weeding or hoeing
- Herbicides

Herbicides	Dose (g a.i/ha)	Product (g/ha)	Remarks
Pendimethalin 30% EC	1000 to 1500	3300 to 5000 in 600-700 litre water.	Control grasses like Chenopodium album, Angallis album. Pre emergence application @ 0-3 DAS
2,4-D sodium salt 80% WP	1000	1250	Post emergence application @ 30-35 DAS i.e at tillering stage to control dicot weeds.

### Harvesting and yield:

Signs of maturity: 1. The leaves and stem turn yellow and became fairly dry.

2. The proper stage of harvesting of wheat is when 80% spikes have about 80% ripened spikes.

3. Proper time of harvest is when grains contain 20% moisture.

Harvesting method: After harvesting it is necessary to dry the grains in bright sunny days for 3-4 days. The harvesting is done with the help of sickles and then threshed in power driven thresher. Now a day's combine harvesters are also

available for harvesting , threshing and winnowing of wheat crop in a single operation.

Yield: Rainfed 12-14qt/ha, Irrigated 40-45qt/ha, Late sown 35-40qt/ha

**Diseases** :Rust Brown rust/Leaf rust(*Puccinia recondita sp. tritici*), Stripe rust / yellow rust(*Puccinia striiformis sp. tritici*), Stem rust /black rust (*Puccinia graminis sp. tritici*) Loose smut,Karnal bunt,Powdery mildew

Insect pest: Termite, Pink borer, Aphids, Rodents

## Barley

*B.N.:Hordeum vulgare*

*Family:Gramineae*

*Origin: Abyssinia & south east asia (China, Tibet & Nepal)*

### **Economic Importance :**

- Staple food for cooler semi-arid areas of world -Tibet, Nepal & Bhutan
- As grain feed: to livestock & poultry
- As malt for manufacturing of beer & other liquors like whisky & brandy
- Flour: preparing 'chapatis'
- Sattu: grain is roasted & ground
- Protein: 8-10%, carbohydrate: 74%

### **Area & distribution**

- Maximum area in world: Russian federation (USSR)
- Maximum production in world: USSR
- Maximum area in India: U.P.
- Maximum production in india: U.P.

### **Classification**

- Based on number of rows of grain
- *Hordeum vulgare*: six row barley
- *Hordeum distichon* & *hordeum irregulare*: two row barley & irregular barley

### **Morphology**

- Plant resembles wheat, Self pollinated crop, Tillers : 2-5
- Root: shallow: spread lateral 15-30cm & deep 75 to 150 cm

**Climatic requirements:** This crop requires cool climate for-early stages, Warm & dry- at maturity

- Low water requirement than wheat
- Drought resistant
- In regions where wheat does not give economic yield.

### **Soil:**

- Deep or loamy soil
- Salt tolerant crop

**Varieties:** Rekha, dolma, preeti, geetanjali, Jawahar barley

### **Crop rotations**

Rice –barley, Black gram-barley, Cowpea-barley

**Field preparation:** Mostly grown on light soils, 4-5 ploughing with local plough or

- 3-4 harrowing followed by planking

### **Seeds & sowing**

- Seed treatment: thirum + bavistin (1:1) @ 2.5 gm or vitavax @ 2.5 gm/kg of seed, For rainfed & sowing in saline soil soak seeds overnight in water for better germination
- Sowing time: Oct 15- Nov 15
  - Rainfed: 2<sup>nd</sup> ft. nt. of Oct.
  - Irrigated: 1<sup>st</sup> ft. nt. of Nov. to 1<sup>st</sup> ft. nt. Of Dec
- Seed rate & spacing
  - Irrigated: 75-80 kg/ha
  - Irrigated late sown: 100-120 kg/ha
  - Rainfed: 100 kg/ha
  - Saline soil: 100 kg/ha
- Spacing:
  - Irrigated : 22.5 cm row to row & depth (4-5 cm)
  - Rainfed: 22.5-25 cm row to row & depth (6-8 cm)
  - Late sown: 20-22.5 cm (4-5 cm)
- Method of sowing :drilling

### **Manure & fertilizers/Nutrient management:**

- 10-15 tons of fym/compost/ha
- RDF:
  - Irrigated: 80:50:50 (1/2 N at 1<sup>st</sup> irrigation) Kg NPK/ha
  - Rainfed: 50:30:30 Kg NPK/ha
  - Late sown: 40:30:20 Kg NPK/ha

### **Irrigation/Water management:**

- 2-3 irrigation are required
- 1<sup>st</sup> irrigation – active tillering 30-35 DAS
- 2<sup>nd</sup> irrigation- flowering & active tillering
- Saline soils- frequent light irrigations
- Weed control
- Irrigation condition: 2,4-D @ 0.75 kg a.i./ha in 700-800 lit. of water
- Molya disease: by nematode *heterodera avenae*
- Resi. Varieties: RD-2035, Karan-16
- Harvesting & yield

- As shattering is problem so it is harvested immediately
- Sickle: stationary threshers
- Yield: 30-35 qtl grains
- 40-45 qtl straw/ha

A.C.Baramati

## Maize

B. N. – *Zea mays*

F. –Gramineae

Origin – Central America & Mexico

### **Economic Importance :**

- 1) Maize is most important cereal crops in the agricultural economy both as food for man & feed for animals.
- 2) It is called Queen of cereals – (because it has very high yield potential than other cereals on earth).
- 3) Up to 85% of maize produced is consumed as human food.
- 4) It is consumed in the form of chapatis prepared from flour & grains, roasted green cobs eaten by people, popcorn is the favourite food for children.
- 5) It is also a good feed for poultry, piggery & other animals.
- 6) Grains contain – 10% protein(**zein**), 4% oil, 70% Carbohydrates, 2.3% crude fibre, 10.4% albuminoides, 1.4% ash
- 7) It is source of vitamin A, nicotinic acid, riboflavin & vitamin E
- 8) It also provides huge quantities of green fodder for cattle, therefore maize is called as king of fodder.
- 9) In several industries like starch, milling based on maize products & by products.

### **Area & Distribution :**

In world it is cultivated in Brazil, China, Mexico & India, USA, Italy, France  
In India – U.P, Bihar, Rajasthan, MP, Punjab, A.P.,  
Maharashtra –Solapur, Dhule, Kolhapur, Sangli, Satara, Beed, Chandrapur.

### **Classification :-** is based on character of kernels.

- 1) *Zea mays indurata* / flint corn- Commonly cultivated in India  
Endosperm of kernel is soft & starchy round short & flat with white / yellow starch
- 2) *Zea mays indentata*/Dent corn :  
Endosperm have both hard & soft starch, grown in USA.
- 3) *Zea mays everta* / Pop corn :  
Has popping quantities, small size of seed & endosperm is hard
- 4) *Zea mays saccharata* / Sweet corn :  
Contain more amount of sugar, absorb more water making cells turgid shrivelled/wrinkled, sweeter taste.
- 5) *Zea mays amylacea* / Soft corn :  
Soft endosperm kernels are soft & blue & white in colour.
- 6) *Zea mays tunicata* / Pod corn :

Each kernel enclosed within a pod or husk primitive type of corn & no importance.

- 7) *Zea mays ceretina kulesh* / Waxy corn :  
When kernels cut gives waxy appearance.  
Produce starch for making adhesive for articles.

### Botanical description :

Tall annual plant - upto 3 m ht/marc

- 1) **Root system** – Well developed fibrous & deep
  - a) Seminal roots / temporary roots - Arise from base of 1<sup>st</sup> node of stem under soil surface.
  - b) Crown / coronal / nodal roots – Arise from basal portion of stem – functional roots.
  - c) Brace, Prop or Aerial Roots – Arise from 2,3<sup>rd</sup> & 4<sup>th</sup> nodes above the soil surface. Primary function – to give support to the plants.
- 2) **Stem** – 12-18 alternating nodes & internodes & completely filled with pith. Leaf is attached to each node.
- 3) **Leaf** – Alternately on opposite side of the stem – thin, flat & expanded blade with definite midrib.
- 4) **Inflorescence** – Maize is monoecious plant – 2 types of inflorescence  
Female inflorescence - which develops into ear (cob) & Born inside young cobs  
Male inflorescence - which contain male flowers. Born in cluster (tassel) – on top end of stem.
- 5) **Kernel / Grain** – Is one seeded fruit

### Climate:

- Maize is a warm weather plant.
- Grows from mean sea level 2500 – 3000 altitudes
- It can be grown under diverse conditions.
- Kharif season – main growing season in north India.
- The most suitable temperature for germination is 21°C – 26°C & for growth 30-32°C
- Extremely high temp. & low humidity- during flowering - damage foliage, pollen – resulting in poor grain formation.
- Require 50-75 cm annual rainfall.
- Very sensitive to stagnant water - during early stage of growth.
- Can't withstand frost at any stage of its growth.

**Soil** : Requires deep, well drained, fertile loamy & slit loamy containing adequate O.M.& soil having 5.5-7.5. Can be grown on alluvial soils. (U.P., Bihar, Punjab)

**Varieties :** Hybrids- Deccan double hybrid, Ganga safed-2, Hi-starch, Ganga-5, Pusa hybrid 1, 2

Composites-Vijay, kisan, J-603, Manjari composite, prabhat, hunis, african tall, panchaganga, kiran

Pop corn- Ambar pop corn, Sweet corn- Madhuri

**Cropping Systems :-** Soyabean, black gram, moong, cowpea, mixed with maize.

Crop Rotation – Maize – Portrait

Maize – Wheat

Maize – toria – wheat

**Field preparation :-** One deep ploughing at least 20-25 cm deep. It should be followed by 2-3 harrowings or 3-4 cross ploughing & then planking is done.

**Seed & sowing :**

1) Sowing time: Kharif-Jun-July, Rabbi-Nov., Summer-Feb-March

Maharashtra – kharif s. yield higher than rabbi/summer due to cooler temp. – in rabi & very high temp. – summer.

2) Sowing method – Grain purpose maize – sown by dibbling, Fodder -drilling

3) Seed rate – Grain purpose – 15 – 20 kg/ha, Fodder-75kg/ha

4) Spacing– 75 × 20-25 cm – sufficient to maintain optimum plant population of 55 – 60 thousand plants/ha.

5) Sowing depth – 5-7 cm

**Manures & fertilizers :**

- Application of 13-15 T of FYM / compost is necessary
- Recommended dose of fertilizers: 120kg N : 60 kg P<sub>2</sub>O<sub>5</sub>:60 kg k<sub>2</sub>O / ha
  - 1/3<sup>rd</sup> N = 40 kg & whole p & k – at sowing
  - Remaining – 40 kg N – at knee high stage (30-35 DAS)
  - Remaining 40 kg N – at tasseling (50 DAS)

**After cares :**

Thinning & gap filling – Thinning is carried out 10-15 days AS during thinning only healthy plant is kept at each hill. The gap if needed may be crop i.e. within 10-12 days AS. This is needed to maintain optimum plant population of 55-60 thousand plant/ha.

Interculturing & weeding : Growth of maize plants is suppressed by weeds during initial stage. Therefore weeding is necessary. Eg. – *Echinochloa*, *Cyperus rotundus*, *cynodon dactylon*, *solanum nigrum*(kanguhi), *phylanthus nirun*(Hajardahi), *commelina benghalensis* (keha). 2-3 hand weedings are given to this crop at 12-15

days interval. Light earthing up is given to the crop after last weeding & soil support is given to the plants which helps to avoid lodging of the crop in later stage. No interculturing is given after flowering of the crop as it damages the lateral root of the crop. Spray simazine/Atrazine @ 1-1.25 kg ai/ha as pre-emergence spray. Also Alachlor(2-3) , fluchloralinc (15-25) Combination of Alachlor (15-20) + Atrazine (1.0) is more effective.

#### **Water Management :-**

Most critical stages for irrigation seedling stage (25-30 DAS) is flowering (60-65) i.e. tasseling, silking& grain filling stage, (75-80)

No. of irrigations – 3-4

Total water requirement – 40-45 hacm

**Diseases :-** Seed Rot & seedling blight, Downy Mildew, Black Bundle Disease, Leaf Rust, Bacterial Stalk Rot, Anthracnose , Pythium Stalk Rot, Leaf Blight, Sugarcane Downey Mildew, Leaf Spot, Brown Stripe , Downey Mildew, Grey/Cercospora Leaf Spot, Grain Smut, Leaf Blights, Loose Smut, Ear Moulds

**Insect pests:-**Stem borer, Pink stem borer, Shoot fly, Maize leaf Roller, Kharif Grass hopper, Myllocerus (ash weevil), Cut worm, white grab

#### **Harvesting & yield:**

##### **Maturity sings:**

- For grain purpose maize – Grain is harvested when grains are dry & do not contain more than 20% moisture & husk turned yellow.
- Stalk & leaves remain green in hybrids & composites.
- Earheads or cobs are removed from the standing crop.
- Harvested cobs are dried in sun before harvest the plant.

##### **Harvesting method:**

- The grains are removed from cobs by hand shelling or maize sheller.
- Maize stalks are used as a cattle feed & food.
- Cobs from which grains are removed are used as fuel.

Fodder maize is harvested at 50% flower stage at which produces maximum yield or dry matter.

**Yield:** - 40 – 50 q / ha

40 – 60 T / ha

## Sorghum

B.N. – *Sorghum bicolor*

F -Gramineae

Origin - East Central Africa

Latin word Sorgo – which means rising above i.e. growing taller than other crops in the field.

### **Economic importance :**

- 1) Sorghum ranks 3<sup>rd</sup> in the major food grain crops of our country in area and production
  - 2) Sorghum is a major source of staple food for human
  - 3) It serves as an important source of cattle feed and fodder.
  - 4) It has capacity to withstand drought.
  - 5) Sorghum is one of the most widely grown dry-land food grain in India
  - 6) Sorghum grain is eaten by cooking it in the same way as rice or by grinding it into flour and preparing chapati.
  - 7) This grain is also feed to cattle, poultry and swine.
  - 8) It contains - 10 – 12 % protein, 3 % fat, 70 % carbohydrates
  - 9) The grains are also used for manufacture of starch, glucose, syrups.
- ( It is commonly known as the ‘ great millet ‘ due to larger size of grain )

Jowar plants start manufacturing Hydrocyanic acid (HCN) from germination upto 8-10 wks, which is poisonous to cattle. Therefore feeding of young plant to cattle before flowering is harmful.

### **Area & Distribution–**

In world – India ( 1<sup>st</sup> rank in area & 2<sup>nd</sup> in production ) USA ( 1<sup>st</sup> ) China, Africa, Australia, Nigeria,

In India – Maharashtra, Karnataka, M. P. A. P. Gujrat, U.P. Rajasthan, Tamil nadu.

In Maharashtra - Pune, Solapur, Satara, Sangli, Parbhani, Osmanabad, Ahmednagar, Nashik, Dhule.

( 2008 – 09 )

	Area ( Mha)	Production(MT)	Productivity (Kgha)
India	7.53	7.25	962
Mahara	4.07	3.59	881

**Botanical description :**

- Annual Plant
- Root system – fibrous, prop roots – on lowest nodes of stem above the ground level – which give support to the stem
- Stem – solid, quite juicy and sweet or pithy ( fodder varieties – more juicy and sweeter than grain varieties )
- Leaves - 60-90 long, 2-7 cm broad with yellowish white midrib
- Inflorescence of sorghum is – Panicle – known a head

**Climate :**

- Requires warm climate.
- It can tolerate drought conditions very well (because it remains dormant during moisture stress conditions but resumes growth when favourable conditions reappear.
- It can also tolerate water logging condition. Therefore sorghum can be grown successfully in areas having an average annual rainfall between 60 to 100 cm.
- It requires 29 – 30 °c temperature for its optimum growth.
- It is grown as kharif crop in North and rabi crop in South India.

**Soil :**

- Medium and black soils are predominantly suitable for growing sorghum
- Soils with clay loam or loamy, having good water retention capacity are best suited for this crop
- Sandy soil – not suitable
- This crop tolerates saline and alkaline conditions of soil.

**Cropping systems :-**

- This crop mixed with soyabean, pigeon pea, moong& black gram
- Crop rotation –
  - o Sorghum - Wheat
  - o Sorghum - pea
  - o Sorghum - gram
  - o Sorghum - cotton
  - o Sorghum - tobacco
  - o

**Field preparation :**

- After harvesting of previous crop field should be ploughed upto depth of 20 – 25 cm deep
- Followed by 2 to 3 harrowings, followed by planking.

## Seeds & Sowing :

- 1) Time of sowing:
  - a) Kharif - June – July
  - b) Rabi - Mid Sept. - Mid. Oct
  - c) Summer - Mid. Jan. - Mid. Feb
- 2) Method of sowing :  
Northern India – Broad casting  
Drilling Method.
- 3) Seed rate - 10 kg / ha
- 4) Spacing - 45 X 12 – 15 cm
- 5) Seed treatment :
  - 1) 30 % brine solution – control of ergot disease.
  - 2) 300 mesh sulphur @ 4 gm / kg of seeds to control smut disease.
  - 3) Thiram / Agrosan @ 3 gm / kg of seeds
  - 4) Carbofuran @ 100 gm / kg of seed to control shoot fly pest.

1<sup>st</sup> week of July - most suitable for sowing hybrids & improved varieties. Under unirrigated conditions sowing should be done preferably within a week of the onset of 1<sup>st</sup> monsoon showers. Timely planted crop & escapes the damage due to shoot fly & midge fly.

## Manures & Fertilizers (Nutrient management) :

- Jawar is a heavy feeder & exhaust the soil fertility.
- For rainfed crop @ 6-7.5 T / ha well FYM or compost apply before last harrowing or at the time of land preparation.
- For hybrids & high yielding varieties @ 12 – 15 T / ha FYM or compost apply before last harrowing or at the time of land preparation. (under irrigated condition )
- Recommended fertilizer dose ( RDF ) is  
120 kg N : 60 Kg P<sub>2</sub>O<sub>5</sub> : 60 Kg K<sub>2</sub>O/ha
- This dose is applied in split application.
- From this dose half N, full dose of P<sub>2</sub>O<sub>5</sub> & K<sub>2</sub>O is applied at the time of sowing. Remaining half N is applied one month after sowing

## After Care :

- 1] Thinning & Gap filling  
Thinning is carried out at 10-12DAS  
Gap filling is done immediately after germination 8 -10 DAS
- 2] Inter culturing :  
2 – 3 hoeings & 1 -2 hand weedings given before 30 – 35 DAS

- Pre – emergence spray of Atrazine @ 1 kg ai / ha
- 2, 4 D as post emergence herbicide @ 3 – 4 kg ai / ha

#### **Irrigation / Water management:**

- Total water requirement of crop 40 – 50 ha cm
- No. of irrigations required - 3 – 4
- In Critical growth stages during irrigation is important are –
  - 1] Grand Growth stage - 20 – 25 DAS
  - 2] Flag leaf stage / boot stage - 50 – 55 DAS
  - 3] Flowering stage -70 – 75 DAS
  - 4] Grain filling stage -90 – 100 DAS

#### **Harvesting & Yield :**

##### **Maturity signs:**

- 1] When grains become hard & when crushed under teeth give cracking noise
- 2] Blackish spot develops at top of grain.
- 3] Earhead bearing peduncle turns yellowish
- 4] Leaves become yellowish.

##### **Harvesting method:**

- 5] Crop harvested by nipping earheads or by cutting whole plants at ground level with the help of sickle.
  - 6] harvested produce kept for drying for 3-5 days on threshing yard.
  - 7] Then threshing is done by biting with sticks or trampling under bullock feet.
- Now a days mechanical thresher is also used for threshing.

Av. Yield - 25 – 30 Q / ha

**Pest** - Shootfly, stem borer, Midge fly, Jassids& aphids.

**Diseases** : Grain smut, loose smut, downy midew, Anthracnase, leaf spot, leaf blight, Ear mould.

##### **Varieties :**

High yielding Varieties: SPV - 462, 475, 946, SSV - 84, Phule Amruta  
Hybrids - CSH – 5, 9, 14, 16, 17, 18, 23

## **Gram/ Bengal gram/ Chickpea**

B. N.= *Cicer arietinum*

Family= Leguminosae

Origin= south-west Asia

Appearance of seed resembles with head of chick, so it is called as chick pea.

### **Economic Importance:**

1. It is most important pulse crop of India.
2. It is used for human consumption in various forms.
3. Gram is consumed in the form of dal, flour(besan), crushed or whole grain,boiled/roasted/cooked/salted
4. In many sweets preparation gram is used.
5. Fresh green leaves of chick pea are used as vegetable
6. It has medicinal effect in blood purification and stomach disorders, malic acid and oxalic acid or 'Amb' collected from leaves has medicinal value.
7. Grains contain 22% protein, 52-70%-carbohydrates, 4-10%fat, minerals like Ca, P, Fe and vitamin- niacin
8. Gram grains are useful for Animal feeding- Husk, broken grains/ soaked grains- valuable cattle feed, Straw- excellent fodder
9. Soaked grain & husk are fed to horse, cattle as concentrate & roughages

### **Botanical Description**

- Small(ht. upto 60 cm), much branched herbaceous plant
- Root system- deep rooted tap root system
- Stem- branched with granular hairs (Trichomes)
- Leaves- pinnately compound with terminal leaflet, color- light green to dark, certain types possess leaflets with red margins

### **Classification**

1. Desi/Brown Gram(*Cicer arietinum*): - Seed size small, plants small good branching habit

2. Kabuli/White Gram(*Cicer kabulium*): - Seeds bold & attractive, taller or erect than deshi

Flowers- single flower at each node. In deshi type- purple colour, kabuli type- white to pale cream

### **Ecology :**

Climatic requirement:

- ✓ Winter season crop
- ✓ Severe cold & frost- injurious
- ✓ Excess rainfall- at flowering & fruiting- heavy yield loss
- ✓ Generally grown under rainfed conditions
- ✓ Best suited to areas having moderate rainfall of 60-90 cm

Soil requirement:

- In Maharashtra- grown on black cotton soil.
- Light soils, sandy loam soils also preferred
- Best soils are well drained
- On light soil- plant remains short, there is abundant vegetative growth on heavy soils
- Soils having more than 8.5 pH- are not suitable for crop.

**Field preparation:** Gram crop required coarse / rough seedbed. One ploughing followed by 1-2 harrowing is sufficient.

### **Cropping system:**

Gram is mixed with wheat, barley, linseed, safflower or mustard and also intercropped with safflower or sorghum

Crop rotations- gram- sorghum

Gram- wheat

### **Seeds and Sowing:**

1. Seed treatment:

1. Thiram @ 2.5 gm/kg of seeds OR
2. Tricoderma @ 5 gm/kg of seeds
3. Rhizobium & PSB each culture @ 250 gm/10 Kg of seed<sup>2</sup>

2. Sowing time- mid Oct.- mid Nov.

Where irrigation facilities are not available- last wk of Sept.

3. Sowing method- drilling

4. Spacing- 30 cm x 10 cm

5. Sowing depth- 8-10cm (shallow sowing of crop affected by wilt)

6. Seed rate- 60-100 Kg/ha, Chafa- 60 kg/ha, Vishal, virat, vihar, PKV-2(bold grain)- 100 kg/ha

#### **Nutrient management:**

This crop requires 6-7 T/ha- well decomposed FYM/compost RDF:

1. Dry land areas- 12.5:25:00 kg NPK/ha
2. Assured rainfall areas- 20-25:40:00 kg NPK/ha
3. Irrigated – 100-150 kg Diammonium phosphate

Whole dose is applied at the time of sowing as a basal dose

#### **Weed management /Aftercare / interculturing:**

- One hand weeding- 20 DAS
- 2<sup>nd</sup> if needed- 30 DAS
- Fluchloralin(basalin)@ 1 kg a.i.- in 800-1000lit. of water/ha as per planting spray Or Metribuzin / pendimethalin(stomp)

#### **Water management:**

- This crop is mostly sown as rainfed crop
- Pre-sowing irrigation- for better germination & good crop growth.
- 2 irrigations- one at pre flowering stage  
2<sup>nd</sup> at pod development stage
- No irrigation is given at flowering stage in gram ???- to avoid premature flower drop.
- Light irrigation should be given
- Total water requirement- 25-30 ha cm

#### **Harvesting & yield:**

Signs of maturity:

- ✓ Leaves- become reddish brown & start shedding

- ✓ Pods- become dry
- ✓ Crop ready for harvesting in 100-110 days

Harvesting:

- ✓ By cutting plant close to ground level with sickle
- ✓ Harvesting done in morning hrs
- ✓ Crop allowed to dry in sunlight for 5-6 days
- ✓ Threshing by beating with stick or trampling or by mechanical thresher.

**Yield :** Rainfed- 10-12q/ha, irrigated- 25-30q/ha

**Varieties:**

☐ Deshi:

1. rainfed- vijay, digvijay, vishal(wilt resistant) , Phule G 12
2. Irrigated –vikas (PG-1), vishwas(PG-5), phule G-12, vijay vishal, digvijay

☐ Kabuli: Virat, vihar, PKV-2(kak-2), shweta, krupa, PKV-4

New variety :Phule Vikram- deshi gram,high yielding, suitable for machine harvesting, recommended for rainfed

**Diseases & pests:**

Diseases: wilt, sclerotinia blight, grey mold, rust, ascochyta blight

Pest- gram pod borer,cutworm

**Short notes:**

**1.Nipping in gram-** term nipping means- removal of apical or terminal bud or tip from the main shoot. Nipping carried out 30-35DAS (initiation of branching).main purpose of nipping is to encourage more branching

- One advantage is to get green leafy vegetable
- Dried in sunlight & used as vegetable throughout yr

**2.Malic acid collection(Amb) form gram:**

-plant attain 50-60 days age, leaves secret malic acid, locally called as “Amb”

-collected by running muslin cloth over plant in early morning & squeezed in bucket.

- Squeezed material contain 90-95%malic acid & 5-10%oxalic acid,
- About 5-7 lit. of malic acid collected from 1 ha crop
- Medicinal value against stomach disorders & blood purification

## Pea

B.N. *Pisum sativum*

F. Leguminoseceae

Origin. Mediterranean region of Europe & West Asia

### Economic Importance:

- Popular pulse crop of the world.
- Grains contain- 19.7-22.5% proteins, vit. A,B,C
- It is used as cover crop to control soil erosion
- Also useful as a green manure crop
- Pea is used as fodder purpose
- In various vegetable preparations pea is used

### Soil & Climate requirement:

Soil requirement:

- ✓ well drained loam soil- best for cultivation
- ✓ Medium to heavy soils, sandy loam soils with drainage are suitable for cultivation.
- ✓ Soils having pH 5.5 to 6.7 are also suitable.

Climatic requirement:

- ✓ Pea require cool climate.
- ✓ Optimum temp. 13 to 18<sup>0</sup>C is good for growth of pea
- ✓ High temp., High humidity, frost conditions are harmful.

### Botanical description:

- Annual herbaceous plant(30-200cm)
- Root system- tap root
- Stem-hollow, succulent
- Leaves- pinnately compound
- Tendrils- at terminal

**Field preparation:** one ploughing followed by 2,3- harrowing

### Classification

Garden Pea

- ✓ *Pisum sativum* var. *hortense*
- ✓ Used as table pea

- ✓ Used as vegetable & for canning purpose
- ✓ Seeds- bold, dark green
- ✓ Flowers- white

#### Field Pea

- ✓ *Pisum sativum var. arvense*
- ✓ Used as pulse crop
- ✓ forage & green manure crop
- ✓ Seeds- round, grayish green or grayish brown
- ✓ Flowers-coloured

#### Seeds & sowing:

1. Seed treatment:
  - Water soaking for 24 hrs- for good germination
  - Thiram@ 3 gm/kg seeds
  - Rhizobium culture @ 250 gm/ 10 kg seeds
2. Sowing time: Oct.- Nov.
3. Sowing method: drilling, dibbling
4. Spacing: 30 x 15 cm
5. Seed rate: 60-80 kg/ha
  - for early maturing varieties- 100 to 125 kg/ha (when row spacing is 20 cm)
  - for late sown varieties- 75 to 80 kg/ha (row spacing is 30 cm)
6. Sowing depth: 5cm

#### Nutrient management:

Manure- @10 to 12 T/ha well decomposed FYM/Compost, apply At last harrowing or land preparation

RDF: **20-30 : 60-70 : 30-40 kg NPK/ha**

- Whole dose is applied at the time of sowing as basal dose.

#### Water management:

- Total water requirement: 30 ha cm
- No. of irrigations: 1-3
  - 1<sup>st</sup> irrigation: at flowering stage(35-45 DAS)
  - 2<sup>nd</sup> irrigation: at pod filling stage
- Light irrigation, Poor drainage reduces no. of branches & pods/plant

**Weed management/ interculturing:**

- 2-3 hand weedings up to 40 to 50 days after sowing
- Staking or support is necessary to avoid crop lodging
- Herbicide : fluchloralin/ Pendimethalin

**Diseases & pests:** Wilt, Root rot, Powdery mildew, Rust, Pea stem fly, Leaf minor, Pea aphids, Pod borer

**Harvesting & yield:**

Signs of maturity:

- When plant & pods are dried
- Colour changes to yellow

Harvesting

1. For vegetable purpose: 3-4 hand pickings, when grains are small
2. For grain purpose: plants are harvested with the help of sickle at ground level. Then sun drying, threshing, winnowing operations are carried out.

Yield: 20-25q/ha

**Varieties:**

Khaperkheda, English wonder, Rachana, Arkel, Bonville, Harbhajan, Wai early, Wai late, **Phule priya**

## Safflower

B.N: Carthamus tinctorius

F: compositeae

Origin: India & Afganistan

### Economic importance:

- Mainly grown for edible oil
- Contain 24-36% oil
- Safflower oil having 78% linoleic acid which is very useful for heart patients
- The unsaturated fatty acids of safflower reduces cholesterol level
- Oil also used for manufacturing of paints, varnishes, soaps, adhesive material
- Oil cakes from decorticated seeds used as cattle feed, it contains 40-45% proteins
- Oilcakes from undecorticated seeds used as manure, contain 5%N,1.4%P<sub>2</sub>O<sub>5</sub>, 1.2%K<sub>2</sub>O
- Green safflower crop- leaves- used as vegetable green fodder for cattle
- Flower petals-Used as substitute for saffron, used in preparation of herbal tea, For preparation of natural colour

### Soil requirement:

- Mainly grown on black cotton soil
- Requires- well drained fertile soils with good water holding capacity & neutral pH
- It can be grown on light textured soils.

### Climate requirement:

- Drought resistant crop
- Can be grown in areas having rainfall about 100 mm
- Frost- harmful
- Excessive rainfall, high humidity increases attack of fungal diseases

### Botanical Description:

- Branched, herbaceous, annual plant(30-150cm)
- Root system- tap root
- Stem- thick at base, tapering with ht
- Leaves- dark green, prominent mid rib, serrated margins, short spines

### **Seed & sowing:**

- Sowing time: Rainfed- 2<sup>nd</sup> fortnight of Sept. to 1<sup>st</sup> fortnight of Oct.,  
Irrigated- upto end of oct.
- Late sowing- beyond 1<sup>5th</sup> Oct is uneconomical
- Early sowing- before 15<sup>th</sup> Sept due to high humidity- incidence of leaf spot disease
- Timely sowing- escapes attack of aphids
- Seed rate: for sole crop: 10-12kg/ha, for mixed crop: 5-6 kg/ha
- Sowing method: drilling, dibbling
- Spacing : 45 cm x 20 cm
- Sowing depth: 5-6 cm
- Seed treatments: Thirum @ 3gm/kg seeds, PSB@250gm/10 kg seeds, Azotobactor/ Azospirillum @ 250 gm/10 kg seeds

### **Nutrient management:**

- apply well decomposed FYM/Compost @ 5-6 t/ha, at the time of last harrowing.
- RDF: for rainfed crop- 50:25:0 kg NPK/ha, whole dose is applied at the time of sowing as a basal dose for rainfed crop.  
For irrigated crop- 60:30:0 kg NPK/ha, half nitrogen(30Kg) and full dose of P<sub>2</sub>O<sub>5</sub> applied as a basal dose. Remaining half nitrogen(30Kg) is applied 30 DAS.

### **Interculturing:**

1. **Thinning:** important operation carried out at 10-12 DAS
2. **Weed management:** 2-3 weedings are sufficient
  - 1<sup>st</sup> 20DAS
  - 2<sup>nd</sup> 40DAS
  - 3<sup>rd</sup> 55 DAS
3. **Topping:** at age of 30-35DAS, tops of plants are removed
  - For profuse branching, for increase production of flowers and seeds

**Water management:** Grown as rainfed crop, requires 1-2 irrigations, 1<sup>st</sup> – 30DAS, 2<sup>nd</sup> – 60DAS (i.e. at flowering). Total water requirement- 25-30ha cm  
Total water requirement is 25-30 ha cm

## Harvesting & yield

- Signs of maturity:
  - Matures within 120-140days
  - Leaves, stem- becomes yellow
- Harvesting should be done in morning hrs???( in morning, there is dew formation due to this plant and spines are not sharp, they become flexible, to avoid difficulty in harvesting by the spines)
- Harvesting method:
  - Plants are harvested by cutting or pulling whole plants

Drying- threshing( beating/trampling/thresher)

Yield: Rainfed crop: 12-14q/ha, irrigated crop: 15-20q/ha, mixed crop: 2-3q/ha

**Diseases:** Rust, Leaf spot, Wilt, Root rot, Stem fly,

**Pests:** Safflower fly, Safflower aphid, Safflower caterpillar

## Sunflower

B.N.: *Helianthus annuus*

F: Compositae

Origin: Mexico

### Economic importance:

- Oil is rich in linoleic acid(64%)
- Oil used for cooking
- Contain 45-50% oil
- Oil used in soap making, cosmetics,
- Leaves- medicinal property
- Used to recover malarial fever
- Consumed as raw or roasted
- Stalks used as fuel
- Oilcakes- contain 40-44 % proteins- so good for poultry & livestock rations

### Climatic requirement:

- Short duration, photo insensitive
- Requires cool climate from germination to seedling stage
- Warm weather – seedling to flowering stages
- Warm & sunny days- flowering to maturity
- High humidity, cloudy weather, heavy rainfall- at flowering- poor seed set
- Rainfall- 200 to 750 mm
- High temp. affects oil quality & quantity

### Soil requirement:

- Any soil with good drainage
- Best- deep loam soil with 6.5 to 8.5 pH
- Grow best on heavy black cotton soil

### Field preparation

- One- ploughing
- 2,3- harrowing
- Planking

### Seeds & sowing:

- Sowing time: 1<sup>st</sup> fortnight of Oct. to 1<sup>st</sup> fortnight of Nov.
- Seed rate: 8-10 kg/ha, Hy.- 5-6 kg/ha
- Spacing: Heavy soil-60 x 30 cm, medium- 45cm x 30cm

- Depth: 5-6 cm
- Seed treatment: 1. water soaking- quick germination  
2. thirum@3gm/kg  
3. Azotobactor@250/10 kg seeds
- Sowing method: drilling, dibbling

**Manures & fertilizers/ Nutrient management:**

- For irrigated crop- 5-6 T/ha
- For rainfed crop- 2.5 T/ha
- **Recommended fertilizer dose:**

	N	P	K
Irrigated crop	60	30	30
At sowing	30	30	30
30DAS	30	00	00
Rainfed crop	50	25	25

**Water management:**

- Total water requirement- 30 -35 ha cm
- No. of irrigations – 4
- Critical growth stages- Seedling(15-20DAS)  
Capitulum initiation(30-35 DAS)  
Flowering(45-50DAS)  
Grain filling(60-65 DAS)

**Weed management:**

- 1,2- hand weeding or hoeings -15 DAS, 30 DAS
- Pendimethalin @ 1.5 – 2 Kg a.i. – as pre emergence spray

**Diseases:** Rot,Blight,Wilt

**Pest:** Cutworm,Tobacco caterpillar, Bihar hairy caterpillar,Semi- looper,Bugs

**Harvesting & yield:** Signs of maturity: Head turns yellowish- brown

Moisture in seed is 20 %

plant become– brown & dry

Harvesting: 2-3 times, Cutting heads

- Drying- threshing by bitting with sticks

Yield: irrigated- 15-20 q/ha, rainfed- 10-15 q/ha

**Varieties:** Modern, Bhanu, Surya, Sunrise selection, Phule raviraj

## Mustard & Rape seed

B.N: Brassica juncea

F: Cruciferae

O.: China

Rape seed: India, Afganistan

Sarson	Yellow	Brassica campestris vr. sarson	Rape seed
	Brown	Brassica campestris Vr. Dichotoma	
	Gobhi	Brassica napus	
Toria	Toria	Brassica campestris vr. toria	
Taramira	Taramira	Euruca sativa	

### Economic importance:

- Major rabi oil seed crop- India
- Contain- 37-49% oil
- Seed & oil- used as condiment( in pickles, for flavoring curries & vegetables
- Oil- also used in- hair oils, medicines, soap making, for lubrication
- Rape seed oil- used in manufacturing of griss
- Oil cake- cattle feed & manure
- Green leaves of young plant- vegetable
- Green stem leaves- fodder for cattle

### Climate requirement:

- Require cool climate- for growth
- Dry weather- at maturity
- Rainfall- 35 to 45 cm
- Sarson & taramira- prefer low rainfall
- Mustard & toria- prefer medium to high rainfall
- Frost- injurious at flowering

**Soil requirement:** Grow best on light loamy soils- with neutral pH. Plants- can tolerate salinity. Can be grown on sandy loam to clay loam soils

**Field preparation:** As seeds of these crops are- small. It requires fine seed bed for good germination. 1-2 ploughing followed by 3-4 harrowings, Followed by planking

**Botanical description:** Herbaceous, annual plant, Tap root system, Leaves- broad at base, narrow at top, Flower- yellow

- Fruit- siliqua

**Seeds & sowing:**

- Sowing time- 1<sup>st</sup> fortnight of Oct.
- Spacing: Mustard & sarson- 45 cm x (10-15)cm, Toria- 30 cm x 10-15 cm
- Seed rate : for pure/sole crop- 5 to 6 kg/ha, for inter/mixed crop- 1.5 to 2 kg/ha
- Sowing method: drilling
- Sowing depth: 2.5 – 3 cm
- Seed treatment: 1. thirum @ 2.5gm/kg seeds, 2. Mixed with fine sand/soil

**Manures & fertilizer requirement:**

- 15-20 T/ha FYM
- RDF: Rainfed- 40:20:00 kg NPK/ha- Whole dose apply- at sowing  
Irrigated- 50:25:00 kg NPK/ha- ½ N & full P & k- at sowing, ½ N- 30-35 DAS

**Weed management/After care:**

1. Thinning & gap filling: Thinning- 2 times- 1<sup>st</sup>. 15DAS, 2<sup>nd</sup>. 25 DAS
- 1-2 hoeing & 1-2 weedings
  - Herbicide- isoproturon as pre- emergence spray

**Water management:**

- Total water requirement- 25- 30 ha cm. No. of irrigations- 2
- Critical growth stages: flowering, pod filling stage

**Cropping system:** Crops mixed with wheat, barley, gram. Inter crop- sugarcane

- Crop rotation: maize- toria- wheat, green gram- mustard

**Harvesting & yield:**

- Signs of maturity: Pods turn yellow, Harvesting should be done just before pods open to avoid shattering
- Harvesting method: Cut close to ground
- Drying(5-6 days)--- threshing(by biting/ trampling)
- Yield: Rainfed- 8-10 q/ha, Irrigated- 12-15q/ha

**Pest:** Mustard saw fly, Bihar hairy caterpillar, Mustard aphids

**Diseases:** Blight, Downy mildew

**Varieties:** Mustard-Varuna, sita, pusa bold, prakash, TM-21

**Rape seed**-Brown sarson, pusa kalyani, BSH-1, KBS-1

**Yellow sarson**-Pusa bahar, S-24, K-88

**Toria**-Sangam, agrani, T-9, T-36

**Taramira**-T-27, TMC-1

## LINSEED

B.N- *Linum usitatissimum*

Family- Linaceae

**Origin-** 1. small seeded type ( mainly grown for oil purpose) south west asia (India,Afghanistan,Turkey)

2. Bold seeded type (grown for fibre purpose) Mediterranean region (Egypt,Algeria,Spain,Italy,Greece)

### **Economic importance-**

1.It is important oilseed & fibre crop

2.Seed contain 33-47% oil

3.Due to its quick drying property is used to prepare paints, varnishes, printing ink,soap & waterproof fabrics

4.Oil cake is very good cattle feed & contains 36% protein

5.Oil cake is also used as organic manure contain-5% N,1.4% P,1.8 % K

6.Husk & straw is used for making ropes,paper,rugs &twines

### **Climate-**

1.Linseed is cool season crop

2.Ideal temperature range is 21-26.5 c for its growth

3.High temp above 32c during flowering stage reduces yield,oil content & oil quality of seed

4.Plant are susceptible to frost at the time of flowering

5.Crop is suitable for low rainfall area

6.This crop is grown in areas receiving 45-75cm rainfall

**Soil:** It grows best on well drained loam to clay loam soils rich in humus content.

In Maharashtra linseed is grown on black cotton soils.The crop can tolerate soils acidity to some extent but ideal PH is 6.

**Land/Field Preparation-** It needs weed free & fine seedbed. After harvesting of previous crop one ploughing followed by 2, 3 harrowing are sufficient.

**Seed&Sowing-** 1.Seed treatment-

Seeds are treated with thiram @3gm/kg of seeds to control seed born diseases.

2.Seed Rate- Small seeded crops- 8-10 kg/ha (for drilling)

Bold seeded crops -20-30kg/ha, broadcasting- 40kg/ha

3. Spacing- 30cmx15cm, 45cmx10cm

4. Sowing Time- 1<sup>st</sup> wk of Oct.-1<sup>st</sup> wk of Nov.
5. Sowing Method- Drilling & Broadcasting
6. Sowing Depth- 2-3cm deep.

#### **Manures & Fertilizers-**

-Apply 8-10 well decomposed FYM/ compost at the time of field preparation.

-Recommended dose of fertilizer-

1. For Rainfed crop- 25:50:00kg NPK/ha (whole dose is apply at the time of sowing as a basal dose)
2. For Irrigated crop- 60:30:00 kg NPK/ha  
- half dose of N and full dose of P<sub>2</sub>O<sub>5</sub> is applied at the time of sowing and remaining half dose of N is applied at 40-45 DAS

#### **Irrigation/ water management:**

-It is mainly grown as rainfed crop

-2 irrigations are sufficient to obtain good yield

-If irrigation facilities are available, 1<sup>st</sup> irrigation is given at 30-40 DAS

2<sup>nd</sup> irrigation is given at- just before flowering

-If sufficient rainfall is available, there is no need of irrigation

#### **Weed control/management/interculturing:**

1. thinning is done at the time of 1<sup>st</sup> weeding to maintain plant to plant spacing

2. 1-2, weedings are given- 1<sup>st</sup> weeding- at 3 wks after sowing

2<sup>nd</sup> weeding- at 6 wks after sowing

**Harvesting & yield:** The crop takes 130-150 Days to mature.

Signs of maturity:

- The crop may be harvested when the leaves are dry, plant turn golden yellow in colour, capsules become dry & brownish & seed become shiny.

Harvesting method-

-Harvesting is done by cutting the plant close to ground with the help of sickle or uprooting the plants.

-After harvesting, tie the plant in bundle & leave them on threshing yard for 4-5 days drying. After drying, threshing is done by trampling under bullocks feet or by beating with sticks.

( For fibre purpose )- Harvesting should be done at physiological maturity when crop is green.

Yield- 5-7 q/ha

**Diseases-** rust, wilt, powdery mildew, leaf spot

**Insect pest-** linseed midge, leaf miner, caterpillar, cutworm

**Varieties- Oil purpose-** Malshiras-10 , Solapur-36 , N-3 , No-55 , Kiran , Sheetal, Jawahar-552 , K-2 , Neelam , Mukta , Hira , Himalini .

Dual purpose varieties- Jeevan , Gaurav , Nagarkot , LCK-8528

## Sugarcane

B.N.: *Saccharum officinarum*

F.: Gramineae

Origin: New guinea & India

### Economic importance:

- Main source of sugar in India
- India has largest area & ranks 1<sup>st</sup> in sugar production
- Sugar juice is used- for making white sugar, brown sugar & jaggery
- Main crop of earning foreign exchange
- Byproducts of sugar industry- bagasses & molasses
- Bagasses- used as a fuel & also used for production of compressed fibre board, paper, plastic
- Molasses- used for manufacture of ethyl alcohol, butyl alcohol, citric acid, rum (potable spirit)
- Molasses- used as feed for livestock
- Green tops- good source of fodder for cattle
- Pressmud- used as manure in alkaline & saline soil
- Create employment generation

### Classification

- 3 species are cultivated.
- 1. *Saccharum officinarum*: (New Guinea)
  - Thick & juicy canes, Good for chewing purpose, High sugar content, low fibre & high tonnage, So called noble cane, Resistant to smut
- 2. *S. sinense*: (North east India)
  - Long & thick stalks, broad leaves, low to medium sucrose content, Early maturity, Internodes-long & zigzag & nodes-prominent
- S. barberi*: (North east India)
  - Short & thin stalks, narrow leaves, Low to medium sucrose content, Early maturity

### Botanical description:

- Tall perennial plant growing erect upto- 5-6m
- Plant composed of 4 parts- Root system, Stalk, Leaves, Inflorescence
- Root system
  1. Sett roots: Developed at base of every cane joint, Thin, much branched, function for limited period, Provides moisture & nutrients for primary shoots
  2. Shoot roots (are permanent roots)
    - After emergence of primary shoot, roots developed at lower nodes, 1<sup>st</sup> formed roots go downwards, roots formed near root soil surface- provide anchorage for plant, thick, fleshy & white



- Stalk: Cylindrical & formed by nodes & internodes, Rootstock- a small portion of stalk below ground, At each node- there is bud/eye, on opposite sides, Buds protected by leaf sheath, Just below bud- is a raised portion called- leaf scar, Also wax band just below the nodes, Immediately above each node 2/3 translucent dot i.e root primordia- give rise to sett root, Branches formed grow from below soil- tillers, Single cane produce 20-40 tillers( variety & climate)
- Leaves: Alternately on opposite sides of cane, 2 parts- leaf blade, leaf sheath  
Leaf blade- long, flat, 1-1.5m long, 5-7cm wide, yellowish green to dark green in colour (variety & nutritional status), Mid rib- is prominent with groove on upperside  
Leaf sheath- attached to stalk by basal ring, light green in colour, outer surface is hairy
- Inflorescence: Called Arrow , Long & tapering, Sugarcane flowers usually at age of 10-12 months. So propagated vegetatively

#### **Climate:**

- Is tropical plant but also grown in subtropical
- Hot humid climate- during growth
- Cool & dry climate- during maturity
- Deficient rainfall- produces fibrous cane, heavy rainfall- results in low sugar content
- Rainfall- 75-120 cm with fairly high humidity
- Temp. above 50<sup>0</sup>c decrease its growth & below 20<sup>0</sup>c slow its growth
- Low temp. reduces tillering
- For growth- 26-32<sup>0</sup>c best suited
- For germination- 25-32
- S'cane- requires long growing season for 10-12months
- Temp., rainfall, light- plays important role- in proper growth & development of cane
- Under bright sunlight condition- stems are thicker but shorter, leaves are broader & greener
- Under low sunlight- stems are slender & long, leaves are- narrow & yellowish  
Day length influences tillering & flowering
- Short day length- decreases no. of tillers/plant
- Long day length- plant grows produce more dry matter

**Soil:** In north India- Cultivated largely on loams & clay loam soils. In peninsular India- grown on brown/reddish loam, lateritic, Black cotton soils. On lighter soil with adequate irrigation facilities . On all type of soils from sandy loam to clay loam. Saline, alkaline, acidic soils not suitable .Thrives best on well drained loamy soil. On heavy soil- with proper drainage & addition of organic matter

### Field preparation:

- Shallow ploughing- results in lodging of cane due to poor root development
- 1 deep ploughing followed by 2-3 harrowings. Followed by planking to make field smooth & clod free

### Seed & sowing:

#### Seed selection

- Healthy seeds – it should be pest & diseases free
- Top 1/3<sup>rd</sup> to half portion of cane should be used- It has high viability buds
- Bottom portion is rich in sugar & takes long time for germination
- Not more than 10-12 months age
- Plant within 24hrs
- Seed material should be changed after every 4-5 yrs

#### Seed treatments

1. Water soaking: Soak seed material in water for 12-24hrs- for better germination
2. Lime water treatment: Given for more age & dry eye buds
  - Soak in lime water for 24 hrs. Dissolve 500gm lime in 180 lit. of water
3. Fungicide treatment: Setts are dipped in 0.1% Bavistin/ 0.25% Aretan/0.5 % solution of Agallol(3%) for 2-3 min.
4. Hot water/Air: Specially given to setts to be planted in seed nursery
  - Setts treated with hot water 50<sup>0</sup>c for 2 hrs OR 52<sup>0</sup>c for ½ hrs or hot air 52<sup>0</sup>c for 6 hrs OR moist air 54<sup>0</sup>c for 4 hrs OR aerated steam 50<sup>0</sup>c for 2 hrs. To control grassy shoot, red rot, ratoon stunting diseases.
5. Acetobacter culture & PSB culture: Acetobacter 10 kg+ 1.25 kg PSB per 100 lit. of water for 30 min. Due to this seed treatment there is saving of 50% N & 25% P<sub>2</sub>O<sub>5</sub> fertilizer

#### Planting time

1. Spring planting: known as Eksali :feb.-March, March best time for planting, In Maharashtra- Dec. to feb. Jan. is optimum time
2. Autumn planting: Sept. to oct., Maharashtra- 15<sup>th</sup> Sept. to 15<sup>th</sup> oct. Crop matures in 13-15 months, Called pre-seasonal planting in MS. & gujrat
3. Adsali: 15<sup>th</sup> jul to 15<sup>th</sup> Aug. Planting done commonly in MS

#### Spacing : Spacing between row to row

1. Heavy soil- 120 cm
2. Medium – 100cm
3. Light – 90-100 cm
4. Paired row/patta method- 75-150 cm or 90-180cm

Spacing between plants: For one eye budded planting- 30cm

For 2 eye budded planting- 15-20 cm

#### Seed rate:

1. For one eye bud setts- 30,000/ha
2. For 2 eye bud setts- 25, 000/ha
3. For 3 eye bud setts- 25,000/ha

4. For transplanting- 6000 for Acre i.e. 1,50000 seedlings

### Planting methods

1. Wet method: Light to medium soils. 1<sup>st</sup> allow water in furrows- press setts 5-7cm deep-by feet. Care should be taken- that eye buds are on lateral sides of setts
2. Dry method: For heavy soils. Setts placed in furrows by keeping eye bud lateral side & covered with soil. Then light irrigation is given. Adopted in Adsali planting

On the basis of layout/system of planting

1. Flat planting
2. Rides & furrow
3. Trench/Jawa method
4. Pit/ring method
5. patta/paired row method
6. IISR- 8626

On seed material used

1. Normal/conventional method
2. Rayungan/ rajooning method
3. Spaced planting
4. Spaced transplanting technique(STP)
5. Partha method
6. Strubble/clonal method

### Nutrient management

- Is heavy feeder crop
- Fertilizer requirement is depends on soil & climatic condition
- Being long duration plant- needs adequate amount of organic manure for long term & continuous supply of nutrients
- Therefore well decomposed FYM/compost-@For suru-20t, preseasonal-25 & adsali-30t/ha- at the time of land preparation

Recommended fertilizer doses	Adsali			Pre- seasonal			Suru		
	N	P	K	N	P	K	N	P	K
At the time of planting	40	85	85	34	85	85	25	60	60
6-8 WAP	160	-	-	136	-	-	100	-	-
12-16 WAP	40	-	-	34	-	-	25	-	-
20-24 WAP (final earthing up)	160	85	85	136	85	85	100	55	55
<b>Total</b>	<b>400</b>	<b>170</b>	<b>170</b>	<b>340</b>	<b>170</b>	<b>170</b>	<b>250</b>	<b>115</b>	<b>115</b>

### Fertilizer schedule for Ratoon management:

Time	N	P	K
Within 15 days after harvesting	75	115	115
2 months after harvest	75	-	-
At the time of earthing up	100	-	-

Total	250	115	115
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### Water management:

Planting time	Total water requirement	No. of irrigations
Adsali	340-350	38-42
Pre seasonal	300-325	32-40
Suru	250-275	28-30
Ratoon	225-250	26-28

- Give irrigation as per season- i.e. In Summer- 8-10 days interval  
In Kharif- 14-15 days interval  
In Rabi- 18-20 days interval
- Growth Phases/ stages: Germination phase (planting to 60<sup>th</sup> day)  
Formative phase (60<sup>th</sup> day- 130<sup>th</sup> day)  
Grand growth phase (130<sup>th</sup> day - 250<sup>th</sup> day)  
Maturity phase (250<sup>th</sup> - 365<sup>th</sup> days)

### Weed management:

- Weeds directly reduce cane yield & sugar yield & provide favourable atm. For pest & disease
- 60-80 % yield loss
- Gap filling- should be done 6-8 wks of planting
- Hoeing- 2-3 hoeing should be given at monthly interval till earthing up
- Weed control- at initial stages weed control is more important
- In suru planting- 2-3 times
- In pre-seasonal planting- 3-4 times
- In Adsali planting- 4-5 times

### Chemical weed control-

Atrazine	1-2 Kg a.i./ha in 700-1000 lit. of water	Pre-emergence
Metribuzine	1-1.5	Pre-emergence
2,4 D	1-1.5	Post emergence
Glyphosate	0.6-1.6	Post emergence

### Earthing up: Light earthing up- 12-16wks after planting(3-3.5 months)

- Final earthing up should be done- 20-24wks after planting(4-4.5 months)
- To prevent the crop against lodging due to heavy winds & to keep the crop field open for better aeration, propping is done by tying the canes together using the dry leaves & bottom green leaves.

- Tying should be done in Aug, when cane reaches about 2 m ht.

**Mulching:** The cane trash use as mulch to conserve moisture

- Helps in reducing the water requirement of crop
- Useful for suppressing weed growth

**Detrashing:** Removal of dried leaves from lower parts of plant called detrashing

- Detrashed leaves are useful for mulching & defoliated green leaves are useful for fed to cattle

**Cropping system:** Crop rotation - Paddy-S'cane- ratoon –wheat

Cotton- s'cane- Rabi sorghum

Cotton- s'cane- gram

Bajra- Pre seasonal s'cane- ratoon- wheat- sunhemp

Adsali s'cane- Ratoon- wheat- sunhemp

Inter cropping: Grow short duration crops in between two rows. Usually intercropped with maize, onion, garlic, potato, bhendi, peas, cowpea, soybean, cole crop, mustard, gram

**Harvesting:** Signs of maturity:

- Yellowing of leaves
- Plants stop growing & emergence of arrows in case of flowering varieties
- Swelling of eye buds
- Breaking of cane at nodes
- Increase sweetness of juice
- Cane gives metallic sound
- Brix reading should be 19 to 24<sup>0</sup> at harvesting
- Hand refractometer reading should be 21- 24<sup>0</sup>
- Harvesting is done by means of cutting the plant at bottom with sharp chopper, detrash the trash & cut the tops

Yield -Suru planting: 100 T/ha, Pre seasonal- 125 T/ha, Adsali- 150 T/ha

a) Varieties for suru & pre- seasonal planting-

- CO-86032(Nira), CO-94012(Phule savitri), CO- 8014 (Mahalaxmi), COM-88121(Krishna), COM-7125(Sampada), CO-419, CO-740, CO-7219(Sanjivani), CO-0265(Phule-265)

b) Varieties for Adsali planting:

- CO-86032(Nira), COM-0265(Phule-265),CO-740, COM-88121(Krishna), COM-671

c) Varieties for ratoon s'cane:

- CO-740,CO-7219,CO-86032,CO-94012,COM-0265

### **Ratooning in sugarcane:**

- Ratoon is a crop, which is allowed to grow in the same field from roots of the previous crop without planting new seed setts

Advantages:

- Save cost of seed bed preparation, planting & planting material
- Utilizes residual fertility of the previous crop
- Crop matures earlier
- Total cost of cultivation is less

Disadvantages:

- Severe attack by pests & diseases
- Soil become poorly fertile

### **RATOON MANAGEMENT:**

- Short duration varieties have good ratooning ability should be selected
  - Any harvested plant cane upto 1<sup>st</sup> fortnight of feb. can suitable to maintain for ratooning purpose
  - Stubble cutting should be completed immediate after harvest of plant crop to encourage shoots from lower nodes & to have uniform plant stand
  - On cutting stubbles spray 0.1% Bavistin
  - Within 8-10 days after harvest of plant crop the soil near the stubble should be loosened
  - 1<sup>st</sup> dose of fertiliser has to be applied within 15 days after harvest of plant crop & irrigate the field
  - Trash material @ 5t/ha has been found beneficial if incorporated
  - Use 8kg urea+ 10 kg SSP+ 1Kg decomposing culture per 1 ton of trash for easy composting of trash
  - Gap filling with plantlets raised from one eye bud setts
  - Use biofertilizer & micronutrients- to improve ratoon yield.
  - Spraying of 0.5 % FeSO<sub>4</sub> + 0.2% MgSO<sub>4</sub> + 12.5% urea is recommended for control of mosaic disease
  - Final earthing up should be given 3.5 to 4 month after harvesting of crop
  - Ratoon crop matures earlier, usually in Oct. therefore, it should be harvested earlier
- Yield- 100 T/ha

## Potato

B.N.- *Solanum tuberosum*

F.- Solanaceae

Origin- South America

### Economic importance:

- Most imp. Food crop of India (poor mans friend)
- Rich source of starch, vitamins especially C & B1 & minerals
- Contain 20.6 % CHO, 2.1% protein, 0.3% fat, 1.1% crude fibre & 0.9% ash
- Also contain essential amino acids like leucine, tryptophane & isoleucine
- Used for several industrial purposes such as starch & alcohol
- Starch used in laundries & in textile mills
- Used for production of dextrin & glucose
- Dried products- chips, slice

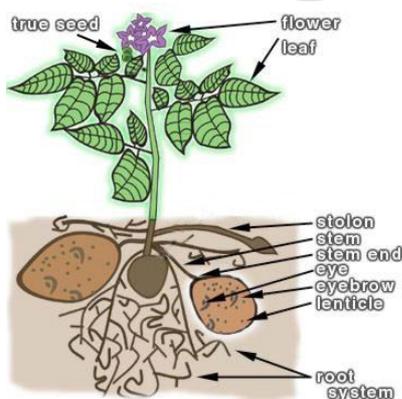
**Classification:** Consist of 7 cultivated sp. & about 154 wild sp. But commercially cultivated sp. are only 2.

1. *Solanum andigenum*:

- Not very common, thin long stem & narrow leaf lets

2. *Solanum tuberosum*:

- More common, plants have shorter & thicker stem & wider leaf lets.



Potato is an enlarged underground stem produced on the end of stolon & not on roots



**Botanical description:**

- Leaves: Are alternate & compound, Arise along the stem, There are 3-4 pairs of leaflets
- Root system- adventitious, arising from base of sprout, Roots usually restricted to top layers, at 20-25 cm, In rich soils roots reach up to 90-100cm
- Flowers-In terminal clusters
- Fruit- In the form of berries.

**Climate:**

- Cool season crop
- Which requires low temperature, low humidity & bright sunny days
- 25<sup>0</sup>c temperature is required for- germination and 20<sup>0</sup>c- for vegetative growth
- Between 17-20<sup>0</sup>c – for tuberization & tuber development
- Temp. above 30<sup>0</sup>c- stop tuber formation completely because at higher temp. rate of respiration increases & carbohydrates formed by the process of photosynthesis is consumed rather than stored in tubers
- High temp. at any stage- affect size of leaflets, tuber formation
- Cloudy days, rains & high humidity- spreads fungal & bacterial diseases

**Soil:**

- Soils for potato should be friable, well aerated, fairly deep & well supplied with organic matter
- Well drained sandy loam & medium loam soils, rich in humus- are most suitable for potato
- Alkaline or saline soils- not suitable
- Can be grown on slightly acidic soils(5-6.5 pH)
- Highly acidic conditions- scab disease
- Light soils- preferred because they promote more uniform soil temp. & make harvesting easy

**Cropping system:**

- Intercrop- sugarcane
- Also with- wheat, radish, carrot
- Rotations-
  - maize- potato
  - Rice- potato
  - Maize- potato- maize

- Maize- potato- sugarcane
- Maize - potato- potato

### **Field preparation:**

Well pulverised seedbed- required for good tuberisation of potato. Give 1-2 ploughings (20-25 cm deep), Followed by 2-3 harrowings or 4-5 ploughings , Followed by 1-2 plankings

### **Seeds & sowing:**

Seed treatments: 1. Chlorocin & boric acid solution: Wash tuber in water , Dip in 1% chlorocin solution , Rinse in fresh water , 3% boric acid solution for 30 min , To control black scurf & scab disease

2. Thiourea: To break dormancy tubers are treated with 1% thiourea + 1ppm gibberellic acid- for 1 hr. Then 3% ethylene chlorohydrin solution & Keep tubers in air tight space for 72 hrs.

Planting time: Rabi- mid Oct to mid Nov, Kharif- June to July

Seed size, Seed rate & spacing:

- Tubers having 30-50 gm wt.- most economical & give highest yield
- Whole tubers should be planted for early crop
- For main crop, cut tuber are planted. While cutting the tubers, care should be taken that each piece has 2-3 eyes & weights at least 25 gm

Seed rate: whole tubers 20-25 q/ha (early crop), Cut tubers 15-20 q/ha

Spacing

- For early crop- (55-60) cm x (20-25) cm
- For main crop- (45-60) cm x (15-20) cm

**Methods of planting:** 3 methods of planting in India:

1. Planting potatoes on ridges

- Ridges made at distance 45-60 cm, planting with the help of khurpi

2. Flat method:

- Planting on flat surface in shallow furrows, 60 cm apart ridges are made after germination, when plants attain 10-12 cm ht,
- Method suitable for light soils, then 2-3 earthings done

3. On flat surface followed by ridges:

-Shallow furrows are opened 60 cm on flat surface, potatoes are planted in furrows & then small ridges are prepared, ridges- made thick by earthing up

**Manures & fertilizers:** Heavy feeder crop

- 20-25 T/ha- well decomposed FYM/compost- at the time of land preparation

- RDF- 100-120 Kg: 60-80 Kg: 100-120 Kg NPK/ha
- Apply half N & full P&K- at the time of planting
- Remaining half N- 30-35 DAS i.e. at earthing up

#### **Water management:**

- Total water requirement- 50-60 hacm
- No. of irrigations required- 8-10
- Medium to heavy soils- 3-4
- 1<sup>st</sup> – immediately after planting
- 2<sup>nd</sup> – 1<sup>st</sup> wk after planting
- Subsequent irrigations given at 6-8 days interval
- Critical growth stages-
  - germination(10-12DAP)
  - Stolon formation (30-35DAP)
  - tuber bulking(55-60 DAP)

#### **Earthing up:**

- 1<sup>st</sup> – at 15-22 cm i.e. at 25-35 DAP
- 2<sup>nd</sup> - at 2 wks after 1<sup>st</sup> earthing up
- It is essential to loosen the soil around the plants and to cover tubers
- After earthing up it is essential to provide one light irrigation

#### **Weed Management:**

- 1 weeding –at 15-20 DAP & 1 weeding with hoeing – at time of earthing up about 30-35 DAP
- Fluchloralin(Basalin) @ 0.675-1.125 kg a.i/ha as a pre-planting spray or
- Alachlor(Lasso) @ 2-2.5 kg a.i/ha as a pre emergence spray
- propanil@ 1 kg a.i./ha- post emergence spray

**Diseases:** Late blight, Early blight, Black scurf, Bacterial wilt & brown rot, Wart , scab

**Insect pest:** Epilachna Beetle, Cutworms, Aphids, Leaf hoppers, White grub, Potato tuber moth

#### **Harvesting & yield:**

- Crop- harvested when haulms start yellowing & falling on ground
- Haulms should be removed at ground level
- Crop harvested 15 days after cutting haulms
- Digging is done with kudali or by ploughing the field or by use of potato digger & exposed tubers are collected.

- There should be optimum moisture in the soil at the time of harvest
- After digging, tubers- allowed to dry on ground in shade
- **Yield-** 30-40 t/ha

**Varieties:**

- Early varieties: Kufri Chadramukhi, kufri Alankar, kufri Lavkar, Kufri Navtal, kufri shakti, pukhraj, Kufri Deva
- Medium & late varieties: Kufri -sinduri, kissan, jyoti, red, chipsona-1, chipsona2, swarna, lalima, bahar, badshah
- Hill region- Kufri jyoti, kufri jeevan, kufri naveen, kufri neelmani, kufri moti, kufri lavkar, kufri navtal
- New varieties- kufri frysona,

## Berseem (Egyptian clover)

**Botanical Name:-** *Trifolium alexandrium* L

**Family:-** Leguminosae

**Origin:** Egypt

**Economic importance:**

1. Berseem is an important winter forage crop.
2. It has 20 % crude protein & 70% dry matter digestibility.
3. It is quite nutritive & succulent , it is also rich in Ca(2.89%) & Phosphorus (0.40%).
4. It is palatable forage crop & preferred by all classes of livestock.
5. Berseem is known to stimulate milk production in dairy cattle.
6. It is very good soil binder & adds about 0.38 to 46% organic carbon, 15-16kg available phosphorus & 45kg available Nitrogen to the soil. There is increase in microbial population
7. If it is fed alone to the cattle and they may suffer from bloating. Therefore, it must be mixed with dry fodder & then fed to the cattle.

**Botany:**

Berseem is small herbaceous annual growing upto a height of 60 to 90 cm. the root system is not as deep as lucerne. The stems are hollow & succulent but become fibrous after flowering stage. Leaves are small tender slightly hairy on upper surface & trifoliate. Flower heads are round & yellowish while in colour. The seed is small in size, about 2mm in length, egg shaped & greenish yellow

**Soil:**

Medium to heavy soil, with well drained.

**Climate:** As like Lucerne crop.

**Land preparation:** As like Lucerne crop.

**Seeds & sowing:**

- 1) Seed treatment:- Same as like Lucerne crop.  
*Rhizobium trifoli* @ 250 gm/10kg seeds
- 2) Time of sowing:- October-November
- 3) Methods of sowing:-Drilling at 30cm apart
- 4) Seed rate:- 30kg/ha
- 5) Spacing :-Distance between two rows 30cm

**Nutrient management:** Fym/compost@ 15-20 tones/ha is applied before last harrowing. **RDF:** 25:120:40kg NPK/ha at sowing time

**Interculturing:** one weeding and one hoeing are sufficient for controlling weeds.

**Water management:** Interval between two irrigation is 10-12 days.

**Harvesting:**

Always harvest the crop at 50% bloom stage. First cutting should be done after 45-50 days from sowing, and subsequent cutting are taken 25-30 days interval. Total number of cuttings is 3-4.

**Yield:** 60-80 tones/ha

**Varieties:** Vardan, Meskavi, J.B-1, JHB-146.

**Nutritive value:** - 17-19% crude protein.

## Lucerne (Alfalfa)

**Botanical Name :** *Medicago sativa* ,Linn.

**Family :-** Leguminaceae

**Origin:** southwest Asia

**Economic importance:**

1. Alfalfa or Lucerne is one of the oldest cultivated fodder crops which practically grown in almost all Parts of world but particularly does well in drier parts of world.
2. It is generally grown in areas where water supply is inadequate for berseem crop.
3. Being a deep rooted crop Lucerne extracts water from the deeper zone of the soil.
4. It can be grown as rainfed in high water table area both as annual as well as perennial crop.
5. The crop may supply green fodder continuously for 3 to 4 years as a perennial crop.
6. The green fodder of Lucerne is very nutrition, palatable and is relished by all classes of Livestock.
7. It is rich in crude protein with 72% digestibility. Minerals ,ca 1.5%,P 0.2% dry wt.& high amounts of vitamin A and D.
8. It can be considered as **a king of legume forages** since rich in nutrients, however it should be used only in small quantity of Lucerne feeding .
9. Hay of Lucerne may replace use of grains and concentrates.

### **Botanical Description :**

- herbaceous annual as well as perennial plant .
- height of 60-150cm.
- root system- deep root system
- stem is erect & branches arise from crown.
- Crown is the compact stem at the point just above ground level.
- Leaves- are trifoliate
- Flower - usually purple, but it may be blue, yellow or white.
- Seeds- kidney shaped, small light in weight & yellowish brown with shiny surface.

### **Climatic requirements :**

- Lucerne can stand a wide range of temperature.
- Require cool and dry climate for its growth.
- It thrives best under cool, dry and sunny conditions.
- High temperature with high humidity is not suitable.

### **Soil requirement :-**

- It can be grown on a wide range of soil from sandy loam to clay.
- It grows best on well-drained fertile deep loam soils.
- It does not thrive well on very heavy and waterlogged soils.
- Crop can't be grown on alkaline soils but can be grown on acid soils.

### **Land preparation/ seedbed preparation :**

- Lucerne needs a fine, well- leveled seedbed with adequate moisture.
  - A fine seedbed ensures better contact of seeds with soil particles and facilitates better germination.
  - All the weeds & stubbles should be removed from the field before sowing.
  - Plough the field once with the mould board plough and 3-4 times with local wooden plough or 2-3 harrowing followed by planking each time to ensure fine & firm seedbed.

### **Seed & sowing :**

#### **a. Seed Treatment :**

seed should be treated with *Rhizobium meliloti* culture @ 250 gm/10 kg of seeds, which helps in nitrogen fixation after the establishment of seedlings.

#### **b. Time of sowing :**

Mid October-Mid November

- delayed sowing resulted in poor germination , poor growth and ultimately low fodder yield due to extreme low temperatures at beginning & high temperature in February –March.

**c. Method of sowing :**

broadcasting, line sowing i.e. seed broadcasted in lines. Care should be take that seed should not go more than 1-cm depth. Seed may be sown either by pre sowing irrigation or irrigation is given after broadcasting the seed.

**d. Seed rate :**

25kg/ha for drilling

**e. spacing:** seed may be drilled in lines 30 cm apart with seed drill

**Manures and fertilizers/ Nutrient management:**

- It is being leguminous crop fulfils its major part of nitrogen requirement through symbiotic nitrogen fixation witch works effectively from 3-4 weeks after sowing.
- However , a starter dose of 150kg n/ha is needed at initial stages witch help in better and quick growth of Lucerne seedlings.
- An adequate application of phosphorus is necessary for proper functioning of modules .
- application of 150kg P<sub>2</sub>O<sub>5</sub> and 40 kg K<sub>2</sub>O/ha as a basal dose before sowing gives remarkable increase in yield
- 15kg N 50kg P<sub>2</sub>O<sub>5</sub> or 100 kg DAP after every every month.
- fym /compost @20 t/ha has an additional effect on the growth of Lucerne ,it is heavy feeder of soil nutrients , some of essential micronutrients such as boron ,iron, zinc and manganese etc. are also likely to become deficient in certain soils and should have supplied through soil or foliar spray.

**Water management :**

To attain good germination ,pre sowing irrigation is essential .since lucren takes a long time to establish at early stages very frequently irrigations at an essential interval of 7-10days are required .later on this interval may be extended as the root system gets well established .Lucerne crop is usually irrigated at 8-10 days interval during summer and 10-12 days interval during winter .water required for lectern is quite high being 858lit.of water per kg of dry matter produced ,the crop required about 20-25 irrigations in a year .during rainy season do not allow water to storage in the crop.

### **Weed control-**

Lucerne takes a long time to establish itself and gives ample scope for weed infestation up to the first cutting .it is very difficult to control weeds in broadcasted crop .if the crop is sown in lines weeding and hoeing becomes easier .first weeding should be done at 20-25 days after sowing and subsequent weedings at an interval of 15 days.

pre sowing applications of diurone (camrex)@2.0 kg a.i ha @3.0 kg/a.i. ha 30DAS or mcpb @0.75a.i/ha ,30DAS use effective.

### **HARVESTING:**

The october sown crop becomes ready for first cuttings in third week of December, (50-60)DAS at half bloom stage and subsequent cuttings 25-30 Days after first cutting. on an average 6-8 cuttings .which may be taken which give a total yield 50-60t/ha of green fodder.

### **Varieties:**

sirsa 9 , anand 2, sirsa 8 ,NDRI-selection no. 1, Rambler, chetak

## Lemon grass

**Botanical name:** *Cymbopogon flexuosus*

**Family:** Graminae

**Origin:** India (Kerala)

**Plant part:** Leaves

**Pollination System :** Cross pollinated

**Chromosome No. :**  $2n=40,60$

In India, lemon grass is confined to Kerala and Jammu. Annual production of lemon grass oil is 1000Mt. India faces stiff competition from **Guatemala** in world market.

### USES:

1. Chief constituent of the oil is Citral, which is used in the manufacture of **Vitamin- A** tablets. Lemongrass oil is thus used as a main substitute for 'Cod liver oil'.
2. Oil has bactericidal, insect repellent, mosquito repellent and medicinal uses.
3. Used for preparing flavored tea, soap and detergent making.
4. Spent grass is good cattle feed and used in making silage.
5. Spent grass is used for preparing card boards, paper and fuel.
6. **Lemon like odour**, which is mainly due to the **presence of citral**.

### BOTANY:

Genus *Cymbopogon* has 120 species, of which nearly 27 species occur in our country.

1. **East Indian lemon grass:** *Cymbopogon flexuosus*
  2. **West Indian lemon grass:** *Cymbopogon citrates*
  3. **Jammu lemon grass:** *Cymbopogon pendulus*.
1. **East Indian lemon grass:** It is indigenous to Kerala. Its oil is known as Cochin oil.
  2. **West Indian lemon grass:** It is cultivated In Guatemala and West Indies.
  3. **Jammu lemon grass:** It is cultivated in Jammu and Kangra valley. It is resistant to frost. Growth period is 8-9 months. Period of dormancy being from December to February.

### VARIETIES

**Sugandhi (OD 19):** It is adapted to a wide range of soil and climatic condition. A red stemmed variety with plant height 1 to 1.75 m and profuse tillering. The oil yield ranges from 80 to 100 kg per hectare with 85-88 per cent citral under rain-fed conditions. Aromatic and Medicinal Plants Research Station, Odakkali, Kerala released this variety.

**Pragati (LS48):** It is a tall growing variety with dark purple leaf sheath suitable for north Indian Plains and Tarai belt of subtropical and tropical climate. Average oil content is 0.63 per cent with 86 per cent citral. This variety is a clonal selection from OD19 developed at Central Institute of Medicinal and Aromatic Plants, Lucknow.

**Praman (Clone 29):** Evolved through clonal selection at Central Institute of Medicinal and Aromatic Plants, Lucknow and belong to species *C. pendulus*. It is a medium sized variety with erect leaves and profuse tillering. The oil yield is high with 82 per cent citral.

**RRL 16:** Average yield of this variety is 15 to 20 tonnes/hectare/annum giving 100 to 110 kg oil. Oil content varies from 0.6 to 0.8 per cent with 80 per cent citral. Evolved from *C. pendulus* and released for cultivation from Regional Research Laboratory, Jammu as Jammu Lemongrass.

**CKP 25:** A hybrid between *C. khasianum* X *C. pendulus*. Gives 60 t/ha herbage in North Indian plains under irrigation. Oil contains 82.85% citral.

**NIMA:** a dwarf variety developed by CIMAP found promising. The citral content of Nima is much higher than Krishna. Oil recovery is in between 0.8-1.0 %.

**Other Varieties:** Kaveri, Krishna ( released by CIMAP.), OD-408 ( released by AMPRS, Odakkali), GRL-1 and RRL-39.

#### **Climate:**

- ✓ Tropical plant.
- ✓ hot and humid climate is best, plenty of sun shine.
- ✓ Rain fall of 150- 300 cm with uniform distribution.
- ✓ Grown mainly as a rain fed crop

#### **Soil:**

- ✓ Hardy and drought resistant crop can be grown on loamy to poor laterites.
- ✓ Optimum range of pH is 4.5 to 7.5.

**Propagation:** Both by seeds and vegetative means through slips.

#### **By Rooted Slips**

- For better quality and yield of oil it is recommended to grow lemon grass by slips obtained by dividing well-grown clumps.
- Tops of clumps are cut off within 20-25 cm of the root.
- The latter is divided into slips and the lower brown sheath is removed to expose young roots.

#### **Seed propagation: Nursery:**

- Seeds are formed in November – December.
- Seeds are collected in January – February.
- Nursery beds are prepared and sowing is done during April – May.
- After sowing nursery beds are lightly irrigated.
- Seedlings will be ready in 60-75 days.

**Slips:** Mature clump is divided. Slips are treated for rooting. Rooted slips are used for propagation.

**Planting:** Land is thoroughly ploughed, leveled. Land is laid into ridges and furrows. Planted with the onset of monsoon at 60 x 45 cm. 2-3 seedlings or slips are planted per hill.

**Manuring:** A fertilizer dose of 100: 50: 50 kg NPK per ha per year is adopted. Entire P and K are applied as basal. Nitrogen is applied as 2 – 3 splits first at 30 days after sowing and remaining after each harvest.

**Irrigation:** High rainfall (well distributed) areas does not require irrigation. In dry and low rain fall areas, irrigate the crop at 7 – 10 day interval.

**Interculture:** Keep the field weed free during the initial 3-4 months and after one month after each harvest. Plants are earthed up after every weeding and after every harvest.

**Harvesting:** First harvesting is done in 90-100 days (3 months) under Kerala conditions. Subsequently cuttings are given within 3-4 months. The crop is cut 10-15 cm above the ground. Delayed or early harvest reduces citral and oil content. Three cuttings are taken in the first year. 5-6 cuttings are taken in the subsequent years. Lemon grass is perennial, yield well from 2nd to 4th year. Plantation is economical for 5 – 6 years.

#### **Yield**

The average herb yield /ha and oil production is as under:

<b>Year</b>	<b>1st year</b>	<b>2nd year</b>	<b>3rd year</b>	<b>4th year</b>
Herb yield (q)	215	360	360	215
Oil yield at 0.7 % recovery (kg)	150	250	250	150

#### **AGE OF HARVESTING**

Citral is considered as quality marker of lemongrass oil, which is influenced by age of crop. At harvesting Citral content of **Krishna variety in Assam condition** as influenced by age of cutting is given below:

Time of harvesting	Crop age at harvesting	Citral content in oil
April	52 days	71%
May	85 days	84%
June	129 days	76 %

**Distillation:** Distilled by steam distillation. Either fresh grass is directly distilled or it is first shade dried for 72 hours and then distilled after chopping. The later method was found to be better

## Citronella grass

### AREA UNDER CULTIVATION

The crop is grown in the states of Assam, Gujarat, Jammu & Kashmir, Karnataka, Maharashtra, Tamil Nadu, West Bengal and Uttar Pradesh.

**Botanical Name :** *Cymbopogon winterianus*

**Centre of Origin :** Sri Lanka

**Pollination System :** Cross pollinated, **Chromosome No. :** 2n=20

**Family: Poaceae (Graminae), Plant part:** Leaves

### PLANT DISCRPTION :

It is a tufted aromatic perennial herb with fibrous roots, erect over 2 m tall, with smooth leaves and bearing a large inflorescence.

### USES

1. Citronella oil is a raw material for production of geranial, citronellal, hydroxyl citronellal etc.
2. These are used in perfumery, soaps, and cosmetics
3. Used in pharmaceuticals.
4. Used in flavouring industries.
5. Used as an ingredient in mosquito repellent creams

### VARIETIES

**MANDAKINI :** Clonal selection, gives a little less herb yield (35 t/ha) and oils (118 kg/ha). The variey is **suitable for hills and Tarai tracts of Himalayas (CIMAP, Lucknow).**

**MANJUSHA :** Clonal selection, gives a herbage yield of 43 tons/ha. and 150 kg/ha of oil per annum. **(CIMAP, Lucknow).**

**MANJIRI :** This variety has been released by **University of Agriculture Sciences, Bangalore.** It is an elite mutant clone of Manjusha M3-8. It has been found to possess 50-90% more oil, high cirtonellol. **It has profuse tillering and rapid growing ability thus producing a high herb yields.**

**CIMAP Bio-13, Java-2, Jorhat-2** :High yielding varieties for the southern and eastern India released by CIMAP.

1. RRL – Jor – 3 – 1970: RRL, Jorhat (Assam). Oil has 46.2% Citronellol; 28.5% Geraniol.
2. NBPGR, Delhi released two strains in Java citronella viz., IW 31243, IW 31245.

**Soil:**The species has been found to grow well under varying soil conditions, but the sandy loam soil with abundant organic matter is the most suitable. Heavy clay soils and sandy soils do not support good growth of the plant. The plant has been found to grow well under a pH range of 5.8-6.0.

**Climate:**Thrive well under tropical and sub-tropical conditions. Require humid climate, abundant sunshine, well distributed rainfall of 200 – 250 cm. Long drought spells or excessive rainfall are harmful. Does not like shade. Under shade growth is poor; leaf blade becomes hard and yield less oil. Susceptible to frost. Grow well in plains and hills up to 900 m, but best elevation is 180 – 250 m above MSL.

**PROPAGATION:**Citronella is a perennial grass, however, it does not produce viable seeds, therefore, the species can be propagated only vegetatively by slips. Citronella is propagated by splitting the clumps of vigorously growing plant of 6-months to one year old into slips. The clump is gently dug out and separated into number of slips containing 2- 3 tillers/slip. The fibrous roots and leaves are trimmed off at 25 – 30 cm height before planting. One-year-old clump on an average, gives about 50 slips.

**SEASON OF PLANTING:**The ideal planting time is the beginning of monsoon (May-June). Late planting after July may result heavy casualty. Under irrigated condition March-April is also suitable when there will be low weed growth.

**METHOD OF PLANTING:**The slips are planted at 45 x 45 cm in plain land at 5-8 cm depth on one side of the ridges half way up the slope in plains or 60 x 45 cm in sloppy land. One slip is inserted in each pit, latter filled with loose soil and firmly pressed keeping the slip vertical. The soil moisture is maintained till the crop establishes. Casualty should be replaced within the next month. 40,000 slips are required to plant one-hectare area.

## MANURING & FERTILIZATION

It is a soil exhausting crop therefore requires liberal application of manures and fertilizers. In Red soils of Karnataka, where the plant grow throughout the year, apply 200 kg N; 80 kg P and 50 kg K. In Tamil Nadu; basal dose of 60 kg P and 50 kg K are to be applied. 125 kg Nitrogen is given in equal splits one month after each cutting.

**IRRIGATION:** Java citronella requires sufficient moisture for good growth and yield of the leaves. In the areas where annual rainfall is about 200-250cm, well distributed over the year and the humidity is high, supplemental irrigation is not necessary. In drier months, however, irrigation is provided twice a week during the first month of planting and thereafter once in 5 days.

## INTERCULTURAL OPERATIONS

The citronella plantations should be kept weed free. When the plants have established themselves and formed bushes, the problem is not so severe because of the very nature of growth of the bushes. The bushes do not allow weeds to grow around them by cutting off the sunlight. However, in the newly established plantations and after each harvest, the weeds grow in the inter-row spaces and weeding is essential. This can be economically accomplished by running cultivator in between the rows.

## HARVESTING

It is advisable to harvest (a partial harvest) after 3 months to induce tillering. In the first year only 3 cuts besides the partial harvest can be taken. From second year onwards, 5-6 harvests can be taken per year at 2 months intervals. Harvesting is done by sickle and cut at 15 cm above the ground. Cutting close to the ground results into mortality of the plant. Harvesting preferably is done before 12 O'clock.

**Yield:** maximum yield is recovered from 2<sup>nd</sup> to 3<sup>rd</sup> year. Later it declines.

Year	Herbage	Oil
I	15-20 T	100-120 kg
II	20-25 T	150-200 kg
III	18-20 T	150 kg
IV	13-15 T	100 kg

## POST HARVEST TECHNOLOGY

### DISTILLATION :

The grass is steam-distilled for better recovery of oil and economical purposes. The distillation equipment consists of a boiler in which steam is

produced, a distillation tub for distilling the grass, a condenser and 2-3 receivers /separators. The distillation tub is made steel with a perforated bottom, which of mint called false bottom, on which the grass rests. It has two opening: one at the bottom for steam entry and the other at the top through which the oil vapour and steam escape. The top of the still is fitted with a lid, which is removable. Charging and discharging of the grass is done in perforated cages with chains. These cages may be lowered in the tub with the help of chain-pulley system. Tubular condensers oil vapours, coming out from the distillation tub, enter from the top of the condenser and cool down while passing through the tubular tubes. Oil and water vapour after condensation are led to a receiver where the oil separates out from the water and floats on the top and is drawn off.

The harvested grass sometimes contains dead leaves. These should be removed. The remaining leaves are cut into shorter lengths. This reduces the volume of the grass and facilitates firm and even packing within the still. Further, chopping the grass gives a higher yield of oil compared to uncut grass. Generally, distillation is complete within 2½ to 3 hours under normal pressure starting from the initial condensation of the oil. About 80% of the total oil yield is recovered in the first hour, 19% in the second hour and about 1% in the 3rd hour, of distillation. Larger percentages of the major components in the total oil, such as citronellal, geraniol, citronellal and geranyl acetate are recovered on the first hour of distillation.

Growers cultivating smaller areas can make use of properly designed direct-fired stills, in case they are not able to invest in the purchase of a boiler. In such cases, the lower portion of the distillation tub is filled with water and this function as a boiler. The water in the boiler is separated from the remaining part of the still by means of a false perforated bottom on which the grass rests. In the still, the water does not come in contact with the grass. The tub is heated from below either by wood or coal and the steam thus produced passes through grass place above in the tub carrying oil vapours with it. However, distillation in such direct-fire still takes a little more time and the quality of the oil is also inferior.

Java citronella oil should preferably be stored in glass /aluminum containers.

## Mentha

**Botanical Name : Mentha arvensis**

**Family : Lamiaceae**

**Centre of Origin : Mediterranean regions**

**Pollination System : Cross pollinated**

**Chromosome No. : 2n=96**

**Plant Description :**

It is a perennial herbaceous plant with the root-stock creeping along or just under the ground surface. It has a rigid branching, pubescent 60-90 cm tall stem bearing aromatic leaves.

**Japanese Mint or Menthol Mint ( *Mentha arvensis* )**

**Hybrid 77** It is a tall vigorous compact growing variety. It produces 762q/ha of fresh herb, 468 kg oil/ha containing 81.5% menthol (obtained from 3 cuts). It is highly resistant to rust diseases.

**EC-41911** This is an erect type variety, which is less affected by rains. It produces 236.5 q/ha of herbage and 125.2 kg/ha of oil with 705 menthol. This oil is preferred in food flavours.

**Spearmint ( *Mentha spicata* ).**

**MSS-1** It is a selection from spearmint cultivars introduced from USA. It produces fresh herbage of 535q/ha and yield 253 kg of oil in 3 cuttings containing 60% carvone.

**MSS-5** It is a selection from MSS-1, which yields 690q/ha of oil in 3 cuttings. It has 70% of carvone in the oil.

**Punjab Spearmint-1** It is an erect growing variety producing 209 q/ha of herb containing 0.57% oil. The oil yields 119.29 litres/ha containing 68% carvone.

**Bergamot Mint ( *Mentha citrata* )**

**Kiran** The variety produces 239 kg of oil with 48% linalool, over 172 kg and 39% linalool over parent cultures.

**OTHER**

**Shivalik** It is an introduction from China. This variety is highly suitable for obtaining second cut through ratooning. The herbage yield is 300q/ha while the essential oil yield amounts to about 180 kg/ha with a low menthol content (70%). Shivalik is highly sensitive to the fungal diseases and pests prevailing in the tarai area.

**Himalaya** This variety yields high amount of essential oil and is not susceptible to pests and diseases. Like Shivalik, Himalaya can be ratooned for two cuts of herbage. Much like MAS-1 and Kalka, it can be used in areas and conditions where only one cut of herbage can be taken. The yield of herbage is

400q/ha and essential oil is 250 kg/ ha. Its oil is of high quality with menthol content of 80%.

### **Uses**

Menthol mint essential oil is the main source of natural menthol. The dementholised oil (DMO) is reconstituted to produce oil similar to *Mentha piperita* oil. Several of the many dozens of terpenes present in the essential oil are valuable compounds that find uses in the cosmetic and pharmaceutical industries. Menthol itself is used as a flavouring agent mouth-related produces such as fresheners, tooth pastes and chewing gums, etc. Menthol mint oil because of its antimicrobial properties enhances the shelf of edible products and grains. Menthol mint oil is an essential ingredient of the ointments, pain balms, lozenges and syrups. It is also used in cosmetic preparations, colognes, deodorants, cosmetics, etc. In India, menthol and mint oil are extensively used in betel (pan) related industries.

### **SOIL**

Loamy Well-drained soils with good water holding capacity and rich in organic matter are better suited Mint crop does not tolerate water stagnation having a pH 6.5-8.0.

### **CLIMATE**

Open sunny situation during the growing period is favourable. Japanese mint can be grown in all tropical and subtropical areas. Bergamot mint can be grown even in temperate climate. Excessive rains and damp winters which cause root rot. Peppermint and spearmint cannot be grown profitably in tropical and sub-tropical areas, especially with very high summer temperature (41<sup>0</sup> C).

### **PROPAGATION**

Mint can be planted in the field in the following ways :

1. By means of underground vegetative parts called suckers or stolons ,
2. Through propagules/ seedlings. Where mint is to be planted early in the season, stolons are used as the planting material.
3. In case of spearmint, pepper mint and bergamot mint, sometimes runners are also used for planting.
4. In the case of late planting, first the stolons are densely planted in nursery to produce propagules / plantlets / seedlings which in turn are transplanted in the field.

### **PLANTING**

#### **Planting from Stolons**

In a nursery sown in August with mature plants, the stolons become available for planting during December - January. The field should be ploughed and harrowed thoroughly and divided into beds to facilitate irrigation and free of weeds and stubbles. In each bed, lines are opened at a distance of 50 to 70 cm depending upon the variety to be cultivated. The furrows are opened about 5 to 6 cm deep manually or tractor driven harrow like instruments. Within a furrow, stolons are placed end

to end and furrows are closed with soil. The stolons sown bed is irrigated immediately. On an average, 4 to 5 quintals of stolons are required for planting of one hectare of land. The stolons sprout in about 3 to 4 weeks when planted in January and 2 to 3 weeks when planted in February. Generally the planting should be done as early as possible in January to February.

### **Planting from Seedlings**

The field should be prepared to a fine tilth and divided into beds of convenient sizes. The beds to be transplanted with mint should be flooded with water. The seedlings to be used should be dug out from the plantlet nursery. The fresh seedlings of about 9 - 15 cm height should be transplanted at a spacing of 40 x 10cm. Transplanting should be completed between the month of March and mid of April. Transplanting of mint seedlings later than 15th April should be avoided.

The major essential oil contents are located in the leaves of mints. More the leaves, the better is the yield from crops. The vegetative growth for the higher production of leaves can be stimulated by the application of essential plant nutrients to the soil or to the plant directly. The recommended fertilizer dose per hectare by CIMAP is as follows-

During land preparation	During planting	1 <sup>st</sup> dose 5 weeks after planting	2 <sup>nd</sup> dose 5 weeks after first application	3 <sup>rd</sup> dose immediately after harvest	4 <sup>th</sup> dose 5 weeks after 3 <sup>rd</sup> application
FYM @ 25-30 T/ha	100 kg Urea 300 kg SSP 60 kg MOP	Urea 50 kg	Urea 50 kg	Urea 50 kg	Urea 50 kg

Foliar spray of urea @ 2% is also advisable especially late in the season when top dressing of soil is difficult. This technique should also be used in the crops of mint grown in sandy soil. It is also advisable to spray on foliage 0.5% FeEDTA to promote photosynthetic capability of the leaves by prevention of chlorosis.

### **Harvesting**

The mint crop herbage is harvested when the field is dry and weather is bright and sunny. A simple way to judge the maturity is to see whether the lower leaves have started turning yellow or when the plant starts flowering. The yellowness of lower leaves indicates that any further delay in harvesting may cause loss in the yield due to falling of the yellow leaves. The usual method of harvesting consists of cutting the green herb by means of sickle from 2-3 cm above the ground. The crop planted with stolons in January and February is harvested twice and that planted with seedlings during March and April is harvested once. The stolon planted crop is first

harvested after 100-120 days of growth in the month of May. The second harvest is taken between 60-75 days following the first harvest. The transplanted mint crop is harvested in June or July.

### **Yield**

The yield of herbage from a mint crop depends upon a number of factors. On an average, 20-25 tonnes of green herb per hectare can be obtained in three cuttings yielding 125-200 kg of oil/ha.

### **DISEASES**

#### **Stolon Rot (*Macrophomina Phaseoli*)**

The disease causes rotting of the underground stem and death of the entire plant. One of the main damages caused by the disease is the reduction in the production and rotting of the stolons by the end of the cropping season.

**Control :** The disease can be controlled by proper crop rotation. Mint should not be planted continuously in those areas where attack of stolon-rot is observed. It is better to follow 3-year-crop rotation with rice, wheat and mint. It is safer to discard all the diseased stolons while planting and treat the stolons with 0.25% solution of Captan or 0.1% Benlate.

#### **Root Rot (*Thielavia Basicola; Rhizoctonia*)**

Numerous dark brown necrotic spots appear on stolons and roots

**Control :** It is safer to discard all the diseased stolons while planting. The stolons should be pretreated with 0.25% solution of Captan or 0.1% Benlate

#### **Leaf Spot (*Corynespora cassicola; Curvularia lunata; Alternaria spp*)**

Small dirty brownish necrotic spots are observed on the leaves and twigs leading to defoliation

**Control :** Treating the stolons with 0.25% solution of Captan or 0.1% Benlate or spraying with 0.3% Copper Oxochloride is recommended.

#### **Fusarium Wilt (*Fusarium Oxysporum*)**

The leaves of the affected plants turn yellow, curled and finally dry.

**Control :** Benlate, Bavistin and Topsin can be used to control the disease.

#### **Root knot (*Meloidogyne Incognita, M. Javanca*)**

The nematode affected plants show stunted growth with yellowing of the leaves.

**Control :** Application of neem cake during planting reduces the nematode population.

#### **Rust (*Puccinia Menthae*)**

Golden brown spots are observed on the leaves and twigs. The leaves turn yellow and fall off.

**Control :** Spraying the crop with 0.3% Copper fungicides immediately on the appearance of the disease is recommended. Early harvest of the crop during May is suggested so as to decrease the losses due to falling of leaves.

#### **Powdery Mildew (*Erysiphae Cichoracearum*)**

Powdery white patches on the upper and lower surfaces of the leaves and stems are observed. Under favourable conditions, the disease causes severe loss due to defoliation. It also reduces the oil content up to 50%.

**Control : Spraying Sulphur formulation or fungicide like Karathen-WD is recommended. Spraying** should commence as soon as the disease appears in the field and should be repeated every 10-15 days.

## **PESTS**

### **Mint Leaf Roller (*Syngamia Abrupatalis*)**

The caterpillar folds the leaf in the form of a roll and feed inside the leaf tissue. The edges of the leaves are held together with silk-like filaments. Leaves get rolled in August September

**Control : Thiordan @1.5ml/litre of water should be sprayed at weekly intervals. Two-three sprayings** are sufficient to control the pest.

### **Red Pumpkin Beetle (*Aulocophora Fovicollis*)**

Leaves and buds are eaten away

**Control : Malathion spray @1ml/litre of water is effective.**

### **Cutworms (*Agrotis Flammatra*)**

Pest damages the young plants at the collar region during spring season.

**Control : Soil treatment with Phorate 10G before planting the crop is recommended.**

### **Hairy Caterpillar (*Diacrisia Obliqua*)**

The caterpillar starts eating the under-surface of the leaves. And the leaves are damaged

**Control : Spraying of Thiordan or Malathion @1.7ml/ litre of water is recommended as control.**