

## Potato

**Botanical Name:** *Solanum tuberosum* L.  
**Family:** Solanaceae  
**Origin:** Peru and Bolivia in South America  
**Chromosome no(2n) :** 48

**Importance and Uses:** Potato is the staple food of many European countries of the world and has proved its worth in feeding the nation in emergency. It is an important source of starch. It is a rich source of body building substances such as carbohydrates, vitamins (B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub> and C), minerals (Ca, P and Fe) and protein. It contains all the dietary substances except fat.

**Soil:** It can grow in almost all types of soil. The well drained clay loam soil is considered as ideal for its cultivation. On sandy loam soil, crop can be successfully grown provided manuring is done heavily and the crop is irrigated properly and timely. It produces best when soil reaction is 6.0-6.5

**Climate:** It is a cool season crop and can tolerate moderate frost. It requires 20°C soil temperature for better germination. Young plant growth is good at 24°C but later growth is favoured by a temperature of 18°C. No tuberization takes place when the night temperature exceeds 23°C. Maximum tuberization occurs at 20°C. Tuber formation stops completely at about 29-30°C.

**Varieties:** The varieties of potato are categorized into three groups on the basis of their maturity. The Central Potato Research Institute (CPRI) is the premier institute working on research on potato and is situated at Shimla in Himachal Pradesh. The varieties released from CPRI have Kufri<sup>®</sup> as their first name.

**Early varieties:** These varieties are ready for harvest in 70-80 days such as Kufri Ashoka, Kufri Chandermukhi, Kufri Jawahar, and Kufri Lauvkar.

**Main season varieties:** They are ready for harvest in 90-95 days. Among the white coloured varieties, Kufri Jyoti, Kufri Sutlej, Kufri Pukhraj, Kufri Megha, Kufri Badshah, Kufri Anand, Kufri Bahar, Kufri Sadabahar, Kufri Deva, Kufri Sherpa, Kufri Swarna, Kufri Shailza, Kufri Surya, Kufri Himalini, Kufri Girdhari and Kufri Khyati are important.

**Late varieties:** Kufri Jeevan, Kufri Neelamani, Kufri Khasigar, Kufri Naveen

**Varieties for processing:** Kufri Chipsona 1, Kufri Chipsona 2, Kufri Chipsona 3, and Kufri Himsona

**Soil preparation and planting:** A well prepared soil provides sufficient room for the development of tubers and also helps to retain moisture. The fields are ploughed to a depth of

20-35 cm first with soil turning plough and afterwards by 4 to 5 ploughings with country plough/disc harrow. Clods must be broken to make the field well pulverized and levelled.

### Planting time

Region	Season	Planting time	Harvesting time
<b>North western hills</b>			
Very high hills	Summer	April-May	Sept-Oct
High hills	Summer	Mid-March-April	Sept-Oct
Mid hills	Spring	Jan-Feb	May-June
North central high hills	Summer	Mid Feb-March	August-Sept.
North eastern high hills	Spring	Mid Dec-Mid Jan	July-August
Shillong hills	Summer	March-April	July-August
	Autumn	March-April	Dec-Jan
	Winter	Jan-Feb	May-June
North western plains (Jammu, Punjab, Western U.P., Haryana, Rajasthan, Plains of M.P)	Early	Mid-Sept	Mid Nov-Dec
	Autumn	Mid-Oct	Feb-March
	Spring	Jan	April
North Central Plains	Winter	Mid-Oct	Feb-March
<b>North eastern plains</b>			
Bihar	Winter	Oct end to 2nd week of Nov.	Jan-Feb
W.B.	Winter	Early Nov	Jan-Feb
Orissa	Winter	Early Nov	Jan-Feb
<b>Plateau regions</b>	<i>Kharif</i>	June-July	Sept-Oct
	<i>Rabi</i>	Oct-Nov	Feb-March

**Seed Rate:**25-35 q/ha.

Potato is traditionally propagated through tubers. The eyes on the tuber surface contain axillary buds. The tubers have a dormancy of nearly 8-10 weeks after harvesting. The axillary buds on the tubers start germinating by producing sprouts only when this dormancy is over. The sprouted tubers put up fast and vigorous growth when planted in the soil.

**Breaking of Dormancy:** Hill tubers can not be used for autumn crop immediately because of dormancy period of 2-3 months in tubers. This dormancy can be broken by using some chemicals; Thiourea (Sodium Potassium thiocyanate) @ 1-2% solution which is used as a treatment to cut tubers for 1-1½ hours and about 1 kg of thiourea is sufficient for 10 quintals of seed tubers. Tubers are kept in 5ppm solution of GA<sub>3</sub> for 10 seconds. or Treat the tuber with aqueous solution of thiourea for one hour followed by dipping in 2 ppm solution of GA for 10 seconds. The tubers from cold storage are warmed up at 60°F for 10-14 days before sowing which sprout quickly and give good germination stand.

### **Seed size and Spacing**

Proper combination of seed size and spacing is essential to get the required number of stems per unit area. It can be obtained by planting 40-50 g tuber with 40-50 mm diameter at a spacing of 45-60 cm between rows and 20-25 cm between the tubers within the rows. Large tubers are cut into pieces and each should contain at least 1-2 eyes. Tuber cutting is not recommended especially for the production of a seed crop as it transmits viruses and bacteria.

### **Treatment of cut seed tubers**

Cut tubers should be treated with 0.2% solution of Dithane Z-78 which help in improving tuber size and crop yield. The cut pieces should be allowed to heel at 18-21°C and 85-90% relative humidity for 2-3 days which prevents rotting of cut tubers as seed (this process is known as suberization/healing). Do not treat the tuber with any of the chemicals if sprouts are coming out.

**Methods of Planting:** Ridge and furrow method is the most popular method carried out manually or mechanically. Care should be taken that seed tubers should not come in direct contact with fertilizers. In mechanical method, furrows are made with the help of tractor drawn 2-4 row marker cum fertilizer drills so as to apply fertilizer in one sequence. This is followed by planting of tubers with the help of 2-4 row planter-cum-ridger.

**Manures and fertilizers:** Apply farmyard manure @100q/ha at the time of field preparation. Fertilizer dose varies depending upon the fertility of the soil. However, fertilizers are applied @ 120:80:60 kg N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O /ha, respectively. Full dose of farmyard manure, phosphorus and potassium and half of N should be applied at the time of planting. Remaining part of N should be top dressed at the time of earthing up for effective utilization by the crop.

**Interculture and weed control:** Mulching helps in conserving soil moisture, reducing soil temperature and inducing quick germination. Local available materials such as pine needles or leaf litters are quite effective in controlling run off losses and conserving moisture. Weeds are effectively managed by cultural or chemical methods or combination of both methods. Weeds can be managed by hoeing and weeding when the crop is about a month old followed by earthing up. Pre-emergence application of fluchloralin @ 1 kg *a.i.* per ha or alachlor @ 1 kg *a.i.* per ha or pendimethalin @ 1.8 kg *a.i.* per ha or atrazine @ 1.0 kg *a.i.* per ha can effectively control the weeds. Post emergence application (only 5-10% plant emergence) of paraquat @ 0.36 kg *a.i.* per ha is also effective. Application of Tok-e-25 @ 2.5kg *a.i.* per ha as post emergence application at about 2-3 leaf stage is also helpful in managing the weeds.

**Irrigation:** Pre-planting irrigation is advantageous for uniform germination. Second irrigation is given after about a week and subsequent as and when required. Light and frequent irrigations are better than heavy and less frequent irrigations. Water is applied effectively and economically at critical stages in crop development *i.e.* stolon formation, tuber initiation and tuber development stages of the crop. Irrigation is stopped about 10 days before harvesting of crop to allow firming of tuber skin.

**Harvesting:** The crop is harvested when it is fully matured which can be characterized by Yellowing of haulms and no pulling out of skin on rubbing of tubers. At the time of harvesting, field should not be too wet nor too dry. Tractor operated potato diggers are available for digging the tubers from the fields.

**Yield:**

Early varieties	200 q/ha
Late varieties	300 q/ha

**Post harvest handling**

**Grading:** The tubers are, generally, categorized into 3 grades according to the size and weight of the tubers.

1. **Grade A (Large):** Tuber weight more than 75g
2. **Grade B (Medium):** tuber weight between 50-75g
3. **Grade C (Small):** Tuber weight less than 50g

**Value added products:** Potatoes can be easily processed into dehydrated and canned products like Chips, Flakes, French fries, Finger chips, Granules, Disc, Cubes, Flour etc. Processing industry is also picking up in the recent past. It is desirable to avoid glut and consequent difficulty of storing large quantities of potatoes during period of high temperature after harvest in the plains.

**PHYSIOLOGICAL DISORDERS**

1. **Hollow heart:** It is caused by rapid growth of tubers. Tubers become oversized and remain empty inside leading to the formation of cavity in the centre with the death of the small area of pith cells. This results in adjacent cracks and hollowness as the centre expands during the growth of the potato. Maintain soil moisture conditions to the optimum level. Avoid over fertilization particularly nitrogen. Grow those varieties which are less prone to this defect.
2. **Black heart:** It is caused by sub-oxidation conditions under potato tuber storage as there is no aeration in the centre of the piles. Due to high temperature and excessive moisture, blackening of tissues in the centre occur. The appearance of the tuber affect the consumers otherwise there is no decay. Provide proper ventilation. Keep potato tubers in layers. Do not store tubers in the heap.
3. **Greening:** The various factors which increase the glycoalkaloid contents are mechanical injury, premature harvest, and excessive application of fertilizers or exposure of tubers to sunlight. High glycoalkaloid contents lead to solanin production which is slightly poisonous. Proper earthing up of tubers as the tuber formation takes place. Store tubers in darkness after digging up.

4. **Knobbiness:** It occurs due to uneven growth of tuber cells/tissues. Uneven watering conditions lead to an obstruction in tuber growth. Heavy irrigation after a long dry spell leads to fast growth of some cells and as a result knobs are formed. Ensure frequent and optimum irrigation.
5. **Cracking:** It is due to boron deficiency or uneven water supply. Application of Borax @ 20kg/ha. Ensure frequent and optimum irrigation.
6. **Sun scalding:** It occurs, generally, in the autumn crop when both the temperature and sunshine are high. Emergence of sprouts and leaflets is drastically affected at that time leading to tip burn. It appears when temperature is more than 30°C. Water should be passed through the furrows to lower the soil temperature.
7. **Black spot:** It means the internal browning of potato tubers. It occurs in vascular tissues with in 3 days of mechanical injury. Phenols are related to black spot in potato tubers. Genetic make up of the varieties. Provide proper storage and growing conditions.
8. **Freezing injury:** It occurs due to the exposure of tubers to freezing temperature during or after harvest. It takes place at -1.5°C or below temperature. There is discolouration of the tissues and affect the vascular tissues at the ring and this is called as called ring necrosis and when fine elements or cells of vascular ring are affected, then it is called as net necrosis. Freezing injury render tubers unmarketable. Tubers show more damage towards proximal end. Avoid exposure of tubers to freezing temperature during storage or harvest.
9. **Sprouting:** It is often a serious problem in storage. It can be inhibited by spraying borax or iron sulphate @ 1000-1500 ppm about 2-3 weeks before harvesting. Chemicals like Chloro IPC (N-tetra chloro isopropyl carbonate) @ 0.5% and/or nomyl/amyl alcohol @ 0.05-0.12mg/ha also help in inhibiting sprouting.

#### **Diseases:**

1. **Early Blight (*Alternaria solani*):** Spots with concentric rings of brown to black colour are formed on the leaves. Heavily infected leaves fall off after drying. Spots also appear on stems.

#### Management:

- Destroy crop debris by burning.
  - Spray mancozeb or zineb @ 2g/l or 0.3% copper oxychloride at fortnight intervals 3-4 times.
  - Grow resistant varieties *e.g.* Kufri Naveen and Kufri Jeevan.
2. **Late Blight (*Phytophthora infestans*):** Lower leaves are infected generally from margin or apex and having cottony growth on the lower side. Water soaked lesions appear on the margins. Tubers decay under severe infection.

#### Management:

- Use disease free certified seed.
- Follow crop sanitation.
- Spray Ridomil MZ 72@ 2g per litre of water.
- Grow resistant varieties like Kufri Griraj and Kufri Himsona.

3. **Brown Rot (*Ralstonia solanacearum*):** Wilting and stunting of plants occur. The disease is soil and seed borne.

#### Management:

- Follow crop rotation with maize and wheat.
- Use disease free tubers.

4. **Black scurf (*Rhizoctonia solani*):** Sprouts are killed before emergence. Cankers cause wilting of plants. Black crust on tubers gives ugly appearance.

#### Management:

- Use disease free certified seed.
- Seed tubers should be treated with recommended fungicides.
- Follow crop rotation.

### Other common diseases

Disease	Management
Common Scab	Seed treatment with 0.5% Agalol-3 for 30 minutes. Grow scab resistant varieties.
Verticillium Wilt (Soil borne)	Use disease-free seeds. Follow long crop rotations.
Charcoal Rot	Surface disinfection with some fungicides.
Wart disease	Soil sterilization by steam, mercuric chloride, copper sulphate or 5% formalin. Grow resistant varieties–Kufri Jyoti, Kufri Sherpa and Kufri Kanchan
Black Leg and Soft Rot	Use disease-free seeds. Long crop rotations.
Bacterial Soft Rot	Remove diseased tubers from healthy ones before storage. Treat seed tubers with 0.5% solution of Agalol-3/Aretan-6/Emisan-6 before storage for 30 minutes
<b>Viral diseases</b>	
Latent Mosaic	Virus is mechanically transmitted (PVX, PVS or PVM). Use disease free seeds. Local quarantine
Mild Mosaic	Use disease free seeds. Grow resistant varieties.
Rugose or Vein-banding Mosaic	Use disease free seeds. Grow resistant varieties.
Purple top leaf roll	It is transmitted by leaf hopper. Use of certified disease-free seed. Control insect vectors by spraying systemic pesticides

**Rot knot nematode** Keep land fallow for a quite long time. Follow crop rotation. Nematicides like DD @ 225 l/ha should be injected in the soil. Place between the rows EDB @ 175 kg/ha 2 weeks before planting.

### Insect-pests:

**1. Cut worm (*Agrotis ipsilon*):** Creamy white, dome-shaped Eggs, laid singly on lower surface of the leaves. Newly emerged young larva is yellow in colour. Dark brown pupae are found in earthen cells lying underground in the potato fields. Adult moth is dark with some grayish patches on the back and dark streaks on the forewings.

#### Symptoms of damage

- Young larvae feed on the epidermis of the leaves.
- Older larvae come out at night and feed young plants by cutting their stems
- They also damage the tubers by eating away part of them.

#### Management

- Flood the infested fields.
- Hand pick and destroy the larvae during morning and evening hours on cracks and crevices in the field Plough the soil during summer months to expose larvae and pupae to avian predators Set up light trap @ 1/ ha, Pheromone traps @ 10/ ha to attract male moths. Spray insecticides or chlorpyrifos 20EC @ 1 lit/ha or neem oil 3% @ 5.0ml/lit.

**2. Potato tuber moth** (*Phthorimaea operculella*): Eggs are laid singly on the ventral surface of foliage and exposed tubers. Larva is yellow coloured and caterpillar has dark brown head. Pupation occurs within a cocoon among the trash and clods of the earth in the field. Adult is small narrow winged moth with greyish brown forewings and hind wings are dirty white.

**Symptoms of damage**

It is a pest of field and storage

Larva tunnels into foliage, tubers Galleries are formed near tuber eyes

**Management**

- Select healthy tubers
- Avoid shallow planting of tubers. Plant the tubers at depth of 10 - 15 cm. Install pheromone traps @ 15 in numbers/ha.
- Collect and destroy all the infested tubers from the field
- Do earthing up at 60 days after planting to avoid egg laying on the exposed tubers Spray NSKE @ 5% or quinalphos 25 EC @ 2ml/lit of water to manage foliar damage Spray *Bacillus thuringiensis* @ 1 kg /ha at 10 days interval
- Store the tubers under 3 cm thick layer of sand Fumigate the stores with carbon disulphide

## Sweet Potato

**Botanical name:** *Ipomoea batatas*

**Family:** *Convolvulaceae*.

**Chromosome no (2n):**90

**Origin:** *Tropical America*

It is important tuber crop of tropical and subtropical climate and belongs to family *Convolvulaceae*. Tubers are generally used for human consumption. It is used in preparation of alcohol and starch. It contains 16% starch & 4% sugar i.e. 20% alcohol producing material.

**Climate:** It requires a long, warm growing period both days and nights (frost free 4 months) and plenty of sunshine and moderate rainfall. It is the most draught resistant vegetable. The Optimum temperature requires for its better growth and development is 21-27 °C. The optimum soil temperature is 20-30 °C, above this the vines grow at the expense of tuber formation.

**Soil:** Well drained sandy loam rich in organic matter is considered the best. Roots tend to be long and slender on deep soil, so deep ploughing is not advocated. Optimum pH is 5.8-6.7 (Slightly to moderately acidic).

**Varieties:** Varieties are grouped according to their colour:

### 1. White

1. Pusa suffaid
2. Pusa Lal (skin red, flesh white)
3. Pusa Sunchari (flesh orange)
4. Jawahar Sakarkand-115 (early var.)
5. Jawahar Sakarkand-145
6. Rajendra Sakarkand-35
7. Rajendra Sakarkand-5
8. Rajendra Sakarkand-43
9. Sree Nandani

### 2. Golden

### 3. Orange to Red

10. Sree Vardhani
11. Kal Megh
12. OP-23 (Kiran)
13. Cross-4
14. H-41
15. H-42
16. H-268 (Varsha)
17. Konkan Ashwini

**Propagation:** It is grown from sprouts or draws produced from tubers and from vine cuttings. The vine cuttings are generally used as a propagation material in India. The cuttings are obtained from previous crop or sometimes by sprouts obtained from tubers. It is desirable to propagate sweet potato in the nursery to obtain good yield. 100 kg tubers are sufficient to raise the cuttings for one hectare. Selected tubers (125-150 g) are planted at a spacing of 45 x 30 cm & 5-6 cm deep that covers an area of 100 m<sup>2</sup>. After 40-45 days, cut the sprouts having 20-30 cm length & raise in the secondary (another) nursery for further growth which covers an area of around 500 m<sup>2</sup>. Ultimately when the nursery vines reach a sufficient length, cuttings are made & planted at about 60 x 30 cm spacing. 40000-50000 cuttings are required to plant one hectare. The length of cutting depends upon the length of internode i.e. at least 4 nodes/cutting. The cuttings from the upper portion of vine should be preferred for getting more tuberous roots. General practice is to bury the two middle nodes & expose the two extreme ones.



**Planting time:**

- In northern India, the vine cuttings are planted during June-July.
- Cuttings for rabi season are planted in Oct-Nov. in south India and Central India (MP, AP, Maharashtra & Gujrat).

**Manures and Fertilizers:** Farmyard manure -100-150 q/ha. 90: 60: 90 kg N: P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per ha. Half of dose nitrogenous fertilizer is applied as basal and half dose 40 days after planting.

**Interculture and Weed Control:** In the early stages the field should be inter-cultured often to keep down the weeds. It establishes within 10 days of planting and starts growing vigorously after 3 weeks when it is given the first weeding. Two manual weedings at 20 and 45 days after planting are sufficient to keep the weeds under control. Earthing up is done at second weeding to prevent exposure of roots (particularly during rainy season). Incorporation of EPTC (Eptam) @ 1-2 kg/ha) or Fluchloralin @ 1.0 kg/ha) in the soil as pre-planting to control the weeds is effective. Also, application of EPCC @ 1.5-3.0 kg/ha as pre-plant soil incorporation and chloramban @ 3.0 kg/ha after planting control the weeds.

**Irrigation:** Planting should be done when monsoon rains are received or at the time of drizzling. Rainy season crop generally does not require irrigation except long dry spell. In rabi season, apply irrigation at 8-10 days interval depending upon the type of soil to ensure better root development and yield. Newly planted cuttings need watering frequently for 1-3 weeks. Once new growth begins watering can be reduced to that needed when visible wilting is seen. Very little water will be necessary the 4th and 5th month.

**Turning of vines:** The plant has a tendency to develop roots from all the nodes which come in contact of soil. So, during early stages, it is essential to lift and turn the vines to disconnect them from soil to increase the availability of nutrients to the main root. It is important to avoid turning of vines at later stages since it results in uprooting of developing tubers.

**Harvesting:** Depending upon variety, the crop is ready to harvest in 120-180 days after planting. Harvesting is done when the leaves turn yellow and start to shed. The surface of mature tuber is cut and exposed to the air, dries up soon, while the immature ones remain moist and turn dark in colour. Irrigate the field 4-6 days before harvesting to facilitate digging of tubers. After harvesting, keep the tubers at 29-40°C temperature & 80-90% RH for 5-7 days for healing the wounds & to increase the storage life.

**Yield:** 100 q/ha in rainfed conditions, It is possible to get yield as high as 300-400 q/ha under better growing conditions.

**Diseases Management**

1. **Stem Rot or Wilt:** Dip cutting in 0.2% solution of Aretan or Agallol before planting.
2. **Black rot:** Dip cutting in 0.2% solution of Aretan or Agallol before planting.

**Insect Pests**

1. **Sweet potato weevil:** Spray malathion/carbaryl.
2. **Leaf eating caterpillar:** Spray Carbaryl (0.01%)