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# Potato (*Solanum tuberosum* L) - Cultural practice in Sindh Pakistan

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## Potato (*Solanum tuberosum* L) - Cultural practice in Sindh Pakistan

Potatoes are considered *Solenostemon rotundifolius* is synonymous with *Coleus parviflorus*. Potato belongs to Solanaceae family. For the year 1990-00 the area under potato crop in Pakistan was 97900 hectares while in Sindh area 700 hectares were under potatoes. Its production was 7400 tones. The yield of potatoes in Pakistan was 14600 per hectare in tones, while in Sindh its yield was 10600 per hectares. Potato contains 80% water, 2% protein, 18% starch. It contains Vitamin B1, Vitamin C and minerals. Potato belongs to Solanaceae, which include tomato, pepper, and eggplant only potato (*S.Tuberosum*) are tuber bearing. It contains only potato (*S.Tuberosum*) are tuber bearing. It contains anthocyanin which produce purple or reddish color. The amount of Sunlight determine the rate of photosynthesis and direct influence on the amount of carbohydrate. It is sensitive to drainage and aeration, the soil must be well drained.

### Common name

Hausa potato, country potato, coleus potato (End), Madagascar potato (Fr), Koorka (Ind), Kembili, Ubi Kembili (Mal) Innala, Ratala ( Sri Lanka), Ketang (Indonesia), Fra –fra-Fa (Birama (Sudan)

### Potato varieties

Phulwa(white)Darjeeling Red, Gola, kufri, Chamatkar, Kufri Sindhuri, fufri Chandramukhi, Kufri-Alankar, Kufri kubner, Kufri-Red, Kufri-Alankar, Kufri kundun, kufri Kisan, Kufri Neela, Kufri Sheetman, Kufri jeevan, Kufri Neelmani, Kufri navin, Kufri Khasigaro. Desiree, Cardinal, Diamant, Ajax, Patrones, multe, Ultimaus, Red Pontiac, Bliss Triumph, Red La Soda, Kennebec, Pele and Waimea, Pele, Waimea. Red Pontiac, Bliss Triumph, Red La Soda, kennebec, Pele and Waimea, Pele, ,Sebago, Sequoia, Pontiac, Kennebec, Bungama, kurrel, Red skin Exton, Manhattan, Bismark, Brownell

### Early maturing varieties:

Irish cobbler, Jemseg, Bison (Red), Shepody (Lonhg white)

### Mid season

Sunrise (Round white), Superior (Scab resistant), Belrus (long Russet), Bake King, Delta Gold (Yellow flest)

### Late Maturing

Kennebec (blight resistant), Katahide (Round white), Russet Burbank (scab resistant)

### Potato clones or varieties

- |            |                  |                     |
|------------|------------------|---------------------|
| ▪ Kenzy    | ▪ 84.501.2       | ▪ Kufri Chamatkar   |
| ▪ 720091   | ▪ 575003         | ▪ Kufri Red         |
| ▪ 800258   | ▪ 678008         | ▪ Kufri Sheetman    |
| ▪ 720057   | ▪ Gasore         | ▪ Kufri Deva        |
| ▪ Stemster | ▪ 720053         | ▪ Kufri Sindhuri    |
| ▪ 676005   | ▪ 720097         | ▪ Kufri Chandramkhi |
| ▪ Skirza   | ▪ 800827         | ▪ Kufri Kisan       |
| ▪ Alharmra | ▪ 322115.3%      | ▪ Kufri Jeevan      |
| ▪ 800928   | ▪ K8401.2        | ▪ Kufri Neelmani    |
| ▪ K.Bahr   | ▪ K8401.4        | ▪ Kufri Navin       |
| ▪ 720084   | ▪ 382113.9       | ▪ KufriKasigaro     |
| ▪ 676008   | ▪ Phulwa         |                     |
| ▪ 84.501,8 | ▪ Darjeeling Red |                     |

### Varities grown in U.K.

Maris, Piper , Penland Dell, Desiree, Crown

### Potato cultivars grown in canada

Jemseg, Eramosa, Superior, conestoga, Red gold, Yukon Gold, Atlantic, Cherokee, Keswick, Narchip, Saginaw Gold, Monona, chieftain, Kennebec, Shepody, Rideau

Nigra, small tubers and black skin, rubra , the tubers of which are small, red-grey or red-yellow , Multa, Patrones, Ajax, spunta, Prima are white colour ,Diamants, spunta, Sebago, Kennebec, Sequoia, red pontiac, Katahdin, Coliban. The yield of tubers is depend upon photosynthesis and the rate of respiration. About 29C° rate of photosynthesis and respiration become balanced

Katahdin, Red Pontiac is a red skin variety, Irish cobbler, white Rose, Kennebec, Cherokee, chippewa Sebago (white skinned potato) Pontiac ( Red skinned varieties), Pontiac, Kennebec and Sebago accepted as new potatoes because having high solid matter content. Sequoia which have few eyes on the basal half of the tubers are cut, such varieties are less suitable for mechanical cutting. Potatoes have 59 varieties, Red Pontiac is red-skinned Variety. It is late maturing and high yielding, white Rose is an old late-maturing variety produce long white skinned tubers with many eyes. Bliss Triumph is an early-maturing red-skinned variety. Sebago is late maturing variety white skin and few shallow eyes.

Seed rate varies from 1,250 to 1,500 Kg of tubers per hectare. The main crops sown in September –November and harvested in February-April. The autumn crop is sown in September-October and harvested in November-January. The winter crop is sown in December-January and harvested in February-April. Spacing 60 X 30 cm the ridges is kept at 45 to 60 cm. It require 125 Kg N, 100Kg P<sub>2</sub>O<sub>5</sub> and 125 Kg K<sub>2</sub>O per hectare. During irrigation soil should not wet but only moist . Harvesting depend upon varieties, the crop becomes ready between 2.5 to 5 months after planting. It kept in cold storage at 2.5C° to 4.5C° at relative humidity of 80-90%. Average yield is 25,000 Kg/hectare up to 60,000Kg/Hectare.

NPK needed 235:170:30/hac, Harvesting methods are:

- Manual harvesting.
- Bullock drawn rigger
- Spinner (most popular)
- Digger and automatic harvesting

Following reasons should be cared.

- Better germination
- Higher percentage of seed size tubers
- Less damage due to mite attacks.

Potato needs pH 4.8 and 5.4. Above pH 7.5 the incidence of scab reduced.

### Soil

Potato can grow in wide varieties of soil from light sands to fairly heavy clay loam, it grows well in light extruded soil. The potato plants are very sensitive to drainage and aeration. It requires pH 4.8 to 5.4 to 7.1. It requires 150 lb N, 35 lb P<sub>2</sub>O<sub>5</sub>, 250 lb of K<sub>2</sub>O. High application of nitrogen lowered the starch content and quality of tubers and delayed maturity, which made the tubers more susceptible to skinning and bruising during harvest. Ammonium Sulfate and aqua ammonia are the best source on the alkaline soil. This made more phosphorus available to plants. Magnesium deficiency is common in potatoes. It requires 40-50 lbs of MgO/acre. It requires 5-10 lbs of manganese Sulfate/acre. Shortened the rest period of potatoes by treating them with ethylene chlorohydrin, thiourea or potassium thiocyanate. Storing freshly harvested tubers at temperature of 20-30 °C for 3-4 weeks are effective in breaking the rest period as ethylene gas. Potato seeds are treated with hot formaldehyde or hot corrosive sublimate to control scab and rhizoctonia. Mature potato produced more sprouts if seeds are treated with thiourea. Area where high summer temperature occurs potatoes are planted and bring the crop in to maturity at time when temperature is low and more favorable to high yields.

Sufficient sugar is accumulated at 40°F to give the fried product an undesirable dark-brown color the accumulated sugar may be used up in respiration if the potatoes are stored at 60-70°F. Prolong storage at high temperature may cause black heart, occurs due to lack of oxygen potatoes for the chip industry stored at 50°F with high humidity to reduce shrinkage. It is found that 3 pounds of maleic hydrazide per acre as foliage spray prevent sprouting of potatoes stored at 50°F. or herbicide 3-CL-IPC applied to the tubers in storage to prevent the sprouting. It is found that irradiation of tubers with 10,000 roentgen of gamma rays kept them in dormant condition for the year. Grading is frequently preceded by washing. Waxing is mostly used in red-skinned potatoes, a red dye is added to improve the color of the skin. High specific gravity tubers are high in dry matter and starch. Are likely to be mealy when baked but to slough or break a part when boiled.

### Seed

Seed should be kept cool until 2 weeks before planting, then warmed to 60-70 °F, so eyes start to sprout, with reasonable high humidity.

### Cutting seeds

Small tubers 1.5 to 2 inches in size planted whole make the best seed. Seed piece have at least one eye and weight between 1.5 to 2 ounces.

Potatoes grown frequently on the same land, we must check the supply of humus. This organic matter is necessary to maintain a loose, friable structure, satisfactory water penetration and retention proper aeration supplies of plant nutrients and activity of desirable micro-organisms. High yield activity of desirable micro-organisms. High yield are difficult to maintain without humus. A Lucerne rotation for 3 years is useful in maintaining the supply of humus. This long rotation are effective in reducing potato losses caused by soil borne disease such as powdery scab, fusarium wilt, Bacterial wilt and blackleg.

Elevations above 2,500 feet, potato may grow all year around. Stems: Succulent, 150-30 cm in length. Leaves, some forms with a central purple marking on lamina, aromatic. Flowers, borne on elongated, terminal raceme, small violet in color. Whole seed potatoes 30-60 g can be planted. Planting the seed 8-12 cm deep, measured from the top of the set, 30 cm apart in rows 60 cm apart. There are three main tubers quality criteria for crisping potatoes.

A high dry matter content. This is measure as specific gravity. Minimum acceptable level is 1.08(20% dry matter) Wetter potatoes cost more to fry, absorb more oil and give a less crisp product.

A reducing sugar level of less than 0.2% .Reducing sugars react with amino acids and other substances during frying to produce dark color crisp. These taste bitter, and pale colored crisps are preferred by the consumer. Medium size tubers 40-60 mm .Large tubers are difficult to process and gibber crisp, which do not fit standard packet well. Tuber specific gravity tended to increase with time the sprouted seed gave tuber of slightly higher specific gravity. Older seed results slightly higher specific gravity. Reducing sugar level also high at the earliest harvest. Larger the tuber specific gravity higher. Usually 500 Kg/ha N, 190 Kg/ha P<sub>2</sub>O<sub>5</sub> , 310 Kg/ha K<sub>2</sub>O, before planting. Depression in specific gravity is caused by the potash applied in the manure  
Potato are annual, herbaceous plants of family Solanaceae .Potato plants have fibrous system of adventitious roots, which develop just above the nodes on underground portion of the stem. Most of the roots are within the top 30 C° of soil and extend laterally for about 60cm Stem develop from the eyes on the seed tubers and grow to a height of 60-150cm or more. Axillary branches are usually produced.

#### Availability water in top 45cm of soil in 3 soil types.

Soil type	Water availability to the plant mm
Sandy soil	22mm
Sandy loam	64mm
Clay	135mm

Excessive irrigation can cause leaching of nutrients particularly nitrogen in light sandy soil, also late in the growth stage of plant can lower specific gravity, it reduce overall tuber quality and particularly crisping quality.

For the best culinary quality, producers should care following points.

- Select the right variety for the growing condition.
- Select well drain soil
- Do not over fertilize especially with nitrogen.
- Consider the use of Sulfate of potash instead of Murate of potash in the basal dressing.
- Do not irrigate more than normal
- Do not harvest too early, as crop mature a higher solid matter content is attained.
- Do not grow potatoes at low latitude during the summer.
- Maintain a sound rotational program, high soil organic matter assists both yield and quality.

Anti-greening agent on washed potato also used.

Potatoes have minimum level of solid matter content below this level, tubers become “Waxy” or “Soapy” and unpleasant to human palate .Sprouting is the greatest energy depleting factor poor seed storage conditions can reduce considerably the yield potential of other wise good.

Blocky seed pieces can be use successfully to increase the planting rate by weight of mechanical planters.

Control of temperature control the time a tuber remains without sprouting, while high humidity prevents dehydration. At temperature around 40F° and humidity of 85-95%, seed potatoes keep well for extended period. The physiological aging is delay by low storage temperature. Bacterial and fungal rot do not spread under low temperature. Potato is essentially a cool weather plant, crop matures during hot weather. Soil pH 6 to 7 is desirable, thick compost layers will reduced soil blowing and fertilizer leaching.

Yield loss due to nutrient deficiency is expected with nutrient concentration at or below theoretical concentration. Maximum normal concentration is more than adequate but do not necessarily cause toxicity.

Dormancy is influenced by a number of factors such as variety, growing conditions of the parent crop, time of harvesting, storage temperature and humidity, varieties like sequoia, Pontiac and kennebec have longer dormant period than Sebago or Bungama. Tubers produced under low temperatures have longest dormant period. Planting wholly or partly dormant seed result in seed piece breakdown and uneven emergence and maturity.

#### Composition of nutrients per 100g of edible portion (tubers)

Composition	Value
Moisture (%)	76.0
Calories	94.0
Protein (g)	1.3
Fat (g)	0.2
Carbohydrate (g)	22.0
Fibre (g)	1.1
Calcium (mg)	17.0
Iron (mg)	6.0
Thiamine (mg)	0.05
Riboflavin (mg)	0.02
Niacin (mg)	1.00
Ascorbic acid (mg)	1.00

Higher the night temperature, the smaller the size of the tubers. The total yield of dry matter to the acre depends on the number of variable factors such as moisture, soil properties, variety, fertilization, temperature and light. Occasionally, plant characters change naturally in a single plant and these are transmitted to its progeny. Planting time depend on local climatic condition. The potato is a dicotyledons annual may be grafted upon such close relative as tomatoes, tobacco and egg fruit, but this grafting does not produce plants of any commercial value. The plant is susceptible to frost, and severe frosts will kill the tops completely. The desiccated earlier to control tuber size, the desiccants are applied when soil condition is dry. The seed producer requires a desiccant that will both quickly and effectively kill haulm, and will not cause damage to the tubers when crop under drought stress. It is cropping pattern is as under: Spring potato, summer fodder (maize, sorghum) or vegetable, Autumn potato cropping season is planted in mid October and harvested from late January to end of February. Normally crops are grown in winter and summer.

Seed potatoes sprouting for period varying from 6 months to 3 weeks, this develop different type of sprout and different yield. Most variety gives lower yields after short sprouting period than from a 10-week sprouting period. The yield obtained are much higher than from un-sprouted seed.

Delay in planting beyond mid-April reduces yield. Potatoes are normally dormant for some weeks after harvest, old seeds break dormancy early, with sprout number tending towards apical dominance and is suitable for production of first early crop. The physiological age defined in term of accumulated temperature input to the seed after dormancy break. This is expressed as cumulative day-degrees over  $4^{\circ}\text{C}$  thus the seed subjected to  $10^{\circ}\text{C}$  for eight weeks will be physiological older than seed managed at  $6^{\circ}\text{C}$  for the same period. Seeds held until planting at  $4^{\circ}\text{C}$  will be physiologically young.

The stems may be green or may contain an anthocyanin which gives purple or reddish color. The stools are slender underground lateral stems arising from buds on the underground portion of the stem. Initially one stolon produced at each node but others may emerge later. The maximum yield obtained at  $60$  and  $65^{\circ}\text{F}$  or  $15.5$  to  $16^{\circ}\text{C}$ , yield also depend on the light intensity. The light not only helps in photosynthesis it also influence on carbohydrates available for tuber growth. Tubers are produced at high temperature only when the plant receives a high rate of illumination higher the light intensity during the growing season the higher the maximum temperature allowing tuberization. Some regions have high daytime temperature but high intensity in these areas tends to compensate for high temperature to greatly reduce respiration. Irrigation reduces soil temperature. Some varieties are sensitive to photoperiod. Some varieties produce high yields under the long day. Early tuberization favored by low temperature and short days. Under cool and short days the plants were small had very high ratio of tubers to tops. As the day become longer and warmer the top of the plant where larger and tuber production was lowered. The greatest yield of tubers produced at low temperature and intermediate day length. The initiation of stolons associated with an accumulation of carbohydrates in the underground stem, but the level necessary for stolon initiation is lower than the level required for tuberization.

### **Tuber crop**

The tuber crops are used as subsidiary foods are used as staple food. Potato (*Solanum tuberosum*).it contain 18% starch and other carbohydrate, 2% protein and 1% Ash and minerals and 78% water. It contain fair amount of vitamins especially Vitamin C.It requires  $18-20^{\circ}\text{C}$  and proper moisture are important for growth and tuber formation. It need spacing  $60 \times 30\text{cm}$ , depth of sowing about  $7\text{cm}$ , distance between ridges  $45$  to  $60\text{cm}$ .It require 25 tones of FYM, 125 Kg N, 100KgP<sub>2</sub>O<sub>5</sub>, 125 Kg K<sub>2</sub>O, Crop become ready in 2.5 to 5 months after planting. Cold storage at  $2.5^{\circ}\text{C}$  to  $4.5^{\circ}\text{C}$ , relative humidity of 80-90%. The average yield is 25,000 to 60,000 Kg/hectare.

### **Soil insects**

Cutworm, wireworms, white Grubs.

### **Foliage insects.**

Tarnished plant bugs, leafhopper, flea beetles, colorado potato beetle.

### **Control.**

1. Phorate

I) Thimet 15G, 14.5-22.4Kg (90days)

2. Carbofuran
  - I) Furadan 10G, 32.5Kg (90days)
3. Disulfoton
  - I) Di-Syston 15G, 15-22.5 Kg or 720Lc 2.75-4.75L

### **Insect control programe**

#### **Group A (Organo-Phosphate)**

- 1) Methidathion
  - I) Supracide 240 Ec, 1.2L (14 days)
- 2) Methamidophos
  - I) Monitor 480 EC, 1.75-2.25 L (14 days)
- 3) Chlorpyrifos
  - I) Lorsban 4E. 1.0L , 1.5L (7 days)
- 4) Azinophos-methyl
  - I) Guthion 240 SC, 2.25 L (1.5L for colorado potato beetle (7 days)
  - II) Azinophos-Methyl 240 EC, 1.7L (7 days)
- 5) Phosmet
  - I) Imidan 50eP, 2.25 Kg (7 days)

#### **Group B (Synthetic Pyrethroid)**

- 1) Deltamethrin
  - I) Decis , 2.5EC, 200-300ml (3days)
- 2) Fenvalerate
  - I) Belmark , 300EC, 100-150ml (7 days)
- 3) Permethrin
  - I) Ambush 500EC, 150-200ml (1 day)
  - II) Pounce, 384 EC, 185-250ml (1day)

**4) Cypermethrin**

I) Ripcord ,400EC,90ml (7 days)

II) Cymbush 250EC, 140ml (200 ml for tarnished plant (7 days)

**Group C (Carbamate)****1) Carbofuran**

I) Furadon 480F, 1.1L (7 days)

**2) Oxamyl**

I) Vydate L2.3-3.0L (7 days)

**3) Carbaryl**

I) Sevin XLR plus Su 1.25L (7days)

**Group D-(Chlorinated Hydrocarbons )****1) Endosulfan**

I) Thiodan 500 wp, 1.1Kg (1day)

II) Thiodon 4EC, 1.5L (1 day)

III) Endosulfan 400EC, 1.5 L (1 day)

**Aphids.**

For green peach, potato or Buck thorn aphid apply:

**1) Methamidophos**

i) Monitor 480EC, 1.75-2.25 L (14 days)

**2) Pirimicarb**

i) Primor , 50W, 450-550g (3 days)

**3) Oxydemeton-methyl**

i) Metasystox-R-240, SC 1.75-2.25L (7 days)

**4) Oxamyl**

i) Vydate L3L (7 days)

- 5) Dimethoate
  - i) Cygon 480 E550ml-1.1L (7 days)
- 6) Fenvalerate
  - i) Belmark ,300 EC, 500ml (3 days)
- 7) Deltamethrin
  - i) Decis, 2.5EC, 500ml (3 days)
- 8) Azinophos methyl
  - i) Guthion Solupak 50Wp,1.75 Kg (7 days)
  - ii) Guthion 240 SC, 3.5 l (7 days)

#### **Late season cutworm**

- 1) Permethrin
  - i) Ambush 500 Ec, 140 ml (1 day)
- 2) Chlorpyrifos
  - i) Lorsban 4E, 1.0L (7 days)
- 3) Cypermethrin
  - i) Ripcord , 400 EC, 175ml ( 7 days).

#### **Insects**

- Colorado potato beetle
- Flea beetles
- Leaf hopper
- Aphids
- Potato cyst nematode (*Globodera rostochiensis*)

Potato contain 80% water, 18% starch, 2% protein also contain B1 and Vitamin C as well as some minerals. Potato contain late blight (*phytophthora infestans*)

**Interpretation of plant analysis for potatoes.**

Nutrient	Units	Critical concentration	Maximum normal concentration
Nitrogen	%	2.50	3.50
Phosphorus	%	0.15	0.50
Potassium	%	1.20	2.50
Calcium	%	-	1.50
Magnesium	%	0.10	0.60
Sulphur	%	0.14	-
Boron	Ppm	2	25
Copper	Ppm	2	25
Manganese	Ppm	15	150
Zinc	Ppm	14	70

**Diseases.**

Potato is subject to many fungus, bacterial and virus diseases late blight, common scab, verticillium wilt is caused by verticillium albo-atrum, black leg caused by *Erwinia atroseptica* is a bacterial disease. Ring rot caused by coryne bacterium *Sepedonicum*. Mosaic is caused by virus X, mild mosaic caused by virus A, The varieties resistant to mosaic are cherokee, chippewa, Earline, Houma, Katahdin, Kennebec, Merrimac, Saco, Sebago, Teton, Sequoia, Internal black spot is a physiological disorder, mechanical injury especially bruising results in to black spot, heavy application of nitrogen and high soil moisture increase the tendency of potatoes to blacken. Leaf roll, bacterial wilt, powdery scab and root rot nematode.

About whole seed weighing 40-60 g is ideal for planting. Cut set kept at temperature 10-21C° with relative humidity 85-95%, adequate ventilation for 3-4 days then store at 4C°

**Disease**

- Seed piece decay
- Common scab
- Powdery scab
- Rhizoctonia
- Verticillium wilt
- Bacterial ring rot
- Blackleg
- Spindle tuber
- Leaf –roll virus and net Necrosis
- Early Blight
- Late blight control by the use of following .

## 1) Chlorothaloni

- I) Bravo ,500, 1.75-2.25L (1 day)

## 2) Mancozeb

- i) Dithane M22, 2.25 Kg (14 days)
- ii) Maneb 80WP, 2.25 Kg (14 days)

## 3) Metiram

- i) Polyram DF, 2.25 Kg (14 days)

- In potatoes the common diseases of mild mosaic, net necrosis, brown rot, late blight, this is caused by a downy mildew fungus, phytophthora infestans, common scab caused by *Streptomyces scabies*. Form aldehyde or hot corrosive spray, verticillium wilt is also called early dying or pink eyes caused by *verticillium albo-atrum* blackleg is a bacterial disease caused by *Erwinia atroseptica*. Ring rot is a bacterial disease caused by *Corynebacterium Sepedonicum*. The virus is transmitted by green pea aphid (*myzus persicae*). Internal black spot is a physiological disorder.

### Evaluating heat tolerance in potato

Studies at cornell university under contract with the international potato center (CIP) have concentrated on developing heat tolerant populations of *Andigena* and of *Andigena X Tuberosumj* to be utilized by CIP plant breeder and their cooperators. For this purpose we have developed heat screening tests and we are studying the physiological basis of heat tolerance. Aspects of plant response to high temperature, ability of seed tubers to growth responses to temperature , relative importance of soil and air temperatures, effects of temperature of the same set of cultivars grown in various climatic zones and use of computer stimulation models to study the relative contributions of various possible components of heat tolerance. Other aspects of heat tolerance that deserve consideration are differences among cultivars in the response curve of photosynthesis to temperature , degree of tissue damage from sudden exposure to hot dry winds and tolerance to drought induced by high temperature.

We need to develop cultivars possessing tolerance to one aspect of heat stress will be tolerant in other respects. For example a clone might excel in the ability to produce biomass at high average temperature but most of the dry matter produced might be partitioned to haulms rather than to tubers. Good crop emergence in hot soils might be independent of degree of foliage damage from hot, dry wind. A clone with superior ability to withstand high air temperature might not have especially well at high soil temperature. In some cases apparent heat tolerance may be mainly associated with resistance to diseases or nematodes that are particularly serve in tropical soils or with such factors as tolerance to high levels of aluminum, screening tests that select for only one aspect of heat tolerance are unlikely to be beneficial in selecting for general heat tolerance.

Potato breeder consider a wide range of characters to cover the demand of both grower and consumer yield ability, resistance to pest and diseases, maturity suitability to soil and climate condition, frost resistance, cooking, chipping, processing and storing qualities, color, shape and eye cutting of tubers , color, flavor and texture of flush.

Storage is done in such a way that minimum losses occur due to sprouting, shriveling and rotting. The temperature 50 to 60F , relative humidity 85 to 95% permit suberization and wound periderm formation. At temperature 40f potatoes can be kept for 6 months without sprouting .

### Control of artificial light

Initially it requires 8-10 hours/day, during this period increased 12-14 hours. Fluorescent light generate some amount of heat.

Cut seeds may be soaked in 1% potassium thiocyanate solution or dip into 1.2% ethylene chlorohydrin solution and keep 16-24 hours.

The following are various planters.

- Hand-assisted planters
- Cup-feed planter
- Belt –feed planter
- Finger-fed planter
- Multicup/bell-fed planter.

### Advantages of sprouting .

The advantages of sprouting may be summarized as:

- More rapid bulking of earlier to give marketable yield while prices are high.
- Usually high yield of main crops especially in season when planting is delayed or growth is curtailed by blight.
- Reduction in severity of tuber diseases and opportunity to discard tubers which are seriously diseased
- Advancement of maturity in some main crop varies to meet special market situation
- Early grower need to produce sprouts, which is not damage during planting.

Killing of vine is necessary, it reduce yields and prevent tubers from attaining maximum solid content and maximum specific gravity. Potatoes are mechanically harvested, two types of harvest or are used, the elevating one or two –tow digger drop potatoes.

The seeds are treated with hot formaldehyde or not corrosive sublimate to control scab and rhizoctonia, which results into weak eyes .The use of chemical such as lime, cement, gypsum or sulfur helps preventing the cut seed pieces from sticking together in the planter .Small size tubers were plated 25g, which given an average uniform seed rate for all progenies of about 2.4t/ha.Biger tuber were planted (35-40 g) which give 3.5 t/hac.

Skin damage makes tubers more susceptible to bacterial and fungus disease causes dehydration and advances sprouting .Seed potatoes can be treated with mercuric chloride formaldehyde commercial organic mercury preparation to control diseases like fusarium, verticillium, common scab, rhizoctonia, phoma and blackleg.

Ethylene chorohydrin applied as gas or dip in a solution extend the storage life. Dry potato vine mixed with hay or straw seems to be well tolerated as cattle feed. For smooth harvest operation, clod formation must be reduced.

This can be achieved by:

- Ridging at planting with a flat or concave non pressing ridger.
- Cultivating and spraying with narrow tractor types running between the ridges.
- Hoeing and later earthing up with concave not pressing ridges
- Avoid excessive irrigation

- Sandy loam's with low night temperatures promote tuber development.
- Propagation by tubers, suckers softwood cuttings.
- Tubers are planted 5-8cm deep on ridge 90cm apart, 15-20cm apart with spacing of 15-20 cm between tubers or suckers. Rooted suckers or cutting are planted horizontally at depth of 5 cm. About 2500 tubers/hectare are required.

Pest	Pesticide	Withholding period (days)	Rate of commercial preparation per100L	Rate of commercial preparation per hac.	Rate of active contituant	Remarks and safety prcaution
Green peach aphid +other aphid	Methamidophos	7		1.1 L of 29%	320g/ha	Dangerious to personeel
Cutworms agrotis spp	Trichlorfon			900 ml	540g/ha	
Green vegetable bug	Monocrotophos	3		1L of 40%	400g/hac.	Dangerious to personeel
Leaf-eating ladybird	Carbaryl	3	200 ml of 50%	2.2L to 50%	0.1% or 1.1 Kg/hac.	
Henosepilachna Sparsa	Carbaryl	3	200ml of 50%	2.2L of 50%	0.1% or 1.1 kg/hac	
Leaf hoppers	Dimothate	7		1.1 L of 30%	330g/ha	
Loopers	Methomyl	-		1.5L of 22.5%	340g/ha	
Potato moth	Acephate	3		660g of 75%	500g/hac	
Phthorimea	Azinophos-ethyl	14		1.1L of 40%	440g/hac	
Operculella	Chlorfenvinphos	1	50ml of 50%		0.025%	
	Derris	1	250g of 0.75% rotenons/bag			
	Methamidophos	7		1.4 L of 29%	400g/ha.	

**Herbicide use for weed control in potatoes**

Time of application (crop)	Herbicide:Active ingredient registered products	Application rate (rate of product/hac)	Weed controlled
Preplant	EPTC 720g/L Eptam	5.5L	Annual broad-leaved, weeds, some perennial grasses
Pre-emergence	Linuron 500g/Kg Linuron 50 Linuron 50WP Afolon	2.2-4.5kg	Annual broad-leaved weeds and grasses .
When plants have fewer than 6 leaves	Metribuzin 700g/Kg Sencor 70 Lexone	500-750g	Annual broad-leaved weeds and some annual grasses
Emerged grasses Inter-row	2,2-DPA various trade name	2.2-5.5 kg	Annual and perennial grasses
Weed control at early crop emergence	Paraquat 200g/L Gramoxone Shirquat	2.8-4L	Annual and prennial grasses
Post-maturity	Diquat 200g/L Reglone Paraquat 200g/L Gramoxone Paraquat 100g/L Diquat 50g/L Tryquat	3-4 L 2.8-4L 5.5L	

\*3 pound of maleic hydrozide per acre as a foliage spray prevented sprouting of potatoes. Irridation of tubers with 10,000 roentgens of gamma rays kept them in dormant condition for a year. When potatoes store at 40F° produce more sprouts.

- Along FYM, the NPK fertilizer is also required
- Potatoes becomes ready for harvesting 150-200 days from planting.
- It yield is 7-15 tonnes/hectare
- It require NPK at the rate of 235, 170 and 30Kg/hectare , after 3-4 year FYM applied at the rate of 12-16 tones /hectares.
- Several chemicals, phenolic compounds, sodium arsenate are used to kill the tops.
- It requires 150 lb of N, 35lb of P<sub>2</sub>O<sub>5</sub> and 250lb of K<sub>2</sub>O in the soil, some chemicals, phenol compound, sodium arsenate are used to kill the tops.
- Skin spot is treated with thiabendazo,e (TBZ) or 3 aminobutance.
- Dry rot is controlled by tecazune
- Rhizoctonia both as stem canker and block scurf are treated with tolclofos methyl (Rhizolex) or thianedazole (TBZ)
- High application of Nitrogen lower to starch content and quality of tubers and delayed maturity.
- Ammonium Sulfate and aqua ammonia best nitrogen source to alkaline soil.

- Both the nitrate and phosphorus content of the petioles increased with increasing Nitrogen application to soil.
- All fertilizer applied before tubers are formed.
- Potato needs 5-10 lbs of manganese Sulfate per acre. The dormancy period shortening, it could be induced to sprout at any time by peeling the tuber or rapping the tuber in cotton saturated with hydrogen peroxide shortened the rest period, as did ethyl bromide gas or potatoes are treated with ethylene Chlorohydrin thiourea or potassium thiocyanate.

### Chemical Treatment.

Seed-piece treatments with commercial dust is important to control maggots pest. The following commercial dust may be used (rates are 50Kg of cut seed)

- metiram-diazinon dust at 450-700 g
- Captan 7%-diazinon , 0.1% dust at 450g
- Thiophanate-methyl (Easout) 250g
- Metiram 7 dust (Polyram) 500-750g
- Metiram 16 dust (Polyram) 225-325g
- It requires 8-16-16 at about 20 pound is adequate
- The pH level of 5.2-5.5, soil test are needed to know about the amount of lime needed.
- Dust: Captan 5-10%, active ingredient, Zineb and maneb 15-20%, Calcium hydrate, 1:1 Calcium hydrate and dusting Sulphur, mancozeb 15-20%.Spray Captan 50% at 1lb/15 gallon, organic mercury, zineb, maneb, mancozeb, zinc oxide all at 50oz.per gallon.Zinc oxide plus captan.
- Advantages of chemical weed control provide better frost protection, reduced soil moisture losses prevention of cold formation and soil compaction and reduced danger of spreading diseases such as blackleg and Virus X.These chemical are: Simonize, prometryne, paraquat, DNPB, linuron, 2,2-DPA(Dalapon).Combination of herbicide have advantages
- Late blight control by the following methods:
  - Plant disease free seed
  - Plant resistance free varieties.
  - Destroy or eliminate dum pile
  - Apply well time application of recommended fungicide
  - Kill potato tops prior to harvest
  - Continu fungicide application until top are cleared.
- Potassium or Sodium thiocyanate as 1.5% dip for 1 1/2 hour is more convenient when tubers are to be cut and planted soon afterwords.The ethylene chlorohydrin treatment involving 5 days gas treatment. Both chemicals are high poisonous and great care must be taken.Gibberellic acid at strength of 1 to 2 parts per million used as quick 1 min dip, has shortened the dormancy of cut and whole pierced seed. Whole pierced seed is seed with small portion of skin removed to facilitate the entry of chemical solution. Raising the storage temperature subjecting seed to cold shock immediately followed by rapid raising temperature and maintains high humidity level, and cutting seed all accelerate sprouting

**Seed requirement is 1.3tonnes/hactare**

Spring crop	Autumn crop
Cut seed is used	Whole tubers are used
No risk of seed rotting	High risk of seed rotting
Better germination	Lesser germination

**Features of building for sprouting**

Either glass house or other building used for sprouting.

**Heating**

A temperature around 16C about a week or 10 days are used .Thermostatic control ensure additional heat when require.

**Ventilation**

It requires controlled ventilation.

**Lighting**

The lighting should be warm white type the color most nearly corresponding to the wavelength to which potato sprouts respond. For less vigorous varieties, one light unit per 5m of alley way may be adequate.

**Tray**

The try 600 X 300 X 150 mm high, try as can hold up to 6Kg of seed.

**Loading**

The standard size try should be loaded with seed at the rate of four trys per 50 Kg.

**Stacking**

Various methods are used in glass house. Spurs of double or treble rows of trays across the house with a pathway down the middle is common .The trays are stacked longitudinally in double row with alleyways of 450mm between. Thus 1.4m allows a double row of standard trys plus an alleyway.

**Capacity of Store**

$$\text{Capacity (tons)} = \frac{W \times L \times H}{X}$$

Where:

W	=	number of rows of try across store
L	=	number of trys along store
H	=	number of trays stacked vertically
X	=	60 to a loading rate of 3 trays/50Kg
	=	70 at a loading rate of 3 1/2 trays/50Kg
	=	80 at a rate of 4 trays/50Kg

### **Palletisation of Trays**

Palletisation of seed try is being adopted as a mean of speeding the handling of seed potatoes.

### **Grading and packaging**

Most of new potatoes are graded in the field at the time of harvest. The grades, defined in the regulations under the plant disease Act, 1924, are as follows:

#### **No.1 Grade, which consists of potatoes**

- That are of similar variety characteristic with a mature skin.
- That are free from-i) damage from insects, disease, decay, weather, soft rot and glassy and ii) greening from exposure iii) deterioration from exposure and iv) any damage not removable by ordinary peeling.
- That are reasonably free from dirt or other foreign matter, second growth, sprouting , and any abnormal condition of growth
- That individual weigh not less than 80 gram more than 350grams.

#### **No.1 Large grade, which consist of potatoes.**

- That are of similar variety characteristics with either a mature or an immature skin.
- That individually weighs not less than 250 grams.

#### **No.1.Small grade which consist of potatoes**

- That are of similar variety characteristic with either a mature or an immature skin.
- That individually weigh not less than 30 grams nor more than 100 grams.

#### **Cocktail grade, which consists of potatoes.**

- That are of similar variety characteristic with either a mature or an immature skin.
- That individually weigh not more than 30 grams.

**New grade, which consists of potatoes.**

- a) That are of similar variety characteristic with an immature skin.
- b) That individually weight not less than 50 grams nor more than 350 grams.

**No.2.Grade, which consists of potatoes**

- a) That are of similar variety characteristics with either a mature or an immature skin.
- b) That are free from greening from exposure and damage from soft rots
- c) That are reasonably free from dirt or other foreign matter, sprouting, deterioration from storage and damage from insects, decay, disease and gassy end.
- d) That may be affected with second growth scab, growth cracks and mechanical damage if the parts affected can be removed by ordinary peeling without appreciable loss.
- e) That individually weigh not less than 70 grams.

**Processing requirement**

For efficient operation and production of a high quality product the following factors are important.

**Watering**

A period without water stress up to the 85th day of growth and then a dry period until harvest will give the highest specific gravity and best color.

**Dry matter content**

A high dry matter content means that less money is spent in transporting water, less energy is used in cooking. The specific gravity of a potato sample is an indicator of the dry matter content and is calculated by the manufacturer before processing. For crisps a minimum specific gravity 1.070 is required.

**Reducing sugar content**

Tubers with a high content of reducing sugar produce dark colored crisps that are not acceptable to the public and trade. The amount reducing sugar present is governed largely by variety and the storage temperature just prior to processing for this reason, tubers that have been cool stored are often conditioned at higher temperature, say 16 to 21C°, for several weeks prior to use in an effort to decrease the reducing sugar content. Tubers dug from crops matured under cold tableland condition are apt to be high in sugar.

**Soil temperature.**

The color of potato crisps is darkened by high soil temperature prior to harvest, and heavy irrigation late in the season.

## Defects

All tubers with defect which as mechanical damage, disease, insect injury and greening have to be hand trimmed. This means wasting a lot of material and expensive because of the labor involved.

## Size

Tubers of about 50 to 350 g in weight are preferred because they produce a crisp of the right size and pass through the processing line with less need for hand-trimming .Large tubers have to be cut in to smaller pieces usually halves. Varieties suitable for crisp production are kennebec and Sebago, provided they have been grown under satisfactory conditions, harvested and handled with care and stored properly.

## Frozen French fries

Can be produced to standards that are less damaging in terms of dry matter and reducing sugar content, however, a more elongated tuber is preferred.

## Canned potatoes

Tubers of canning should be less than 4cm in diameter and low specific gravity, less than 1,070 ,Specific gravities higher than this lead to sloughing of the skin and breakup of the product in the can. Processing or for seed. To be effective the storage shed must allow control over temperature, light, humidity and air movement so that losses from rotting, shrinkage, sprouting, greening and internal disorders do not results.

## Curing

Tubers should be cured properly after being placed in store so that cuts and bruises will heal by suberization, thereby preventing rotting at later stage.A temperature of 13° to 16C°.

With relative humidity of about 90% for a period of 15 days allows proper formation of suborn on damaged surfaces .During this period an air flow of 0.2 to 0.3 cubic meters per minute per tone (m<sup>3</sup>/min/t) of tubers should be maintained.

## Storage temperatures

Table potatoes are stored at 3 to 7C°, relative humidifies should be maintained at 90-95% at temperature below 8C°, starch is converted to reducing sugars and as already noted , this results in dark-colored crisp, it is sometimes necessary to condition such tubers at higher temperature, The disorder known as black spot is always sores at 4C° than at 10C° . Consequently warming up potatoes before handling them from store helps to control the disorder.

## Sprout inhibitors

Use of sprout inhibitors is often necessary for tubers intended for table use or for processing. At temperature greater than 4C°it is difficult to suppress sprouting without the use of inhibitors. If it is known in advance that the potatoes will be stored and used for other than seed purposes, a sprout inhibitor can be used, never use sprout inhibitors on seed potatoes.

### Air flow

Recommendations for the rate of airflow vary greatly .It appears that for most circumstances a flow of 0.3 to 0.5 m<sup>3</sup>/min/t of tubers is sufficient. However, many operators prefer to have reserve capacity, up to 0.6 m<sup>3</sup>/min/t, so that they can quickly dry out any areas of rot that might develop.

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