

Agronomy – Rabi Crops

Potato

Dr. I.P.S. Ahlawat
Head,
Division of Agronomy
Indian Agricultural Research Institute
New Delhi – 110 012

POTATO

Botanical name: *Solanum tuberosum* L.

Family: Solanaceae

Chromosome Number : $2n=12$ (Diploid)

$2n=24$ (Triploid)

Potato is the most important food crop of the world. It is being cultivated in the country for the last 300 years. For vegetable purposes, it has now become one of the most popular crops in India. Potato is an economical food, as it provide a source of low cost energy to human diet. Potato is rich source of starch, vitamins specially C and B₁ and minerals. It possesses 20.6% carbohydrates, 2.1% of protein, 0.3% fat, 1.1% crude fibre and 0.9% ash. It also contain a good amount of essential amino acids.

Potatoes are used for several industrial purposes such as production of starch and alcohol. Potato starch (farina) is used in laundries and sizing yard in textile mills. They are also used for the production of dextrin and glucose. As a food product itself, they are converted into dried products such as potato chips, sliced or shredded potatoes and potato flour etc.



Source: http://personales.ya.com/botanical/Solanum_tuberosum.jpg

Origin and History

There is a controversy about the origin of potato. According to some scientists it originated in the bresslessalti plane of higher Andean region of Peru and Bolivia, South America at an elevation between 3500 to 4500 m above sea level. Other group of scientists opined that potato is originated in Chile and on islands of the coast of Chile, on western coast of South America.

Potato is believed to have been introduced in India from Europe in early 17th century. Since 1830, it is being grown as a commercial crop. With the establishment of the Central Potato Research Institute, Shimla, Himachal Pradesh in 1949, the area, production and productivity of potato have increased by 385, 1147 and 157% respectively. Today India ranks fifth in area and production in the world.

Geographic Distribution

Globally potato is cultivated on an area of 18.95 million ha with total production of 330.3 million tonnes (2004). The important potato growing countries are China, Russian Federation, India, Ukraine and USA (Table 1).

Table 1. The area, production and productivity in major potato growing countries (2004)

Country	Area (m ha)	Production (m tonnes)	Productivity (t/ha)
China	4.50	70.03	15.55
Russian Feb.	3.13	35.91	11.47
Ukraine	1.56	20.75	13.34
Poland	0.71	13.99	19.63
India	1.40	25.00	17.86
Belarus	0.51	9.90	19.45
USA	0.47	20.69	43.80
Germany	0.30	13.04	44.17
Romania	0.27	4.23	15.93
Peru	0.25	2.99	11.96
World	18.95	330.30	17.43

Source: FAO Production Year Book, 2004

In India, potato is grown in almost all the states of India under diversified agroclimatic conditions. The major potato growing belts are:

State	Areas of state
Himachal Pradesh	Shimla, Lahaul Spiti and Mandi
Punjab	Jalandhar, Hoshiarpur, Ludhiana and Patiala
Uttar Pradesh	Farukhabad, Etawah, Mainpuri, Barabanki, Allahabad, Badaun, Moradabad, Agra, Aligarh, Mathura, Faizabad
Madhya Pradesh & Chattisgarh	Sindri, Satna, Rewa, Sarguja, Raigarh, Sagar, Tikamgarh
Rajasthan	Bharatpur, Dholpur
Gujarat	Khera, Disa, Banaskantha, Jamnagar, Vadodara, Mehsana
Orissa	Cuttack, Dhenkanal, Puri and Sambalpur and West Bengal
Maharashtra	Pune, Satara, Kolhapur, Nasik
Karnataka	Belgaum, Hassan, Kolar and Dharwad
Andhra Pradesh	Medak, Chitture
Bihar/Jharkhand and Tamil Nadu	The Nilgiris, Dhindigul

About 90% of the total potato area is located in the sub-tropical plains, 6% in the hills and 4% in the plateau region of peninsular India. Indo-Gangetic plains account for major (> 80%) potato production in the country. Uttar Pradesh has the largest area and production of potato, followed by West Bengal and Bihar (Table 2).

Table 2. Area and production in major potato growing states of India in 2004-05

State	Area (000 ha)	Production (000 tonnes)
Jammu & Kashmir	7.1	117.4
Chattisgarh	12.9	130.2
Meghalaya	18.0	149.4
Himachal Pradesh	14.1	151.9
Maharashtra	17.4	163.3
Orissa	12.9	165.1
Haryana	18.4	441.7
Uttaranchal	22.1	448.5
Assam	73.1	589.0
Karnataka	60.0	603.2

Madhya Pradesh	52.2	782.5
Gujarat	43.3	978.2
Punjab	72.9	1470.2
Bihar	318.0	5656.7
Uttar Pradesh	440.0	9821.7
West Bengal	320.6	7106.6
India	1542.3	29188.6

Source: National Horticultural Board, 2005

Classification

The genus *Solanum* consists of 7 cultivated and about 154 wild species. However, the commercially viable potato has only 2 species *Solanum andigenum* (The plants are characterized with thin and long stems, small and narrow leaflets having profuse flowering and long stolons. The tubers are mostly covered with deep sunken eyes on them. The yield potential is very low, and therefore it is not grown on large scale) and *Solanum tuberosum* (It is more common having shorter and thicker stem, larger and wider leaflets). In addition to the above 2 species, *Solanum lemissum* and *S. stenotomum* are also of some importance, but not being cultivated commercially.

Botanical Description

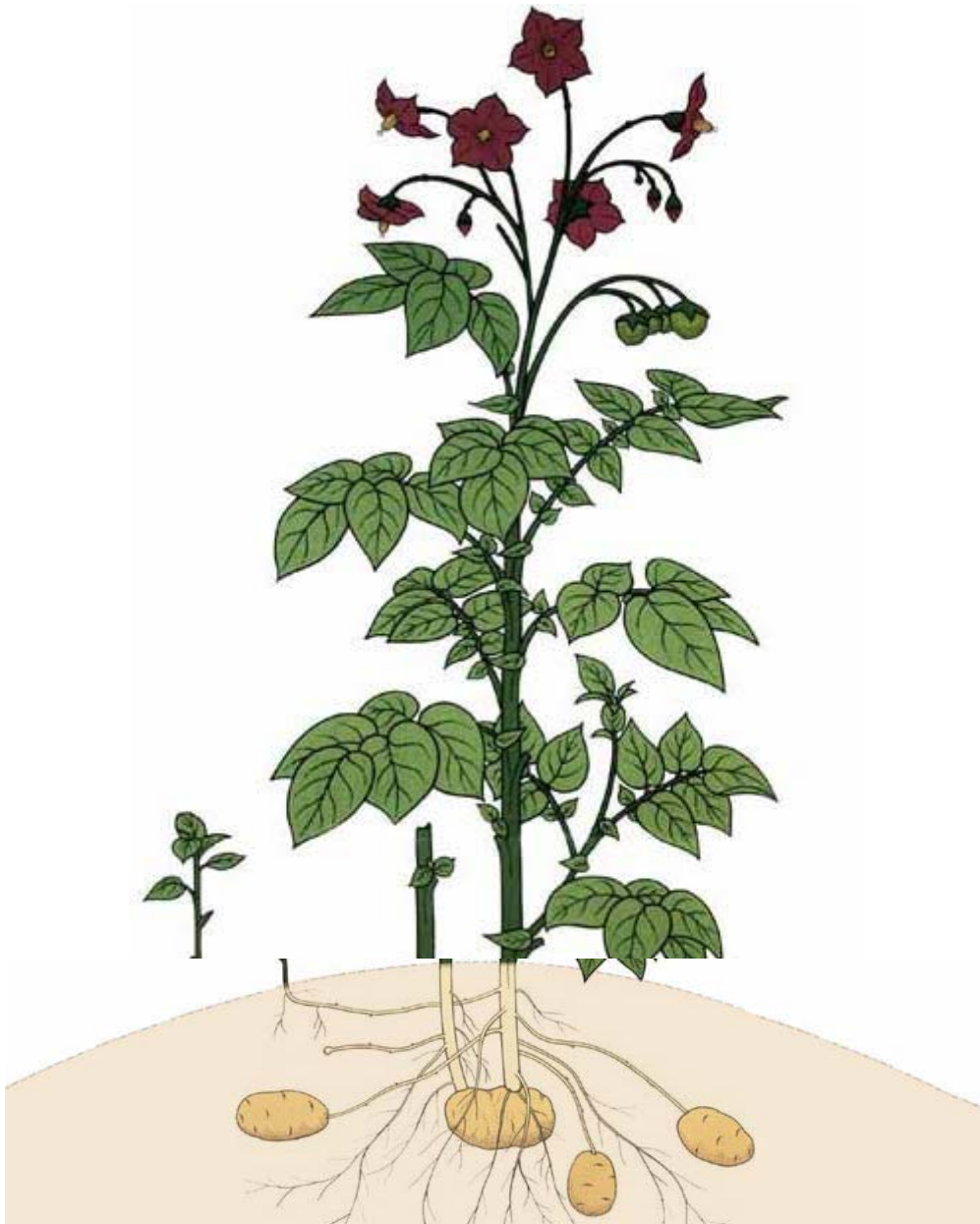
Stem: The upper most part of the sprout develops into the aerial stem or haulms. The aerial stems are angular, pubescent or glabrous, green or purple. These haulms may have anthocyanin pigment in them when the tuber is green coloured. The axillary branches may spread erect giving a close appearance or may spread out giving an open appearance.

Leaves: The leaves of potato are alternate and compound (occasionally bi compound). There are 3-4 pairs of leaflets arising in succession along the rachis. The leaflets are more or less opposite. As 12-15 leaves present in an undeveloped bud (about 28 on a sprout of 2 cm long) and possibly 40 is the maximum produced on any one axis.

Root: The root of potato is adventitious arising from the base of a sprout. The root growth is usually restricted to top layers, at a depth of about 20-25 cm from soil surface.

Flower: The flowers are the terminal clusters. Each flower normally has 5 stamens, two called pistil, 5 sepals and 5 petals united for about half their length. Most varieties bear infertile pollens and hence fruits or berries are not generally formed. In some of the varieties, fruits or berries are formed. The inflorescence is a compact racemose type born on the apex.

Tuber: The tubers are morphologically an underground stem which bear eyes or buds that sprout and develop into haulms or branches. These tubers are formed on the stolon (appearing from the base of haulm or underground side shoots which are very similar to roots in early stage).





Flowers & Tuber

Climatic requirements

Potato is a cool season crop grown in areas, where mean temperature does not normally exceed 18°C. Optimum temperature for potato growth and development ranges between 15 and 25°C. Minimum night temperature is of great significance for tuberization and yield. Temperature below 21°C is favourable for tuber formation. The tuberization ceases at temperatures above 30°C. Under high temperature, the plants are elongated, leaves become wrinkled and plants have silky appearance. Cloudy days, rains and high humidity are conducive for spread of fungal and bacterial diseases. At low temperatures, the vegetative growth of the plant is restricted, and at temperatures near freezing point there is a permanent and often irrecoverable injury to potato. That is why potato is grown as a summer crop in hills and as a winter crop in tropical and subtropical regions of the country. Potato prefers long day conditions for its growth. However, in India, most of the crop is cultivated under short days in plains during winter (*rabi*) season.

Potato zones in India

Based on soil and climate, potato growing areas are grouped into 5 zones.

Western Himalayan zone

It comprises hills of Himachal Pradesh, Jammu and Kashmir and Uttarakhand. In general, the soils are acidic with varying textures and depth of soil. The crop experience moisture stress at early stages and excess moisture at tuberization. Based on altitude, it is divided into 3 sub-zones (a) *very high hills zone*: comprising areas with 2500-3000 m altitude. The crop

is grown during summer and *kharif* (b) *high Himalayan region*: comprising areas with 1800-2500 m altitude. The crop is raised in summer as rainfed and (c) *Mizo-hills*: having areas with 1,000-1,800 m altitude falls. The crop is raised during spring season.

Plains zone

This zone extends from Punjab to West Bengal divided into sub-zones. (a) *north-western plains* (Punjab, Haryana, Rajasthan), the crop is grown mainly in *rabi* and spring seasons. It is important for seed potato production, (b) *north-central plains* (western Uttar Pradesh and Madhya Pradesh) and (c) *north-eastern plains* (eastern Uttar Pradesh, Bihar, Orissa and West Bengal). The later 2 zones account for major potato acreage and production in the country. The potato is grown as winter (*rabi*) crop.

North-eastern hills zone

It comprises of hilly areas of West Bengal, Sikkim and 7 north east states. In this sub-zone, crop is grown from January-August (high hills) and from August-December (low hills).

Low hills and Plateau zone

It comprises potato growing states of Central and Peninsular Indian states of Gujarat, Maharashtra, Karnataka, Orissa, parts of Madhya Pradesh. Potato is grown as a rainfed (July-September) as well as irrigated (November-February) crop. In shrink and swell soils (vertisols), tubers are exposed to light.

Nilgiri and Kodaikanal hills zone (Tamil Nadu)

The potato is cultivated all the year round i.e. summer (March-September), autumn (August-January) and winter (January-May). The first two season crops are rainfed whereas the last is irrigated and grown in valleys.

Varieties

A large number of high-yielding varieties of potato suited to different agro-climatic conditions have been evolved and released for cultivation on farmer's fields. Characteristics of some of the important new high yielding varieties are given below.

For Plains

Early varieties

Variety	Duration (days)	Yield (t/ha)	Special features
Kufri Chandramukhi	80-90	25-30	The variety is susceptible to early blight
Kufri Alankar	75 (plains) 130 (hills)	35	Poor keeping quality and ideal for multiple cropping
Kufri Shakti	95-110		
Kufri Navtal (G-2524)	90-100	20-25	
Kufri Bahar	100-110	25-26	

Kufri Badshah	120	25-30	Moderately resistant to early and late blight
Kufri sheetman	100-110	25	Drought tolerant crop
Kufri Chamatkar	110-130	25-30	Resistant to early blight and susceptible to mosaic and leaf curl
Kufri Navjot	125-130	20	Resistance to late blight

Medium to Late Varieties

Kufri Sindhuri	120-140	30-35	Plains of northern India	
Kufri Red	120			
Kufri Kisan	95-110		Plains of Uttar Pradesh, Madhya Pradesh and Delhi	
Kufri Navtal (G-2524)	90-100	20-25	Suitable for both plains and hills	

FOR HILLS

Kufri Jyoti	110-120	18	Hills of Himachal Pradesh, Uttaranchal and Khasi (Assam)	Susceptible to cracking
Kufri Jeevan	160	17.5	Hills of Himachal Pradesh	Resistant to late blight and wart
Kufri Naveen	150	20-30	Hills of Assam	Resistant to blight and rotage diseases
Kufri Neelmani	150	25-40	Nilgiris in south India	Excellent cooking quality and pleasant flavour
Kufri Moti	100-110	25-26	Nilgiris	Resistant to blight
Kufri Lauvkar	70-80		Deccan plateau	
Kufri Lalima	90-105	25	North Indian plains	Susceptible to late blight and scab. Has large round red tubers

Kufri Kumar	150-160			
Kufri Kundan	120		Northern hills	
Kufri Navjot	100-110 (plains) 120-130 (hills)	20		

Latest varieties of potato

Kufri Jawahar; Kufri Ashoka; Kufri sutlej; Kufri Pukhraj; Kufri Chipsona 1 (for making chips); Kufri Chipsona 2 (for making chips); Kufri Giriraj; Kufri Anand.

The varieties recommended for different states and zones are given below.

State	Varieties
Madhya Pradesh	Kufri Chandramukhi, Kufri Kissan, Kufri Jawahar, Kufri Badshah, Kufri Neelmani, Kufri Lauvkar
Maharashtra	Kufri Chandramukhi, Kufri Kissan, Kufri Kuber, Kufri Jyoti, Kufri Ashoka, Kufri Red, Kufri Naveen, Kufri Lauvkar
Uttar Pradesh	Kufri Kissan, Kufri Chamatkar, Kufri Badshah, Kufri Bahar, Kufri Navtal, Kufri Shakti, Kufri Kundan, Kufri Seetman, Kufri Chandramukhi, Kufri Ashoka, Kufri Jawahar, Kufri Jyoti, Kufri Kundan, Kufri Deva, Kufri Sutlej, Kufri Chipsona-1, Kufri Chipsona-2
Delhi	Kufri Kissan, Kufri Badshah, Kufri Bahar, Kufri Chandramukhi, Kufri Alankar, Kufri Chamatkar
Himachal Pradesh	Kufri Jyoti, Kufri Jeevan, Kufri Navtal, Kufri Kundan, Kufri Chandramukhi, Kufri Jawahar
Assam	Kufri Jyoti, Kufri Naveen, Kufri Megha, Kufri Khasigaro, Kufri Jeevan
Punjab and Haryana	Kufri Chamatkar, Kufri Kissan, Kufri Kuber, Kufri Chandramukhi, Kufri Jawahar, Kufri Ashoka, Kufri Jyoti, Kufri Sutlej, Kufri Badshah, Kufri Sindhuri
Rajasthan	Kufri Chamatkar, Kufri Alankar, Kufri Badshah, Kufri Bahar, Kufri Sindhuri, Kufri Jeevan, Kufri Naveen, Kufri Kanchan
Bihar	Kufri Kissan, Kufri Kuber, Kufri Ashoka, Kufri Jyoti, Kufri Red, Kufri Chandramukhi
Gujarat	Kufri Jawahar, Kufri Kuber, Kufri Alankar, Kufri Pukhraj, Kufri Chamatkar, Kufri Kissan
Karnataka	Kufri Jawahar, Kufri Jyoti, Kufri Chandramukhi, Kufri Sindhuri, Kufri Kuber, Kufri Alankar, Kufri Safed, Kufri Anand, Kufri Badshah, Kufri Bahar, Kufri Deva, Kufri Chamatkar

Meghalaya	Kufri Naveen, Kufri Megha, Kufri Ashoka, Kufri Kuber, Kufri Lalima, Kufri Pukraj, Kufri Sutlej, Kufri Chopsona-1, Kufri Chipsona-2
West Bengal	Kufri Red, Kufri Naveen, Kufri Kanchan, Kufri Jyoti, Kufri Lalima, Kufri Badshah, Kufri Bahar, Kufri Sindhuri, TPS C-3, HPS 1/13
Tamil Nadu and Nilgiri Hills	Kufri Neelmani, Kufri Pukhraj, Kufri Kundan, Kufri Chamatkar, Kufri Jyoti, Kufri Neela, Kufri Navajat, Kufri Kanchan, Kufri motum
Indian Plains	Kufri Chandramukhi, Kufri Sheetman, Kufri Badshah, Kufri Lalima, Kufri Kissan, Kufri Pukhraj, Kufri Kuber, Kufri Safed, Kufri Sindhuri, Kufri Alankar, Kufri Sutlej, Kufri Jawahar, Kufri Deva
Southern hills	Kufri Swarna, Kufri Jyoti, Kufri Chandramukhi, Kufri Giriraj, Kufri Kundan, Kufri Jeevan, Kufri Kumar
Plateau region of Peninsular India	Kufri Chandramukhi, Kufri Badshah, Kufri Jawan, Kufri Jyoti, Kufri Kuber, Kufri Pukhraj, Kufri Lauvkar
Northern, western and eastern hills	Kufri Kundan, Kufri Sheetman, Kufri Kumar, Kufri Giriraj, Kufri Navtal, Kufri Lalima, Kufri Jyoti, Kufri Jeevan, Kufri Kumar, Kufri Megha, Kufri Naveen

Soils

Potato can be grown on a variety of soils, but prefers a friable, well drained, fertile soils. Well-drained sandy loam and medium loam soils are ideal. Light textured soils with high humus content favour tuber development and harvesting becomes easier. With adequate fertilization, potato grows well even in sand. Excellent potato crop is grown under river bed system as cultivation in Deesa (district Banaskantha) in Gujarat. The potato plant prefers soils which are acidic to neutral range (pH 5.5-7.5). Black soils are, however, prone to cracking on drying and expose tubers to sun and tuber moth infestation. Non-sodic and non-saline soils are best for potato.

Land preparation

Tuberization prefers to have pulverized tilth, which may be obtained by giving two ploughings with mould board plough followed by two harrowing, planking and removal of weeds and plant residues or stubbles. Before planting the tubers, it must be ensured that the soil has sufficient moisture required for quick and uniform germination.

Seed rate and sowing

Prime requisite to obtain maximum production of potato depends on the selection of potato seed. Hence, pure and healthy seed is necessary for successful cultivation of crop. The seed tuber should be purchased from trusted agency. Select medium size (25-55 mm, weighing 35-45 g) unshrivelled tubers of uniform shape and colour for cultivation. Seed tubers infected with diseases like wart, scab, brown rot and nematode must be separated before planting.

Seed treatment

The seed tubers should be treated with aretan or tefaran or agallol or captan or dithane M-45 (1 kg in 45 litres of water) for protecting them from various fungal diseases. The tubers should be dipped in solution for 20-30 minutes. To break dormancy, the whole seed tubers

must be given a vapour treatment of ethylene chlorohydrin (1 litre/2.0 tonnes of seed tubers), but the cut tubers should be treated with 10% aqueous solution of thiourea (1 kg thiourea /tonne of seed tuber) by dipping for an hour. The treatment should be followed by a treatment with GA (1 ppm gibberelic acid for 10 minutes) for successful breaking of dormancy of tubers.

Seed tubers should be used for sowing just after taking out from cold store. These must be spread in cool, shady and ventilated place having diffused light for accelerating the sprouting of tubers as sprouted tubers give higher yield than unsprouted ones.

Sowing time

It is essential to plant potato at the optimum time so as to ensure proper growth and provide longer period for tuberization. The best time of planting is when the maximum and minimum temperatures ranges from 30 to 32°C and 18 to 20°C, respectively. The planting time for different potato zones are given in the Table 3.

Table 3. Optimum time of potato planting in different zones

Zone/State	Sowing time (season)
Western Himalayas	
Mid hills	January-February
High and very high hills	March-April and May
North western plains	Mid-September – Early October
North central plains	Mid-September – October (Autumn)
	December-January (Spring)
North-eastern plains	
Bihar	End of September
West Bengal	October-November
North-eastern hill zone	
Darjeeling hills	Mid-December – mid January (Spring)
Shillong hills	February-March (Summer)
Low hills and Plateau zone	
Madhya Pradesh	Last week of October-First fortnight of November
Maharashtra and Karnataka	Last week of June – Early July (<i>kharif</i>) III rd week of October – I st week of November (<i>rabi</i>)
Nilgiri and	August-September (Autumn)

Kodaikanal hills zone	January (<i>rabi</i>)
	March-April (summer)

Seed size, spacing and seed rate

The ideal tuber size for planting should be 3.5-5.0 cm in diameter and approximately 30-50 g in weight. It is established fact that potato yield increases with increase in seed size and decrease in spacing. However, the seed size and spacing depend upon the variety and the purpose for which the crop is grown. Higher seed rates are used for raising a good seed crop, but lower seed rate (preferably cut pieces) for ware potatoes (Table 4).

Table 4. Seed size, spacing and seed rate in potato

Crop	Seed size	Spacing	Seed rate (q/ha)
Early crop	2.5 cm x 3.0 cm in diameter	45 cm x 15 cm	10
Seed crop	4.0 cm x 5.0 cm in diameter	50 cm x 20 cm	25
Ware crop	2.5 cm x 4.0 cm in diameter	60 cm x 25 cm	20

Method of planting

There are 4 popular methods of planting potato tubers in India.

Flat bed planting: This method is common in areas having light sandy soils. Planting of tubers is done on flat surface in very shallow furrows and planking is done. Two earthings, first 25-30 days after sowing, and the second 40-50 days after sowing are required.

Planting on ridges: After preparation of field, the ridges of 30 cm height and 60 cm width are made at a distance of 45-60 cm. Planting of potato is done on the ridges at a distance of 15, 20 and 25 cm in early, seed and ware crops, respectively.

Planting in furrows: This method is adopted in irrigated and light sandy soils, where also 2 earthings as in flat bed planting is done. Potatoes are planted in furrows and immediately after planting tubers, small ridges are made.

Planting by potato planter: recently potato crop is planted mechanically by planters.

Manure and Fertilizers

Potato is a heavy feeder of nutrients due to its shallow root system. Hence, it needs adequate fertilization for good growth and yield of tubers.

Role of organic matter is well established. According to organic matter content of the soil, a dose of 20-30 tonnes/ha of well decomposed FYM, leaf mould or compost should be applied. An application of 0.3-0.5 tonnes/ha of well powdered neem cake helps to control the insect pest and also supplies plant nutrients. The fertilizer needs of potato varies with planting material, purpose of the crop raising and soil characteristics. The recommended dose of fertilizer for different crops and zones is given in Table 5 and 6.

Table 5. Fertilizer scheduling for potato crop

Type of the potato crop	Rate of nutrients to be applied (kg/ha)			Time of application	
	N	P ₂ O ₅	K ₂ O	Basal	Top dressing
Early crop	80-100	60-80	80-100	50N+P+K	50 N
Main crop	100-120	60-80	80-120	60N+P+K	60N+30K
Late crop	100-120	60-80	100-150	60N+P+120K	60N+30K
Hill crop	100-120	60-80	100-150	60N+P+120K	60N+30K
Mid hill crop	80-120	80-120	100-150	Whole amount	-

Table 6. Fertilizer needs of potato in different zones

Zones	Soil	Fertilizer dose (kg/ha)		
		N	P ₂ O ₅	K ₂ O
Plains	Alluvials	180-240	80-100	100-180
Low hills and plateau zone	Vertisols	100-120	60	60
Nilgiris & Kodaikanal hills	Acidic hill soil	90-120	135-150	90
Western Himalayan zone	Acidic hill soil	100-150	100-150	60-120

Entire P and K fertilizers along with 50% N are applied at the time of planting. The remaining N should be top dressed at the time of earthing up.

Ammonium sulphate, CAN and Ammonium sulphate nitrate are better sources than urea. Superphosphate and DAP are the sources of phosphorus. Sulphate of potash is the best source for potassium. Potassium chloride should not be applied.

The fertilizer needs for *rabi* crop are relatively higher than *khari* crop. Adequate potassium fertilization in Punjab is essential to arrest frost and late blight losses. For processing, large sized tubers are preferred by industry and application of higher N and P doses are required for this crop.

In acidic soils of Tamil Nadu and Meghalaya, liming with 2.5 t/ha and application of MgCO₃ @ 30 kg/ha is necessary to avoid Ca and Mg deficiency.

Among micronutrients, Zn, Cu and Fe deficiency are more often encountered in potato. The deficiency of these micronutrients are more in sandy soils with alkaline pH (>8.5) and free CaCO₃. The rates and methods of micronutrients fertilization in potato are given in Table 7.

Table 7. Micronutrient fertilizer scheduling for potato crop

Micronutrient salts	Soil application (kg/ha)	Spray application (g/100 litres of water)	Tuber soaking treatment (g/100 litres of water)
Zinc sulphate	25	200(0.2%)	50(0.05%)
Manganese sulphate	25	200(0.2%)	50(0.05%)
Ferrous sulphate	25	200(0.2%)	50(0.05%)
Copper sulphate	25	200(0.2%)	50(0.05%)
Ammonium molybdate	2	100(0.1%)	20(0.02%)
Sodium borate	2	100(0.1%)	20(0.02%)

Water Management

Potato crop is very responsive to irrigation. It requires frequent and light irrigations at low moisture tension irrespective of the varieties. Furrow method of irrigation is main system of irrigation. In no case water should reach more than two-thirds height of ridges. The lengths of the ridges depend upon the soil type, slope and source of water. The frequency of irrigation also varies with water table and soil type. In medium to heavy soils, 3-4 irrigations would be sufficient. On the other hand, sandy soils having low water table would require 8-12 irrigations.

Over flooding results in soil compaction of the ridges which results into poor aeration and poor tuber development. The most critical stages for irrigation in potato are stolonization followed by tuberization, which generally coincide with 30-35 and 55-60 days after sowing. Since potato crop can not tolerate waterlogging, removal of excess water is essential to get good yield.

Under soil related constraints (undulating topography, very high/poor infiltration soils) pressurized irrigation may be beneficial. In sprinkler and drip system, fertilization is advised. The former method is also useful in protecting crop from frost.

Earthing

Proper development of tubers depends upon proper aeration, moisture availability and proper soil temperature. Therefore, earthing up is most essential operation. Potato tubers are modified under ground stems, which use to synthesize anthocyanin and chlorophyll, if exposed to sunlight. Therefore, it is essential to cover the tubers fully with soil because with chlorophyll formation the tubers stop accumulation of starch and remain smaller, and the solanin formation in green tubers results into bitter taste of tubers. Number of earthing and height of ridges after earthing depends upon the method of planting and soil type. In case of flat bed planting, two earthings at 25-30 days and 45-50 days after sowing are given. In case of furrow planting method, light ridging is done up to a height of 10-15 cm soon after sowing and second earthing is done about 30-35 days after sowing. Earthing should be done when the plants are 15-22 cm high. Generally earthing is done at the time of top-dressing of nitrogenous fertilizers. A ridger may be used for earthing up in large area.

Weed control

Weed infestation in potato causes a drastic reduction in tuber yields. Initial 4-5 weeks after emergence of seedlings is critical period of crop weed competition. Frequent irrigations, coupled with heavy fertilization offer favourable conditions for weed growth. The important weed flora of potato is given below.

Zone	Grasses	Dicots	Sedges
Plains	Poa annua/pratensis Phalaris minor Polypogon monspeliensis	Amaranthus viridis Avena fatua Anagallis arvensis Chenopodium murale Coronopus didymus Fumaria parviflora Trianthema portulacastrum Spergula arvensis	Cyperus rotundus C. iria
Hills	Digitaria spp. Eleusine spp, Eragrostis spp. Pennisetum clandestinum	Amaranthus spp. Cannabis sativa Spergula arvensis Chenopodium album Oxalis latifolia Melilotus indica Rumex spp.	Cynodon dactylon

Weeding in potato should be done as soon as weeds emerge, but preferably when potato plants are about 8-10 cm high. When manual and mechanical hoeing are not feasible, use of herbicides are inevitable.

The most common pre-emergence herbicides used to control weeds in potato crop are atrazine (0.3-0.5 kg/ha), simazine (0.3-0.5 kg/ha), 2,4-D (0.5 kg/ha), metribuzin (0.7-1.0 kg/ha), oxyfluorfen (0.15 kg/ha), dichloromate (1-2 kg/ha) and pendimethalin (1.0 kg/ha). Fluchloralin (0.7-1.0 kg/ha), EPTC (1.5-2.0 kg/ha) as pre-planting may also be used to check the weeds in potato crop.

For controlling perennial weeds like *Cyperus (motha)* and *Cynodon (doob)* grass paraquat may be sprayed @ 0.4-0.6 kg/ha. Spraying should be done at a stage when potato plants are emerging to the extent of only 5-10% and weeds have germinated on the ridges.

Cropping System

Potato can be raised as companion crop in autumn-planted sugarcane crop where 2 rows of potato can be taken between 2 rows of sugarcane. A companion cropping with mustard, wheat, barley can be done without much reduction in the tuber yield of potato. In potato + mustard cropping, seed tubers of 4 rows are planted in 3 rows by reducing plant-to-plant spacing and fourth row is used for sowing mustard. In potato intercropped with barley, wheat or maize, the later crops are grown in every alternate furrow of potato after an early

earthing up of potato (25 days sowing). The important intercropping systems are given below.

Intercropping	Row ratio	Location
Potato- <i>rajmash</i>	3:2	Central & eastern Uttar Pradesh and north Bihar
Potato+cotton	1:1	Dharwad (Karnataka)
Potato+maize	1:1	North Bihar and Madhya Pradesh
Onion/garlic+potato	1:2	Shimla (Himachal Pradesh)

In the irrigated areas, many crop rotations involving potato are feasible. Being a short duration crop, it fits well in many intensive crop rotations. Some of the important rotations are given below.

Maize-potato-sugarcane	Soybean- potato-okra
Maize- potato-greengram	Sesame-potato-groundnut
Cowpea-potato-wheat	Maize-potato-wheat
Maize-potato-maize	Maize-potato-potato
Maize-potato-onion	Rice-potato-sesamum
Potato-jute-rice	Rice-potato-greengram
Rice-cabbage-potato	Rice-potato-wheat

Harvesting

Crop should be harvested when haulms start yellowing and falling on the ground. At this stage, haulms should be removed from the ground level. The crop should be harvested about 15 days after removing the haulms. Suitable tractor operated potato diggers are available now for digging the potatoes in larger areas. There should be optimum moisture in the soil at the time of harvest. After digging the tubers, these may be allowed to dry on the ground for some time in shade.

Yield

By adopting the recommended package of practices, an yield of 30-40 t/ha can be obtained. However, in hills except lower valleys, the yields are less than 25 t/ha. The growth and yield attributes of potato are as follows:

Attribute	Value
Plant height	30-45 cm
Number of stems/hill	Number of stems/hill
Number of stems/hill Number of tubers/hill	5-9

Tuber yield/hill	0.2-0.5 kg
------------------	------------

Post-harvest care

The irrigation in the crop should be stopped about 20-25 days before digging the tubers. This helps in proper skin curing of tubers so that they do not get bruised off their skin while digging or during transport. After harvesting, tubers should be brought in cool shady place and spread in thin layers. After a week, these tubers are stored and graded. The cut tubers should not be brought to the store from the field as they are the first to start rotting and affect other tubers also.

Grading of Tubers

In order to assure uniform quality of superior grade tubers and to get remunerative returns, it is essential to grade them according to their respective sizes. The potatoes of the plains may be graded as follows:

Seed size tubers

large size tubers

chats (tubers with <20 g weight)

The potato tubers obtained from hills are graded as:

Special size with a diameter of 8 cm and above

Phool size with a diameter of 3-5 cm

Ration size with a diameter of 2.5 cm or below

The tubers separated by mechanical graders are classified into 4 grades based on tuber weight as below:

Grade	Tuber weight (g)
A	>200
B	150-200
C	100-150
D	50-100

Seed production

A healthy seed crop may be taken with the help of seed plot technique. For seed production, healthy seeds (tubers) free from viral infection and other diseases should be obtained and treated with Avtar 0.25% solution. Tubers should be planted from 15 October to 25 October at a row-to-row distance of 60 cm and plant-to-plant distance of 15-20 cm. A lower dose of nitrogen (80-100 kg/ha) should be applied to check excessive plant growth. The crop should be carefully examined and protected at least 3-4 times from diseases and pests infestation. The crop should be given light irrigation. Towards 15 December when the crop has tuberized well, restrict irrigation and withheld completely later on, so that haulms dry up and consequently escape aphid build up towards 15 January. Remove tops between 12-20 January. Leave the tubers underground till 30 January so that they mature and their skin hardens.

Additional Reading Material:

<http://en.wikipedia.org/wiki/Potato>

 potato

<http://www.potato2008.org/en/potato/index.html>

http://www.niir.org/books/book/zb,,131_a_0_0_a/Potato+and+Potato+Products+Cultivation,+Seed+Production,+Manuring,+Harvesting,+Organic+Farming,+Storage+and+Processing/index.html

<http://research.cip.cgiar.org/confluence/display/wpa/India>