PACKAGE OF PRACTICES FOR VEGETABLE CROPS IN LADAKH

High Mountain Arid Agriculture Research Institute Leh- Ladakh

SHER-E-KASHMIR

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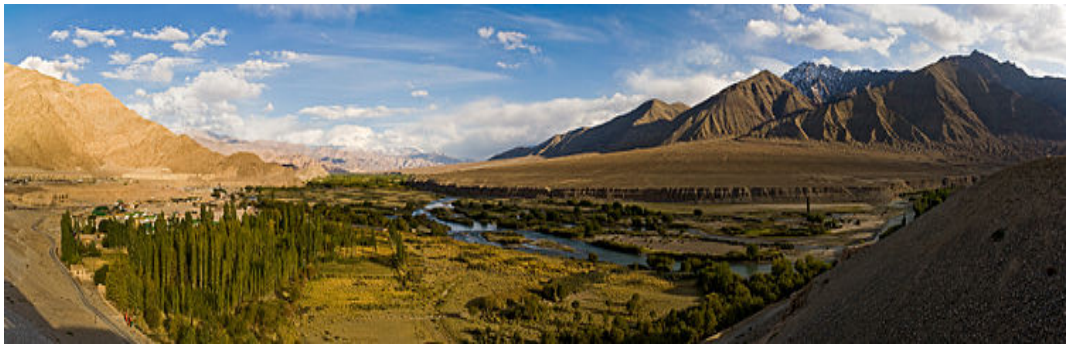
Ladakh (land of high passes) is a region in the Indian state of Jammu and Kashmir that extends from the Siachen Glacier in the Karakoram range to the main Great Himalayas to the south. It is inhabited by people of Indo-Aryan and Tibetan descent. It is one of the most sparsely populated regions in Jammu and Kashmir and its culture and history are closely related to that of Tibet. Ladakh is known for its remote mountain beauty and culture. Ladakh is the highest plateau in the state of Jammu & Kashmir with much of it being over 3,000 m (9,800 ft). It extends from the Himalayan to the Kunlun Ranges and includes the upper Indus River valley. Ladakh is a high altitude desert as the Himalayas create a rain shadow, generally denying entry to monsoon clouds. The main source of water is the winter snowfall on the mountains.



Scant precipitation makes Ladakh a high-altitude desert with extremely scarce vegetation over most of its area. Natural vegetation mainly occurs along water courses and on high altitude areas that receive more snow and cooler summer temperatures. Human settlements, however, are richly vegetated due to irrigation.

Ladakh is a high altitude cold arid region of India. Human settlements are from 2400-4200 meter above mean sea level in the region. The climatic and geographic differentiation segregates the region from rest of the world. Therefore, the agro-

techniques for the vegetable production being employed elsewhere are not suitable for this region. Specific agro-techniques are required for this harsh region.

Due to requirement of intensive operation in production, there is a need for standard package of practices for different vegetables. High Mountain Arid Agriculture Research Institute (HMAARI) Leh has been working on various aspects of vegetables since two decades in the region. Intensive research trials were carried out on various vegetable crops under Precision Farming development Center (PFDC) scheme.

1. Significance and scope of vegetable crops

Any part of herbaceous plant which can be used as culinary purposes is known as vegetable. Vegetables include all those annuals, biennials and perennials of which mature parts like seeds, roots, fruits and immature parts like stem, leaves, flowers and succulent parts are used or cooking purpose.

Significance of vegetables

Vegetables are one of the cheapest sources of natural nutritive foods. Some of the vegetables are good source of carbohydrates (leguminous vegetables, sweet potato, potato, garlic, onion, brussel sprouts, methi), proteins (peas, beans, leafy vegetables, garlic, brussel sprouts), vitamin-A (tomato, carrot, turnip, leafy vegetables, sweet potato, pumpkin), vitamin-B (pea, beans, garlic, tomato, asparagus), vitamin-C (green chilies, turnip, brussel sprouts, drum stick leaves, cauliflower, cabbage, knol khol, bitter guard, radish leaves, leafy vegetables), calcium and iron (all green leafy vegetables, drum stick).

Nutritional values

Vegetables are the most important natural source of vitamin-A and C, and they rank highest as source of vitamin-B_1 and B_2. Every balanced diet should include at least 300 g of vegetables. Besides, vegetables are valued for certain medicinal properties.

In short, it can be concluded that;

- Vegetables are one of the most important components of balanced diet.
- Vegetables increase palatability in food.
- Vegetables eliminate acidity due to non-vegetarian food.

- Vegetables are valuable roughages having higher digestibility coefficient.
- Vegetables are cheapest source of natural protective foods.
- Vegetables are good source of minerals, vitamins, proteins and carbohydrates

Scope of vegetable cultivation

- Most of the vegetables are short duration, fast growing and therefore, more crops can be raised from the same unit of land
- Vegetables fit well in crop rotations, inter-cropping, multiple cropping, mixed and companion cropping systems
- Vegetables can be grown as off season in cold area like Ladakh
- Kitchen gardening of vegetables is the most efficient system of utilizing the home waste and used water
- The yield potential of vegetables is very high, about 5 to 10 times than many cereals
- Productivity is high and can be grown on small and marginal holdings
- Vegetable growing makes more effective use of land and labour
- Vegetable growing provides opportunity for employment to rural poor
- Vegetables have vital role to play in national economy and wellbeing of human beings.

Agro-climatic zone of Ladakh region

The Western Himalayan Region covers Ladakh area of Jammu and Kashmir. The state of Jammu and Kashmir lies in the North of India and extends from 32^0 17′ to 37^0 50′ N Latitude 72^0 40′ to 80^0 30′ E Longitude. The Ladakh region occupies more than double the area occupied by all the zones and due to low temperature and short growing season (four months only); this zone is suitable for the cultivation of millets, barley and wheat.

CAPSICUM

Capsicum is one of the excellent vegetables and has great demand in the market. It is also called as "Bell Pepper". Capsicum is different shapes and colours. Capsicum plants are bushy and can be trained up to 1-1.5m. It is used in salad, stew, stir fries, backed and stuffed foods, pizza etc. Capsicum grown in protected structures has more demand due to good quality produce. Growing coloured capsicum is increasing due to their attractive colours and to use in salad. It is rich in vitamin such as A and C, minerals and antioxidants. Coloured capsicum is nontraditional crop in Ladakh region and is recommended for cultivation under LEHO type greenhouse. It is particularly rich in vitamin A and C thus acts as potential antioxidant**.**

Scientific name	*Capsicum fruitesens*
Genus	Capsicum
Family	Solanaceae
Common name	Shimla Mirch

Climate	It performs well in mild climate hence, considered a cool season crop. It cannot withstand extreme temperatures i.e. below 15^0C and above 30^0C because of significant reduction in growth and fruit set. It is susceptible to frost. Being sensitive to environmental factors, its cultivation under poly tunnels or poly-houses is preferred. Capsicum is grown under protected conditions in Leh, where temperature is maintained at 20-27^{o}C.
Soil	Soil should be well drained, rich in organic matter to maintain adequate moisture either with mulch or plastic covering. On sandy loam soil, it can be grown successfully with proper manuring and timely irrigation. The pH should be 6.0-7.5.
Recommended varieties	Orobelle, Mamtha, S. Gold, Spinx, US-181, Bharath and Shalimar Hybrid-1, California wonder, Shalimar improved and Nishat-1
Sowing time	March
Seed treatment	Seeds should be treated with Captan @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	500 to 600 g per ha of seed in well prepared seed beds. The seeds should be lightly covered with soil, and then watered. The seedlings make an appearance within one to two weeks.
Transplanting	5-6 week old seedlings are ready for transplanting.
Spacing	45×30 cm
Manures and Fertilizers	The soil within the protected structure is ploughed with spade. FYM @ 25ton/ha is applied and mixed well with the soil. Nitrogen (Urea), Phosphorous (DAP) and Potassium (MOP) @ 120 (260.0), 70 (154.0) and 30 (51.0) kg/ha. Basal dose of 1/3 of

	N along with other fertilizers and the remaining N should be top dressed in two split doses, at 21 and 42 days after transplanting.
Weeding, hoeing and mulching	Weeding after few days of irrigation to conserve moisture. 3-4 hoeings are normally needed to check weed growth. Mulching with black polythene is recommended to check weed growth and conservation moisture.
Stacking	Staking should be done after 30 days from the day of transplanting
Pinching	Pinching is done to extra branches and keeps 1 or 2 main branches to obtained quality fruits.
Irrigation	Capsicum cannot withstand heavy moisture. So irrigation scheduling through drip irrigation is fallowed.
Recommended structure	LEHO, Trench and SKUAST model-II type of greenhouse is recommended for successful capsicum cultivation in Ladakh.
Harvesting 	When fruit attains proper size and colour, it is harvested and stored in shed to remove field heat. Pick the fruits with an upward twist with a piece of stem intact.

<table>
<tr><td colspan="2">PLANT PROTECTION</td></tr>
<tr><td colspan="2">Physiological disorders</td></tr>
<tr><td>Flower/fruit drop</td><td>It is one of the major problems in capsicum cultivation. It is due to:
Low humidity and high temperatures
Decrease in light intensity
Control: Irrigate at flowering and at first fruit set, Foliar application of 50 ppm NAA and use Epsom salt @ 5g/liter of water to encourage plants to bear fruits.</td></tr>
<tr><td>Sun scald
  </td><td>Due to high temperatures during the summer, scorching occurs on the direct exposed part of the fruit.
Control: It is controlled by regulating the poly house temperatures by opening of door and windows for proper ventilation and also covers the poly house with shade net.</td></tr>
<tr><td>Blossom end rot
  </td><td>Blossom end rot symptoms occur on both green and ripe fruits and identified by water-soaked areas that gradually widen and mature into sunken, brown, leathery spots on the bottom end.
Control: Use calcium to deal with the disease. Foliar application of Liquid Calcium @ 5% is effective to control.</td></tr>
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TOMATO

Tomato is a herbaceous sprawling plant growing to 1-3 m in height with weak woody stem. The flowers are yellow in colour and the fruits of cultivated varieties vary in size from cherry tomatoes, about 1–2 cm in size to beefsteak tomatoes, about 10 cm or more in diameter. Most cultivars produce red fruits when ripe. Tomato is one of the most important "protective foods" because of its special nutritive value. It is one of the most versatile vegetable with wide usage in Indian culinary tradition. Tomatoes are used for soup, salad, pickles, ketchup, puree, sauces and in many other ways It is also used as a salad vegetable. Tomato has very few competitors in the value addition chain of processing.	
Scientific name	*Lycopersicon esculentum*
Genus	Lycopersicon
Family	Solanaceae
Common name	Tamatar (Hindi) and Tomato
Climate	It requires different climatic range for seed germination, seedling growth, flower and fruit set, and fruit quality. Temperature below 10^0C and above 38^0C adversely affects plant tissues thereby

	slow down physiological activities. It thrives well in temperature 10^0C to 30^0C with optimum range of temperature is 21-24^0C. The mean temperature below 16^0C and above 27^0C is not desirable. The plant doesn't withstand frost, it requires low to medium rainfall, and does well under average monthly temperature of 21 to 23^0C. Avoid water stress and long dry period as it causes cracking of fruits. Bright sunshine at the time of fruit set helps to develop dark red colored fruits.
Soil	Tomatoes do very well on most mineral soils, but they prefer deep, well drained sandy loams. Upper layer of soil should be porous with little sand and good clay in the subsoil. Soil depth 15 to 20cm proves to be good for healthy crop. Deep tillage can allow for adequate root penetration in heavy clay type soils, which allows for production in these soil types. Tomato is a moderately tolerant crop to a wide pH range. A pH of 5.5- 6.8 is preferred.
Recommended varieties	Roma, Shalimar-I, Shalimar-II, Arka Vardan and Himsona are recommended for both open and Polyhouse condition in cold arid condition, we are grown in tomato under Polyhouse condition to take only indeterminate type of verities because they are provide continuous yield.
Sowing time	2nd Week of March to April
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	400 to 500 g/ha.

Transplanting	When seedling is 10-15 cm tall 4-5 week old, these are uprooted and transplanted. The transplanting is done in small flat beds or in shallow furrow depending upon the availability of irrigation. In heavy soil it is usually transplanted on ridges and during the rains also it is advantageous to plant the seedlings on ridges.
Spacing	45×30 cm Polyhouse 60×45 under open
Manures and Fertilizers	For best result 20 to 25 tons of FYM or compost should be incorporated into the soil about 4 weeks before transplanting. In tomato 120 kg N, 60 kg/ha P and 60 kg/ha K, should be given. For best result 15 to 20 tons of FYM or compost should be incorporated into the soil about 4 weeks before transplanting. FYM=20 t/ha, N=120 kg/ha, P=60 kg/ha, K=60 kg/ha. ½ N full P and K as basal dose, ½ N is 30 days after transplanting.
Weeding, hoeing and mulching	There is need of light hoeing during first four weeks in the field which encourage the growth but also remove the weeds from the field. The surface soil is loosened by hand hoeing as soon as it is dry enough after every irrigation or shower. All weeds should also be removed in this process. Mulching with straw, black polythene and many other materials has been found beneficial in moisture conservation, in controlling soil temperature, weeds and some diseases both open and Polyhouse condition.

Staking	For indeterminate varieties/hybrids, the seedlings have to be staked using bamboo or iron sticks of two meter length for support the plant.
Training	Training tomatoes is not difficult, but you have to start when they're young. Wait no more than a month after transplanting. Tie the stems of your tomato plants to the support structure every 6 or 8 inches as they grow. The growing stems are soft and easily damaged, so you need to tie them loosely.
Irrigation	Irrigation is essential to produce consistent yields of high quality tomatoes. Drip irrigation has become the standard practice for tomato production. Although it can be used with or without plastic mulch, its use is highly recommended with plastic mulch culture. One of the major advantages of drip irrigation is its water use efficiency. Drip irrigated vegetables require 50 percent less water. Weeds are also less of a problem, since only the rows are watered and the middles remain dry.
Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse, Trenches, Walk in tunnel, Leho commercial and Green shade net are recommended for successful cultivation.
Harvesting	The crop will be ready for harvest in about 2- 3 months after planting. The harvesting of the tomatoes is done as per the requirement of the market and in a typical season 8 to 10 harvesting is done to feed the market as per its requirement.

<table>
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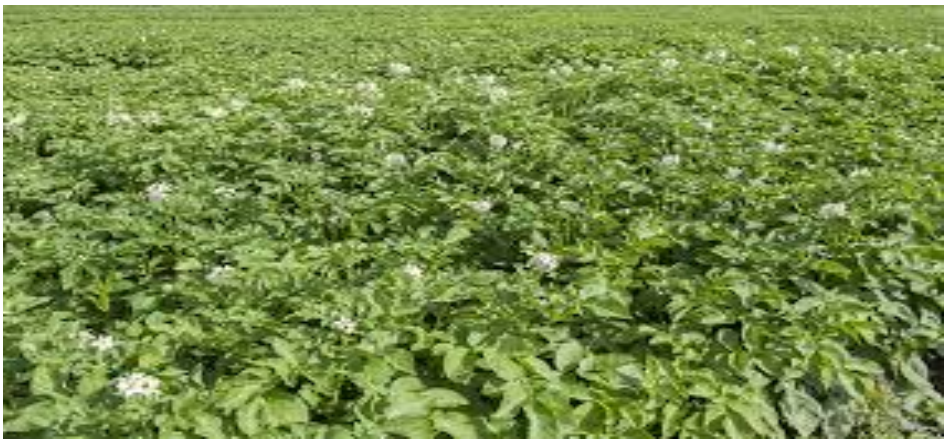
<tr><td>Fruit Cracking
  </td><td>Cracking on the surface of the fruit at the stem end is a common occurrence. It is developed mostly in fully ripe fruit than in mature green or breaker stage. Sudden water availability causes rapid fruit expansion leading to fruit cracking. High temperature and high light intensity, boron deficiency (especially calcareous soil)
Control:
1. Soil application Borax @ 15-20 kg/ha.
2. Spraying of borax 0.25% 2-3 times fruiting stage to ripening stage.
3. Maintaining plants at low to medium soil moisture so preferable to grow in the greenhouse.</td></tr>
<tr><td>Blossom end rot
(BER)
  </td><td>The water soaked area near the bottom or blossom end of the fruit. The area usually develops rapidly eventually resulting in a blackened, dry, sunken leathery spot. BER affects the blossom end of the placenta and adjacent locular contents as well as the outer wall. It can most easily be identified by a discolored, sunken spot at the blossom end of the fruit. BER is not caused by any single factor but a combination of one or more factors intensifying the effect it includes high salinity high MgSO4, NH4 and/ or K concentration. Accelerated growth rate, unfavorable moisture relationships.
Control:
1. Cultural practices, such as the use of polyethylene mulch maintain adequate soil</td></tr>
</table>

	moisture, and avoiding varieties that are most susceptible to BER will help reduce the incidence. 2. Misting or fogging inside the greenhouse reduces the incidence. 3. Foliar spray of CaCl2 solution 0.5%@ time of fruit developed was an effective control.
Puffiness 	Puffiness refers to the existence of open cavities between the outer walls and the locular content in one or more locules and is also known as hollowness or boxiness. Non fertilization of ovules, embryo abortion after normal fertilization and high temperature and high soil moisture are predisposing factors. Control: 1. Maintenance of normal temperature. 2. Spraying of Borax or Solubor 10-15 ppm at the peak flowering time.
Sunscald or Sunburn 	Green fruits exposed to direct sunlight ripen unevenly so that yellow patches appear on the side of the tomato fruit when it ripens. Symptoms are most likely to appear at the mature green to breaker stage of development. The lesions are infected by secondary infection of fungus which shows black dark spots making tomatoes units for consumption. **Control:** 1. The best protection against sunscald is to utilize cultivars with enough foliage to cover the fruit and to provide enough water

	and pest protection to maintain the healthy foliage 2. Crop are planted at higher densities are less susceptible 3. Cultivation of indeterminate /semi-determinate varieties without staking
Blotchy Ripening 	This disorder also known as the gray wall is recognized as grayish appearance caused by partial collapse of the wall tissue hence the term gray wall. The affected area remain green or yellow are usually found nearly at the stem end of the tomato fruit. It is caused due to Potash deficiency. **Control:** 1. Use of balanced fertilizer dose (after soil testing) in the crop prevents the occurrence of blotchy ripening 2. Adjust planting date to achieve favorable light intensity for good fruit development.
Cat Face 	Cat face is a disorder characterized by gross deformity of tomato fruit, which usually renders them unmarketable. The defect is usually located on the blossom end of the fruit cat face is a commonly observed in first harvest. In the field air temperature of 17/10c for a weak are sufficient to induce abnormal flower development, low temperature during the sensitive period increases the no. of locules in the fruit. **Control:** 1. Maintenance of sufficient soil moisture 2. Recommended cultural practices should be adopted

POTATO



Potato is the most important food crop of the world. The potato is a crop which has always been the 'poor man's friend'. Potato is being cultivated in the country for the last more than 300 years. For vegetable purposes it has become one of the most popular crops in this country. Potatoes are an economical food, they provide a source of low cost energy to the human diet. Potatoes are a rich source of starch, vitamins especially C and B1 and minerals. They contain 20.6 per cent carbohydrates, 2.1 per cent protein, 0.3 per cent fat, 1.1 per cent crude fibre and 0.9 per cent ash. They also contain a good amount of essential amino acids like leucine, tryptophane and isoleucine etc.

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

Scientific name	*Solanum tuberosum* L.
Genus	Solanum
Family	Solanaceae
Common name	Alu

Climate	Potato is a cool season crop. It thrives best in cool regions where there is sufficient moisture and fertile soil. Satisfactory tuber growth occurs if soil temperatures are between 17 and 19°C. Higher soil temperatures adversely affect the tuber development. Tuber development virtually stops if temperatures rise above 30°C. It grows best under long day conditions. Sunshine along with cooler nights is essential for reducing the spread of diseases.
Soil	Potatoes can be produced on a wide range of soils, ranging from sandy loam, silt loam, loam and clay soil. Soils for potato should be friable, well aerated, fairly deep and well supplied with organic matter. Well drained sandy loam and medium loam sols, rich in humus are most suitable for potato. Soil structure and texture has a marked effect on the quality of the tuber. Light soils are preferred because they tend to promote more uniform soil temperatures and make harvesting of the crop easier. Alkaline or saline soils are not suitable for potato cultivation. They are well suited to acidic soils (pH 5.0 to 6.5) as acidic conditions tend to limit scab disease
Recommended varieties	Kufri Jyoti, Gulmarg Special, Kufri Giriraj, Shalimar Potato-1 and Shalimar Potato-2
Sowing time	Mid April to May
Seed treatment	This treatment is usually given to cut tubers to avoid decaying by soil microorganisms after sowing. Cut tubers are dipped in 0.2 % Bavistin or Dithane Z – 78 solution for 5 to 10 minutes.

Seed rate	20-25 q/ha
Planting	There are two planting method is commonly used in Ladakh. 1. **Planting potatoes on ridges:** After preparation of field, ridges are made at a distance of 45-60 cm with the help of spade. Planting of potato is done on the ridges with the help of khurpi. 2. **Flat method:** Planting of potato is done on the flat surface in shallow furrows. Ridges are made after germination when plants attain 10-12 cm height. This method is suitable for light soils. Later on two to three earthlings are done to make the ridges thick.
Spacing	60×20 cm.
Manures and Fertilizers	FYM=25 t/ha, N=150 kg/ha/P=100 kg/ha, K=100 kg/ha, ½ N full P,K as basal dose and ½ N at first earthing 45 days after transplanting.
Weeding	There is need of light hoeing during first four weeks in the field which encourage the growth but also remove the weeds from the field.
Earthing	Proper development of tubers depends upon, aeration, moisture availability and proper soil temperature. Therefore, proper earthing up is necessary. Earthing should be done when the plants are 15-22 centimeters high. Generally earthing is done at the time of topdressing of nitrogenous fertilizers. The ridges should be broad, loose and high enough to cover up tubers. If necessary, a second earthing may be done after two weeks of the first one.

Irrigation	In Potato, following stages are considered critical from point of view of maintenance of adequate moisture in the root profile, as even small shortages at any of these stages could result in proportionally very high loss in yield. **Germination:** for assured, rapid, uniform emergence of seedlings and good uniform crop stand at the start; and synchronous maturity at the end of crop season. **Stolonization :**Stolon formation initiation 30-35 days after the seeding of the crop. **Tuberization :** When the stolons, formed under-ground start to swell at the tips. This follows 10-15 days after stolonization initiation. Any shortage at this phase reduces the chances of stolons to be converted into tuber-bearing stolons, or tubers if formed may fail to progress in their size gain.
Harvesting	Crop should be harvested when haulms start yellowing and falling on the ground. At this stage haulms should be removed at ground level. The crop should be harvested about 15 days after cutting the haulms. Digging is done with spades or khurpi in small fields. Suitable tractor operated potato diggers are available now for digging the potatoes in big fields. There should be optimum moisture in the soil at the time of harvest. The clods hinder the efficient functioning of potato-digger. After digging, the tubers may be allowed to dry on the ground for some time in shade

PLANT PROTECTION	
Physiological disorders	
Black Heart 	Black heart occurs primarily in storage when the tubers do not receive enough oxygen. Blackening of the tuber center follows acute oxygen deficiency associated with either low temperature in confined storage or high field soil temperatures. The tissue dies from the inside out and turns jet black. Smell is absent and affected tubers rot later **Control:** • In the field, promote good soil drainage and avoid excessive irrigation. • Do not delay harvest in hot soils. • Positive store ventilation will improve gas exchange, dry crops quicker and help prevent condensation events. • Avoid a buildup of carbon dioxide in excessively sealed stores
Greening 	The tubers turn green in color when exposed to direct sunlight. The green pigment produced is *solanin* which is slightly poisonous and make the tubers unfit for consumption. **Control:** • Earthing up should be done to avoid the exposure of tubers to direct sunlight.
Sprouting in storage 	Sprouting of potato tuber in storage is the major problem of storage which deteriorate the quality and make the product unfit for consumption. The intensity of sprouting depends on the variety. **Control:** • Grow those varieties which sprout late

	• Spray the crop with maleic hydrazide @ 3000 ppm at 15 days before harvesting • Store the potato tuber in cold storage 2-4^{0}C and 90-95 per cent relative humidity.
Poor/ Uneven Sprouting in the field	Adequate crop stand cannot be maintained due to this disorder which happen due to Control: • Planting immediately after removal from cold storage • Soil moisture deficiency • Held tuber in storage till end of dormancy period Treat the cut tuber pieces with 0.25% Diathane M-45 for 10 min.

BRINJAL

Brinjal or Eggplant is an important crop of sub tropics and tropics. The name brinjal is popular in Indian subcontinents and is derived from Arabic and Sanskrit whereas the name eggplant has been derived from the shape of the fruit of some varieties, which are white and resemble in shape to chicken eggs. In India, it is one of the most common, popular and principal vegetable crops grown throughout the country except higher altitudes but under protected structures it can be easily grown in higher altitude. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. A number of cultivars are grown in India, consumer preference being dependent upon fruit color, size and shape.	
Scientific name	*Solanum melongena* L.
Genus	Solanum
Family	Solanaceae
Common name	Brinjal and Began
Climate	The brinjal is a warm season crop, therefore susceptible to severe frost. Low temperature during

	the cool season causes deformation of vegetables. A long and warm growing season is desirable for successful brinjal farming. Cool nights and short summers are not suitable for satisfactory production. A daily average temperature of 13 to 21^0 C is most favorable for optimum growth and yield. The brinjal seed germinate well @25^0C. This temperature is maintained under different protected structure. To grow successful brinjal crops in cold condition.
Soil	The brinjal plants can be grown in all types of soil varying from light sandy to heavy clay. Well drained soil rich in organic matter with pH of 6.5-7.5 is good for brinjal cultivation.
Recommended varieties	Local Long, Pant Samrat, Shalimar Improved, Shalimar Brinjal Hybrid-1 and Pusa Purple Long
Sowing time	3rd Week of March to April
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	Open pollinated -400g/ha Hybrid-250g/ha
Planting	The seedlings are ready in 4-5 weeks for transplanting, when they attained a height of 12-15 cm with 3-to 4leavess. Harden the seedlings by withholding irrigation. Uproot the seedlings carefully without injury to the roots. Transplanting should be done during evening hours followed by irrigation
Spacing	In Polyhouse 60×60 cm & in open 60×45 cm

Manures and Fertilizers	20 t/ha FYM, 120 kg/ha N, 90 kg/ha P and 60 kg/ha K should be required for better crop growth. Entire FYM, P, K and ½ N applied as basal dose and remaining ½ N as top dressing.
Weeding	The weeds should be controlled as soon as they seen, either by traditional method of hand weeding and hoeing. Mulching is also controlled the weeds.
Pruning and Pinching	Pruning and Pinching of eggplants is helpful in maintaining a suitable growth pattern. Modest pruning is highly recommended to produce high quality eggplants. Remove older leaves from the lower portions of plants to allow for more air circulation and lighting. Pinch suckers (the new growth that begins between the leaf and the stem) weekly. Maintain three branches per plant: two branches from the primary division of the main stalk and one branch below this division. All the other lateral branches are removed periodically.
Staking	The best time to stake an eggplant is when its young, the stake in this case not only serves as a support but as a guide that will help train the plant to the desired growth pattern. A stake should be sturdy enough to support the full mature weight and height of the fruit laden plant.
Irrigation	Water the field as per the need of crop. Timely irrigation is quite essential for good growth, flowering, fruit setting and development of fruits. Higher yield may be obtained at optimum moisture level and soil fertility conditions. In plains irrigation should be applied every third to fourth day.

Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse, Trenches, Leho commercial and Green shade net are recommended for successful cultivation.
Harvesting	The brinjal fruits are harvested when they attain full size and colour but before start of ripening. Tenderness bright colour and glossy appearance of fruit is the optimum stage of harvesting of fruits
PLANT PROTECTION	
Physiological disorders	
Poor fruit set	On the basis of style length brinjal flowers can be grouped into four categories i.e. (i) long styled with big sized ovary (ii) medium styled with medium sized ovary (iii) pseudo short styled with rudimentary ovary and (iv) true short styled with very rudimentary ovary. Among these flowers only long and medium styled flowers produce fruits and pseudo short and true short styled flowers fail to set any fruit. **Control:** However, the foliar application of growth substances like 2,4-D (2ppm) at flowering stage and NAA (60 ppm) or PCPA (50 ppm) at full bloom stage result in higher percentage of fruit set.

COMMON INSECT PESTS OF SOLANACIOUS CROPS

Pests	
Aphids	Aphids appear on the tender shoots, leaves and the lower surface of the old leaves. They suck the sap and reduce the vigour of the plant result in lower yield. **Management-** • Spray Dimethoate 30 EC (0.03 %) or Methyl Demeton 25 EC (0.025 %). • Spray the chemicals alternating at 10 days interval till the aphids population is checked. • Avoid spraying when predatory beetles are seen in sufficient numbers.
Fruit borers	Fruit borers are polyphagous and appear in vegetative phase at the time of fruit formation. The caterpillars are pale greenish brown in colour with dark markings. The larva enters inside by second and third in-star by making a hole near calyx and feed on seed. The affected fruits drop off or develop white colour on drying. The fully grown caterpillars enter the soil for pupation. **Management-** • Spray Chloropyriphos 20 EC (0.05%), 2.5 ml/l • Thiodicarb 1 g or Spinosad 0.23ml or Acephate 1.5g of water.

	• When the borer attack is severe and Quinalphos 2.5 ml/l can be sprayed. • The dosage of these chemicals should not be increased as they cause flower drop.
White grub: **(*Holotrichia sp., Adoretus sp. and Brahmina* sp.)**	Both adults and grubs damage the crop by feed on roots, causes wilting and finally death of the plant. The adult beetles defoliate the crop during the night hours as they are voracious feeders. This pest is active from April to October. The ETL of white grub is 1 grub per square meter. **Management:** • Install light traps from May to July to destroy the adult beetles. • Deep ploughing of the field is very useful to expose the grubs and adults so that they may be fed upon by birds. • Collection and destruction of the adult beetles on most preferred host trees during dusk to dawn. • The population of adult beetles can be suppressed by spraying chlorpyriphos 20 EC @100ml/100 lit of water during mass beetle emergence period. • Drench the soil with chlorpyriphos 20 EC @100ml/100 lit of water when crop is in vegetative phase and damage is noticed.
Cutworm: (*Agrotis ipsilon*)	The damage is caused by greenish brown coloured greasy caterpillars. At a slightest touch they form a loop and feign death. During night they cut seedlings or the young plants at or below the

	ground levels. The injured plants get dislodged at the later stage of their growth. In case of severe infestation the whole field is covered with cut plants. This pest is active from May to July. Economic Threshold Level (ET L) is 0.4 larvae per square meter or when 3% or more of the plants are cut or 2 or more cutworm per 100 plants is observed. **Management:** • Installations of light traps in the month of May to June @ 5 per hectare and pheromone traps @ 20 per hectare are very much useful in trapping • Deep summer ploughing will expose pupae to scorching sunlight and thus the pupae get killed. • Flood irrigation helps the larvae to come up on the ground surface and birds will eat them up, proper adjustment of transplanting/sowing dates by a synchronizing susceptible crop Stage with aggressive stage of the pest. • Due to nocturnal behavior and hiding during day time cutworm cannot be observed on plant in the field during day time. Pit fall trap is a simple plastic container (1 litre capacity) without lid. Container with half-filled water with a few drops of teepol on water surface is buried in the field in such a way that the top surface is at level with that of soil surface.

	Observation should be made 48 to 72 hrs. After fixing the trap, cutworm larvae fall into the container and get trapped which are collected and destroyed. Ten traps may be required per hectare. • Application of Quinalphos 10% dust @ 25kg/ha or drenching with chlorpyriphos 20 EC @ 3ml/liter of water before sowing of the crop.
Brinjal Fruit and shoot borer (*Leucinodes orbonalis*)	Fruit and shoot borer is mostly monophagous, sometimes also feeds on other crops like tomato, potato, etc. Upon hatching, the larva starts boring near the growing point or into the flower buds or fruits. During the early vegetative phase of the crop growth, it feeds on the tender shoots. Soon after boring into the shoots and fruits, the larva seals the entry hole with excreta. The larva tunnels inside the shoot and feeds on the inner contents. It also fills the feeding tunnels with excreta. This results in wilting of young shoots, followed by drying and drop off, which slows plant growth. In addition, it produces new shoots, delaying crop maturity. **Management** • Avoid brinjal monocultures and follow crop rotations. • Keep weeds under control in brinjal seedling production areas as well as in brinjal fields to reduce the availability of alternate host plants for some of the major insect pests.

	• Avoid ratoon cropping if stem borer is a serious problem in the region. • Remove and destroy infested shoots and fruit promptly at regular intervals until final harvest to manage FSB.
Thrips, ***Thrips palmi***	Thrips are polyphagous pest and are known to feed on tomato, potato, hot pepper, watermelon, muskmelon, bottle gourd, cucumber, pumpkin, squash, etc. Although it prefers to feed on cucurbits, occasionally it infests brinjal severely. Thrips attack brinjal mostly during the dry season. This species is commonly known as "melon thrips" because of its preferential feeding on cucurbits. The adults and larvae suck the plant sap and prefer to feed mostly on foliage, sometimes on fruit. Slightly infested leaves exhibit silvery feeding scars on the lower leaf surfaces especially along the mid-rib and veins. In severe infestations, the leaves turn yellow or brown and dry on the lower leaf surfaces. Infested fruit is scarred and deformed. **Management** • Spray dimethoate 30 EC @ 100 ml/100 litres of water or imidacloprid 17.8 SL @ 170 ml/100 litres of water.
Diseases	
Damping off Causal organism: *Pythium spp*, *Rhizocotonia spp* , *Phytophthora spp*	Pre emergence damping off results in the killing of seedlings from initial stage of seed germination to the time of emergence above the soil. Post emergence damping off consists of a relatively rapid shrinking and commonly

	darkening of cortical tissue of the hypocotyls when capsicum plants are kept growing in a highly succulent condition. **Management:** • Treat the nursery beds with formalin (1 part formalin: 7 part water) and cover with polythene sheet 15-20 days prior to seed growing. Care shall be taken not to sow seed till the soil is free of formalin vapors. • Treat the seeds with Captan 50 WP @ 2.5 g/kg of seed or Mancozeb 75WP @ 2.5 g/kg seed or thiram 75 DS @ 2.5 g/kg of seed • Drench the nursery beds with a mixture of mancozeb 75 WP (25 g/10 liters) and carbendazim 50 WP (5g/10 liters) as soon as the symptoms of post emergence damping off appear.
Wilt and Rot rot Causal organism: *Fusarium solani*	The disease symptoms begin as dropping of lower leaves, which soon advance resulting in the wilting of whole plant. The wilted leaves later die and turn brown. The stem of such plants, when split open, show dark brown discoloration of vascular bundles near soil line. **Management:** • Follow crop rotation at least three year • Ensure field sanitation by removing crop debris. • Seed treatment with carbendazim 50wp or captan 50 WP@2.5g/kg of seed.

	• Apply sufficient quantity of well decomposed FYM (20 t/ha) along with recommended dose of N, P and K to soil before transplanting. • Seedling dip in carbendazim 50 WP (0.1%) for 30 minutes before transplanting • Transplanting of seedling should be done either on raised beds or on ridges. • Drench root zone of plant with carbendazim 50 WP (0.1%) at the time of transplanting and again at 50% flowering stage • Irrigate only when required.
Phytophthora blight **Causal organism:** ***Phytophthora capsici***	The disease may appear any time when wet conditions prevail. The disease has two different phases. A crown rot phase develops when plants are grown in wet infested soils and is characterized by stunning, chlorosis and wilt. The foliar phase appears when wind driven rains blow inoculums on to the foliage, stem and fruit. The affected parts develop blackened lesions which collapse and kill the plants. **Management:** • Follow the crop rotation for at least 3 years. • Adopt phytosanitary measures. • Use resistant varieties • Seed treatment with metalaxyl MZ 72 WP (0.3%) or mancozeb 75WP (0.3%) at 10-12 interval.

	• On appearance of disease, spray the plants with metalaxyl MZ 72 wp (0.3%) or mancozeb 75 WP (0.3%) at 10-12 days interval.
Fusarium wilt ***Fusarium oxysporum***	Yellowing of the lower leave appears twist usually affecting the leaflets unilaterally. The affected leaves wilt and die, and the symptoms continue to appear on successive younger leaves. One or more branches may be affected while other remains symptomless. Sometimes browning of vascular system may be seen in cross section of lower stem. The whole plant growth is stunted and permanent wilting of leaves leads to their death. **Management:** • Adopt field sanitation • Use resistant varieties • Adopt crop rotation at least 3 years • Treat the seed with Dithiocarbamate at 2 gm/kg of seed, carbendazim 50 WP (0.2 %) or captan 50 WP (0.25 %). • Dip seedling roots for 30 minutes in the suspension of carbendazim 50 WP (0.1%) before transplanting. • Drench root zone of plants with carbendazim 50 WP (0.1 %) at the time of transplanting and again at 50 % flowering stage.
Early blight **Causal organism:** ***Alternaria solani***	Irregular brown spots with concentric ring are formed on the leaves to produce a characterstistic target broad effect. The disease tissues appear as

	spot on the leaflets. They are circular to angular, dark brown to black in colour. **Management** • Ensure field sanitation by removing crop debris of previous crop. • Spary the crop with zineb 75 WP (0.2 %) or mancozeb 75 WP (0.3 %) or Hexaconazol 5 EC (0.03 5). Repeat spray after 10-20 days giving atleast 3 sprays during cropping season.
Late blight **Causal organism:** ***Phytophthora infestans***	Symptoms: Patches of brown colour are formed on the leaves which under rainy season get rot. Infection under favorable conditions spread to whole leaf and pass to stem which rot away. **Management:** • Field sanitation • Use healthy tubers • Before sowing dip the seed of potato for 20-30 minutes in metalaxyl MZ 72 WP (0.3 %) or Mancozeb 75 WP (0.3%). • On appearance of first symptoms of disease, spray the crop with metalaxyl MZ 72 WP @0.3 % or Mancozeb 75 WP @0.3 % or copper oxychloride 50 WP @0.25 % at intervals of 12-15 days.

CAULIFLOWER

Cauliflower is one of popular vegetable and known as “Ghobi or Gobi” in India and this flower belongs to “Cruciferaceae” family often overshadowed by its green cousin broccoli. This edible portion of the cauliflower is called ‘Curd’ surrounded by leaves narrower than those of cabbage. Cauliflower is a cool-season crop, It is more difficult to grow than its relatives because it does not tolerate the heat or cold. Two varieties There are two main seasonal types of cauliflower is cultivated in India they are 1) Early season type crop 2) Late season crop. Late cauliflower types are grown for a longer period compared to Early crop type.	
Scientific name	*Brassica oleracea* var. *botrytis*
Genus	Brassica
Family	Brassicaceae/ Cruciferaceae
Common name	Phool gobhi and Ghobi
Climate	Cauliflower grows well in a moist and cool climate. Cauliflower can sustain to low temperatures and for hot climatic conditions just like cabbage. Extreme dry conditions or low humidity are not suitable for Cauliflower cultivation.10°C to 25°C is optimum temperature for good seed germination. High temperatures cause poor quality of curds. Lower

	temperatures may result in delays in maturity and undersized curd.
Soil	Cauliflower can be grown in wide varieties of soils provided they are rich in organic matter and holds sufficient moisture and finally possess a good water drainage. Sandy loamy soils are recommended for early crops and for late crops, clay loams and loam soils are preferred. This vegetable thrives best in soils whose pH. range is 6.0-7.0. It is better to go for soil testing before cultivation.
Recommended varieties	Snow Ball-1, Snow Ball-16, Pusa Katki, Pusa synthetic and Himani are performed better.
Sowing time	April- May
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	500-600 g/ha
Transplanting	The seedling are prepared in raised beds and transplanted after 4-5 week old seedlings with 5 to 6 true leaves are transplanted.
Spacing	Spacing for early (under Polyhouse) crop is 45 X 45 cm and late (open condition) crop it is 60X 45 cm.
Manures and Fertilizers	FYM=15-20 t/ha, N=100 kg/ha, P=120 kg/ha, K=60 kg/ha. ½ N full P and K as basal dose, ½ N is 30 days after transplanting.
Weeding, hoeing and mulching	To kill the early weeds, shallow cultivation should be given in the cauliflower plantation by hoe or khurpi. Mulching is necessary to control weed and conserve moisture and raise the temperature, black mulch is best for its cultivation.

Earthing	The cauliflower plants should be slightly earthen after 4 to 5 weeks of transplanting.
Irrigation	Watering should be provided to crop every 4-7 days to the early planting and 10 to 15 days for late crop cultivation. At head formation time, there should be enough moisture content in the main field, so irrigation is required at this point in time. When cauliflower is cultivated late in the season, it should be irrigated frequently. Drip irrigation or Sprinkler irrigation can also be considered for utilizing the water source effectively.
Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse, Trenches, Leho commercial and Green shade net are recommended for successful cultivation.
Harvesting	Cauliflower would be ready for harvesting when the proper head has developed. Make sure the head is compact and the plant should be cut below the head so that the stub has left the head from damaging during transportation. The cauliflower plants should be when curds are well developed. As all curds will not come to the maturity at the same time, so only those which are full developed are removed. Harvesting during morning or evening is preferred so that the produce may be kept cool for the market.

PLANT PROTECTION	
Physiological disorders	
Browning 	Sometimes there is a appearance of water soaked lesions in the steam, leaf and on the surface of the curd which later become rusty and brown in color. This symptom is mainly observed when there is a deficiency of boron in plant or in soil. **Control** Soil application of Borax @ 10-15 kg/ hectare is recommended. This dose of fertilizer may differ from country to country, type of soil, time of application, methods of application & various other factors. If there is acute deficiency, spraying of Borax solution @0.25% to 0.5% is generally recommended. This means 2.5 to 5 gram of borax fertilizer on 1 liter of pure water. Spraying of fertilizer should be done at the time of early morning or at the time of evening.
Whiptail 	This disorder is caused due to the deficiency of Molybdenum. Young cauliflower plants become chlorotic in nature and may turn white, particularly along the leaf margins, leaves also become cupped and wither. Whiptail develops with high nitrate supply and low molybdenum. So in acidic soil, heavy application of nitrogenous fertilizers should be avoided. **Control** Application of 1.5 kg sodium or ammonium molybdate per hectare is recommended mixed with fertilizers or irrigation water when the plants are set in the field. Spraying the crop with 0.1%

	ammonium molybdate can also be done.
Buttoning 	Buttoning is generally known as the development of small curds with inadequate foliage in cauliflower. It is also referred as premature heading. The causes of buttoning are transplanting over-aged seedlings, poor nitrogen supply, and wrong selection of cultivars which means transplantation of early season variety on late season and vice-versa. **Control** Maintenance of adequate supply of nutrients, proper age of seedling and good plant population checks the disorders
Ricyness 	In this disorder velvety or granular appearance on the surface of the curd is seen. Due to higher or lower temperature than the optimum temperature required for a particular variety, temperature fluctuation at the time of curd development, poor seed stock generally causes ricyness. **Control** Selection of proper variety and transplanting at right time controls this malady
Hollow stem 	Hollowness is caused by boron deficiency and higher supply of nitrogen. **Control** Spraying of borax @ 15-20 kg/ha. Plants spacing is closer to protect hollow stem disorder

Diseases	
Damping off Causal organism: *Phytopthora spp*, *Phythium spp*. *Rhizoctonia solani*	It is a serious disease in the nursery. In severe conditions, the affected seedlings droop and fall off due to infection at the collar region. **Control:** • Seed treatment with Thiram or Captan @ 2.5-3 g/kg of seed. • The seedlings should be treated with Hexaconazole 5% + Captan 70% WP or Metalaxyl-M + 640 g/kg Mancozeb @ 2g/l of water.
Downy Mildew Causal organism: *Perenospora parasitica*	The disease is very serious in nursery and it can also appear in field planting. High humidity, fog, drizzling rains, and heavy dew favour the disease development and spread. The first symptom observed are small, light green-yellow lesions on the upper leaf surface, later showing on the undersurface. The spots turn yellow as they enlarge. Cabbage heads develop sunken black spots. **Control:** • All the weeds serving as alternate host to the fungus should be destroyed. • The crop should be irrigated judiciously to avoid periods of high humidity. • For controlling the disease in the field, the crop is sprayed with Copper Oxychloride (0.5%) or metalaxyl MZ 72 WP @ (0.2%) or Mancozeb 75 WP@0.35 % at an interval of 10-15 days, the first spray be given just after the appearance of the disease.

	• Removal and destruction of infested/contaminated crop debris.
Alternaria leaf spot Causal organism: *Alternaria brassica*, *Alternaria brassicola*	Symptoms: Leaf spot incited by *A. brassicola* appear as small dark coloured areas which spread rapidly to form circular lesions up to 10 mm in diameter. The enlargement of the spots may be in concentric circles. In humid weather the fungus may appear as a blemish growth in the center of these spots. Management: Spray the crop with Hexaconazole 5 EC (0.03%) or copper oxychloride 50 WP (0.25 %) or Zinab 80 WP (0.2 %) or Mancozeb 75 WP (0.03 %) at 12-15 days interval

CABBAGE

Cabbage is very important vegetable crops of the Ladakh region for it thrives well in a relatively cool climate and rich source of nutrients and is used as a leafy green vegetable. The only part of the plant that is normally eaten is the leafy head, more precisely, the spherical cluster of immature leaves, excluding the partially unfolded outer leaves. Cabbage is used in a variety of dishes for its naturally spicy flavor. Cabbage is an excellent source of vitamin C. It also contains significant amounts of glutamine, an amino acid that has anti-inflammatory properties It is recommended to acquire good productivity and quality cabbage using combination of black polythene mulch and drip irrigation.	
Scientific name	*Brassica oleracea* L. var. *capitata*
Genus	Brassica
Family	Brassicaceae
Common name	Band Gobi
Climate	Cabbage is a cool season crop and grown as summer crop in Ladakh condition. It requires cool and moist climate. It Produces marketable heads at

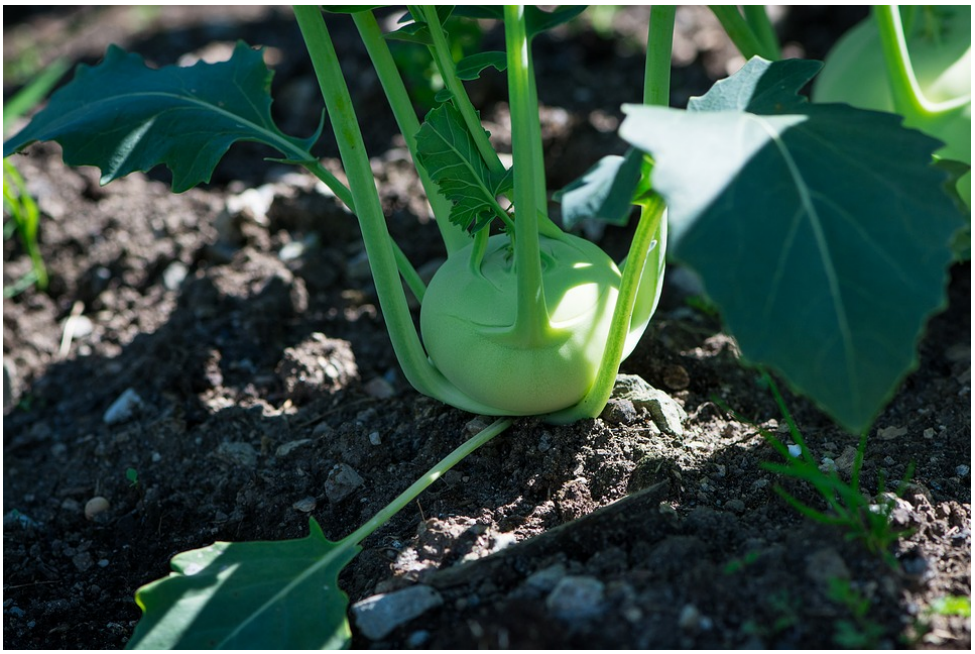
	temperature range of 15-30 ^{0}C but the day temperature should not be above 35 ^{0}C.
Soil	Sandy and sandy loam soils are preferred for early crop whereas for late crop silty soils are preferred. The optimum soil pH is 6.0 to 6.5.
Recommended varieties	Golden acre, Pride of India, Mitra and KGMR-1
Sowing time	March to April Under open condition and during winter it is grown under protected structure in the month of September
Seed treatment	Seeds should be treated with Captan @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	500 g per ha of seed in well prepared seed beds. The seeds should be lightly covered with soil and then watered. The seedlings make an appearance within one to two weeks.
Transplanting	5-6-week old seedlings are ready for transplanting.
Spacing	Under Polyhouse- 40×40 cm and 45×45 cm Open condition- 60×45
Manures and Fertilizers	FYM @ 25 ton/ha is applied and mixed well with the soil. Nitrogen (Urea), Phosphorous (DAP) and Potassium (MOP) kg/ha @ 120, 60 and 60. Basal dose of 1/3 of N along with other fertilizers and the remaining N should be top dressed in two split doses at 30 days after transplanting.
Weeding, hoeing and mulching	Three hoeing are sufficient. Farmer are advised to use blue or black polythene mulch (100 µm) to check weed growth and conserve moisture, which directly increase the productivity and improve the quality of cabbage.

Irrigation	Cabbage crop requires a continuous supply of moisture for proper development. Micro irrigation i.e. drip irrigation is recommended to grow fully developed and quite firm head.
Recommended structure	LEHO, Trench and LEHO commercial type greenhouse is recommended for successful cabbage cultivation in Ladakh condition.
Harvesting	Cabbage head is harvested when they attain full size and are hard. The best time for harvesting is in after noon or early morning.
PLANT PROTECTION	
Pests	
Diamondback Moth	Young caterpillars cause small yellow mines on leaves, scrapping of epidermal leaf tissues producing typical whitish patches on leaves and full-grown larvae bite holes in the leaves and feeds on curd. **Control:** • Remove and destroy all debris and stubbles after harvest of crop • Grow mustard as trap crop at 2:1 ratio (cabbage: mustard) to attract DBM for oviposition at least 10 days ahead of planting of main crop • Spray mustard crop with dichlorvos 76 WSC 0.076% to avoid dispersal of the larvae • Crop rotation with cucurbits, beans, peas, tomato and melon
Cutworms	The caterpillars are 3 to 4 cm long, gray or brown to almost black with various markings. They hide in

	daytime and feed at night. They cause damage by biting the foliage and by cutting down the young seedlings just above the ground level. **Control:** • Picking and destruction of the larvae at the early stage of the crop. • Growing of paired rows of mustard after every 25 rows of the crop. • Application of the heavily infested crop with Furadan
Cabbage Aphid	They suck the sap from leaves. The growth of young plants is checked and which reduce the yield. **Control:** • Install yellow sticky trap @12 no/ha to monitor "macropterous" adults (winged adult). • Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide.
Diseases	
Damping off Causal organism: *Phytopthora spp*, *Phythium spp*. *Rhizoctonia solani*	It is a serious disease in the nursery. In severe conditions, the affected seedlings droop and fall off due to infection at the collar region. **Control:** • Seed treatment with Thiram or Captan @ 2.5-3 g/kg of seed. • The seedlings should be treated with Hexaconazole 5% + Captan 70% WP or Metalaxyl-M + 640 g/kg Mancozeb @ 2g/l of water.

Downy Mildew Causal organism: *Perenospora parasitica*	The disease is very serious in nursery and it can also appear in field planting. High humidity, fog, drizzling rains, and heavy dew favour the disease development and spread. The first symptom observed are small, light green-yellow lesions on the upper leaf surface, later showing on the undersurface. The spots turn yellow as they enlarge. Cabbage heads develop sunken black spots. **Control:** • All the weeds serving as alternate host to the fungus should be destroyed. • The crop should be irrigated judiciously to avoid periods of high humidity. • For controlling the disease in the field, the crop is sprayed with Copper Oxychloride (0.5%) or metalaxyl MZ 72 WP @ (0.2%) or Mancozeb 75 WP@0.35 % at aninterval of 10-15 days, the first spray be given just after the appearance of the disease. • Removal and destruction of infested/contaminated crop debris.
Alternaria leaf spot Causal organism: *Alternaria brassica*, *Alternaria brassicola*	Symptoms: Leaf spot incited by *A. brassicola* appear as small dark coloured areas which spread rapidly to form circular lesions up to 10 mm in diameter. The enlargement of the spots may be in concentric circles. In humid weather fungus may appear as a blemish growth in the center of spots. Management: Spray the crop with Hexaconazole 5 EC (0.03%) or copper oxychloride 50 WP (0.25 %) or Zinab 80 WP (0.2 %) or Mancozeb 75 WP (0.03 %) at 12-15 days interval.

KNOL KHOL



Knol-Khol is an annual vegetable. Knol khol can be eaten raw as well as cooked. Knol khol vegetable is known by many names in India. The commercial cultivation of Knol khol is very limited. The fleshy edible proration is an enlargement of the stem, which develops entirely above ground and is used as a vegetable. It is an excellent vegetable if used at its early stage before it becomes tough and fibrous and edible preparations are made with both the stem and the leaves.	
Scientific name	*Brassica oleracea* var. *gongylodes* L.
Genus	Brassica
Family	Cruciferaceae
Common name	Knol khol (English), Gaanth Gobhi (Hindi), Surtim (Ladakh) and Kholrabi
Climate	Knol- Khol is a cool season crop and thrives well in a relatively cool moist climate. The specialty of this vegetable is this can withstand extreme cold and

	frost conditions better than other cool season crops. Seeds of knol khol germinate well at 15°C to 32°C. This crop grows well with a monthly average temperature of 15°C–20°C, maximum and minimum average being 24°C and 4.5°C.
Soil	It can be grown in wide range of soils. A soil rich in manures and fertilizers produces excellent knobs. Sandy loam soil is best suited for an early variety crop and clay or silt loam soils for higher yield and late variety crop. This crop will not thrive well in highly acidic soil. For better yield and quality of vegetable, the required soil pH is 5.5–7.0
Recommended varieties	Early White Vienna, King of market, G-40 and Purple Vienna is recommended for both open and protected condition of Ladakh regions.
Sowing time	During summer –March to April Winter-September to October
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	1 -1.5 kg/ha
Transplanting	3-4 week old seedlings become ready for transplanting. Ridges and furrow type of layout is used. After transplanting, the seedlings should be watered and protection may be given from sun rays for 4-5 days.
Spacing	30×20 cm
Manures and Fertilizers	Knol khol crop responds very well to manuring, as it is a heavy feeder. Supplement 20 to 25 tons of well-decomposed farmyard manure (FYM) to soil at the time of land preparation. At the time of

	transplanting add 70 to 75 kg of 'N, P and 50 kg of K/ ha. Second dose of 50 kg 'N' should be applied one and half month after transplanting the seedlings in the main field.
Weeding, hoeing and mulching	Weed control operation is very important for getting good yields. Regular intercultural operations like hoeing and weeding should be carried out after irrigation when the soil is soft and in working condition. Black color mulch is also used to reduced weed infestation and also provide micro climate for its growth and development.
Earthing	The plants should be earthen-up after 3 to 4 weeks of transplantation to protect lodging.
Irrigation	It is requires continuous supply of moisture for uniform growth and development of knobs. Provide irrigation immediately after transplanting and continue this for 4 to 5 days during summer and after 1 week interval during winter month. Subsequent irrigations should be given at an interval of 7 to 8 days. However, depends on the soil moisture stress, and climatic condition, an irrigation should be provided.
Recommended structure	LEHO and SKUAST model-II, LEHO commercial and ETH type of greenhouse is recommended for successful cultivation of Chinese cabbage in cold arid condition of Ladakh
Harvesting	The knobs are harvested by cutting the stem just below it by a sharp knife or sickle before they are fully grown. Usually the demand is high for knobs of smaller size of about 5 to 8 cm in diameter. In preparing the produce for the market, the root

	portion should be removed and the plants should be tied in bunches along with the tender leaves.
PLANT PROTECTION	
Pests	
Cutworms	Cutworms are grayish, fleshy caterpillars up to 5 cm long, which curl up when disturbed. Plants may be chewed off above or below ground level and may be damaged higher up by climbing cutworms. Most of the cutworm damage is to newly set plants in the field, but they are often found attacking seedlings in plant bed and greenhouses. Late infestation of variegated cutworm occasionally occurs. **Control:** • Prepare the soil two weeks before planting to cultivate in cover crops and destroy weeds. • Check plants frequently and treat when damage is first observed. • Application of the heavily infested crop with Furadan
Aphids	The cabbage aphid is a major pest of Cole crops worldwide. Aphids are small, soft bodied, slow moving insects. A colony consists of winged and wingless adults and various sizes of nymphs. Aphids may be black, yellow or pink, but mostly are various shades of green. They are often found in large colonies on the under surface of leaves; however, aphids will feed on heads, flower stalks as well as leaves, resulting in unmarketable produce. Aphids feed by piercing plants and sucking out

	plant sap, resulting in distorted plant parts and a slowing of plant growth. **Control:** • There are many natural enemies that will feed on aphids, thus helping to reduce the populations of this pest in the field. • Cultural controls include using high pressure sprinkler irrigation to knock the insects off of plants, as well as using living mulch such as clover inter-planted with the crop. • Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide.
Diseases	
Damping off Causal organisum: *Phytophthora spp*. *Rhizocotonia solani*	Pre-emergence damping off occurs when seeds are attacked and decay, as well as when plants germinate, but fail to emerge. Post-emergence damping off occurs when the stem of 2 to 5 cm tall plants are attacked. A water soaked area completely encircles the stem near the soil line and the seedling wilts and topples over. Wire stem results from an extension of the damping off process, but new infections may occur on plants 10-15 cm tall. The stem above and below the soil line darkens, and the outer cortex tissue decays and sloughs off in sharply defined area encircling the stem. The stem is thin and wiry at the lesion but remains erect. The plant may survive, but will perform poorly.

	Control: • Plant density should permit adequate light and air penetration. • Rise seedlings on raised nursery beds and practice the rotation of seed-bed. • Treat seed with Captan (2g/kg seed) before sowing. • Drench the nursery beds with Captan (0.2%) or Mancozeb (0.25%) and Carbendazim (0.05%) or 1% Bordeaux mixture or Copper oxychloride 0.3%, 2-3 times at weekly intervals starting from 13th day of sowing on appearance of symptoms.
Bacteral soft rot *Causal organism:* *Ervinia spp.* *Pseudomonas spp.*	Leaves turn yellow (chlorotic) beginning at margins and spreading inwards. Veins within area turn black. Infection enters main stem turning the inside black. Plants either die or are dwarfed when young, become defoliated if more mature. **Control:** • Plant resistant varieties and rotate crops from year to year. • Spray the crop with Steptocycline or Plantomycin @ 100-200 ppm combind with 0.3 % copper oxychloride.
Alternaria Blight Causal organism: *Alternaria brassicae,* *Alternaria brassicola*	Symptoms: Leaf spot incited by *A. brassicola* appear as small dark coloured areas which spread rapidly to form circular lesions upto 10 mm in diameter. The enlargement of the spots may be in concentric circles. In humid weather the fungus

	may appear as a blemish growth in the centre of these spots. Management: Spray the crop with Hexaconazole 5 EC (0.03%) or copper oxychloride 50 WP (0.25 %) or Zinab 80 WP (0.2 %) or Mancozeb 75 WP (0.03 %) at 12-15 days interval.

BROCCOLI

Broccoli is a cool-season crop that, like spinach, can be grown in the spring or fall. In fact, you may be able to get a continual harvest throughout both seasons if planted at correct time. A member of the cabbage family, Broccoli is a great choice for a home garden. Freshly cut broccoli heads are rich in vitamins and minerals. They are delicious raw in salads or lightly steamed and they freeze well. In India, Broccoli is boom for rural economy. Broccoli is a derivative of cabbage and was selected for its edible, immature flower heads. The flower buds are green or purple, are picked before they open, and are eaten raw or cooked. Broccoli sprouts are also edible, consumed raw and are a popular health food. There are two distinct forms of broccoli: sprouting broccoli, and heading broccoli. Heading broccoli is the most commonly grown in the India.

Scientific name	*Brassica oleracea* var. *italic*
Genus	Brassica
Family	Brassicaceae
Common name	Broccoli
Climate	Broccoli is a cool-weather crop that does poorly in sultry climate. It grows best when exposed to an average daily temperature between 18°C and 23°C but some verities can survive lower temperature (0^0C). Broccoli prefers full sun, but partial shade

	can prevent plants from bolting (going to seed) in areas with warm spells.
Soil	It can be grown on a wide range of soils provided they are rich in nutrients, have adequate soil moisture and possess good drainage. The soil should contain plenty of organic matter. It must be thoroughly prepared so that it becomes loose, friable and retentive of moisture with the pH between 6.0 and 6.8.
Recommended varieties	Solan Green, Lucky, Fiesta and Green magic (Green magic is best performed during winter session under polyhouse condition)
Sowing time	The best time for sowing seed in the nursery for summer crop mid marc h –April and winter crop October
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	The usual planting rate is 300 gm/ha of seed. Sown the seed in the nursery or on the seedling bed. Thin the seedlings to 3 cm apart 2-3 days after germination
Transplanting	Transplant the seedlings at 4-5 true leaves stage about 25 to 30 days old seedling with 4 leaves is transplanted along with little soil on true roots to protect wilting during transplanting.
Spacing	Polyhouse 45x45 cm Open condition 60x45 cm
Manures and Fertilizers	Apply 15-20 tones FYM/ha, 80-100kg N, 80kg P and 60kg K/ha. ½ N, full P&K is basal dose and ½ N is basal. Full dose of P, K and half of N are

	applied at the time of land preparation. The remaining half dose of N should be top dressed in 2 equal split doses. The first is applied 4-5 weeks after transplanting, whereas the second dose before head formation
Weeding, hoeing and mulching	The crop should be kept free of weed. Shallow hoeing should be done to remove weeds and also for breaking the surface crust to facilitate better aeration and water absorption. Since it is a shallow-rooted crop, hoeing should not be done beyond the depth of 5-6cm to avoid injuries to the roots. Mulching is also useful to cultivation of broccoli because they are conserved soil moisture and also maintain soil temperature to provide congenial environment to crop growth.
Earthing	Earthing is not necessary to broccoli production but light earthing-up at final hoeing is beneficial.
Irrigation	Broccoli is shallow rooted crop. Therefore, irrigation should be applied frequently to prevent the plant from injures in dry soil. Drainage must be carried. It is necessary to remove side shoots as soon as possible to improve the yield and quality of main head
Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse and Leho commercial are fit for cultivation of broccoli.
Harvesting	The quality broccoli heads are usually harvested when they reach full size and firm, before buds beg to open. Harvest the head along with little basal stem.

PLANT PROTECTION	
Physiological disorders	
Whiptail	Deficiency of molybdenum cause whiptail in which the lamina of the newly-formed leaves become leathery, irregular and consisting of only the mid-rib **Control:** • This can be corrected by soil application of 1-1.5 kg • Molybdenum before planting. • Foliar spray of 0.01% solution of Ammonium molybdate helps to check this disorder.
Browning Head	It results from boron deficiency. First water-soaked areas appear on bud clusters which in turn pinkish or rusty-brown in advanced stages resulting in rotting. **Control:** • Soil application of Borax or Sodium Borate @ 20 kg/ha will prevent the disorder. • Foliar spray of 0.25-0.5% solution of borax is more effective than the former one, especially when the deficiency is acute. The affected portion does not recover fully but helps in appearance of new, healthy bud clusters.
Pests	
Aphids	The cabbage aphid is a major pest of Cole crops worldwide. Aphids are small, soft bodied, slow moving insects. A colony consists of winged and wingless adults and various sizes of nymphs.

	Aphids may be black, yellow or pink, but mostly are various shades of green. They are often found in large colonies on the under surface of leaves; however, aphids will feed on heads, flower stalks as well as leaves, resulting in unmarketable produce. Aphids feed by piercing plants and sucking out plant sap, resulting in distorted plant parts and a slowing of plant growth. **Control:** • There are many natural enemies that will feed on aphids, thus helping to reduce the populations of this pest in the field. • Cultural controls include using high pressure sprinkler irrigation to knock the insects off of plants, as well as using living mulch such as clover inter-planted with the crop. • Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide.
Disease	
Clubroot Causal organism: *Plasmodiophora brassicae*	Leaves turn bluish and wilting turning into a weak dying plant. When inspected, the roots will appear to be thick and distorted mass. Control: Improve crop rotation and never grow broccoli in this area again for few years.
Alternaria blight Causal organism: *Alternaria brassicola*	Symptoms: Leaf spot incited by *A. brassicola* appear as small dark coloured areas which spread rapidly to form circular lesions upto 10 mm in diameter. The enlargement of the spots may be in concentric circles. In humid weather the fungus

	may appear as a blemish growth in the center of these spots. Management: Spray the crop with Hexaconazole 5 EC (0.03%) or copper oxychloride 50 WP (0.25 %) or Zinab 80 WP (0.2 %) or Mancozeb 75 WP (0.03 %) at 12-15 days interval.

CHINESE CABBAGE

Chinese cabbage (*Brassica oleracea L. var. chinensis*) is a hardy biennial grown as an annual. It has broad, thick, tender leaves and heavy midribs. There are several varieties of Chinese cabbage, some are loose head and some are tight headed. Plants grow from 15 to 18 inches tall. The common names of the plant are Chinese cabbage, white cabbage, flowering cabbage, pakchoy, Michihli and Napa cabbage.	
Scientific name	*Brassica oleracea L. var. chinensis*
Genus	Chinensis
Family	Brassicaceae
Common name	Chinese cabbage
Climate	Chinese cabbage performed best during the cooler periods of the growing season. Although the optimal temperature range of Chinese cabbage development is between 13 and 15 °C, certain cultivars tolerate the higher temperatures.

	Temperature below 0^0C is tolerated for short time period but too low temperature can induced premature bolting. The summer climate of Ladakh is suitable for the cultivation under open conditions and during winters it is cultivated in trench/polyhouse. It doesn't tolerate hot weather so if you want to get good results from production then you should start its cultivation before extreme hot weather. Cool temperature seems to be the best for the production of cabbage. It grows well when it exposes to direct sun light however it can tolerate shade as well.
Soil	Chinese cabbage can be grown on wide range of soils ranging from sandy loam to textured loam. However, well drained sandy loam soils with good organic matter are proved to be good for excellent yield and quality produced. The ideal pH ranges for 5.5-7.0.
Recommended varieties	Palampur green, Spring sun-60
Sowing time	Summer crop seed is sown in March and for winter crop in November
Seed treatment	Seeds should be treated with Captan @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	500 to 600 g per ha of seed in well prepared seed beds. The seeds should be lightly covered with soil or vermicompost, and then watered. The seedlings make an appearance within one week.
Transplanting	Seedling can transplant when the seedling are about 15 to 16 cm tall or 3-4 weeks after sowing
Spacing	20×20 cm

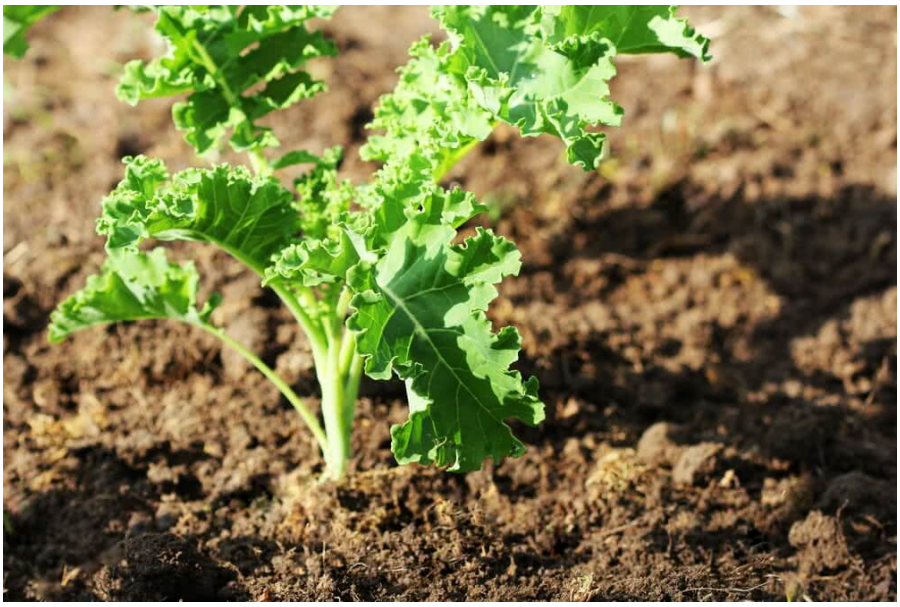
Manures and Fertilizers	The soil within the protected structure is ploughed with spade. FYM @ 15 to 20 ton/ha. is applied and mixed well with the soil. Nitrogen (Urea), Phosphorous (DAP) and Potassium (MOP) @ 160, 80 and 120 kg/ha. Basal dose of 1/3 of N along with other fertilizers and the remaining N should be top dressed in two split doses.
Weeding, hoeing and mulching	Weed control is very important for successful grown of crops. Hoeing and light intercultural operation to control weed growth. Mulching is another practice of checking weed growth which is also useful in keeping moisture intact.
Earthing	Earthing up should be done after 2 month of planting to get quality produce.
Irrigation	Chinese cabbage required good irrigation throughout its life cycle. The frequency of irrigation actually depends on soil type, climate and plant or crop age. When crop is grown in winter session, it may require 1 times a week.
Recommended structure	LEHO and SKUAST model-II, LEHO commercial and LEREDA type of greenhouse is recommended for successful cultivation of Chinese cabbage in cold arid condition of Ladakh
Harvesting	Chinese cabbage becomes ready for harvesting within 70 to 100 days after planting depending variety. The leaves can be harvested by hand when the leaves are fully developed. The leaves should be cut at the plant base. In general, harvesting can be done when the plant reaches the 8 leaf stage.

PLANT PROTECTION	
Pests	
Cutworms	Cutworms are grayish, fleshy caterpillars up to 5 cm long, which curl up when disturbed. Plants may be chewed off above or below ground level and may be damaged higher up by climbing cutworms. Most of the cutworm damage is to newly set plants in the field, but they are often found attacking seedlings in plant bed and greenhouses. Late infestation of variegated cutworm occasionally occurs. **Control:** • Prepare the soil two weeks before planting to cultivate in cover crops and destroy weeds. • Check plants frequently and treat when damage is first observed. • Application of the heavily infested crop with Furadan
Aphids	The cabbage aphid is a major pest of Cole crops worldwide. Aphids are small, soft bodied, slow moving insects. A colony consists of winged and wingless adults and various sizes of nymphs. Aphids may be black, yellow or pink, but mostly are various shades of green. They are often found in large colonies on the under surface of leaves; however, aphids will feed on heads, flower stalks as well as leaves, resulting in unmarketable produce. Aphids feed by piercing plants and sucking out plant sap, resulting in distorted plant parts and a slowing of plant growth.

	Control: • There are many natural enemies that will feed on aphids, thus helping to reduce the populations of this pest in the field. • Cultural controls include using high pressure sprinkler irrigation to knock the insects off of plants, as well as using living mulch such as clover inter-planted with the crop. • Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide.
Diseases	
Damping off Causal organism: *Phytophthora spp.* *Rhizocotonia solani*	Pre-emergence damping off occurs when seeds are attacked and decay, as well as when plants germinate, but fail to emerge. Post-emergence damping off occurs when the stem of 2 to 5 cm tall plants are attacked. A water soaked area completely encircles the stem near the soil line and the seedling wilts and topples over. Wire stem results from an extension of the damping off process, but new infections may occur on plants 10-15 cm tall. The stem above and below the soil line darkens, and the outer cortex tissue decays and sloughs off in sharply defined area encircling the stem. The stem is thin and wiry at the lesion but remains erect. The plant may survive, but will perform poorly. **Control:** • Plant density should permit adequate light and air penetration.

	• Rise seedlings on raised nursery beds and practice the rotation of seed-bed. • Treat seed with Captan (2g/kg seed) before sowing. • Drench the nursery beds with Captan (0.2%) or Mancozeb (0.25%) and Carbendazim (0.05%) or 1% Bordeaux mixture or Copper oxychloride 0.3%, 2-3 times at weekly intervals starting from 13th day of sowing on appearance of symptoms.
Bacterial soft rot Causal organism: *Ervinia spp.* *Pseudomonas spp.*	Leaves turn yellow (chlorotic) beginning at margins and spreading inwards. Veins within area turn black. Infection enters main stem turning the inside black. Plants either die or are dwarfed when young, become defoliated if more mature. **Control:** • Plant resistant varieties and rotate crops from year to year. • Spray the crop with Steptocycline or Plantomycin @ 100-200 ppm combind with 0.3 % copper oxychloride.

KALE



Kale is king of leafy vegetables, very close to wild cabbage and also called as "Cabbages cousin". This leafy vegetable is a minor temperate vegetable which is introduced in 19th century. Commercial cultivation of Kale leaves is limited in India but Jammu & Kashmir, Himachal Pradesh, Punjab, Uttar Pradesh, Haryana and Niligiri hills it is grown commercially. It is hardy plant and can withstand unfavorable weather condition. Kale leaves possess excellent health benefits. Kale can be categorized according to the physical appearance of the leaves (curly, bumpy, plain, etc.) or according to their commercial names, the most well-known of which are common curly kale, red Russian and savoy types.	
Scientific name	*Brassica oleracea* var. *acephala* L.
Genus	Brassica
Family	Brassicaceae
Common name	Kale and Sag
Climate	This is a hardiest crop which can withstand cold as low as -10°C to -15°C. Basically this leafy vegetable

	prefers temperate climate and can be cultivated in the areas having cold winters.
Soil	This crop prefers a well-drained sandy loam soils with good organic matter. The ideal soil pH of 5.5 to 6.5 (slightly acidic) will result in good yield.
Recommended varieties	G. M. Dari, Khanyari, Kawdari, Siberian kale and Kashmiri Haak
Sowing time	Summer in open condition –March to April Winter in Polyhouse condition-September to October
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	2-2.5 kg/ha
Transplanting	When seedlings are 30-40 days old or 10-15 cm in height transplanting is done
Spacing	30x10-15 cm
Manures and Fertilizers	FYM=20-25 t/ha, N=90kg/ha, P=60 kg/ha, K=60 kg/ha , ½ N full, P, K applied as a basal dose and rest ½ N 30 days after transplanting.
Weeding, hoeing and mulching	Weed control is essential in Kale farming. Regular shallow hoeing and weeding should be carried out to make the crop weed free. 3 to 4 hoeing and weeding are sufficient and once the leaves cover the soil, there is no need of hoeing.
Irrigation	First irrigation should be given immediately after transplanting in the field. Provide subsequent irrigations at 7-8 days interval.
Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse, Trenches and Leho commercial

	are recommended for successful cultivation of kale during winter.
Harvesting	For better quality, it should be harvested at right vegetative stage. Harvested leaves should be bundled, packed and marketed.

COMMON INSECT PESTS OF COLE CROPS

Pests	
Diamondback Moth	Young caterpillars cause small yellow mines on leaves, scrapping of epidermal leaf tissues producing typical whitish patches on leaves and full-grown larvae bite holes in the leaves and feeds on curd. **Control:** • Remove and destroy all debris and stubbles after harvest of crop • Grow mustard as trap crop at 2:1 ratio (cabbage: mustard) to attract DBM for oviposition at least 10 days ahead of planting of main crop • Spray mustard crop with dichlorvos 76 WSC 0.076% to avoid dispersal of the larvae • Crop rotation with cucurbits, beans, peas, tomato and melon
Cutworms	The caterpillars are 3 to 4 cm long, gray or brown to almost black with various markings. They hide in daytime and feed at night. They cause damage by biting the foliage and by cutting down the young seedlings just above the ground level. **Control:** • Picking and destruction of the larvae at the early stage of the crop.

	• Growing of paired rows of mustard after every 25 rows of the crop. • Application of the heavily infested crop with Furadan
Cabbage Aphid	They suck the sap from leaves. The growth of young plants is checked and which reduce the yield. **Control:** • Install yellow sticky trap @12 no/ha to monitor "macropterous" adults (winged adult). • Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide.
Cabbage butterfly: **(*Piers brassicae*)**	Cruciferous vegetables are the host plants of the pest. Period of activity stars from May to Oct. Damage is caused by caterpillar only larvae scrap the leaf surface and later make holes in them. The old larvae consume leaves from the margins leaving only the main veins. In severe infestation entire plants are eaten away. **Management** • Hand picking and mechanical destruction of caterpillars during early stage of attack can reduce infestation. • Destroy the egg clusters of cabbage butterfly present on the under surface of leaves wherever possible. Also destroy young leaves containing caterpillars. • Spray chloropyriphos 20 EC @ 100 ml/100 liters of water or Quinalphos 25 EC @ 100

	ml/100 liters of water on the crop for vegetable consumption.
Disease	
Damping off Causal organism: *Phytopthora spp*, *Phythium spp*. *Rhizoctonia solani*	It is a serious disease in the nursery. In severe conditions, the affected seedlings droop and fall off due to infection at the collar region. **Management** • Seed treatment with Thiram or Captan @ 2.5-3 g/kg of seed. • The seedlings should be treated with Hexaconazole 5% + Captan 70% WP or Metalaxyl-M + 640 g/kg Mancozeb @ 2g/l of water.
Downy Mildew Causal organism: *Perenospora parasitica*	The disease is very serious in nursery and it can also appear in field planting. High humidity, fog, drizzling rains, and heavy dew favour the disease development and spread. The first symptom observed are small, light green-yellow lesions on the upper leaf surface, later showing on the undersurface. The spots turn yellow as they enlarge. Cabbage heads develop sunken black spots. **Management** • All the weeds serving as alternate host to the fungus should be destroyed. • The crop should be irrigated judiciously to avoid periods of high humidity. • For controlling the disease in the field, the crop is sprayed with Copper Oxychloride (0.5%) or metalaxyl MZ 72 WP @ (0.2%) or Mancozeb 75 WP@0.35 % at aninterval

	of 10-15 days, the first spray be given just after the appearance of the disease. • Removal and destruction of infested/contaminated crop debris.
Alternaria leaf spot Causal organism: *Alternaria brassica*, *Alternaria brassicola*	Leaf spot incited by *A. brassicola* appear as small dark coloured areas which spread rapidly to form circular lesions upto 10 mm in diameter. The enlargement of the spots may be in concentric circles. In humid weather the fungus may appear as a blemish growth in the centre of these spots. **Management** • Spray the crop with Hexaconazole 5 EC (0.03%) Copper oxychloride 50 WP (0.25 %) • Zinab 80 WP (0.2 %) or Mancozeb 75 WP (0.03 %) at 12-15 days interval
Bacteral soft rot *Causal organism:* *Ervinia spp.* *Pseudomonas spp.*	Leaves turn yellow (chlorotic) beginning at margins and spreading inwards. Veins within area turn black. Infection enters main stem turning the inside black. Plants either die or are dwarfed when young, become defoliated if more mature. **Management** • Plant resistant varieties and rotate crops from year to year. • Spray the crop with Steptocycline or Plantomycin @ 100-200 ppm combind with 0.3 % copper oxychloride.
Alternaria Blight Causal organism: *Alternaria brassicae,* *Alternaria brassicola*	Symptoms: Leaf spot incited by *A. brassicola* appear as small dark coloured areas which spread rapidly to form circular lesions upto 10 mm in diameter. The enlargement of the spots may be in

	concentric circles. In humid weather the fungus may appear as a blemish growth in the centre of these spots. **Management:** • Spray the crop with Hexaconazole 5 EC (0.03%) • copper oxychloride 50 WP (0.25 %) or Zinab 80 WP (0.2 %) • Mancozeb 75 WP (0.03 %) at 12-15 days interval.
Clubroot Causal organism: *Plasmodiophora brassicae*	Leaves turn bluish and wilting turning into a weak dying plant. When inspected, the roots will appear to be thick and distorted mass. **Management:** • Improve crop rotation and never grow broccoli in this area again for few years.

SPINACH

Spinach is a hardy vegetable grown all across India, this can be grown in back yards as well as open fields commercially. Known for lush green foliage spinach is rich in iron, vitamins and anti-oxidants. Spinach crop can be harvested after 6-8 weeks from planting. In warm climate spinach tends to produce seeds rather than growing the foliage. So harvest it at right time. It is called as 'Palak' in Hindi. It is higher in iron, calcium, and vitamins than most cultivated greens and one of the best sources of vitamins A, B, and C. There are three basic types of Spinach: Savoy has dark green, crinkly and curly leaves. It is the type sold in fresh bunches in most supermarkets. Flat/smooth leaf spinach has broad smooth leaves that are easier to clean than savoy. This type is often grown for canned and frozen spinach, as well as soups, baby foods, and processed foods and Semi-savoy is a hybrid variety with slightly crinkled leaves. It has the same texture as savoy, but it is not as difficult to clean. It is grown for both fresh market and processing.	
Scientific name	*Spinacea oleracia* L.
Genus	Spinacia
Family	Amaranthaceae
Common name	Palak
Climate	Spinach prefers a cool climate. The minimum temperature for seed germination is 2^0C with a maximum germination temperature of 30 C and an

	optimum range of 7 to 24 C. Young plants can withstand temperatures as low as -9^{0}C. Best crop growth occurs at 15 to 20^{0}C with a minimum temperature of 10 ^{0}C and a maximum of 32 ^{0}C.
Soil	Spinach grows in any type of well-drained soil. However loamy soil is ideal. Soil should be loose too so that spinach seedlings could establish roots easily and quickly. Add a fine layer of compost or field yard manure (FYM) to the soil. It will provide nutrients to plants during period of germination .
Recommended varieties	Pusa Bharti, Banerjee Giant, Pusa harit, All green, Shalimar Green and Local Spinach are performed better during winter in cold arid condition
Sowing time	Spinach is propagated from seeds. In well prepared seed bed, seed should be sown 3-4 cm deep in rows at 20 cm apart. Water the soil without affecting seeds. Seeds germinate in a week. It is sown from April as main crop in open condition and in September to October as a winter crop to be grown in protected structures in this region. Seeds are soaked in water before sowing. Seeds are generally broadcast in flat beds.
Seed treatment	Seed should be treated Captan or Thiram @2g/kg
Seed rate	30-40 kg per ha.
Spacing	Line sowing at 20 cm distance is convenient for intercultural operation as this increases air circulation around the crop and minimizes the chances of any fungal attack.
Manures and Fertilizers	Spinach doesn't have feeding requirements. 20 to 25 tones farmyard manure (FYM) should be at the time of soil preparation. The full dose of 50 kg

	phosphorus and potash and half nitrogen 70 kg/ha should be applied at the time of field preparation and rest of nitrogen is given in two equal split doses at the time of first and second harvesting.
Weeding, hoeing and mulching	One or two weeding should be given to keep the spinach crop clean and healthy. Mulch the soil using dried leaves, straws etc. to retain moisture.
Irrigation	Spinach is a humidity loving plant. First irrigation should be given immediately after sowing and subsequent irrigation should be given at an interval of 10-15 days under protected condition. Inline drip irrigation is recommended for better growth of foliage. When crop is sown in summer month to needs irrigation at 6 to 7 days interval.
Recommended structure	In Ladakh Region, LEHO types greenhouse followed by Chinese types greenhouse is best for spinach cultivation during winter month. LEHO green house is affordable to the farmers of the region. Chinese greenhouse being costly can be exploited commercially by rich farmers.
Harvesting	Start harvesting crop after 6-8 weeks of planting. Cut off outer leaves which are 3-4 inches long. It will encourage more growth on the plant and ultimately results in more foliage to harvest. Only well grown succulent and tender leaves be trimmed. Winter crop gives more cuttings. On an average Palak crops gives 4 -6 cuttings. After harvesting, leaves are tied in bundles and sent for marketing. Remember to harvest the crop completely before plant blots and produces seeds.

LETTUCE

Lettuce is one of the salad crops grown commercially across the world. Lettuce was grown for centuries and has originated in Asia continent. The demand for salad crops are increasing day by day due to their diet value and medicinal values. In India, it is yet to gain significance in terms of commercial crop cultivation. Lettuce is a leafy vegetable which can be consumed raw. Among all the lettuce varieties, Romaine lettuce variety is famous for its nutrition values. Lettuce is mainly used in food items like wraps, sandwiches apart from using as leafy vegetable. China is top producer of lettuce in the world. Lettuce plant leaves are mainly in the green and red colour spectrums. Lettuce produces smooth, radical, spirally arranged leaves. There are other improved varieties whose colors are available in yellow, gold or blue leaves. When it comes to shape, they have a wide range of shapes and texture from dense head to iceberg type. Lettuce plants can spread upto15 to 30 cm. Lettuce can be grown in greenhouse, polyhouse and even hydroponically. However, proper business plan and farm management practices make the lettuce farming as successful commercial business. In India, there is a huge potential due to its value in diet.

Scientific name	*Lactuca sativa* L.
Genus	Lactuca
Family	Asteraceae

Common name	Salad Ke Patte (Hindi) and Dum (Ladakhi)
Climate	Lettuce is cool season crop and requires monthly average temperature about 15 °C for optimal growth. This crop does not thrive well in hot weathers. However, among four types of lettuce, the leafy types mature quickly and are more suited for warm climates. Lettuce can be grown round the clock and requires shade especially in warm climatic conditions. Usually, lettuce grows best in the spring and fall seasons in Ladakh condition Lettuce Growing in Greenhouse during winter and summer session it is grown in open condition.
Soil	Lettuce can be cultivated in wide variety of soils. However, good fertile (rich in organic matter) friable loamy soils having high water holding capacity and good drainage is ideal for lettuce production. Lettuce crop is very sensitive to acidic nature, so avoid growing lettuce in high acidic soils. The best suitable soil pH for lettuce cultivation ranges from 5.5 – 6.5. Commercial growers should go for soil test before starting the crop. Based on test results, any micro-nutrient gap should be filled.
Recommended varieties	• Losse-leaf (Red and Green Leaf): This type has delicate taste and leaves. • Cos or Romaine: This type is classic Greek salad and has sweet and crunchy taste. • Crisp head or Head lettuce: Iceberg. White on the inside and has crisp texture and mild taste. • Butter head: Boston and Bibb. This type has large green leaves that are soft and sweet.

Sowing time	Summer/Open condition-March to April Winter/Polyhouse-October
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	2-3 kg/ha
Transplanting	As leaf varieties are mostly grown, they can be sown directly in the field and raised on nursery beds (seedlings of 4 to 5 weeks can be transplanted). The lettuce grown on nursery beds can be transplanted in the main filed. When it comes to sowing distance, lettuce seeds can be sown in rows 15 to 25 cm part. Generally.
Spacing	15×15 cm under Polyhouse condition 25×25 cm in open condition during summer
Manures and Fertilizers	As the lettuce crop responds to manures and fertilizers very well it is very important to apply these in time. When it comes to manure and fertilizer requirement, 15 to 20 tons of well decomposed farm yard manure (FYM), 90 kg N (for leaf growth, Nitrogen is very important) , and 60 to 65 kg each of Potash and Phosphorus per ha should be applied for better yield of lettuce crop.
Weeding, hoeing and mulching	For proper plant growth and yield, hoeing and weeding operations should be carried out. Shallow cultivations should be done as part of the intercultural operation as the root system of lettuce is not deep rooted. Mulching is also plays important role to conserve moisture and check weed growth.
Irrigation	Uniform moisture supply is very important for proper plant growth. Irrigation should be carried out

	once in 4 to 5 days.
Recommended structure	In Ladakh Region, LEHO, Chinese, LEREDA types greenhouse and trench is also preferred for lettuce cultivation during winter month.
Harvesting	Harvesting of lettuce depends on the variety (cultivar). Leaf type lettuce varieties can be harvested when the leaves are tender and immature for fresh consumption. Generally, first harvesting should take 40 to 60 days after sown in the field. In case of head varieties, the crop is harvested when it has attained a good size and solid head. While handling care should be taken not to damage the wrapper leaves. Cos or Romaine and Head type lettuce mature in two months and you should pull the entire plant. Leafy type will mature in six weeks, cut the outer leaves when mature to allow center leaves to develop.

CORIANDER

Coriander is an annual herb and coriander is indispensable spice in the kitchen. It gives good flavor to dish, because of this property coriander seed (Dhaniya) and fresh leaves are commonly used in every kitchen to prepare testy dishes. The fresh leaves are an ingredient in many Indian foods (such as curries, chutneys and salads). Coriander leaves constitute one of the richest source of Vitamin 'C'. All parts of the coriander plant are eatable, but the fresh coriander leaves and the dried seeds (Dhaniya) are most traditionally used in cooking. The fruits have a fragrant odour and pleasant aromatic taste. The odour and taste are due to the essential oil content, which varies from 0.1 to 1.0 % in the dry seeds. These essential oils are used for flavoring liquors, coca preparations in confectionary and also to mask the offensive odours in pharmaceutical preparations. The dried ground fruits are the major ingredients of the curry powder. The whole fruits are also used to flavor foods like pickles, sauces and confectionary.	
Scientific name	*Coriandrum sativum* L.
Genus	Coriandrum
Family	Apiaceae
Common name	Dhaniya
Climate	It is a tropical crop and can be grown throughout the year (except very hot season) for leaf purpose, but

	for higher grain yield it has to be grown in specific season. A dry and cold weather free from frost especially during flowering and fruit setting stage favours good grain production. Cloudy weather during flowering and fruiting stage favours pest and disease incidences. Heavy rain affects the crop. As an irrigated crop, it can be cultivated on almost all types of soils provided sufficient organic matter is applied. Black cotton soils with high retentivity of moisture is best under rainfed conditions
Soil	Coriander grows well in well drained loamy soils. The Optimum PH range 6 to 8 in soil is best suited for its cultivation.
Recommended varieties	Pant haritima, Shalimar. Dhania-1 and CO-1
Sowing time	In open condition- April-May and Polyhouse condition seed are sown round the year.
Seed treatment	Soak the seeds in water for 12 hours for better germination. Treat the coriander seeds with Azospirillum @ 1.5 kg /ha for better crop establishment and to control wilt disease, Trichoderma viride @ 50 kg/ha.
Seed rate	10-12 kg/ha
Spacing	Seed are sown in rows spaced at 20 cm apart with 15 cm between hills. Soil depth should not exceed 3.0 cm. the seeds are covered with thin soil. Germination takes place in 10 to 15 days.
Manures and Fertilizers	FYM=20 t/ha, N=40 kg/ha, =30 kg/ha, K=20 kg/ha, ½ N , full P, K as basal and ½ N is 2 split doses at 30 & 60 days after sowing.
Weeding, hoeing and mulching	The first hoeing and weeding are given in about 30 days. Thinning the plants is also attended

	simultaneously, leaving only two plants per hill. Depending upon the growth one or two more weeding are done
Irrigation	1st irrigation should be given immediately after sowing and the second on the third day and subsequent irrigations at 6 to 10 days interval. In open condition irrigation is given through sprinkler to save approximate 60 % of water.
Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse, Leho and Leho commercial are recommended to coriander cultivation under cold arid condition.
Harvesting	For fresh coriander leaf, pull out the plants when they are 30 to 35 days old. For seed purpose crop is ready for harvest in about 90 to 110 days depending upon the varieties and growing season. Harvesting has to be done when the fruits are fully ripe and start changing from green to brown colour. The plants are cut or pulled and poled into small stacks in the field to beating with sticks or rubbing with hands. The produce is winnowed, cleaned and dried in partial shade.

COMMON INSECT PEST OF LEAFY CROPS

Pest	
Aphids	The cabbage aphid is a major pest of Cole crops worldwide. Aphids are small, soft bodied, slow moving insects. A colony consists of winged and wingless adults and various sizes of nymphs. Aphids may be black, yellow or pink, but mostly are various shades of green. They are often found in large colonies on the under surface of leaves; however, aphids will feed on heads, flower stalks as well as leaves, resulting in unmarketable produce. Aphids feed by piercing plants and sucking out plant sap, resulting in distorted plant parts and a slowing of plant growth. **Management** • There are many natural enemies that will feed on aphids, thus helping to reduce the populations of this pest in the field. • Cultural controls include using high pressure sprinkler irrigation to knock the insects off of plants, as well as using living mulch such as clover inter-planted with the crop. • Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide.
Cutworms	Cutworms are grayish, fleshy caterpillars up to 5 cm long, which curl up when disturbed. Plants may be

	chewed off above or below ground level and may be damaged higher up by climbing cutworms. Most of the cutworm damage is to newly set plants in the field, but they are often found attacking seedlings in plant bed and greenhouses. Late infestation of variegated cutworm occasionally occurs. **Management** • Prepare the soil two weeks before planting to cultivate in cover crops and destroy weeds. • Check plants frequently and treat when damage is first observed. • Application of the heavily infested crop with Furadan
Thrips (*Frankliniella occidentalis)*	Thrips are small, slender insects with mouthparts developed primarily for sucking and rasping. The adults measure about 0.04 inch (1 mm) in length and have two pairs of fringed wings, carried lengthwise over the back. Both the young and adults cause damage by rasping and puncturing surface cells. This results in a silvering, and sometimes deformation, of the leaves: edges of leaves tend to curl downward. **Management** • In case of severe infestation, spray the crop with dimethoate 30 EC @ 100ml/100 liters of water during the month of July and repeat the spray after 15 days if the re infestation of the pest is observed.

Diseases	
Leaf spot Causal organism: *Cercospora beticola*	Lower leaves near the ground are attacked first. The spots are small, circular, ash coloured in the center with deep violet or reddish purple borders. Individual spots are 3 to 5mm in diameter and are scattered. **Control:** • Adopt phytosanitary measures. • Seed treatment with carbendazim 0.2 % • Spray the crop with mancozeb 75 WP (0.3%) 8-10 days interval or carbendazim 50 WP (0.05%) at 10-12 days interval on the appearance of disease.

PEA (GARDEN PEA)

Pea is an important vegetable in India; the crop is generally cultivated for its green pods. It is highly nutritive and is rich in protein. It is used as a vegetable or in soup, canned frozen or dehydrate. It is cooked as a vegetable along or with potatoes. Split grains of pea are widely used for dal. Pea straw is a nutritious fodder.	
Scientific name	*Pisum sativum* L
Genus	Pisum
Family	Leguminaceae
Common name	Muttar (Hindi) and Pea (English)
Climate	Pea is a cool season crop and performs best at 10^0 C to 18^0 C. The flower and young pods are badly affected by frost. The germination of seeds takes place at 3.3^0 C soil temperature. The optimum mean monthly temperature for pea is 12.8^0 C to 18^0 C.
Soil	Green Peas can be cultivated in wide variety of soils. However they grow best in well-drained soils with pH range of 6 to 8. Soils with good organic matter will result in good yield and quality of peas.

	Appropriate rotten Farm Yard Manure (F.M.Y) can be applied at the time of land preparation.
Recommended varieties	Bonevilla, Jawahar, PB-89, Arkel and Shalimar Mattar
Sowing time	April to 2nd week of May
Seed treatment	Pea seeds should be treated with rhizobium culture to give higher yields and quality.
Seed rate	80-90 kg/ha
Spacing	30 cm×10 cm
Manures and Fertilizers	FYM=20-25 t/ha, N=40 kg/ha, P=60 kg/ha, K=60 kg/ha, ½ dose of N and full dose of p and K should be given as a basal dose and rest ½ N should be applied after one month of sowing.
Weeding	One weeding is required
Irrigation	Frequent irrigation should be carried out in green peas cultivation, again it all depends on season. However, each irrigation should be carried out at an 8 to 10 days interval. Usually Pulse crops require higher water percentage compared to cereal crops. In green peas farming, Irrigation is very important at the time flowering and pod or grain development stage.
Harvesting	In general, the green peas pods should be harvested while just short of reaching maturity. Harvesting of peas may start as soon as peas started changing colour from dark to green. For early variety may be harvested in 60 days, mid-season crop can be harvested in 75 days and Late season crop can be harvested in 100 days.

COMMON INSECT PEST OF LEGUMINOUS CROPS

Pests	
Pea pod borer **(*Etiella zinckenella*)**	The pest is sporadic and attacks all the crops like Pea, Green gram & black gram. The adult is grayish brown. The young larva bore into the floral parts and green pods and feed inside the flower and developing pods. The larva is radish pink white the ventral side in pale green to creamy white in colour. **Management:** • Spray Chlorpyrifos 30 EC @ 100ml/100 liter of water
Aphids **(*Apis cracivora*)**	The aphids are pale green, pink or yellow in colour. Both nymphs and adults attack young shoots and suck the sap. Honey dew secretion promotes sooty moulds growth on leaves. Acts as vector of many viral diseases. **Management:** • Spray the crop with Dimethoate 30 EC @ 100 ml/100 liter of water and repeat the spray after 15 days interval to effective control of aphid population
Diseases	
Powdery mildew Causal organism: *Erisyphe pisi*	The first symptoms appears as white, of colored spot on the upper surface of lower and older leaves. These spots increase in size and appeared as white, powdery areas. The disease can progress in susceptible cultivars until the entire plant is covered with white, powdery growth. Severe infection results in early crop senescence and reduced quality as well as decreased green pea and seed yield. The

	disease is serious when days are warm and dry and nights are sufficiently cool for few deposition. **Management:** • Collect and destroy the crop debris by burning or deep ploughing • Seed treatment with triadimefon 25 WP @0.05 % is effective in reducing the initial disease level. • When disease is anticipated, spray the crop with triadimefon 25 WP @0.05 % or Hexaconazole 5 EC @ 0.03 % or dinocap 48 EC @ 0.1 % or spray the plants with elemental sulphur @ 3-4 kg/hectare.
Fusarium root rot Causal organism: *Fusarium solani*, *Fusarium sp. pisi*	Initial symptoms on seedling roots consist of reddish brown to blackish brown streaks near the soil line which extends upwards soil line and downwards into the root zone. A seed discoloration of vascular system may occur in root but usually does not progress above the soil line. Above ground symptoms consists of stunted growth, and yellowing of basal foliage. Root rot is enhanced by the conditions adverse to root growth, including soil compaction, soil temperature exceeding to 30^0C, high soil moisture and poor soil fertility. **Management:** • Follow crop rotation for 5 years • The disease can be significantly reduced by tillage practices, better fertility and practices promoting favorable soil moisture and root penetration

	• The ammonical fertilizers tend to increase the susceptibility of peas to this disease, thus their application should be avoided. • Seed treatment with carbendazim 50 WP or Captan 50 WP @ 2.5 g/kg seed is helpful

ONION

The onion is one of the most important commercial vegetable crops grown in India: The demand for onion is worldwide. It is used both in raw and mature bulb stage as vegetable and spices. The pungency in onion is due to a volatile oil known as ally-propyldisulphide. The bulb of onion consists of swollen bases of green foliage leaves and fleshy scales.	
Scientific name	*Allium cepa* L.
Genus	Allium
Family	Amaryllidaceous.
Common name	Pyaz, Ganda
Climate	Onion is a cool season crop. It is grown during winter and harvested before the real hot season begins. Onion can be grown under a wide range of climatic condition. It is adapted to temperature range of 13-24° C for vegetative stage and 16-21° C for bulbing stage, 30 -35° C at maturity and

	harvest. The best performance can be obtained in a mild weather without the extremes of cold and heat.
Soil	Onions can be cultivated in a wide range of soils from sandy loam to clay loam with good drainage facilities. The optimum pH would be 6.5-7.5.
Recommended varieties	Red onion, Brown Spanish, Local and Red coral
Sowing time	March to April
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	10-12kg/ha
Transplanting	The seedlings will be ready for transplanting in 45-50 days after sowing.
Spacing	Form flat bed or broad based furrow for planting. Spacing: 15X10 cm for both.
Manures and Fertilizers	FYM=20-25 t/ha, N=100, P=80, K=60. Entire FYM, P and K and ½ N applied before transplanting and ½ N when seedlings have established in the field.
Weeding, hoeing and mulching	Being a shallow rooted crop shallow hoeing twice or thrice will help plant growth and suppress the weed.
Irrigation	Irrigation is necessary at the time of transplanting and light irrigation should be done on third day after planting and subsequent irrigation will be done at 7-10 days interval depending upon the soil condition and season. Water the transplants immediately after planting. Because of the shallow root system, onions require frequent furrow irrigation. Avoid overhead irrigation,

Recommended structure	Generally onion is grown in open condition if it is grown under poly house condition all type of Polyhouse are suitable for its cultivation viz., Leho, Leho commercial, SKUAST Model-I, SKUAST Model-II, Trench and Walk in tunnel
Harvesting	Onions should be harvested at 50% neck fall stage. Follow harvesting of onion bulbs at right stage of maturity. It is important in deciding storage life of onion as bulbs may be stored for about six months. The onion bulbs, reach maturity when the plants cease to produce new leaves and roots. In onion, neck fall is the indication of maturity.
Storage	Onion for storage should be fully developed. Loose neck bulbs which result due to premature harvesting do not store well. Late harvesting leads to increased respiration, subsequent susceptibility to diseases and excessive sprouting during prolonged storage and left in field sunburn is also noticed. Bulbs are harvested by hand pulling if soil is light; they are also harvested by hand implements. Kharif crop, since the growth continues forced toppling should be taken up to stop growth 15 days before harvesting. Onion along with tops are kept in field for 2-3 days, curing for 3-4 days is necessary to remove excess moisture from outer skin and neck to reduce shrinkage and development of colour in storage.
PLANT PROTECTION	
Physiological disorders	
Bolting	It is a serious disorder of onion. It refers to the emergence of seed stalk prior to time of their

	formation and adversely affects the formation and development of bulbs. Bolting is an undesirable character because it directly affects the bulb yield of onion. It is caused due to late transplanting of seedlings, transplanting of aged seedlings of above 10 weeks and poor supply of nitrogen in nursery and field. **Control :** • Adjust the time of transplanting in such a way that the crop may expose to moderate temperature at bulbing. • Maturity of Rabi crop coincides with high temperature compared to kharif crop. • Grow non-bolting cultivars • Transplant healthy and 6 to 7 week old seedlings. • Supply recommended dose of nitrogen. • Cut the seed stalk at early stage.
Freezing Injury	The sensitivity of onion bulbs to freezing injury depends on the genetic makeup of a cultivar. The cultivars having very high total soluble solids are not found sensitive to freezing injury because the bulbs of such cultivars have a very low freezing point. The sensitivity of onion bulbs to freezing injury depends also on water content. **Control:** • The bulbs with less water content have more resistance against freezing injury. • Many varieties could be stored successfully without any freezing injury, even at –2°C

	temperature, although below this temperature, the freezing injury is developed. • Cultivating fields outcome layer of moist soil at the surface that acts as insulation.
Sprouting of bulbs	It is one of the most important disorder in the storage and causes a huge loss to cultivations. It is found both onion and garlic. However, this malady is not of permanent nature. Sprouting is also associated with excessive soil moisture at maturity and supply of nitrogen **Control:** • Adjust sowing time in such a way that harvesting can be done in dry period. • Withhold irrigation as soon as bulb reaches to maturity • Apply less quantity of nitrogenous fertilizers • Spray growth inhibitors like MH (2500-3000 ppm) 15-20 days before harvesting.

COMMON INSECT PESTS OF BULB CROPS

Pest	
Onion maggot **(*Delia antiqua*)**	Onion maggot, *Delia antiqua,* is a serious pest of onion and related Allium crops (i.e., garlic and leek) in northern temperate regions throughout the world. Maggots bore into underground stems and consume the interior of bulbs, reducing stands and decreasing the uniformity of remaining plants. A single maggot can destroy up to 20 small seedlings. Injury to older plants may result in wilting, stunting, internal damage and contamination, external scarring and discoloration of the product and bulb deformation. Onion maggots are highly host-specific to plants in the onion family including onions, leeks, shallots, garlic, and chives. **Management** • Avoid planting in soils that are high in undecomposed organic matter. Use herbicides to kill cover crop strips 3 to 4 weeks before seeding. In soils amended with animal manures, allow adequate time for the manure to break down before planting. • Destruction of crop debris and removal of culls from the field can reduce the overwintering populations of onion maggots through the

	• Onion sets should be planted one week before fly emergence is predicted. • Preventative soil insecticide applications are recommended for the control of the first generation larvae if damage from the previous year's crop exceeds 5-10%. Spray chloropyriphos 20 EC @ 100 ml/100 liters or Quinalphos 25 EC @ 100 ml/100 liters of water as a directed spray to the base of the onion plants. Spray at dusk along the edges of onion fields as flies migrate back into the fields to lay eggs.
Thrips: **(*Thrips tabaci*)**	Onion and garlic are the preferred host of thrips. Period of activity starts from April to August. Thrips are most damaging insects when they feed during the early bulbing stage of plant development. Scarring of leaves is a serious problem on green onions. They feed under the leaf folds and in the protected inner leaves near the bulb. When population levels are high, thrips can also be found feeding on exposed leaf surfaces. Both adults and nymphs cause damage, lacerate the leaf sheath and feed on oozing sap; white patches and streaks. When foliage is severely damaged, the entire field takes on a silvery appearance (Silver blast). Severe scarring also creates an entry point for foliar leaf diseases. Economic threshold level is 2-3 thrips per leaf **Management:** • Use yellow/blue sticky traps @10/ha before the emergence of adult.

	• Spray chloropyriphos 20 EC @ 100 ml/100 liters of water or Quinalphos 25 EC @ 100 ml/100 liters of water for crop to be consumed as fresh vegetables as soon as the nymphal stage of pest appears. Waiting period of eight days should be observed before the crop is consumed.
Disease	
Downy Mildew Causal organism: *Peronospora destructor*	The affected leaves turn yellow and die off from the tip downwards, In moist conditions, a white, and later purplish mould develops on affected parts of the leaf. This is, in turn, commonly followed by darker mould growth of other leaf-infecting fungi. Bulbs can also be infected and often sprout prematurely or shrivel in store **Management:** ▪ Onion bulb should be heated (dry heat) at 400C for 8 hours before sowing or bulb seed dip in metalaxyl MZ @ 0.3 % for 8-12 hours. ▪ Two to three foliar spray with metalaxyl MZ @0.2 % at intervals of 10-14 days (starting from the last week of March) or spray the crop with Zineb t wet Sulphur (1:1) (0.2 %). ▪ Ensure field sanitation and give restricted light irrigation if required
Purple blotch Causal organism: *Alternaria porri*	The disease occurs under favorable condition of temperature 28-300C. Small sunken, whitish flecks with purple coloured centers are common symptoms occurring on leaves and flower stalks.

	Further, large purple area develops forming dead patches. **Management:** ▪ Use disease free seeds ▪ Crop rotation of 2-3 years with non related crops should be followed ▪ Spray mancozeb @0.25 % or Chlorothalonil @ 0.2 % at fortnightly interval commencing from one month after transplanting

RADISH

Radish is a popular vegetable in both tropical as well as temperate regions. Being a quick growing crop it can be easily planted as a companion crop or intercrop between the rows of the other vegetables. It can also be planted on ridges, separating one plot from another. It is cultivated all over India, especially near the city markets. There are two distinct genetical groups in radish. The Asiatic varieties, which are primarily for tropical climates, produce edible roots in the first season and seed in the second season as a biennial crop. On the other hand, the exotic or European varieties produce roots in the plains of tropical and subtropical climate and seeds in the hills of temperate climate.	
Scientific name	*Raphanus sativus* L.
Genus	Raphanus
Family	Brassicaceae
Common name	Mooli and Radish
Climate	Radish is best adapted to cool or moderate climate. Tropical varieties can adopt high temperature but to develop good flavor texture lower temperature between 15- 25^0 C is required initially 20 and 23^0 C temperature is required. During hot weather the roots become tough and pungent before reaching

	edible size. However, pungency is also a varietal character.
Soil	Radish grows in any type of well drained and loose soil. Till the soil to depth of 6-8 inches to make it loose and more suitable for growing radish. Usually heavy soils produce rough, misshapen roots with a number of small lateral and such soils should be avoided. Soils with pH range of 6.0-7.5 are more suitable for radish cultivation.
Recommended varieties	White Icicle, Whit round, Red round, Japanese White and some local cultivar are best performed in Ladakh region.
Sowing time	Open condition April to May Under Polyhouse- it can be round the year except November to December
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	8 -10 kg/ha
Method of sowing	Radish is usually grown on ridges to facilitate good root production. It is grown, as a single crop or as a companion crop. The plant rows or ridges about 22 cm high are kept about 45 cm apart, whereas the plants within the rows are kept 8 cm apart. The European or temperate types, as they need closer spacing, can be sown 20 -30 cm apart. Generally the seed sowing is done 1.15 cm deep. Seed is sown by any of the two methods namely line sowing and broadcasting. There are two types of Sowing in Radish Farming 1) Line sowing: Seed is mixed with

	sand or soil in the ratio of 1:4 and placed in a row by hand, over the ridges and then covered with Soil. 2) Broadcasting: Seed is mixed with sand or soil in ratio of 1:4 and scattered over the field, as even as possible, followed by planking. Plants are spaced after germination while hoeing.
Spacing	25-30 cm ×10 cm.
Manures and Fertilizers	Radish is a short duration crop. Do not apply fresh and undecomposed manure in the field as it results in forking and misshapen roots. Application of FYM 20-25 ton/ha and application of 90 kg Nitrogen, 60 kg Phosphorus and 60 kg potash is recommended. Half of the dose of nitrogen applied is 20-30 days after sowing.
Weeding and hoeing	Regular weeding in Radish Farming is necessary. In rainy season, two weeding will be required to keep the growth of weeds under control.
Thinning	After germination thinning is done to space plant the seedling is reduced competition for nutrient and improved quality of roots.
Earthing	Radish has a tendency to bulge out of soil as it grows in size. Therefore, thorough covering by earthing up is recommended to produce quality roots.
Irrigation	Radish requires steady and continuous supply of soil moisture for better root growth. This also helps in production of tender and attractive root growth. At the time of sowing there should be sufficient moisture. So irrigate field before sowing. In dry weather frequent irrigation are necessary. Water

	stress makes roots rough and pungent. In winter season irrigation at interval of 6-8 days are given.
Recommended structure	It can be grown all type of protected structures
Harvesting	Depending upon varieties roots become ready for harvesting in 40- 45 days after sowing. Early rapid maturing varieties become ready for harvesting even at 25-30 days of sowing. Harvesting radish at proper stage of maturity. Delay in harvesting result in pithiness and bitterness in radish roots.
PLANT PROTECTION	
Physiological disorders	
Forking 	It is a common disorder in radish. It generally occurs due to excessive moisture during root development. Forking generally occurs in heavy soil due to compactness of soil. Use of undecomposed organic matter also causes forking. **Control:** • Reduce the excess moisture from the field by giving balanced irrigation and proper drainage system. • Use well decomposed organic manure and grow the crop in sandy loam soil
Pithiness 	Pithiness is characterized by the death of xylem and collapse of parenchymatous tissues in roots. It may lead to production of hollow roots. Pithiness is the sign of senescence and its degree varies from varieties to varieties. Pithiness may occur due to excess N, P and K; high temperature prevailing before harvesting and delay in harvesting. **Control:** • Select resistant variety,

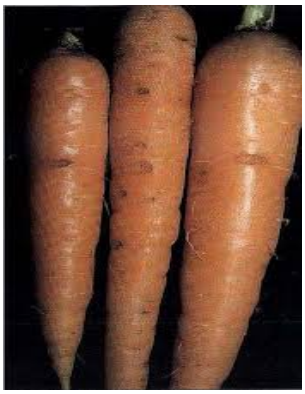
	• Plant at proper spacing, maintain optimum soil moisture • Harvest at appropriate maturity stage and avoid excess fertilization an injury to the roots during intercultural operations and harvesting.

CARROT

The carrot is a root vegetable, usually orange in colour, though purple, black, red, white, and yellow cultivars exist. Carrots are a domesticated form of the wild carrot. Carrot is most important root crop in curries and made into pickles and sweet, 'Gajar Halwa' is a delicious dish prepared from carrot. Carrot juice is also used. Carrot is rich source of carotene a precursor of vitamin A. the tops of carrots can be used as source of essential oil. Carrot has medicinal properties also. Carrot is annual or biennial herb with react to much branched stem. The edible portion or carrot root is an enlarged fleshy tap root. It consists primarily of phloem or cortex and minimum of core.	
Scientific name	*Daucus caroto* L
Genus	Daucus
Family	Umbellifrea
Common name	Gajar and Carrot
Climate	Carrot is a cool climate season crop and when grown at 15°C to 20°C will develop a good colour, very high or low temperature is not conductive for root development.
Soil	It can be grown on all types of soil but be growth is obtained in a deep, loose, loamy soil. For early

	crop sandy loam soil preferred but for large yield silt-loam is desirable. In well drained, deep soil, long smooth slender roots are formed. The carrots grown on heavy soil are rough and coarse. Maximum yield is expected at soil pH 6.5.
Recommended varieties	Early Nantes, Chamman, Local carrot, Chantenay, Pusa rudhira and Shalimar carrot -1
Sowing time	Open condition-March to April Under Polyhouse-October
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	3.5 to 4 kg/ha
Sowing	Carrots are grown from direct seedling. The seeds are sown either by broadcasting or drilling in lines. To facilitate even distribution seeds are mixed with fine sand. Seeds can be sown on flat bed at loser spacing of 15-25 cm or on both sides of ridge, while sowing soil should have sufficient moisture. Follow shallow sowing for better seed germination. Seed soaking in water for 12-24 shallow before sowing gives good germination.
Spacing	Follow sowing at 15 X 15 cm distance in flat bed. In case of ridges and furrow layout 25 X 15 cm spacing is kept.
Manures and Fertilizers	Carrot is a short duration crop. Do not apply fresh and unrecomposed manure in the field as it results in forking and misshapen roots. FYM=20 t/ha, N=90 kg/ha, P=60 kg/ha, K=60 Kg/ha, ½ N, full P and K give as a basal dose and rest ½ N should be given 30 days after sowing.

Weeding and hoeing	Prompt weeding in early period of one half month after sowing is essential as the cross sown closely. Later on it is difficult to weed. In this regard clean cultivation before sowing is important. Weed competition causes heavy loss of top and impair root quality. Manual weeding not only control not only controls the weeds but improves aeration resolution in better root growth.
Thinning	After germination thinning is done to space plant the seedling is reduced competition for nutrient and improved quality of roots..
Earthing	Earthling up is also practiced which control the weeds and also covers the exposed roots to prevent discoloration of roots
Irrigation	Water supply should be given once in five days. This prevents excessive water loss during sunny days. Germination of the seeds is also improved.
Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse, Trenches, Leho commercial and Green shade net are recommended for successful cultivation.
Harvesting	Harvesting of carrots at proper stage of maturity is essential to fetch good price in the market. Delay in harvesting deteriorates the quality of the roots and becomes unfit for consumption. Every variety has certain period for harvesting. Delay in harvesting results in splitting of roots. Formation of adventitious roots, increase in dry matter sucrose, carotene and bolting.

<table>
<tr><td colspan="2">PLANT PROTECTION</td></tr>
<tr><td colspan="2">Physiological disorders</td></tr>
<tr><td>Cavity spot
  </td><td>Cavity spot is characterized by elliptical lesions present on the surface of the roots. It generally occurs due to deficiency of calcium and excess of K as K reduces the uptake of Ca.
Control:
Proper and balanced dose of fertilizer should be given
Proper water management and irrigation done at correct stage and grow resistant varieties. Physical condition of soil should be maintained good.
Increase in Ca level in growing medium results in increased Ca accumulation in plant and leads to reduction of cavity spot.</td></tr>
<tr><td>Splitting
  </td><td>Appearance of longitudinal cracks on the carrot root is known as carrot splitting. Carrot splitting occurs due to genetic factors and other factors (higher dose of ammonical form of N_2, irregular irrigation and fertigation at the time of root development, wider spacing).
Control:
Grow resistant varieties
Supply recommended dose of fertilizers
Maintain optimum moisture in field
Harvest crop at right maturity stage</td></tr>
</table>

Forking 	It is a common disorder in Carrot. It generally occurs due to excessive moisture during root development. Forking generally occurs in heavy soil due to compactness of soil. Use of undecomposed organic matter also causes forking. **Control:** • Reduce the excess moisture from the field by giving balanced irrigation and proper drainage system. • Use well decomposed organic manure and grow the crop in sandy loam soil

TURNIP

The turnip is a root vegetable generally grown in temperate climates, tropical and subtropical regions of India for its white, bulbous taproot. The most common type of turnip is colored in white. The small and tender roots are used for culinary purpose where as bigger size turnips are used as animal feed. They mature very rapidly and you can enjoy both the greens and the roots. Try this ancient root vegetable that's been grown for over 3,000 years. Turnips are hardy biennials usually grown as annuals by the home garden.	
Scientific name	*Brassica rapa* subsp. *rapa*
Genus	Brassica
Family	Brassicaceae
Common name	Shalgam
Climate	Turnips thrive best in cool and moist climatic conditions. These root vegetables can be grown even in the areas where summer temperatures are moderate. The optimum temperature range of 10 °C to 16°C is ideal for development of good root texture, best flavor and excellent size. It requires short day lengths and cool climate for better development of roots. The Asiatic type of turnip

	tolerates high temperature whereas temperate type of turnip thrives well in cool climatic conditions.
Soil	Turnip vegetable can be cultivated on wide range of soils. However, well drained sandy loam soils with high in humus are the best for its cultivation. Very light sandy soils or too heavy soils are not suitable for its cultivation.
Recommended varieties	Purple Top White Globe, Punjab Safed 4, Pusa Chandrima & some Local cultivar also grow in best.
Sowing time	Open condition April to may and some lower altitude in Ladakh it can be grown in July Polyhouse –It can be grow round the year except December to January.
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	5-7 kg/ha
Spacing	30 cm×15-20 cm
Manures and Fertilizers	FYM=20 t/ha, N=90 kg/ha, P=60 kg/ha, K=60 Kg/ha, ½ N, full P and K give as a basal dose and rest ½ N should be given 30 days after sowing.
Weeding and hoeing	About 3 hoeing can be given to control the weeds in the turnip plantation. Total of 3 weeding are required in turnips farming till the harvesting time.
Thinning	Thinning should be carried out after 2 weeks of germination.
Earthing	The earthing up should be done during 2nd and 3rd hoeing after the top dressing application of "N" fertilizers for producing quality roots.
Irrigation	Irrigation should be carried out as soon as seeds are sown and the frequency of irrigation depends on the

	soil moisture holding capacity and climate conditions. Generally to maintain optimum moisture, Irrigation should be given at 8 to 10 days intervals. Mulching also retains good moisture content in soil apart from preventing weed growth.
Recommended structure	HMAARI, SKUAST model-I, SKUAST model-II, Local greenhouse, Trenches, Leho commercial and Green shade net are recommended for successful cultivation.
Harvesting	Turnips will be ready for harvesting when tender roots are uprooted with good size. Usually, the turnip roots are harvested when they are about 6 to 10 cm in diameter depending on the turnip variety cultivated. If turnips are not harvested in right time, they become tough & fibrous. Harvesting is preferred in the evening.
PLANT PROTECTION	
Physiological disorders	
Brown heart	It is caused by the deficiency of boron. The disorder is prevalent in very acidic soils where boron is deficient. The symptoms are characterized by the appearance of grey or brown colour in the inner portion of the affected roots. **Control:** • Avoid the sowing in too acidic soils. • Incorporate borax @ 10-15 kg/ha in the soil before sowing • Spray the crop with boric acid (0.2%) 2-3 times at vegetative stage.

COMMON INSECT PEST OF ROOT CROPS

Pest	
Aphid *Aphis gossypii*	Aphids are small ranges in color from yellowish green to greenish black. Both winged and wingless forms are produced. The winged individuals are somewhat slender and are not as robust as the wingless form. A mature individual measures about 0.06 inch (1.5 mm) in length. The aphids develop in colonies and prefers the underside of leaves. These small, green aphids can be a major problem on young plants where they feed near the tips of runners or in growing points. They cluster in numbers on the underside of growing leaves, distorting and curling the leaves, and produce a large amount of honeydew. **Management** • Remove and bury the few severely infested plants as they appear in spring; this helps prevent rapid spreading of the aphid population. • Spray dimethoate 30 EC @ 100ML/100 Litres of water
Cutworm: **(*Agrotis ipsilon*)**	The damage is caused by greenish brown coloured greasy caterpillars. At a slightest touch they form a loop and feign death. During night they cut seedlings or the young plants at or below the ground

	levels. The injured plants get dislodged at the later stage of their growth. In case of severe infestation the whole field is covered with cut plants. This pest is active from May to July. Economic Threshold Level (ET L) is 0.4 larvae per square meter or when 3% or more of the plants are cut or 2 or more cutworm per 100 plants is observed. **Management:** • Installations of light traps in the month of May to June @ 5 per hectare and pheromone traps @ 20 per hectare are very much useful in trapping • Deep summer ploughing will expose pupae to scorching sunlight and thus the pupae get killed. • Flood irrigation helps the larvae to come up on the ground surface and birds will eat them up, proper adjustment of transplanting/sowing dates by a synchronizing susceptible crop Stage with aggressive stage of the pest. • Due to nocturnal behavior and hiding during day time cutworm cannot be observed on plant in the field during day time. Pit fall trap is a simple plastic container (1 litre capacity) without lid. Container with half-filled water with a few drops of teepol on water surface is buried in the field in such a way that the top surface is at level with that of soil surface. Observation should be made 48 to 72 hrs. After fixing the trap, cutworm

	larvae fall into the container and get trapped which are collected and destroyed. Ten traps may be required per hectare. • Application of Quinalphos 10% dust @ 25kg/ha or drenching with chlorpyriphos 20 EC @ 3ml/liter of water before sowing of the crop.
Diseases	
Alternaria leaf spot Causal organism: *Alternaria raphanin*	The spot appear as small dark coloured areas which spread rapidly to form circular lesions up to 10 mm in diameter the enlargement of the spots may be in concentric circles. In humid weather the fungus may appears as a blemish growth in the center of these spots. The spot initiated by *A raphani* are yellow, raised, and spherical to elliptical and up to 1 cm in diameter. Black sporulation may be seen on the spots. The center soon dries and many drop out. **Management:** • Hexaconazole 5EC (0.03 %) or copper oxychloride 50 WP (0.25 %) or zineb 80 WP (0.2 %) or mancozeb 75 WP (0.3%) may be sprayed 2-3 times at 12-15 days interval.
Bacterial soft rot **Causal organism:** ***Erwinia carotovora***	Symptoms: the disease produces characteristic soft decay of the fleshy tissues. The tissues often become watery or slimy in consistency and as the rot progresses the water exudes. In dry atmosphere water is lost rapidly by evaporation. **Management:** • Crop rotation for at least 3 years

	• Set out plant rows that will allow good air drainage • Avoid stagnant water sources
Alternaria blight Causal organism**:** *Alternaria dauci,* *Alternaria radiciana*	**Symptoms:** The lesions produced are usually more irregular shaped and necrotic tissue is more consistently dark brown to black. The chlorotic area surrounding the necrotic tissue is usually more pronounced. The fungus is inclined to attack older leaves rather than younger leaves. Fleshy roots are not affected by the Alternaria blight organisms. Management: Hexaconazole 5EC (0.03 %) or Copper oxychloride 50 WP (0.25 %) or Zineb 80 WP (0.2 %) or mancozeb 75 WP (0.3 %) may be sprayed 2-3 times at 12-15 days interval

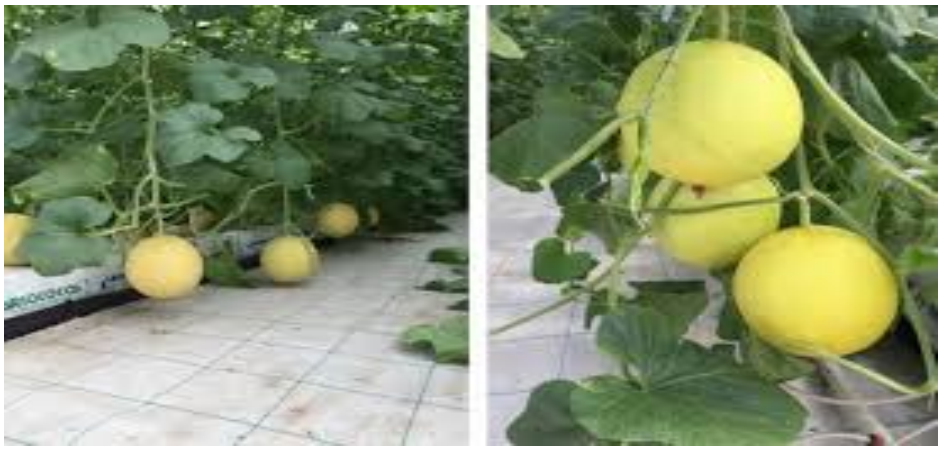
WATERMELON

Watermelon is a warm season crop, by selecting suitable varieties and giving them proper care, good quality of watermelons can be produced in the Ladakh. Watermelon is a vine-like flowering plant originally from southern Africa. It is a large, sprawling annual plant with coarse, hairy pinnately-lobed leaves and white to yellow flowers. It is grown for its edible fruit also known as a watermelon, which is a special kind of berry botanically called a pepo. The fruit has a smooth hard rind, usually green with dark green stripes or yellow spots and a juicy, sweet interior flesh, usually deep red to pink, but sometimes orange, yellow. In Ladakh condition its possibility to grow under polyhouse condition.	
Scientific name	*Citrullus lanatus* var. *lanatus*
Genus	Citrullus
Family	Cucurbitaceae
Common name	Tarbooz
Climate	Watermelon not only tolerates hot weather but for best growth requires more heat than any other vegetables. Watermelon seeds germinate well and plants thrive at 25°C - 30°C. Fruits mature best at 30°C. Watermelon requires dry weather and plenty of sunshine. Continuous rain or cloudy will not only stunt the plant growth but also reduce the flowering

	and fruit setting. If watermelons mature in rainy season, the sugar content will be greatly reduced.
Soil	Watermelons do best when grown on sandy or sandy loam soils that are well drained. Poorly drained soils should be avoided. The pH off soil should be between 5.8 and 7.5.
Recommended varieties	Sugar baby, Ashi Yamato Kaliya and Sultan
Sowing time	2nd week of March to April
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	3-4 kg/ha
Spacing	Under poly house condition if plant is spread in ground it can be planted 1.5×1.5 meter distance. When plant is trailing in vertical distance should be reduced 1×1 meter they get good result.
Manures and Fertilizers	Apply a farmyard manure (FMY) of 10 tones/ha as basal dose at the time of land preparation. Apply N 75 kg/ha, P 40 kg/ha, K 40 kg/ha. The full dose of P & K, half dose of N should be applied before sowing the seeds. The rest part of nitrogen should be applied in 2 split doses with first when plants start to run and 2nd dose at the time of fruiting.
Weeding/hoeing and Mulching	One or two weeding is sufficient to plant growth. Mulching the bed surface with straw is recommended for growing watermelon in the Tropics. Mulching not only retain the soil moisture, prevent nutrient leaching and improve soil aeration, but also control the weeds and provide support for tendril.
Irrigation	Irrigate the crop once in 4-5 days interval.

Recommended structure	HMAARI, Trenches, Leho commercial, walk in tunnel, Low tunnel are recommended for successful cultivation of water melon.
Harvesting	Look at the color on the bottom. A green watermelon will have a white bottom; a ripe melon will have a cream or yellow colored bottom, Press on it. If the watermelon sounds dull it's ripe, check the tendril if it's green, wait. If it's half-dead, the watermelon is nearly ripe or ripe. If the tendril is fully dead, it's ripe or overripe.
Plant Protection	
Physiological disorder	
Delayed ripening	The main causes of delay in ripening in these crops are high soil moisture, low temperature and fluctuation in temperature at ripening. **Control:** • Adjust sowing time in such a way that fruit ripening coincides with hot. • Withhold irrigation at ripening stage.

MUSKMELON



Cantaloupe/Musk melon is a popular fruit crop grown throughout India. This fruit is being used as desert fruit and also eaten fresh.	
Scientific name	*Cucumus Melo* L.
Genus	Cucumis
Family	Cucurbitaceae
Common name	Kharbooj
Climate	The muskmelon thrives best and develops the highest flavor in a hot dry climate. High temperature and sunshine produce melon high in sugar contents. Ideal temperature for its cultivation is 25-35^{0}C.
Soil	Musk melon/Kharbooj can be cultivated on wide range of soils. However, its cultivation is best suited on sandy loam/ light textured, warm, well-drained soils with high in organic matter. High yield with good flavor can be expected with soil pH 6.0 to 7.0. Soil temperature below 15°C slows the seed germination and growth.

Recommended varieties	Afghan selection, Hara Madhu, Metha, Madhu rash and Arka rajhans.
Sowing time	2nd week of March to April
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	3 kg/ha
Spacing	Under poly house condition if plant is spread in ground it can be planted 1.5×1.5 meter distance. When plant is trailing in vertical distance should be reduced 1×1 meter they get good result.
Manures and Fertilizers	Apply a farmyard manure (FMY) of 10 tones/ha as basal dose at the time of land preparation. Apply N 75 kg/ha, P 40 kg/ha, K 40 kg/ha. The full dose of P & K, half dose of N should be applied before sowing the seeds. The rest part of nitrogen should be applied in 2 split doses with first when plants start to run and 2nd dose at the time of fruiting.
Weeding/hoeing and Mulching	During the early stage of musk melon crop, give 3 to 4 hoeing to control the weeds and retain the soil moisture. Mulching the bed surface with straw is recommended for growing. Mulching not only retain the soil moisture, prevent nutrient leaching and improve soil aeration, but also control the weeds.
Irrigation	Irrigation should be given immediately after sowing the seeds in the field. Subsequent irrigations may be given @ 5 days interval to maintain the good soil moisture. Drip irrigation is performed best and save 60-70% water.

Recommended structure	HMAARI, Trenches, Leho commercial, walk in tunnel, Low tunnel are recommended for successful cultivation of water melon.
Harvesting	To get good quality of fruits, they should be harvested in right time. Cantaloupe or Musk melon fruits are ready for harvesting when the fruit external colour is changed. Clear sign of maturity in most melon varieties is when the rind changes colour from grey or green to yellow. Normally these fruits mature in 85 days to 115 days depending on the variety and climatic condition.
Plant Protection	
Physiological disorder	
Delayed ripening	The main causes of delay in ripening in these crops are high soil moisture, low temperature and fluctuation in temperature at ripening. **Control:** • Adjust sowing time in such a way that fruit ripening coincides with hot. • Withhold irrigation at ripening stage.

CUCUMBER

Cucumber belongs to Cucurbitaceae family and is an important summer vegetable crop cultivated throughout India. Cucumber plant has a climbing or trailing habit. The tender cucumber can be eaten raw or with salt in salad. Cucumber is also used in daily cookings. Cucumber seeds can be used in oil extraction. Growing cucumber is greenhouse is a fun and profitable business. Most of the people are showing interest in greenhouse production of cucumbers as they can be grown under controlled environment throughout the year.	
Scientific name	*Cucumis sativus* L.
Genus	Cucumis
Family	Cucurbitaceae
Common name	Khira and Cucumber
Climate	The cucumber crop requires a moderate warm temperature and grows best at a temperature between 20^0 C and 24^0 C.
Soil	Cucumber can be grown in wide varieties of soils from sandy loam soils to clay soils with good drainage. Make sure the soil contains organic

	matter. Soil pH should be between 5.5 and 6.7 is favorable for optimum growth.
Recommended varieties	Japanese Long Green, Shalimar Cucumber Hybrid-1, Shalimar Cucumber Hybrid-2, Aviva and Gladia
Sowing time	2nd week of March to April
Seed treatment	Seeds should be treated with Captan or Thiram @ 2g/kg seed before sowing to prevent any soil borne disease.
Seed rate	3 kg/ha
Spacing /Seed sowing method	The cucumber seed is sown by method of dibbling at a distance of 1 m (row to row) x 60 cm. (Plant spacing). Two to three cucumber seeds are sown in each pit.
Trellising	Cucumber vines can be trained on trellises to save space and improve yield and fruit quality. The high cost of trellising makes commercial production by this method uneconomical in most cases but greenhouse cucumbers must be trellised, because the long fruits bend if they rest on the ground. Besides that, trellising increase harvest efficiency, pest management efficiency and reduce fruit loss due to soil diseases.
Training, Fruit Thinning and Pruning	• Make sure to remove the side shoots and tendrils on the main stem of the cucumber plant • When it comes to fruit thinning, thin to 1 fruit/ 2 nodes • Old and diseased leaves should be removed to allow better light and aeration into the plant center

Manures and Fertilizers	FYM=10 t/ha, N=75 kg/ha, P=40 kg/ha, K=40 kg/ha, ½ N and full P, K should be applied as a basal dose. ½ N in 2 split doses with first when plants start to run and 2nd dose at the time of fruiting.
Weeding/hoeing and Mulching	Shallow cultivation can be given during the early stages of cucumber plant growth to control the weeds. Mulching the bed surface with black plastic mulch is recommended for growing. Mulching not only retain the soil moisture, prevent nutrient leaching and improve soil aeration, but also control the weeds.
Irrigation	Drip Irrigation is most effective method for cucumber farming. Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1 meter. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
Recommended structure	HMAARI, Trenches, Leho commercial, walk in tunnel, Low tunnel Leho are recommended for successful cultivation of water melon.
Harvesting	Harvesting can be done @ 40 to 45 days after sowing. On an average of 8 to 10 harvests can be done. Timely picking of cucumber is more important for better quality for fruit. Yield: 8 to 10 t/ha in 80 to 90 days for salad purpose.
Plant Protection	
Physiological disorder	
Pillow	It is a fruit disorder of processing cucumber due to low calcium level in the tissue. In this disorder, an

	abnormal white styofoam like porous textured tissue is formed in the mesocarp of the fleshy harvested fruits. Vascular tissue with some pillow areas may collapse and become necrotic.
Bitterness	All cucurbits produce a group of chemicals called cucurbitacins, which cause the vegetables to taste bitter and the higher the concentration of cucurbitacin the more bitter the vegetable will taste. Mild bitterness is fairly common in cucumbers resulting from higher levels of cucurbitacin triggered by environmental stress, like high temperatures, wide temperature swings or too little water. Uneven watering practices (too wet followed by too dry), low soil fertility and low soil pH are also possible stress factors. **Control:** • Provide proper irrigation • Maintain proper temperature to protect bitterness

COMMON INSECT PESTS OF CUCURBITACEOUS CROPS

pest	
Aphid ***Aphis gossypii***	Aphids are small ranges in color from yellowish green to greenish black. Both winged and wingless forms are produced. The winged individuals are somewhat slender and are not as robust as the wingless form. A mature individual measures about 0.06 inch (1.5 mm) in length. The aphids develop in colonies and prefers the underside of leaves. These small, green aphids can be a major problem on young plants where they feed near the tips of runners or in growing points. They cluster in numbers on the underside of growing leaves, distorting and curling the leaves, and produce a large amount of honeydew. **Management** • Remove and bury the few severely infested plants as they appear in spring; this helps prevent rapid spreading of the aphid population. • Spray dimethoate 30 EC @ 100ML/100 liters of water
Thrips **(*Frankliniella occidentalis)***	Thrips are small, slender insects with mouthparts developed primarily for sucking and rasping. The adults measure about 0.04 inch (1 mm) in length and have two pairs of fringed wings, carried

	lengthwise over the back. Both the young and adults cause damage by rasping and puncturing surface cells. This results in a silvering, and sometimes deformation, of the leaves: edges of leaves tend to curl downward. **Management** In case of severe infestation, spray the crop with dimethoate 30 EC @ 100ml/100 litres of water during the month of July and repeat the spray after 15 days if the re infestation of the pest is observed.
Flea Beetles	Adult beetles chew and make small holes in leaves, giving them a sieve like appearance. The small, slender, white larvae feed on underground parts of the plant. On rare occasions, flea beetles may feed directly on ripe fruit, just below the calyx. This damage is usually seen only in late-season plantings that show extreme foliar stress resulting from lack of water or powdery mildew. **MANAGEMENT** • Eliminate plant stress from insufficient moisture and powdery mildew. • Spray the crop with chlorpyriphos 20 EC @ 100ml/100 liters of water if the infestation is severe.
Red pumpkin beetle (*Rhaphidopalpa faveicollis*)	It is most destructive pest of all cucurbitaceous vegetables. The damage of the plant is caused mainly by the adult insects which feed voraciously on leaves, flowers and fruits. The beetles makes hole on plant tissues causes death or retardation of growth. The damage done to young seedlings is

	often devastating. The grubs of this pest remain in the soil and feeds on roots and stem of the plant. **Management** • Mechanical collection and destruction of pest. • Expose the pupae to natural enemies by ploughing and turning over soil after harvest. • Using ash, mixture of ash and insecticidal dust as repellent. • Spray the crop with chlorpyriphos 20 EC @ 100ml/100 liters of water
Fruit fly (*Dacus cucurbitae*)	Both adults and maggots damage the crop. Maggots after hatching start feeding on pulp of the fruits leading to rotting of such fruits. Adult flies puncture the fruits where from exudation come out making such fruits vulnerable from exudation come out making such fruits vulnerable to fungal and bacterial infection. The pest remains active from May to September. ETL of the pest is 3 percent fruit infestation. **Management** • Infested fruits and leaves should be collected and burn in deep pits. • Alter in the date of sowing • Expose the pupae to natural enemies by ploughing and turning soil after harvest. • A cotton pad (0.3 mg) treated with 0.25 ml of vinegar (acetic acid) or dextrose or lactic acid are potent attractants for luring

	and trapping the fruit flies from a distance of 0.8 km. • Dusting with some repellents like tobacco dust or fine ash mixed with kerosene oil to repel the flies. • Poison baiting of saturated sugar solution 5ml + Malathion 50 EC 0.5 ml/100 ml of fermented palm juice will reduce the population to the great extent. In sever infestation keep the bait in earthen lids placed at various corners of the field.
Diseases	
Alternaria leaf spot Causal organism: *Alternaria cucumerina*	Lesion is round to irregular target spots on older leaves. The symptoms are first observed at the crown of the plant. As the spots enlarge, concentric rings are formed in the lesion. The disease is favored by continuous wet conditions. Management: • The fungus is controlled with a 2 year cucurbit free rotation • Destruct the previous crop residue • Spray Mancozeb 75 WP (0.3 %)
Anthracnose Causal organism: *Colletotrichum orbiculare*	Symptoms appear twist on crown leaves as small, brown black spot usually after vines begin to run these lesions are also visible on the underside of leaves. During the spore masses turn gray. Lesions can coalesce, causing the leaves to die. Management: • Crop rotation for 3 years • Use disease resistant varieties. • Field sanitation

	• Spray crop with carbendazim 50 WP (0.05 %) or Hexaconazole 5 EC (0.03 %) or mancozeb 75 WP (0.3 %) in the field.
Bacterial wilt Causal organisum: *Erwinia tracheiphila*	Symptoms begin with wilting, which may be confined to individual runners or many involve the entire plant. Plant may wilt at any growth stage, but wilting is often most severe during periods of rapid growth. Affected leaves display marginal chlorosis and necrosis. In time the entire plant become necrotic and dies. A diagnostic produce for identifying this disease in the field to make a cut through a symptomatic stem, region the ends and slowly pull the pieces apart. In infected plants, bacteria from the vascular tissue will cohere as filamentous strands between the two pieces. Management: • Control cucumber beetles which vector *Erwinia tracheiphila* to help control this disease • Eliminate all weeds and volunteer cucurbits • Remove and destroy infected plants as soon as they are identified • Crop rotation for at least 3 years
Cercospora leaf spot Causal organism: *Cercospora citrullina*	The disease is usually found on foliage, but if the environment is suitable, symptoms may also occur on petioles and stems. The fungus is not known to infect fruit. Larger least spots which are circular to irregularly circular develop on muskmelon. The centers of these leaf spots are tan to light brown becoming transparent and brittle with time.

	Lesions with surrounding chlorotic halos may coalesce and turn leaves yellow. Although defoliation from the disease may reduce fruit size and quality. **Management:** • The crop debris should be buried in soil • Crop rotation for 3 years • Seed treatment with Captan 3 g/kg of seed • Spray the crop with carbendazim 50 WP@0.1% or mancozeb 75 WP @ 0.2% or copper oxychloride @ 0.25%
Angular leaf spot Causal organism: *pseudomonas syringae pv lachrymans*	Disease appears on leaves, stem and fruit as small water soaked irregular or angular small lesions. On leaves they enlarge up to 3 mm are shiny, become tan indica on upper surface and gummy on lower surface and assuming an angular shape as the lesions are delimited by veins the necrotic center of the many drop out. On stems, petioles and fruits the water soaked spots are covered with white crusty bacterial exudates. As the fruits begin to mature, brown lesion in the fleshy tissue beriath the rind develops and discoloration continues along the vascular system which extends to the seed. **Management:** • Ensure field sanitation • Spray Streptocyclin @ 2-4 g/10 litre of water • Repeat spraying after an interval of 7-10 days (3 spraying)

Powdery mildew Causal organism: *Erysiphe cichoracearum*	The first symptoms are white superficial spots on leaves and stems which become powdery in consistency as they enlarge the fungus may run over the entire host surface. Black pin pointed fruiting bodies appears conspicuously. Defoliation occurs thus reducing quality and quantity of fruit. **Management:** • Adopt phytosanitary majors • Seed treatment with Triadimefon 20 WP (0.15 %) or carbendazim 50 DS (0.2 %: • Spray the crop with Dinocap 48 EC@0.1% or Hexaconazole 5 EC@0.03 % or Carbendazim 50 WP@0.05% or Triadimefon @ 0.05 % at interval of 10-15 days