

DIHAR

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VEGETABLE SEED PRODUCTION IN LADAKH



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INTRODUCTION

For seed production of certain vegetables crops, climatic conditions of Ladakh are suitable. The region enjoys the availability of long photoperiod, high light intensity, low rainfall and humidity and low disease and pest incidence. However, with above positive climatic factors, crop specific agro-techniques are essentially required for successful seed production of any crop. Defence Institute of High Altitude Research (DIHAR), Leh has developed technologies of quality seed production of certain temperate vegetable crops. The vegetable seed crops such as cabbage, knoll-khol, onion, leek, beetroot, temperate radish, temperate carrot, turnip, swede, celery, parsley can be grown in sandy to heavy soils with adequate water and nutrients supply. All the fields where wheat and barely are growing in Ladakh are suitable for seed production of vegetables.

1. Suitable crops and their varieties

Selection of vegetable crop and identification of their varieties suitable for seed production is the utmost important factor for successful seed production in this region. Based on the experiments, following varieties of vegetables found suitable for commercial seed production in cold desert conditions of Ladakh (Table-1):

Table 1. Vegetables and their commercial varieties suitable for Leh valley

S.No.	VEGETABLE	SUITABLE VARIETIES
1.	Beet leaf	Mongol
2.	Beetroot	Detroit Dark Red, Action
3.	Bottle gourd	Pusa Summer Prolific Long, Arka Long
4.	Brinjal	Pusa Purple Round, Pusa Purple Long, Pusa Hybrid -5, Pusa Hybrid-6
5.	Broad bean	Local, Sindhu Brahma
6.	Cabbage	Eclipse Drum Head, Pusa Drum Head, Golden Acre
7.	Carrot	Nantes, Local, Yamdagni
8.	Capsicum	California Wonder, Yolo Wonder, Pusa Deepti, Hybrids
9.	Celery	Early Zem
10.	Chinese cabbage	Local
11.	Coriander	Pant Dhania-1
12.	Cucumber	Poinsette, Japanese Long Green, Astrix and Hybrids
13.	Fenugreek	Kasuri, Pusa Early Bunching
14.	French bean	Contender, FRL sel, VL-I, Pusa Parvati
15.	Karm sag	Kashmiri
16.	Knolkhol	White Vienna
17.	Lettuce	Great Lake
18.	Long melon	Arka Sheetal, Long Green
19.	Orich (Ustakh)	Local
20.	Onion	Local White, Sindhu Sweta, Pusa Red, Brown Spanish, AFDR, AFLR, Red Pinoay, Early Grano-50
21.	Leek	Bejosheetal
22.	Pea	Bonneville, Arkel, FRL Sel, Lincoln, Pusa Pargati
23.	Parsley	Sindhu Selection

24.	Potato	Kufri Chandramukhi, Kufri Jyoti, Chipsona-2, True Potato Seed (Hybrid)
25.	Pumpkin	Pusa Vishvas, Sindhu Yellow, Arka Chandan
26.	Radish	Sindhu Local, Pusa Himani, Rapid Red White Tipped
27.	Summer Squash	Australian Green
28.	Swiss chard	Sindhu Red Petiol
29.	Tomato	Marglobe, Sindhu-1, Sindhu-2, Hybrid (F1)
30.	Turnip	Purple Top White Globe
31.	Veg. Mustard	ARU-Black
32.	Water melon	Sugar Baby, Asai Yamato

2. Agro-techniques of seed production of certain vegetables crops

A. Cole crops (Cabbage and Knolkhol)

There are three distinct methods of seed production of these crops viz head to seed method, seed to seed method and the stump method, but in Ladakh's agro-climatic conditions, head to seed method for cabbage and knob to seeds for knolkhol are the most suitable. Seed produced from this method will be of good quality because the heads/knobs provide a better scope for inspection, selection and roguing. These crops take two growing season to produce seed.

First Growing Season:

Raising of seedlings and transplanting

Nursery is sown in the month of April to raise the seedlings for planting of seed crop. With 80% germination, 600 g seed is required for planting of one-hectare land. Seeds are sown in 10 cm apart and 2 cm deep furrow. Watering and other standard practices are followed for raising healthy seedlings. In Ladakh, 4 to 6 week old seedlings are transplanted in well prepared flat beds at a distance of 60 cm x 45 cm for cabbage and 45 cm x 45 cm for knolkhol. Transplanting should be carried out in the evening and to minimize transplanting shock the field be irrigated immediately after transplanting.

Field preparation and mixing of manure

Cabbage and knolkhol crops respond well with manure and fertilizers due to their heavy nutrient requirement. Fields should be well prepared by ploughing two to three times and incorporating 25 to 30 tones of well rotten farmyard manure. To obtain good yield, 120 kg nitrogen, 80 kg phosphorus and 75 kg potassium per hectare for cabbage and 100 kg nitrogen, 60 kg phosphorus and 50 kg potassium per hectare for knolkhol are required.

Irrigation & intercultural operations

Adequate supply of moisture is required for good crop growth. Depending upon the soil type and weather condition, irrigation should be given at an interval of 8 to 12 days. Irrigation frequency should be reduced when the head/knobs begin to mature and it should be completely stopped at maturity stage. Excess irrigation at maturity stage can become cause of head splitting in cabbage. Depending upon weed population, two to three manual weeding should be done to keep field free from weeds.

Harvesting and storage of heads and knobs

To store the heads of cabbage and knobs of knolkhol, whole plant is uprooted during October to mid November and re-planted in an underground store. Sandy or sandy loam soil is suitable for re-planting of the plants in underground store. There is no need to add manure and fertilizers as the plants remained in dormant stage during storage. By harnessing the soil heat and to protect from outside cold, the underground store maintained adequate temperature in winter (above freezing temperature). Uprooted whole plants are planted at a distance of 30 cm x 30 cm (close planting) or plant to plant gap may be decreased or increases depending upon the size of

heads of cabbage and knobs of knolkhol. To minimize the water loss from the plants through evapo- transpiration, a light irrigation should be given immediately after re-planting. Thereafter, very light irrigation should be given at an interval of 15 to 20 days; interval of irrigations may be increased during December-January as slightly higher humidity observed in these months. In general, basement of house is used as underground stores. But, if the underground store made independently then care should be taken to maintain inside temperature by covering the roof of the underground store with polythene sheet or alfalfa hay. If proper care is taken during the storage, the survival rate of the plants is as high as 80 to 90 percent. Freezing temperature inside store, due to inadequate care will spoil the heads of cabbage and knobs of knolkhol.

Second Growing Season:

Re-plantation for seed production

During the months of March-April when minimum temperature reaches minus 4°C, the dormant plants are uprooted from the underground store and planted in well prepared field beds. Distance of plantation should be followed as per the variety. In case of Drum Head variety of cabbage 75 x 60 cm spacing has been found suitable, however Golden Acre produced maximum seed yield at 60 x 45 cm spacing. 45x45 cm spacing is recorded to get maximum seed yield of knolkhol. Standard cultural practices are followed to keep the field free from weeds. Adequate moisture should be maintained by irrigation of the crop at proper interval.

Inspection and roguing

The crop should be inspected before the marketable stage. Off-type plants should be rogued out on the basis of head shape, colour of leaves at maturity time of the heads/knobs in the first growing season. Minimum three inspections should be made, first before the marketable stage of heads/knobs, second before storage in the underground store of heads/knobs and the third at the flowering stage.

Isolation

Cabbage and knolkhol being highly cross-pollinated crop require isolation from the fields of other varieties and the same variety, which do not conform to purity. The isolation distances depend upon direction of the crop from field of other crop. Low insect population is found in this region and mostly wind blows from western side to eastern side with high speed therefore, distance should be more (2000-2500 m) from other variety in case planting of seed crop in eastern side of other crop field. But 800-1000 m distance is sufficient when the crop is planted in all other direction of other crop.

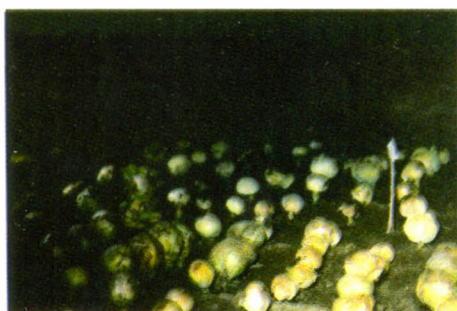
Harvesting and threshing

When the pods turn yellow and the seed becomes brown, harvesting can be commenced to avoid shattering. Seed crop may be harvested in two to three lots. Individual plants can be harvested first and the remaining crop can be harvested when about 75% of the pods turn yellowish brown. Plants are stacked on tarpaulin/clay soil threshing floor, so that shattered seeds are not lost. About 10 to 15 days drying is usually necessary before threshing. Pods have a natural tendency to dehisce and threshing is easy when pods are dry. After threshing, seed should be processed and stored properly. Average 13.15 q/ha seed yield from Drum Head variety and 7.2 q/ha from Golden Acre and 6.8 q/ha from White Vienna variety of knolkhol recorded in subsequent two years experimentation.

B. ROOT CROPS (Radish, Carrot, Turnip, Beet Root, Swede)

First Phase

The temperate varieties of these crops require two growing seasons to produce seeds under the prevailing agro-climatic conditions in Ladakh. In the first growing season (first phase), the seed crop is raised as that for table purpose. It requires deep, fertile, sandy loam soil. In heavy soils, sowing on ridges is preferred. All these crops require good drainage otherwise the roots are likely to become more branched, misshaped and mal-formed.



Storage of cabbage heads during winter



Seed setting in cabbage

In the first phase after the preparation of land, seeds of beet root are sown during May depending upon the weather conditions and those of carrot, radish and turnip are sown in the month of June. In Ladakh, roots of these crops are ready for harvesting in the month of October. Cultural operations applied are similar to production of table crop. Matured roots are usually pulled by hand or dugged out. True to type roots are selected, leaf tops are cut without damaging the crown leaves.

Storage of roots in pits

After selection and cleaning of roots, these are required to be stored until the next cropping season. The roots are stored in underground pits of about 6-7 feet deep. The length and width of the pit depends upon the quantity of roots to be stored. After filling the pit with roots, a 60 cm layer of dry sand is laid on the roots.

To avoid the losses of roots by spoilage in pit storage, DIHARhas designed underground structure for moderating extreme cold conditions at cold arid conditions for storage of roots of these crops during winter (October-April).

Second Phase

Re-plantation of roots for seed production

When the ambient temperature is reached around -2 to -4°C (in the month April), roots are transplanted in well prepared open fields beds.

Spacing

The optimum plant spacing is a must for proper growth of the plant to harvest maximum seed yield. Yield and quality of seeds produced are directly proportional to the growth of mother plant. It is observed that the seeds harvested from the thickly populated crop will be undersized, weak and poor in quality. This assumption however, does not hold good for all the crops. In carrot, maximum seed yield of better quality is achieved by close planting of carrot roots (45 cm x 45 cm). It is because that the major contribution towards total seed yield is made from the first and second order umbels. The quality of seed obtained from the third and fourth order umbels are very poor and their quantity is also found less.

Wider spacing (60 cm x 60 cm) is favored for good quality seed production of radish Cv Sindhu Red. Plant spacing of 45 cm x 30 cm in turnip (Cv. Purple Top White Globe) and 60 cm x 45 cm in beet root (Cv. Detroit Dark Red) gave higher seed yields in Leh valley.

Adding manure & fertilizers in the field

Uninterrupted and rapid growth of root crops produced maximum quantity of high quality seed. Adding Manure and fertilization in the field facilitate such growth. A basal dose of farmyard manure/compost or other locally available organic manure (30 tones/ha) at the time of field

preparation is beneficial. When organic manure applied at the higher rate, the dose of inorganic fertilizers can be reduced. However, application of 80:50:50/ N: P: K per hectare for all the root crops found sufficient to obtain optimum plant growth and good seed yield. Complete dose of phosphorous and potassium and half dose of nitrogen should be applied in soil as basal doses before transplanting of the root and remaining N should be given in 2 equal split doses at 25 and 40 days after transplanting the roots.

Irrigation

Irrigation should be given according to local needs. Timely irrigation is very important for obtaining higher seed yields. According to prevailing weather conditions in Ladakh, irrigation should be given at an interval of 10 - 12 days.

Isolation

Carrot, radish, turnip and beet root are cross pollinated crops therefore, proper isolation distance should be maintained to produce genetically good quality seed. The isolation distance for these crops should be maintained as per described above for cabbage and knolkhol. However, turnip and swede should also be isolated from each other and both the crops should also be isolated from Chinese cabbage and mustard.

Selection and roguing

Off type plants on the basis of foliage characteristics should be removed from the field itself before the roots are pulled out in the first phase. Root should be conformed to variety characters such as colour, shape, size and small, mis-shaped, forked, diseased and other undesirable roots should be shorted out. The third roguing is done at the time of early vegetative growth in second phase to discard diseased and undesirable plants and fourth at the onset of flowering. Off-types and very early bolters should be removed from the field.

Harvesting and threshing

Pods of turnip shatter very rapidly when they are fully ripe. Therefore, it is advisable to cut the whole crop when 60-70% of the pods turn yellow brown in colour. After 4-5 days it is turned upside down and allowed to cure for another 4-5 days. It is then threshed with ordinary sticks and lifted with hand sifters.

Unlike turnip, shattering is not a problem in radish and so harvesting can be done when the pods are fully ripe and the harvested crop is left in the field for drying and curing.

In carrots, the primary umbels mature first so it would be better that the crop is harvested in two or three pickings. Though shattering is also not a problem in carrot but if by chance which is rare there are repeated showers after the umbels are ripe, then viability of the seed is affected. After proper drying the crop is threshed.

The seed crops of beet root should be harvested when 80 per cent of the seed/seed balls on a plant get hardened and the base of the inflorescence turn brown. Otherwise, there is possibility of shattering of seeds during harvesting. About 10 days drying is essential for easy removal of seed balls from stalk.



Carrot seed production

season bulbs are produced using seeds and thereafter, harvested bulbs of onion are stored till the next cropping season (October – April). In the second season, bulbs are planted to produce seeds. Seed of the leek is produced by seed to seed method. The plants of leek can be grown in trench greenhouse or they should be covered during winter when grown in open field. After winter in the month of June the plants formed seed stalk and umbels. Seeds of leek are matured in October. Onion seed have poor keeping quality and lose their viability within a year. Therefore, it is essential to produce fresh seeds every year and use the same for bulb production. Onion seed can be produced by bulb-to-seed or sets to seed method. Bulb-to-seed is the only practiced method in high hills.

First Growing Season- Bulb production

Protected nursery raising

Foundation seed should be used for quality seed production of bulbs crop. For raising onion and leek seedlings, 1.0 m wide and 10-12 cm raised nursery bed should be made at proper place. Generally 8-10 kg seed is required for transplanting one hectare of land. Seed is sown in rows with spacing of 8-10 cm. Sowing is done in the month of April. After sowing, light irrigation should be given. After irrigation nursery beds should be covered with polyethylene sheet to protect from severe cold. For obtaining healthy seedlings other standard cultural practices should be followed.

Field preparation and mixing of manure

Field is ploughed to a fine tilth by giving three to four ploughing. Ploughing may be shallow because the roots do not penetrate deep into the soil. Soil for onion and leek growing should be liberally manured and fertilized. At the time of field preparation FYM @ 30 tones per hectare should be mixed in the field. Thereafter, according to soil fertility dose of nitrogen, phosphorus and potassium in the ratio of 80:50:60 kg per hectare should be given at the time of last ploughing. Full dose of phosphorus, potassium and one third dose of nitrogen is given at the time of last ploughing and remaining two doses of nitrogen should be given at 25-30 and 45-50 days after transplanting.

Transplanting

In the first fortnight of May seedlings are transplanted in well prepared field beds at a distance of 20 cm x 10 cm when they attained the height of 12 to 15 cm. Field should be irrigated just after transplanting.

Irrigation

For better plant growth and good bulb formation sufficient watering is done at 7 – 10 days interval. The irrigation should be stopped about 20 days before harvesting for proper maturity of bulbs. It is essential to protect bulbs from low temperature during night at the time of harvesting as it causes spoilage of bulbs in the field.

Intercultural operations

To obtain better yield of onion, field should be free from weeds. For the same 2-3 weedings are required for keeping the onion field free from weeds. Shallow hoeing can be done in onion crop.

Harvesting and underground storage of bulbs

Onion crop is harvested with half dried leaves because leaves do not dry completely till harvesting to short growing period and progressively low temperature at the time of crop maturity. Depending upon the ambient temperature crop is harvested in the month of October. After harvesting, bulbs are selected in respect of size, shape & colour. Diseased and injured bulbs are discarded. After selection, bunches are made by tying the leaves together. Depending upon the bulb size 10-20 bulbs can be tied in a bunch with the help of leaves. These bunches should be hanged in underground store. Bunches can be hanged with the help of wire or ropes inside the underground store. During severe winters (December to February) care should be taken to maintain proper temperature above 1°C by covering polyethylene or alfalfa

hay on roof of the underground storehouse. Ventilators should be provided at side walls at ground level. If proper care is taken survival rate of the bulbs after underground storage is as high as 85-95 per cent.

Second Cropping Season

Plantation of bulbs for seed production

Depending upon the atmospheric temperature, stored bulbs are taken out from the store and selection is done for removal of disease infested, rotten and other undesirable bulbs. These are then transplanted in well prepared field beds during mid-April to mid May at a distance of 45-30 cm x 15 cm depending upon the bulb size. Before planting, the field should be tilted and manured along with other cultural practices in the same way as done for bulb crop. Bulbs start sprouting within 10-15 days after transplantation.

Isolation

Onion is a highly cross-pollinated crop. Onion seed fields should therefore be isolated from the fields of other varieties and fields of the same variety not conforming to variety purity. A distance of 1000 m for foundation and 500 m for certified seed production should be kept.

Inspection and roguing

Minimum of four roguing are essential for pure seed production. First roguing should be done within 20-25 days after transplanting and second during the bulb formation in first year in order to determine volunteer plants, off types including bolters and other relevant factors. The third inspection should be made after harvest and before storage of the bulbs and fourth will be at flowering stage.

Harvesting and Threshing

Depending upon the altitude and planting time seed crop of onion and leek are ready for harvesting from September- October. The umbels should be picked up when about 20 per cent black seeds become visible. The harvesting of umbels is done with the help of sharp sickle taking care not shatter the seeds. Harvested umbels are kept for curing for 8-10 days. Then the seed are threshed and cleaned.

Yield

On an average 7.32 quintals seed of onion and 3.2 quintals of leek is produced from one hectare. In Ladakh, yield of onion and leek seed is low as these crops are highly cross-pollinated crops and the presence of pollinator insects in Ladakh is less.

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