

Plastic tunnels

for off season vegetable cultivation

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In open field it is not possible to cultivate summer vegetable during winter due to low temperature, cold waves and high frost levels, and winter season vegetable during monsoon due to high rainfall intensity which directly damage plants or interfere with flowering and pollination. However, these crop can grow inside the protective structure like green house, low tunnel, and walk in tunnel, so that proper atmosphere may be given to plants for their maximum growth and yield. Though, the greenhouses has registered substantial growth in the recent years on productivity and quality improvement but still the low cost protected structures like walk-in and low tunnel needs to be promoted due to poor financial status of our farming community.

Keywords: Off-season vegetable, Plastic sheet, Tunnel

VEGETABLE are an important component of human diet as they are the rich source of vitamins, carbohydrates, protein, salts and minerals. There is a year round demand of fresh vegetable but supply is restricted to cultivation season. Vegetables, especially as practiced by smallholder farmers in developing countries are particularly vulnerable to sudden climate change. Fluctuation in temperature, humidity and high rainfall intensity causes several biotic and abiotic stress conditions in open field cultivation, which adversely affect the growth. Due to unfavourable climatic conditions, during season market flooded with the vegetables irrespective of its demand, substantially bringing down the prices and high price of vegetables in the off-season. To increase the availability of fresh vegetable all around the year, off season cultivation is necessary. Off-season vegetable farming is one of the potential sources of income for vegetable growing farmers. The main objective of off-season vegetable cultivation is to produce and supply

the vegetables to the market during the lean period.

The tunnels are elongated semi-circular shaped low height structures made up of polyethylene sheet. These are the temporary structures which can be moved to another place easily if required so. Generally tunnels are used to give favourable controlled environment like temperature, humidity, light intensity, ventilation, disease control, fertigation and protect the crop from adverse climatic conditions for eg. high rainfall, hail storms and frost throughout the season irrespective of the natural conditions outside.

Walk in tunnel

Walk-in tunnel is the temporary protected cultivation structure made from pre-galvanized pipe or bamboo poles. The structure made by folding rust resistance galvanised pipe having half inch thickness into the semi-circular shape, grounded temporarily to support the transparent UV Stabilized (150-200 micron) plastic sheet as cladding. A transparent plastic sheet allows sunlight inside the

structure and the light gets trapped and absorbed by plants, this increases the inside temperature. The rise in temperature in greenhouse is responsible for growing of vegetable in cold climate. The central height of the tunnel is kept about 3.5 m and width 4-6 m on the base from one end to the other (Fig. 1). The length of the structure generally ranges 20-30 m but it can vary as per requirement. Structure should be designed to withstand wind up to 120 km/hr and trellising loads up to 25 kg/m². Trellising arrangement should be provided inside the tunnel to keep the plant upright and reducing contact of the plants like tomato, capsicum etc. with soil surface. Walk-in-tunnels provide higher yields than low tunnels because of better sun light and ventilation. Walk-in-tunnel technology is a simple and profitable technology for cultivation of tomato, capsicum, cucumber, bottle gourd, bitter gourd, melons, etc. during winter season. When the sunlight penetrate inside the tunnel temperature increase about 3-10°C, due to which these warm season

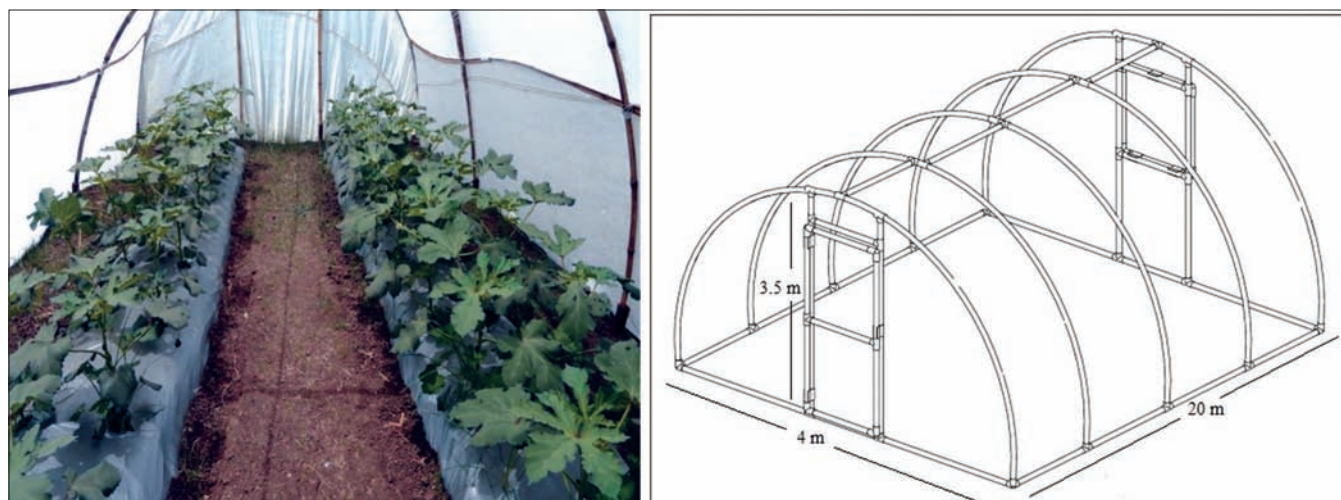


Fig. 1. Walk-in-Tunnel

crops can be successfully grow during winter. This tunnel is widely used for cultivation of cabbage, cauliflower, spinach, coriander, fenugreek etc. during rainy season as it protects the crop from direct sunshine and heavy rains.

Low Tunnel

Low tunnels or row covers are miniature greenhouse-like structures, covering the plants along the row. These tunnels are about 1.0 m high and 1.5 m wide at the base and are erected with the hoops (Fig. 2). Hoops of the low tunnel can be made from metal wire, plastic bars or wood. Place the hoops in the field once the raised beds are established at interval of about 2 m along the length of row. A transparent plastic film of 25-50 micron having 2m width is placed to cover the roof. This reflects infra-red radiation to keep the temperature of the low tunnels higher

than outside. These tunnel increases the inside temperature and entrapment of carbon dioxide, resulted more photosynthetic activity of crops hence early produce. The distance between the rows is generally kept about 1.5 m. Low tunnels modify the micro-environment around the plants, increases soil and air temperature due which plants grow faster and mature earlier and yields are potentially higher compared with open-field cultivation. Low tunnels are widely used for early production of a range of vegetable crops but they are most effective for cucurbits: muskmelons, watermelons and squashes. When the crop height reaches to the height of low tunnel polythene sheet requires to be remove. Low tunnels are less expensive as compared to walk-in tunnels.

Advantages

- Off season cultivation of high-value vegetable crops are possible.
- Production is 2-4 times more as compared to that is taken in the open field.
- Cost of the structure is less than other protected structure.
- Efficient utilization of input resources like land, water and fertilizer.
- Protection to high value crops from rain, wind, frost, pests and diseases.
- The economic return is more due to market prices of vegetable crops are high during off season.
- Uniform and better quality of the crops compared to open field condition.

Site selection

Site selection is the important consideration in the tunnel farming. Site should be at higher level than the surrounding land with adequate

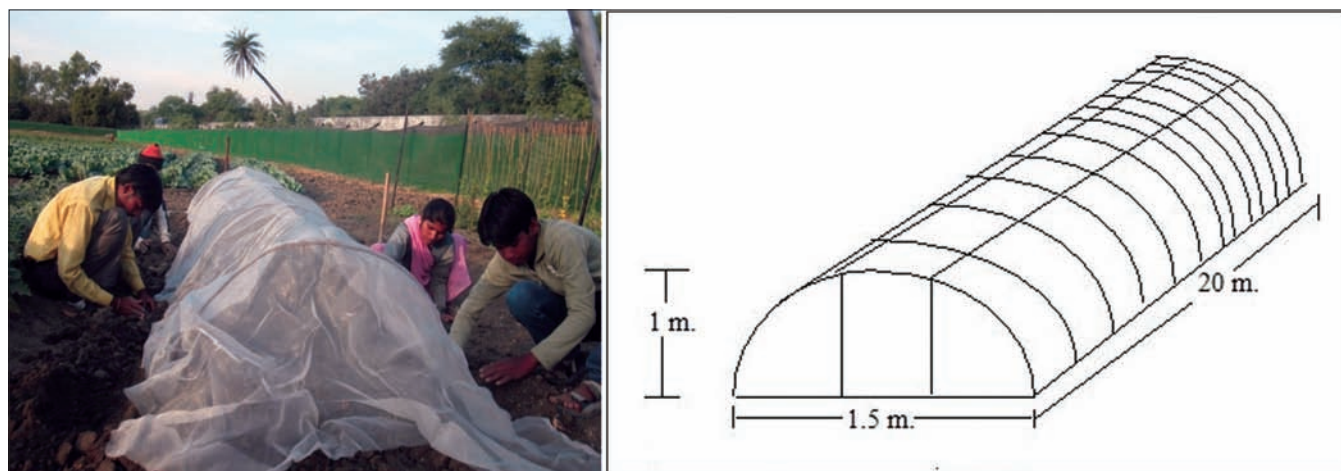


Fig. 2. Low Tunnel

drainage facility. If possible, locate the greenhouse where it will receive at least 6-8 hours of direct sunlight during the winter months. Orientation affects the amount of sunlight received, so direction of the tunnel should be from East to West for better temperature gains inside the tunnel and it should be free from shadow. The tunnel must preferably be situated close to a market, in order to facilitate that products reach the market place as soon as possible.

Land preparation and sowing

Land preparation is an important practice for vegetable cultivation in tunnel. Soil should have good water absorbing and holding property. Soil must be loose, fine tilth and free of stone. Soil solarization should be done 14 days before the bed preparation which helps in killing of harmful organism, fungal spores, bacteria and nematodes, when the temperature rises up to 40-45 °C. Well decomposed FYM should be applied 1.5-2.0 kg/m² at the time of final land preparation. Soil pH range should be 6-6.8. If soil is acidic in nature, it is advisable to apply dolomite/lime and if alkaline gypsum may be apply as per recommendation. The soil should be mixed well with manures and brought to a fine tilth before transplanting. About 100 cm wide and 10-15 cm raised bed leaving 50 cm space between the beds should be prepared for sowing/transplanting of vegetable crops. Direct seeding should be done for leafy vegetables. Transplanting of wide spaced crops seedling is done in rows at a distance of 45 × 45 cm and sowing of leafy vegetables should be done at 15-20 cm apart in the rows. Seedlings or seed should be treated for 15 minute at the time of sowing/transplanting to protect crop from fungal infection and get better yield and quality produce.

Soil solarization: Soil solarization is a non pesticidal method of controlling soil borne pests by placing plastic sheets on moist soil during periods of high ambient temperature of about 40-45°C. In this process soil is wetted thoroughly with formalin 4% solution at 4 lit per sq.m. Then surface is covered with white and transparent polythene sheet (100

Table 1. Crops and their varieties suitable for cultivation under plastic tunnel

Crop	Suitability	Season	Suitable varieties
Tomato	Walk-in tunnel	Oct-Feb	Avinash, Badshah, ArkaAbhijit, ArkaSaurabhi, Naveen, Avtar, Sonali, Heemsohna, Nun 7730 etc.
Capsicum	Walk-in tunnel	Oct-Feb	Yamuna, Bomby, Triple star, Natasha, Nun 3019, Inspiration, Pasarella, Swarna, Orobelle, Bachata etc.
Cucumber	Walk-in tunnel	Nov-Feb	Kian, Hilton, KPCH1, Multistar, Isatis etc.
Cabbage	Walk-in tunnel & low tunnel	Jun-Sep	Ruby ball, Magic ball, BC-76
Cauliflower	Walk-in tunnel & low tunnel	Jun-Sep	Pusa snowball, Himjyoti, PusaShubhra, Sumedha etc.
Spinach	Walk-in tunnel & low tunnel	Jun-Sep	All green, Pusajyoti, Pusabharti
Coriander	Walk-in tunnel & low tunnel	Jun-Sep	Super Midori, Khushboo, Saurabh
Watermelon	Walk-in tunnel & low tunnel	Jan-Feb	Aayesha, Madhubala, KSP 1081, Lalima, Raja, Sugar baby, ArkaManik etc.
Muskmelon	Walk-in tunnel & low tunnel	Jan-Feb	ArkaJeet, Pusamadhurima, Pusa Sarda etc.
Bottle gourd	Walk-in tunnel & low tunnel	Jan-Feb	Pusa Naveen, Arkabahar, Samarat PKM1 etc.
Bitter gourd	Walk-in tunnel & low tunnel	Jan-Feb	Varun, Sapan, JhalriPriya 5, Pallavi, NS-454 etc.

micron thickness) and leave plastic sheet for 3-4 weeks. The plastic sheets allow the sun's radiant energy to be trapped in the soil, heating the upper levels. During the process temperature of soil rises upto 48-60°C. Solarization during the hot summer months can increase soil temperature to levels that kill many disease-causing organisms (pathogens), nematodes and weeds.

Crop selection

The selection of the kinds of crops to grow under tunnels is an important decision and should be made carefully. The choice should include the consideration of the crops best suited for tunnel cultivation like tomato, capsicum, cucumber, squash, cabbage, cauliflower, leafy vegetables etc. The crop should be of self-pollinated and improved varieties which can avoid or tolerate the limiting factors. Hybrid variety seeds are generally recommended for cultivation in tunnels because they have the ability to resist multiple diseases and have high germination capacity.

Irrigation and fertigation

The water and fertilizer

requirement of the crop is generally depends on the type of crop, growing season, soil type etc. Drip irrigation system is the most widely-used system for irrigation in the tunnels. This irrigation system can also be used to provide water soluble fertilizer to the crop through fertigation. Fertilizer should be applied according to the recommended dose fertilizer for particular vegetable crop. The quantity of water should be applied according to its water requirement and it can be changed according to the climatic conditions. The inline lateral of 16 mm diameter with 2 litres/hour (lph) to 4 lph discharge rate is generally used for irrigation in vegetable crops. Irrigation frequency depends on soil texture, weather conditions and plant growth stage. Generally water applied to the vegetable crops through drip irrigation system is at 3-5 days interval. Excessive irrigation can lead to misbalanced soil aeration and lack of oxygen in the root zone, resulting in reduced development of the root system. So optimum amount water should be applied to the crop. Plastic mulching can be used in combination with drip irrigation system. The use of plastic mulching over the crop not

only reduces the evaporation loss from the soil upper layer but it also acts as a barrier for emergence of weeds, hence providing a chemical free weed management technique.

Insect and pest management

The tunnels are effective in reducing crop damage caused by diseases and insect pests, in promoting crop growth, and in achieving stable production of high quality vegetables. Insect and pest are lower in tunnels as compared to open field, largely due to lower humidity, control of leaf wetness. If required insecticide and pesticide according to crop can be applied at early stage through drip system or foliar spray. Mulching on the raised bed can be used for controlling the weeds, insect-pest and for increasing water use efficiency.

Economic consideration

Cultivation of vegetables in plastic tunnel is economically advantageous to farmer during offseason. Construction of tunnels requires an initial investment making production costs significantly higher than the traditional practices, however, this cost should be offset by higher returns from earlier harvests, better quality and higher yields. The cost of tunnel, including plastic and all the materials required for construction can represent a considerable initial investment. In general, construction cost of walk in tunnel ranges from 200-450 ₹/square meter and low tunnel ₹ 80-120/square meter

depending on tunnel dimensions and features.

Limiting factors in tunnel farming

Although plastic tunnels offers several important advantages over conventional production practices, but these structures having some limitations. Farmers face many challenges during cultivation of vegetable crops inside protected:

- Various construction materials like GI pipes, polyethylene sheet etc. are not generally available in local market.
- Sometimes for installation and supervision, skilled workers are required which are not easily available in the village areas.
- The package of practices of different vegetable crops for round the year cultivation have not been standardised, hence the recommendation of one region may not work for other region.
- Self-pollinated vegetable crops required for cultivation in tunnel.
- If the frame is not attached to the ground properly. Structure can be blown away by strong winds.
- Poly tunnels are prone to damage, caused by pets and birds.
- In low tunnels, if the sheeting is not straight and tightened properly, condensation can build up and harm the plants, as high humidity levels promote mould growth.
- Low tunnels require raising and lowering of polythene film at the time of spraying chemicals or other intercultural operations.

Results of few studies in India

Studies conducted on musk melon cultivation under low tunnel in Bihar ascertained benefits in musk melon such as frost protection, earliness in planting and harvesting.

Higher number of fruits per plant, fruit yield per plant, fruit diameter under low poly tunnel led to higher yield compared to open field. Low tunnels modified microclimate by raising soil and air temperatures that increases the net photosynthesis and production of more assimilates available for individual to grow. Effect of low tunnel on flowering and fruiting behaviour during off season of bottle gourd was studied. It was found that fruit length, fruit girth, fruits/plant, fruits weight and yield per hectare were higher under low tunnel condition during winter season. In East Sikkim under the Integrated Organic Farming Systems approach low cost plastic tunnels (transparent UV stabilized sheet of 45 GSM) had been adopted for vegetable cultivation in which Broccoli-Radish-Methi-Coriander-Palak vegetable sequence were used for cultivation under low cost plastic tunnel and successfully cultivated with benefit cost ratio of 4:1. Under All India Coordinated Research Project In coriander, 80% of recommended dose of fertilizers in plastic walk-in-tunnel proved significantly better for yield and its attributing characters.

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Jai Kisan, Jai Vigyan

- A total of ₹ 788.33 crores have been sanctioned for opening six new agricultural colleges for eastern India under Central Agricultural University, Imphal, and a new Central Agricultural University in Meghalaya.
- For the establishment of two new agricultural research institutes in Asom and Jharkhand, a sum ₹ 100 crores is allocated.
- First academic session of the Rani Lakshmibai Central Agricultural University has been allocated for four new agricultural colleges in Ditiya and Jhansi.
- An Memorandum of Understanding was signed for transforming the Rajendra Central Agricultural University, Pusa, Samstipur, Bihar. A proposal of ₹ 400 crores is submitted in EFC.
- Post-Graduate Institute of Horticulture is being established in Amritsar, Punjab.
- Foundation stone of the Indian Institute of Agricultural Biotechnology is laid at Ranchi for promoting agricultural biotechnology.