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Vegetable seed production under protected conditions

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Abstract
Protected vegetable production is likely to be commercial practice not only because of its potential but out of sheer necessity. In vegetable production hybrids seeds, transgenic, stress resistant varieties, micro propagated transplants, synthetic seeds are likely to replace conventional varieties. Protected environments will be helpful in production of hybrid seeds of cucumber and summer squash by using gynoecious lines. Gibberlic acid is used to maintain such lines followed by selfing. The desired pollen can be used for production of hybrid seed of cucumber. Similarly in summer squash use of Ethaphone in inducing female flower at every node would help in the hybrid seed production by using desired pollen parent.

Keywords: poly house, vegetables, seed production, green house, low cost polyhouse

Introduction
India has a wide spectrum of diverse agro-climatic conditions but vegetable cultivation practices in India have been generally restricted to regional and seasonal needs. Although the production of vegetables has increased to a level of 94 million tons, still the technology used and practices followed are pre-dominantly traditional resulting in low yields and inconsistent quality and quantity of produce supplies to the markets. In several parts of the country, especially in northern plains, the soils are highly fertile but extremes of temperatures ranging from 0°C to 48°C during a year do not allow year-round outdoor vegetable cultivation. Protected structures modify these extremes to a greater extent to grow vegetables almost year-round. In upper reaches of Himalayas, cold desert conditions prevail, where the temperature is extremely low (-5°C to -30°C) during winter season and the region remains cut off from rest of the country from November to March due to heavy snowfall. It is, therefore, difficult to grow vegetables in such a climate, but some specific protected structures, called polytrenches, have been proved very useful for vegetable cultivation as the region receives an abundance of sunshine (Singh, 2000). Similarly, in several parts of the country biotic stresses during rainy and post rainy season do not allow successful vegetable cultivation. As a result, most of the vegetables are damaged by the severe incidence of viruses. Protected structures covered with insect proof nets (insect proof net houses) provide a big opportunity of virus free vegetable cultivation even on a commercial scale.
Protected conditions for vegetable cultivation are created by using different types of structures, which are season- and location-specific. These structures are designed as per climate modification requirement of the area. Temperature, humidity, wind velocity, soil conditions, etc. also play a major role in the design of protected structures for growing vegetable crops, but here are several constraints and problems which restrict protected cultivation of vegetable crops (Sirohi *et al*., 2002). It is therefore necessary to work out the best-suited design of protected structures for different climatic conditions along with their techno-economic feasibility.

Principle of greenhouse
A greenhouse is generally covered with a transparent material such as polythene or glass. Depending upon the cladding material and its transparency major fraction of sunlight is absorbed by vegetable crops and other objects. These objects in greenhouse in turn emit long wave thermal radiations for which cladding material has lower transparency. With the result, solar energy is trapped *ENVIS Bulletin Vol 12(2): Himalayan Ecology* and raises the temperature inside the greenhouse. This is popularly known as greenhouse effect. This rise in temperature in greenhouse is responsible for growing vegetable in cold climates. During summer months, air temperature in greenhouse is to be brought down by providing cooling

device. In commercial greenhouses besides temperature-controlled humidity, carbon dioxide, photoperiod, soil temperature, plant nutrients etc facilitate round the year production of desired vegetable crops. Controlled climatic and soil conditions provide an opportunity to the vegetable crops to express their yield potentials.

Benefits of Greenhouse

Vegetable forcing for domestic consumption and export

During winters in Kashmir region, the temperature and solar radiations are sub-optimal for growing off season vegetables namely tomato, capsicum, brinjal, cucumber, okra and chilli. In tomato, low temperature and low radiation cause puffiness and blotchy ripening. Hence during extreme conditions of winter season (October-February) these vegetables will be cultivated under polyhouse. In a medium cost greenhouse, the yield of tomato and capsicum can be taken @ 98.6-110.5 tonnes/ha and 87.2 tonnes/ha, respectively. The protected environments would be well adapted in the field where winter is prolonged. A polyhouse can be made which will receive sunlight for growing chilli, tomato, brinjal, capsicum and cucumber. The improved varieties and hybrids of these crops would be evaluated. The high priced vegetables- asparagus, broccoli, leek, tomato, cucumber and capsicum are most important crops for production around metropolis and big cities during winter season or off-season. Thus, in the NEH region during winter it may be useful to grow tomato and capsicum in plastic tunnels as the plants which are protected from cold and frost will manifest faster and better growth resulting in earlier fruiting than the crops grown in the open.

Raising off season nurseries

The cost of hybrid seeds is very high. So, it is necessary that every seed must be germinated. For 100% germination, it requires the controlled conditions. The cucurbits are warm season crops. They are sown in last week of March to April when night temperature is around 18-20^{0}C. But in polyhouse their seedlings can be raised during December and January in polythene bags. By planting these seedlings during end of February and Ist week of March in the field, their yield could be taken in one and one and a half months in advance than the normal method of direct sowing. This technology fetches the bonus price due to marketing of produce in the off-season. Similarly, the seedlings of tomato, chilli, capsicum, brinjal, cucumber, cabbage, cauliflower and broccoli can be grown under plastic cover protecting them against frost, severe cold and heavy rains. The environmental conditions particularly increase in temperature inside polyhouse hastens the germination and early growth of warm season vegetable seedlings for raising early crops in spring summer. Vegetable nursery raising under protected conditions is becoming popular throughout the country especially in hilly regions. Management of vegetable nursery in protected structure is easier and early nursery can be raised. Needless to emphasize, this practice eliminates danger of destruction of nurseries by hail storms and heavy rains because world highest rains occur in this region and the period of rainy season is also wide (April to October). Protection against biotic and abiotic stresses becomes easier.

Vegetable seed production

Seed production in vegetables is the limiting factor for cultivation of vegetables in J&K region of India as well as in India. The vegetables require specific temperature and other climatic conditions for flowering and fruit setting. Seed production of brinjal, capsicum, cauliflower and broccoli is very difficult in open conditions in this area due to high rainfall at maturity stage. To reduce such micro climatic condition a protected environment is essential. Therefore, the seed production of highly remunerative crops namely tomato, capsicum and cucumber is performed under protected environments. The maintenance and purity of different varieties/lines can be achieved by growing them under greenhouse without giving isolation distance particularly in cross-pollinated vegetables namely onion, cauliflower and cabbage. Hence vegetable production for domestic consumption and export in low and medium cost greenhouse is a technical reality in India. Such production system has not only extended the growing season of vegetables and their availability but also encouraged conservation of different rare vegetables.

Hybrid seed production

In 21st century, protected vegetable production is likely to be commercial practice not only because of its potential but out of sheer necessity. In vegetable production hybrids seeds, transgenic, stress resistant varieties, micro propagated transplants, synthetic seeds are likely to replace conventional varieties. Protected environments will be helpful in production of hybrid seeds of cucumber and summer squash by using gynoecious lines. Gibberlic acid is used to maintain such lines followed by selfing. The desired pollen can be used for production of hybrid seed of cucumber. Similarly in summer squash use of Ethaphone in inducing female flower at every node would help in the hybrid seed production by using desired pollen parent.

Maintenance and multiplication of self-incompatible line for hybrid seed production

In case of cauliflower, there is problem of maintaining and multiplication of potential self-incompatible lines for the production of F_1 hybrid seed. Temporary elimination of the self-incompatibility with the use of CO_2 gas has solved this problem. For this purpose, the self-incompatible line is planted in a greenhouse and bees are allowed to pollinate the crop when it is bloom. Then keeping the greenhouse closed tightly within 2-6 hours of pollination, it is treated with 2-5% CO2 gas which allows successful fertilization by temporarily eliminating the self-incompatibility.

Polyhouse for plant propagation

Asparagus, sweet potato, pointed gourd and ivy gourd are sensitive to low temperature. The propagating materials of these vegetables can be well- maintained under polyhouse in winter season before planting their cuttings in early spring summer season for higher profit.

Status

Commercial greenhouses with climate-controlled devices are very few in the country. Solar greenhouses comprising of glass and polyethylene houses are becoming increasingly popular both in temperate and tropical regions. In early sixties, Field Research Laboratory (FRL) of DRDO at Leh attempted solar greenhouse vegetable production research and made an outstanding contribution to the extent that almost every rural family in Leh valley possesses a polyhouse these days. Indian Petro Chemical Corporation Ltd (IPCL) boosted the greenhouse research and application for raising vegetables by providing Ultra Violet (UV) stabilized cladding film and Aluminium polyhouse structures. Several private seed

production agencies have promoted greenhouse production of vegetables. In comparison to other countries, India has very little area under greenhouses as is evident from Table 3.

Table 1: Approximate area (ha) under greenhouses

Country	Area
Japan	54000
China	48000
Spain	25000
South Korea	21000
Italy	18500
Turkey	10000
Holland	9600
USA	4000
Israel	1500
India	525

Source: ENVIS Bulletin Vol 12(2): Himalayan Ecology

The major share has been in the Leh & Ladakh region of Jammu and Kashmir where commercial cultivation of vegetables is being promoted. In NEH region, polyhouse cultivation is still a new emerging technology for raising nursery of vegetable crops. Assistance provided under the plasticulture scheme since the VIII & IX plan has helped in generating awareness about the importance of greenhouses in enhancing productivity and production, particularly of horticultural crops.

Types of greenhouse/polyhouse

Low-cost greenhouse/polyhouse

The low cost polyhouse is a zero-energy chamber made of polythene sheet of 700 gauge supported on bamboos with sutli (ropes) and nails. It will be used for protecting the crop from high rainfall. Its size depends upon the purpose and vailability of space. The structure depends on the sun for energy. The temperature within polyhouse increases by 6-100C more than outside. In UV stabilized plastic film covered pipe framed polyhouse, the day temperature is higher and night temperature is lower than the outside. The solar radiation entering the polyhouse is 30-40% lower than that reaching the soil surface outside.

Medium-cost greenhouse/polyhouse

With a slightly higher cost, a Quonset-shaped polyhouse (greenhouse) can be framed with GI pipe (class B) of 15 mm bore. This polyhouse will have a single layer covering of UV stabilized polythene of 800 gauge. The exhaust fans are used for ventilation. These are thermostatically controlled. Cooling pad is used for humidifying the air entering the polyhouse. The polyhouse frame and glazing material have a life span of about 20 years and 2 years, respectively.

High cost greenhouse/polyhouse

It is constructed on the structure (frame) made of iron/aluminum structure, designed domed shaped or cone shaped (as per choice). Temperature, humidity and the light are automatically controlled as per requirement of the users. Floor and a part of walls are made of concrete. It is highly durable, about 5-6 times costlier, required qualified operator, proper maintenance, care and precautions while operating. The low and medium-cost greenhouses have wide scope in production of domestic as well as export-oriented vegetables. NEH region recorded highest rainfall in the world. The duration of rainy season is also wide (April-October). During this period, growing of vegetables such as cabbage, cauliflower, broccoli, tomato, brinjal and French bean in open conditions is very difficult. Severe attacks of pest and diseases occur due to heavy rains. So growing of vegetable crops in low cost polyhouse during this period is very profitable. Control of disease and pest in polyhouse is also easy.

Other plant protection structures

Plastic low tunnels

Plastic low tunnels are miniature form of greenhouses to protect the plants from rains, winds, low temperature, frost and other vagaries of weather. The low tunnels are very simple structures requiring very limited skills to maintain are easy to constructs and offer multiple advantages. For construction of low tunnels, film of 100 micron would be sufficient. The cost of a 100 micron thick film would be about Rs.10/m2.

Net houses

Net houses are used for raising vegetable crops in high rainfall regions. Roof of the structure is covered with suitable cladding material. Sides are made of wire mesh of different gauges. Such structures are useful for NEH region.

Constraints in protected vegetable production

In Kashmir region poly house culture is in infant stage and has not become popular as yet. High cost and non-availability of various components are the two major limiting factors in the adoption of polyhouse technology for commercial cultivation.

Many of the polyhouse components like fiber glass, cooling pads, fans, etc have to be imported at high costs including freight and custom duty. Greenhouse and other structures design for different agro-climatic of the region is not standardized. Lack of awareness among farmers pertaining to potentials of protected vegetable production and lack of major research programme on protected vegetable farming are other limiting factors.

Prospects of Protected Cultivation of Vegetables in India

There are a number of opportunities in various agro-climatic zones in India for protected vegetable production. In temperate areas vegetable growers can use low cost protected structures for raising early crops to increase their income. Raising of vegetable nursery in protected structures has several benefits such as ease in management, off seasonality, and protection from biotic and abiotic stresses. Plastic low tunnel technology for off-season cultivation of cucurbits in northern plains of the country has great potential for the future. Walk-in tunnel can be used on a large scale for growing off-season nursery and vegetables in northern plains or hilly areas during winter months when the temperature is very low. For virus and pesticide free tomato, chilli, sweet pepper and okra cultivation during rainy season or late rainy season, insect proof net houses can be used on a large scale. Low cost greenhouses can be used for protected vegetable cultivation in peri-urban areas of the country as consumer awareness for good nutrition and quality vegetables free from pesticides is increasing day by day. Protected vegetable cultivation is a boon to cold dessert of the country where this technology is suitable for commercial cultivation for several vegetables and production during frozen winters when nothing can be produced outdoor.

The potential of protected vegetable cultivation to meet the demand should not be over looked. Protected cultivation provides many fold advantages over open field vegetable

cultivation. This technology is highly productive, amenable to automation, conserves water, fertilizer and land. It is also eco-friendly and does not require much sophistication. In this century, protected vegetable cultivation is likely to be a common commercial practice, not because of its potential but out of its sheer necessity.

Conclusion

Though India is the largest producer of vegetables in world next to only China, its requirements of vegetables are rapidly increasing because of its continuous increasing population. Adverse climatic conditions, horticultural crop potentials, agro-inputs availability, small land holdings and increasing demand of high quality vegetables necessitate adoption of the protected cultivation of vegetable crops. Low cost protected structures, viz., plastic low tunnels, walk-in tunnels, low cost greenhouses are suitable for off-season vegetable cultivation and nursery raising in major vegetable growing areas and peri-urban areas of the country. Insect proof net houses are also highly suitable for raising virus free healthy seedlings and growing pesticide free vegetables during rainy and post rainy season. Poly trenches are best suited to vegetable cultivation in the cold desert of the country. Increased productivity and off-season ability under protected conditions favour its early adoption in peri-urban areas of northern plains and hilly areas of India.

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