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Latest Trends in Protected Cultivation of Winter Vegetables

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SUMMARY

Vegetable crops are the backbone of horticulture, providing substantially higher income to smallholder farmers while also being the best resource for overcoming nutritional shortages. Despite the fact that India has a varied range of environmental circumstances, vegetable farming tactics have traditionally been limited to seasonal and regional needs. Protected cultivation has rapidly expanded in various regions of all over the world, mainly in those with mild winter climatic conditions. In this context, the greenhouse business is always inventing new technologies and tactics to address specific cultivation limits while minimizing any associated environmental impact. It is for this object that it is necessary to update the scientific knowledge of this industry. Crops, climate control, growing procedures, fertilizer and water management are some of the characteristics of greenhouse farming related to new innovations in structure.

INTRODUCTION

The practice of cultivating crops in a controlled environment is referred to as protected farming. In moderate winter regions, greenhouse production is typically based on low-technology cold greenhouses, a low level of mechanization and automation, and a lack of systems for controlling environmental conditions. As a result, the microclimate in these greenhouses is dependent on the external climatic conditions. On the other hand, the greenhouse industry and growers are constantly developing new technologies and strategies to solve specific problems related to improving solar radiation capture, particularly during the winter season, reducing excessive temperatures, and increasing winter night-time temperatures in the most cost-effective manner. New technology, however, must be both environmentally friendly and commercially feasible. The protected cultivation industry is mostly concerned in vegetable growing, most notably Solanaceae (tomato, capsicum, and brinjal) and Cucurbitaceae (cucumber, muskmelon, watermelon and summer squash). In recent years, there have been some developments in cultivation techniques targeted at increasing yield and improving economic returns. This study discusses the most recent improvements in greenhouse structure and climatic control, cropping and growing techniques (grafting and fruit-setting), environmental issues, and water and fertilizer management.

High-technological trends in greenhouse structures and climate control

Recent greenhouse structures

The aim for temperate region greenhouses is to use available natural resources, such as solar radiation and temperature, wisely, while not depend on on external energy sources. Traditional greenhouses do not achieve such objective and so, research efforts have been focused on developing advances in three main aspects:

- Improving solar radiation transmission in the winter.
- Decreasing extreme day-time temperature.
- Raising the temperature at night in winter.

Productivity is directly related to solar radiation. Newly designed greenhouses have better light transmission than traditional greenhouses, which have about 55% transmissivity.

Several studies have been carried out to increase greenhouse transmissivity. Assumptions show that, in terms of roof shape, a symmetrical flat roof with a 30° slope is a good for construction costs and transmissivity, there being little benefit in increasing the roof slope. In terms of orientation, an east-west orientation is ideal to north-south as it is more transmissive, although light transmission is better in N-S oriented greenhouses.

Natural ventilation and cooling methods

Natural ventilation is the most important tool that growers can use to maintain the greenhouse microclimatic condition (humidity, temperature and CO_2). The greenhouse is basically a solar collector and only a minute fraction of the solar energy entering the greenhouse is converted into dry matter by photosynthesis. Most of the energy becomes sensible heat by means of plant transpiration. The greenhouse temperature increases and must be decreased by ventilating. When relative humidity increases, ventilation can decreases humidity as external air is usually drier. Finally, natural ventilation can escape CO_2 depletion if the greenhouse CO_2 concentration is lower than that of external air.

In greenhouses, the most common cooling method is shading (e.g., whitewash). The shading challenge is to create more efficient selective shading (i.e., NIR reflecting) and/or dual purpose screens (shading and energy saving). Evaporative cooling systems (pad and fan, fogging, etc.) can use a lot of excellent water. Active cooling with cold water is simply prohibitively expensive.

Greenhouse cladding materials

Plastic film covers are used by the vast majority of greenhouses because they are less expensive than rigid materials and are adaptable to all types of constructions. Polyethylene is the most commonly used material. The optical qualities of the film are the most important to growers. Durability of plastic is a big issue for growers because the cost of replacing plastic is quite high. At the moment, most commercial greenhouses employ plastic film with additives that stabilize it against UV and chemicals like chloride and sulphur, allowing it to be used for longer growth seasons.

Energy storage in passive greenhouses

Due to the low night temperatures, the winter greenhouse environment is often unfavourable. Furthermore, active heating is frequently uneconomical. To boost night-time temperature passively, three ways can be taken: employing (external or internal) screens, sealing greenhouse openings as much as feasible, and improving greenhouse thermal inertia. Screens serve as a barrier to the exchange of far-infrared radiation (FIR). Such far-infrared radiation exchange regulates the greenhouse's energy losses at night. Semi-closed greenhouses strive for little winter ventilation in order to raise the greenhouse's mean day temperature. This involves the possibility of CO2 depletion and the production of excessive humidity. Condensation is collected in some sophisticated plastic-covered greenhouses.

Crops and cultivation techniques

Vegetables crops

Because they are frequently consumed and reasonably well adapted to the variable climatic circumstances, Solanaceae and Cucurbitaceae are the main species in cold greenhouses. This condition usually leads to monoculture, which necessitates crop diversity. The tomato is the most prominent example of intraspecific genetic variation in action. This variety is likely to be found in many other developed greenhouse-grown crops. Growers produce a wide range of sweet pepper varieties, brinjal in a variety of shapes, sizes, and colours, various types of summer squash, melon in a variety of colours and shapes, short, medium, and long cucumber types, seedless and small sized watermelon, lettuces in a variety of colours, textures, and shapes, and yellow and variegated green bean cultivars. Miniaturisation, for example, little veggies, should be mentioned in an unusual way. Organic vegetable growing is another approach to diversify crop production.

Vegetable Grafting

Vegetable grafting is mostly utilized in Solanaceae and Cucurbitaceae species, and it is quickly growing and expanding around the world. This approach generates more strong plants, with the initial goal of protecting against soil-borne illnesses. Grafting's aim has also been greatly broadened to incorporate many sorts of increasing productivity, stress tolerance, and crop quality and length. Nowadays, rootstock breeding for vegetable crops includes other desirable qualities such as better productivity and quality, compatibility with the scion in adverse settings, and greater use of soil, water, and fertilizer resources. As a result, in horticultural crops, grafting is often employed as an alternative to breeding since adequate and compatible rootstocks can increase plant performance by enhancing utilization efficiency and nutrient uptake.

Flower and fruit set

The success of fruit set, which is linked to pollination, determines the majority of vegetable yield, particularly in a greenhouse. Certain insects, such as honey bees, were used to increase fruit setting, decreasing the need for chemical sprays. The air movement in the greenhouse, as well as the crucial temperature and humidity conditions for pollen generation and viability, favour the use of insect pollinators for pollination. Indeed, because of the lower cost of insect pollinators compared to other strategies to increase fructification, this is already a widely utilized strategy in tomato, melon, watermelon, and summer squash. However, there is a continuing need to induce parthenocarpy in vegetable crop plants, as this is a very desirable characteristic. Parthenocarpic cucumber cultivars account for the vast majority of commercial cucumber cultivars grown today. Other vegetable species with parthenocarpic cultivars include tomato, sweet pepper, brinjal, and summer squash. Furthermore, triploid watermelon cultivars are frequently used to produce seedless fruit.

Water and nutrient management

Water and management water quality are crucial to good greenhouse horticulture output. Water quality information allows water treatments to be planned, avoiding production restrictions caused by poor plant development, clogged watering pipes, discoloration, and other unpleasant impacts. Irrigation water originates from a variety of sources in commercial settings, hence the key quality varies. While it is not possible to provide a standard analysis type for every scenario, analytical testing should be undertaken on a regular basis to avoid losses caused by variations in water composition that can occur. It is also recommended to check the pH and EC of the water circulating in the greenhouse on a daily basis in order to intervene quickly in the event of unexpected changes in the contents of salts dissolved in the irrigation water. Once the quality criteria for allowing plant cultivation have been established in order to reduce expenses and increase production, sustainable irrigation management methods must be addressed in order to conserve water supplies. It is possible to achieve high water use efficiency in greenhouse production by controlling both environmental conditions and cropping strategies optimally. The majority of irrigation systems have the highest efficiency associated with micro-irrigation, for example, by performing a regular and slow flow of water at low pressures (< 2 bars) straight to the root zone.

Plant nutrition and Soil fertility

It is difficult to provide universal fertilizer recommendations because plant needs are modified by environmental variables and cropping systems. Nitrogen application necessitates specific consideration in order to minimize losses and optimize output in relation to the environment. Optimal fertilizer management promotes unrestrained growth and yield close to maximal potential, while reducing environmental losses. Furthermore, vegetable quality is optimal when fertilizer availability matches crop needs throughout the growing season. Estimating fertilizer requirements for crops is critical for both environmental and economic reasons. Nutritional imbalances can be avoided by closely monitoring crop mineral status. Traditionally, this is done by soil studies or visually in the field.

Soilless culture

Soilless culture is the production of crops in soilless systems in which plant roots grow directly in "substrate culture," also known as "hydroponics" or "water culture," which includes deepflow and deepwater culture, nutrient film technique (NFT), floating systems, and aeroponics.

The main benefits of soilless cultivation include the absence of soil-borne pathogens, the conservation of water and nutrient supplies, a safe and environmentally friendly alternative to soil disinfection, higher yields and quality, earlier harvests, and the avoidance of soil tillage and preparation. Cocopeat, rockwool, and perlite cultivation in bags, containers, or slabs is an emerging trend in vegetable production. Water culture has not been widely used, but recently, the production of new crops such as leafy vegetables (spinach, lettuce, watercress, lamb's lettuce, etc.) and herbs (basil, parsley, oregano, thyme, dill, etc.) in aeroponics, NFT, and floating has begun to increase, allowing cleaner crops and more plants per unit area. In addition, "vertical farming systems" in tower shapes using aeroponic processes have recently begun to be used. This technique produces ten times more plants per unit area, reduces harvest time by half, saves fertilizer and water, produces cleanly, and produces all year. Growing green vegetables using substrate culture, particularly in "multy-storey" or "A-shape" systems, has also gained popularity in recent years.

CONCLUSIONS

The current improvements in greenhouse production in winter climates highlighted in this study demonstrate the high level of innovation and research carried out in recent years within research Centre’s and industry with the goal of obtaining more competitive and sustainable production. Climate change will undoubtedly bring more challenges that must be addressed in the near future, as well as modifications in most current industrial tactics, particularly those related to water scarcity and rising temperatures. As a result, new effective strategies for dealing with this new circumstance will be required, without jeopardizing the competitiveness of the vegetable crops value chain.

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