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Protected Cultivation of Tomato Under Polyhouse

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Introduction:

Tomato is botanically known as solanum lycopersicum L., the identical genome formula 2n=2x=24. Tomato comes under Solanaceae family this family also called night shade family. Originally, tomato was classified under the botanical name Solanum lycopersicon. In the year 1978, Miller renamed the cultivated tomato as Lycopersicon esculentum and the wild from as L. pimpinellifolium. Lycopersicon. It's most popular vegetable crop grown throught the year as well as all over the world. Tomato was first cultivated and domesticated in the Andean region of South America and in Mexico from the wild ancestor known as Lycopersicon sub. Cerasiforme (cherry tomato), (Bai and Lindhout, 2017). Various research has shown that tomato contain an antioxidant called lycopene, which has been linked to a significant reduction in the risk of cardiovascular diseases and developing prostate cancer (Kucuk 2001). Tomato called as a protective fruit because it is a good source of various amount of minerals, vitamins, organic acids, phenol, lycopene (responsible for red colour) Beta- carotene (responsible for yellow colour) and flavonoids. Tomato fruits contain appro.3-4% sugar, total solids 4-7%, Vit -C 15-30mg)/ 100g , lycopene content 6-8mg/100g, and beta- carotene content around 0.5-2.5mg/100g.

There are 700 different types of tomatoes grown worldwide. Tomatoes are a significant crop for both farmers and consumer due to their short growing time, easily cultivated, good performance all the growing season and high yield. They are economically important, leading to an increase in the cultivation area over time.

Couses for preferring Protected Cultivation of Tomato: -

Now a day Protected cultivation I a very usefull for high- value vegetable and flowers (Maitra *et al*.2020).

Here are some reasons why farmers are commercially following protected cultivation –

- We can produce better quality produce.

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- Off season cultivation.
- Water and resource efficiency
- Higher yields and quality
- Protection for pest and disease
- Required controlled environment condition.
- Nursery raising and hardening of plat under polyhouse
- Efficient use of resources (i.e water, fertilizer etc)
- We can achive good research opportunities.

There are some overall reason offers by protected cultivation, benefits for farmers looking to maximize their yields, quality and sustainability in growing high – value crops like vegetable some flowers.

Importance of tomato under polyhouse condition: -

Tomato is one of the most popular, commercially and widely consumed vegetables of worldwide production crop. The greenhouse production of tomatoes offers several benefits that contribute to their importance.

- Greenhouse tomato production allows for the cultivation of tomatoes during times when supply is a low in the market, extending the availability of tomatoes.
- Greenhouse tomatoes are typically sold at a higher price than field grown tomatoes.
- This system provides profitable opportunities in the spring before field tomatoes are harvested and, in the fall, when field tomato supplies are depleted.
- Greenhouse grown tomato plants produce more fruit/ plant, & the heating cost are lower compared to field production.
- In green house when outside temperature increases light intensity and duration also increase, reducing the cost of heating and providing ventilation and control humidity, these all the factors contribute to increase the yields, making spring production more profitable than fall production.
- Cultivation practices in Green House

Soil

Tomatoes can be successfully grown in a variety of soil types, ranging from sandy to heavy clay. However, the most ideal soil for growing tomatoes is a well-drained, fertile loam with good moisture retention capacity. The texture of the soil is crucial for optimal tomato

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growth. Even lower quality soils can yield a good early crop if properly managed. Tomatoes thrive in soil with a pH level between 6.0 and 7.0. Liming acidic soils can be beneficial for tomato cultivation.

Climate:

Tomatoes are plants that thrive in warm weather. They can survive even in very cold conditions in a short period of time and is not tolerant to frost, nor to waterlogged condition in the fields. The seeds need a minimum temperature of 8-100c to start sprouting. the night temperature is crucial for the tomatoes to produce fruit, with the optimum range of temperature is 20-24, means temperature below to 16 and 27 above are not desirable for tomato cultivation. If the temperature goes below 12 , the fruits will not develop properly. During day time when the temperature goes above 32 and night temperature goes above 22, the tomato plants struggle to set fruits. The red colour in tomato responsible by lycopene pigment, 21-24 is the best temperature for development of lycopene.

In controlled environments like greenhouse, poly house, tomatoes can be grown round the year by adjusting temperatures. During warm weather (April – July) condition cooling system are used to poly house to cool the atmosphere under poly house, and heating system in the winter months (Dec.-Jan.) in the northern region to extend the growing season to 10-12 month. Under high-cost polyhouses use fan pad system to cooling and heating the atmosphere of polyhouse (Harel et al.2014) Suitable varieties: - In tomato under polyhouse condition use indeterminate type varieties. Tomato crops are grown vertically in a polyhouse, vertical crop production gives the grower the freedom to utilized the space within a polyhouse efficiently, which helps in increasing the crop yield too almost 3-4 times.

Selection of Varieties-

- Avtar
- Arka Meghali
- Arka Surabhi
- Pusa Tomato
- Pant Cherry tomato 1
- All Rounder
- NS Cheery-1,
- NS Cheery-2

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- Astona
- Delphi

Selection criteria of cultivated varieties: -

1. Successful tomato cultivation in a greenhouse requires choosing the right tomato variety.
2. Hybrids that grown tall, reaching 15 feet or more, and utilize vertical space efficiently in the greenhouse while yielding 170 t/ha or more within a 6 months crop duration are ideal for greenhouse cultivation for an extended period of 8-9 months.
3. The chosen cultivar should have traits such as high yield, resistance to diseases and cracking, high fruit production, resistance to green shoulder, long self-life , a high sugar, and dry matter contents.
4. Indeterminate hybrids, which continue to grow and produce fruit throughout the season under greenhouse.

Sowing time:- Tomato grown under polyhouse all-round the year.

Seasons:

- **Spring**- Nursery are prepared during dec- jan , and after 25-30 days seeding are ready for transplanting in the month of last feb – 1at week of march.
- **Autumm**- Seed are sowing in nursery in the month of Aug- Sep. and transplanting oct-nov.

Seed rate- Under polyhouse generally required 125 g/ ha, 10-12g seed is sufficient for growing a commercially crop in 1000m area.

Raise the tomato seedlings in a nursery[1] follow these steps:

1. Use 98-cell pro trays with drainage holes at the bottom.

2. Prepare a growing media mixture of vermicompost, sand, and sterilized cocopeat in a 1:1:1 ratio.

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3. Create shallow depressions in each cell and sow one seed treated with Captan (@ 0.2g/100 seeds).
4. Drench the emerging seedlings with a Copper-oxychloride solution (@ 3g/liter) and cover with a plastic sheet after germination.
5. Provide nutrition by drenching with a 0.2% solution of 19:19:19 (N:P:K) fertilizer plus trace elements at 15 days after germination.
6. Prevent thrips infestation by spraying with Acephate (0.75g/liter).
7. Harden the seedlings by gradually reducing irrigation frequency and exposing them to sunlight.
8. Spray the seedlings with Imidacloprid (0.03 ml/liter) solution one day before transplanting.
9. Drench with Carbendazim (0.1%) solution on the day of planting to prevent damping off.
10. The seedlings are ready for planting within 21 days of sowing when they reach a height of 25 cm.
11. For planting in a 1000 m2 greenhouse area, 20g of seed is required.

Land preparation

Land preparation for planting tomatoes involves ploughing or digging the land to improve its structure and water holding capacity. Ploughing also helps with water conservation in areas where water is scarce. Fallow ploughing after harvesting the previous crop can improve soil structure, water holding capacity, and reduce soil-borne pests and diseases by exposing the soil to sunlight. Deep ploughing is necessary to break hard subsoil layers, remove weeds, and create a fine tilth for planting. This process also encourages root growth. Harrowing the land multiple times helps break up clods and remove crop residues to level the land.

When cultivating tomatoes, planting them on raised beds, ridges, or furrows can improve drainage and irrigation. However, despite these benefits, more than 60% of tomato crops are still cultivated using flood irrigation methods.

Spacing: -

Short production cycles, tomato plants should be grown with a single stem and topped above the 5^{th} truss, with a spacing of 115 x 25 cm (Ihsah et al. 1988). Alternatively, for short cycles, they recommended growing plants with two stems at a spacing of 115 x 40 cm. For longer cycles, topping the plants above the 8^{th} or 10^{th} truss with single stems at 115 x 25 cm

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was advised. Tha closer plant spacings reduced leaf area, thereby decreasing the net photosynthetic area. (Papadopoulos and Ormrod 1988). However, they noted that upper leaves were not affected by the closer spacing. They also observed that in spring, when carbohydrate supply is lower than in autumn, there is more intense competition for light among plants.When spacing tomato plants, it is important to consider the variety of tomatoes you are planting and the growing conditions. Here are some general guidelines for spacing tomato plants:

- **Determinate Tomatoes:** These are compact, bushy plants that typically do not require staking. For determinate tomatoes, you can space the plants about 12-18 inches apart in rows that are 24-36 inches apart.
- **Indeterminate Tomatoes:** These are vining tomatoes that require staking or trellising for support. Indeterminate tomatoes should be spaced about 18-24 inches apart in rows that are 36-48 inches apart to allow for air circulation and easy access for pruning and harvesting.
- **Container Tomatoes:** If you are growing tomatoes in containers, make sure to choose a container that is at least 5 gallons in size for each plant. Space container tomatoes about 12-18 inches apart to allow for proper root development and growth.
- **Vertical Growing Systems:** In polyhouses, vertical growing systems like trellising or string systems are often used to support tomato plants and maximize space utilization. These systems can help maintain plant health, improve fruit quality, and make harvesting easier Overall, proper spacing of tomato plants is crucial for optimal growth, air circulation, and disease prevention. Adjust the spacing based on the specific requirements of the tomato variety you are planting and your gardening setup. Transplanting tomatoes under a polyhouse involves several steps to ensure the successful establishment and growth of the plants. Here is a detailed guide on how to transplant tomatoes.

Seedling section:

Selecting healthy tomato seedlings that are around 6-8 weeks old and have 4-6 true leaves, short day condition the seeding is ready for transplanting under 6-8 week, but long day condition 3-4 week old seeding are transplanted. Transplanting should be

Mulching

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In horticultural practice, a 100-micron thick polyethylene mulch film with a gauge thickness of 400 is employed to envelop the planting bed. The film, measuring 1.2 meters in width, is punctured with holes of 5 centimeters in diameter according to the suggested spacing of 60 centimeters by 45 centimeters. The mulch film is then applied to the planting beds by ensuring the edges are secure and filling the interior with soil. Done either morning or evening. In the evening, plants close their stomata, tiny openings on the leaves, to reduce water loss. This helps prevent excessive water loss and wilting in newly transplanted seedlings, especially when their roots may be stressed from the transplanting process. After transplanting irrigation should be done.

Plastic mulch **Organic mulch**

Transplanting

Choose a cool, overcast day for transplanting to reduce stress on the seedlings. Dig planting holes in the polyhouse beds at a distance of about 18-24 inches apart, depending on the variety. Carefully remove the tomato seedlings from their containers, handling them by the leaves to avoid damaging the delicate stem. Place each seedling in a planting hole and gently firm the soil around the roots to secure them in place. Water the transplanted seedlings thoroughly to help settle the soil and reduce transplant shock.

Irrigation-

Irrigation is most important practices in nursery stage, Drip irrigation 10-12 days after transplanting, to supply the water of 2-3 / sq. m/ day depending on the weather.

Pollination

Pollination of the pistil is a prerequisite for successful fruit development. Insufficient pollination can lead to reduced fruit set per plant. Poor pollination may result in irregularly shaped, smaller, or rough-textured fruits, caused by uneven seed distribution within the fruit.

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Various stress factors, including extreme temperatures, drought, high humidity, nutrient imbalances, and inadequate pollen transfer, can impede the pollination process. To facilitate effective pollination, the pollinator wand should be gently applied to the upper side of each flower stem without direct contact with individual flowers. Additionally, securing string to plant support wire using a simple slipknot can aid in supporting the plant during the pollination process.

Assisted pollination It is essential due to restricted air circulation and high humidity levels. Bumblebees are regarded as ideal pollinators, even in challenging environmental conditions.

Electric or battery-operated vibrators They are utilized to stimulate flower clusters, causing the release of adequate pollen required for pollination. This procedure is conducted twice daily, from 10 am to 11 am and 2 pm to 3 pm, with flowers being regularly shaken on a daily basis. Additionally, the mist flower's air has been found to be effective in aiding pollination.

Utilization of neem cake with Trichoderma application:

Neem cake is ground into a powder, lightly moistened, and left for two days before being combined with Trichoderma formulation at a rate of 1kg per 100 kg of neem cake. The mixture is sealed with a plastic sheet and turned once every two days. It is applied to beds after 15 days once formaldehyde fumes have dissipated completely, at a rate of 200g per square meter.

Fertilizer application:

The commercial fertilizers containing 50:50:50 NPK kg/ha are applied to growing beds before fumigation.

Training

Training tomato plants in a glasshouse is crucial for their cultivation. Tomatoes naturally grow as vines(indeterminate type varieties) and need support to prevent them from

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sprawling on the ground. One most common method is to use strings that are wrapped around the stem and hung from supports above. Use 9-Gauge or 3/32-inch galvanized wire or stronger, Under playhouse conditions mostly gowns indeterminate type tomato varieties for supporting the vine use gauge wire. Gauge wire is also most suitable to support / staking of the tomato plants as they grow. Install stakes or trellises at planting time to provide support for the plants and prevent them from bending or breaking and logging under the weight of the fruit. As the plants grow, gently tie the main stem to the stake or trellis using soft plant ties or twine. Another popular technique is the arch method, where multiple wires are placed over rows of plants, approximately 180 cm above the Pruning.


Prunning

Tomato plants grow side shoots quickly, so it is recommended to carefully remove these shoots. When the plants reach a height of 120 cm, their leaf area is at its maximum potential for transpiration. It is advised to gradually remove leaves to improve air circulation around the entire plant. Pinching off the growing tips above the 1st and 2nd sets of flowers, along with planting the tomatoes closely together, can help in earlier fruiting and shorten the harvesting period.Pruning means removal of off type plant plants that are disease or damages. Under the playhouse to increase the tomato plant yield, prune them to a single stem by removing lateral shoots known as ‘suckers’. Suckers emerge from the junction where each leaf connects to the main stem, right above the leaf stem. After 30-45 days of transplanting remove the sukers.If we are allowing all suckers to grow and bear fruit it may be more, total number of fruit they are likely to be small and of lower quality. A single main stem that bears fruit will result in larger, more uniform, and higher quality fruit.Becsuse all the food material (carbohydrates, mineral, essential nutrients) of plant are sarculate the reproductive organs like- flowers and fruits.

Regularly removing suckers, approximately once a week, will help manage their growth. It’s recommended to leave one or two of the smallest suckers at the top of the plant. In case the

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plant gets damaged and the main stem breaks off, one of these suckers can be allowed to grow and take over as the new main stem. Typically, any sucker longer than one inch should be removed. Removal of suckers is an important operation in intermediate varieties, but open field conditions in summer months do not follow this practice because determinate varieties are affected by sunburn.

Research by found The using plastic mulch and removing the plant apex led to increased tomato yields in greenhouses (Wien and Minotti , 1988). the highest total yield was achieved in plants pruned from the 5th truss and mulched with wheat straw. For early yields, pruning from the 4th tr^{us}s and using various mulches like transparent polythene, black polythene, and wheat straw under low tunnels proved to be effective (Ankara and Arin, 1998).

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