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Low tunnel technology: A review

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Abstract

Low tunnels are modified miniature structures working on the greenhouse concept. These are the structures built on a steel frame and covered with polythene roofs (Lodhi *et al.* 2015). Although technology can make available better quality vegetable produce around the year but, at the same time it should be economically feasible for the farmers. Low tunnels also known as plastic tunnels are miniature structures producing greenhouse like effect. The total productivity per unit area increased using protected cultivation. The average increase rate for all studied traits was 1.9 times higher in protected cultivation compared to open cultivation. As a result, we recommend late cultivation of spinach and lettuce crops under low tunnels to shorten the cultivation period after the completion of long-season summer cultivation.

Keywords: Low tunnel, protected cultivation, microclimate, micro-environment

Introduction

Under such harsh climatic conditions, vegetable cultivation in open condition yield poor-quality produces and less returns. By creating a suitable micro-climate for plant growth through protected cultivation structures like low tunnel, the cultivation of vegetables can be done around the year even under adverse climatic conditions. Low tunnels are modified miniature structures working on the greenhouse concept. These are the structures built on a steel frame and covered with polythene roofs (Lodhi *et al.* 2015) [5]. Although technology can make available better quality vegetable produce around the year but, at the same time it should be economically feasible for the farmers. Low tunnels also known as plastic tunnels are miniature structures producing greenhouse like effect. Launched in 1999, as a pilot project by the Agricultural Technology Management Agency, the low tunnel technique is catching up among the farmers. They facilitate the entrapment of carbon dioxide which enhances the photosynthetic activities of the plant that helps to increase yield. Among the different types of covers available to use with LTs, spun bonded row covers of various thicknesses are most popular. They are semi-transparent porous fabrics that allows airflow and ventilation, hence helps to avoid condensation that may damage the foliage in contact with water (Rekha Rani1, SR Meena1, BR Choudhary, MK Jatav, PL Saroj, and Anita Meena, 2022) [8]. 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.

Effect of Low Tunnel Technology on Vegetable Crops

(Deepika Yadav, Yogesh Rajwade and Nilendra Verma, 2020) [3] 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 (Deepika Yadav, Yogesh Rajwade and Nilendra Verma, 2020) [3]. Higher number of fruits per plant, fruit yield per plant, fruit diameter under low poly tunnel led to higher yield compared to open field.

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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

(Pragti Negi, July 2024) ^[9]. It is done by modifying the microclimate inside low tunnels which helps the grower to raise healthy and early nursery. The plants grown inside low tunnels have stronger root development in comparison with the plants in open field. Therefore, it enhances the uptake of nutrients, Every crop requires certain temperature to grow like cool season crops require around 21 °C and warm season crops requires temperature as high as 32 °C. Low poly tunnels are capable of maintaining an optimum temperature for summer sowing crops if cultivate in winter season.

Ajmer Singh Dhatt, Naveen Garg*, Rajinder Singh and I. S. Aujla, 2017. A two-year study was conducted to compare the performance of brinjal hybrid BH-2 using paddy straw mulch @ 6 t ha⁻¹, clear plastic mulch (25 µm), black plastic mulch (25 µm), plastic low tunnel and control (bare soil) under net-house and open field. In open field conditions, use of PSM reduced the soil temperature over bare soil by 0.1-0.90C during morning and by 0.1-1.50C during afternoon hours. On the contrary, plastic mulches and low tunnel increased the soil temperature over bare soil during both morning and afternoon hours. The maximum increase was recorded in BPM closely followed by CPM. The BPM enhanced the soil temperature by 0.7-2.60C and 0.2- 3.30C whereas CPM increased it by 0.2-1.70C and 0.1-2.20C during morning and afternoon time.

Reduced incidence of fruit borer under net-house than in open has also been reported earlier in brinjal (Sidhu and Dhatt, 2007) ^[6], tomato (Cheema *et al*, 2004) ^[2] and bell pepper (Singh *et al*, 2004) ^[7]. This may be due to the reason that Treatment Days to first picking Early yield. PLT were better than PSM in improving growth attributes, early and total yield, however, BPM and CPM are recommended for commercial utilization due to incidence (5.3%) of Sclerotinia rot under PLT. In open field, PLT is recommended as it was better than other treatments in improving growth attributes, increasing early and total yield, protecting plants from frost injury, and decreasing the incidence of shoot and fruit borer (Ajmer Singh Dhatt, Naveen Garg, Rajinder Singh and I. S. Aujla, 2017).

The early maturation of heads under low tunnel provided sufficient time to gain size and firmness of super heads which resulted in 55.8 per cent increase in yield of super heads over open field grown cabbage. Under low tunnel the heads were ready for harvest in the first fortnight of June and reaped the early market high price (Rs. 10 to Rs.14/kg.) as at this point of time only distant produced vegetables are available in the market (Tahir Saleem, Mohd Mehdi, A.H. Hakeem^{1*}, M.S. Trumboo¹ and N.A. Ganai, 2014) ^[10].

Low tunnels allow growers to start planting earlier, so they can harvest earlier, and receive a higher price for their produce before vegetable prices begin to decline in mid-season. This study tested various plastic materials used as low tunnels (clear and white perforated plastic) as well as their combination with a spun-bond material (for heat trapping) for benefits including: frost protection, earliness in

planting and harvesting, and season extension. Our results showed by combining plastic mulch and our new low tunnel design (perforated plastic plus spun-bond plastic) air temperature during frost events was increased by 1-4°C inside the tunnels. The outcome will be greater awareness among growers of the potential to use low tunnel technologies to reduce frost risks, and enhance earliness and profitability (Faivor, Rebekah Marie Struck, 2014) ^[10].

Seed germination percentage ranged from 87-96% in low tunnel compared to 70-84% in open field condition. This technology reduced days taken to reach the 3-4 leaf stage, which is considered fit for transplanting, from 53 to 45.6 days. Good moisture supply and protection from fluctuating temperature under low tunnel may be the cause of increased germination percentage and rapid growth. Rapid germination also avoids the chance of attack by soil micro-organisms (Chatterjee, 1990) ^[1].

Improved microclimate resulted in early maturation coupled with increased proportion of head formed plant in low tunnels. The average head weight was more in open field because of the high light intensity, which increases the rate of photosynthesis (Jain, 2005) ^[4] but was not able to compensate the yield difference.

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The experiment results indicated that using protected cultivation methods led to significantly better outcomes in various aspects compared to open-field cultivation. For both spinach and lettuce crops, protected cultivation resulted in higher seed germination percentage (1.3 times), increased leaf area of seedlings (3.3 times), more marketable plants (1.8 times), greater number of leaves per plant (1.3 times), taller plant height (1.3 times), higher seedling weight (3 times), and greater plant weight at harvest (1.5 times). Overall, the total productivity per unit area increased using protected cultivation. The average increase rate for all studied traits was 1.9 times higher in protected cultivation compared to open cultivation. As a result, we recommend late cultivation of spinach and lettuce crops under low tunnels to shorten the cultivation period after the completion of long-season summer cultivation (Prof. Dr. Rida DRAIE 2022-23).

Low tunnel technology is a suitable technology for the region, which is low cost than other forcing structures, has potential to increase the per unit area returns and can play a positive role in nutrition by making vegetable available in the off-season. The technology needs testing with other crops as well.

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