



Role of Precision Farming Development Center (PFDC) Hyderabad in Plasticulture

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MUD and KC designed the study and monitored over all research trials carried out in PFDC Hyderabad. Authors IK wrote the protocol, and wrote the first draft of the manuscript. Author BS managed the analyses of the study. Author Deepika managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The use of plastics in horticulture has made considerable headway during the last decade. We are aware that plastics contribute from planting to post harvest handling and processing in many fruit crops. Plastic is used at each and every stage of horticultural life cycle right from seeds packaging, planting, propagation, mulching, irrigation, harvesting, fruit packing and preservation. The application of plastics in agriculture sector is popularly known as Plasticulture. India produces about 5 million tons of plastics annually and use about 0.35 million tons in agriculture. Plastics are used in greenhouses to promote growth and production, mulching to suppress weeds and maintain soil temperature and moisture as well as in containers for seedling and soil solarization to reduce pest and diseases. The efficient use of plastics in agricultural and horticultural operations are utilized by PFDC Hyderabad. The plasticulture operations were performed and demonstrated by research trials by selecting suitable crops under polyhouse and shade nets. Use of drip irrigations system and sprinkler irrigation system with suitable irrigation scheduling and fertigation, demonstrating performance of agricultural and horticultural crops under plastic mulch sheets. The present study aims to determine the role of precision farming development center (PFDC) Hyderabad in plasticulture.

Keywords: Precision farming development center; plasticulture; precision agriculture; precision farming.

1. INTRODUCTION

Plastic is very useful because it can be colored, melted, shaped, squashed, cheapness, light weight, impermeable to moisture and gases, rolled into sheets or made into fibers [1-5]. The unique advantages of plastic over conventional materials are higher strength/weight ratio, superior thermal insulation properties, excellent corrosion resistance, superior flexibility, resistance to most of the chemicals, excellent moisture barrier properties, favourable gas permeability, smooth surface resulting in reduction in friction losses, excellent light transmissibility, helps to enhance shelf-life of the produces, better visibility of the produce etc [6-10]. Precision Farming Development Centres (PFDCs) Hyderabad has been established in India to promote "Precision Farming & Plasticulture Applications for high-tech horticulture" and located in State Agricultural University (SAU), Water Technology Centre, PJTSAU, Rajendranagar, Hyderabad. The use of plastics in agriculture and horticulture were demonstrated by various technologies like polyhouse, shade nets, mulching, drip irrigation and sprinkler irrigation.

2. METHODOLOGY

2.1 Location

The research trials were carried out in horticulture garden, PJTSAU, Hyderabad under different climatic conditions viz; polyhouse, shade net and open field with and without mulch. The shade net trials and mulching demonstrations were carried out in college farm under different colored shadenets.

2.2 Plasticulture Applications under PFDC, Hyderabad

2.2.1 Protected Cultivation

Polyhouse is a framed structure covered with plastics film (transparent and translucent) in which plants are grown under the partially or fully controlled environment. The polyhouse technology has been considerable importance in better space utilization, growing crops in extreme climatic conditions. The plastics film used in polyhouse act as selective radiation filters. The properties of cladding material are UV stabilized,

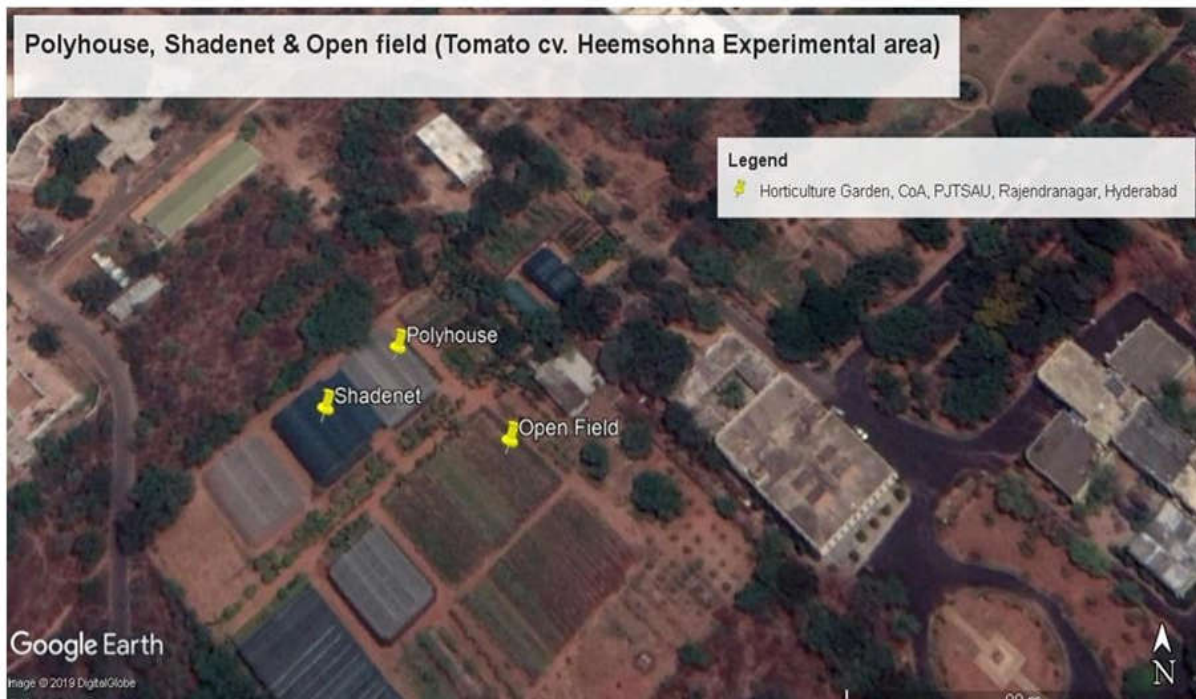


Fig. 1. Research trial under polyhouse, shade net and open field condition at horticulture garden, CoA, PJTSAU, Rajendranagar, Hyderabad

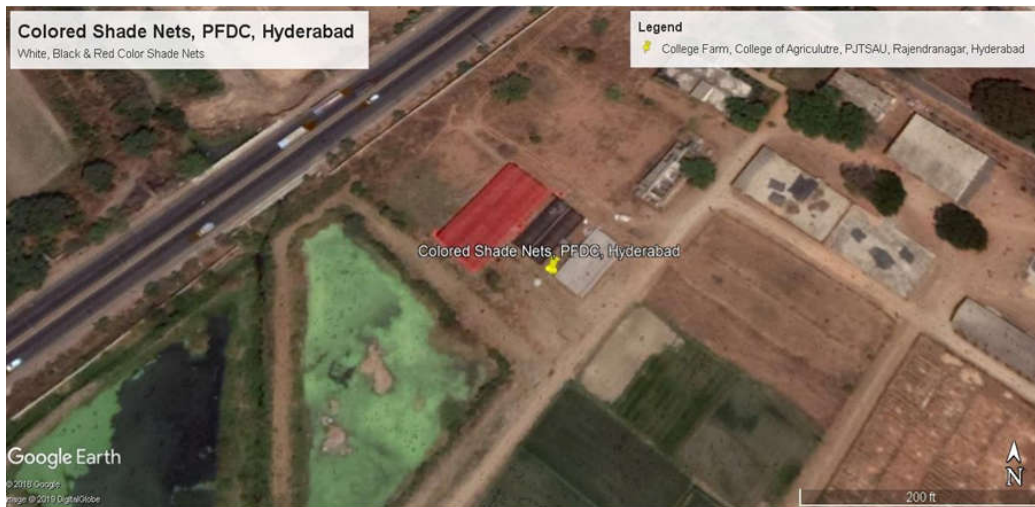


Fig. 2. Research trial under different colored shadenets at college farm, CoA, PJTSAU, Rajendranagar, Hyderabad

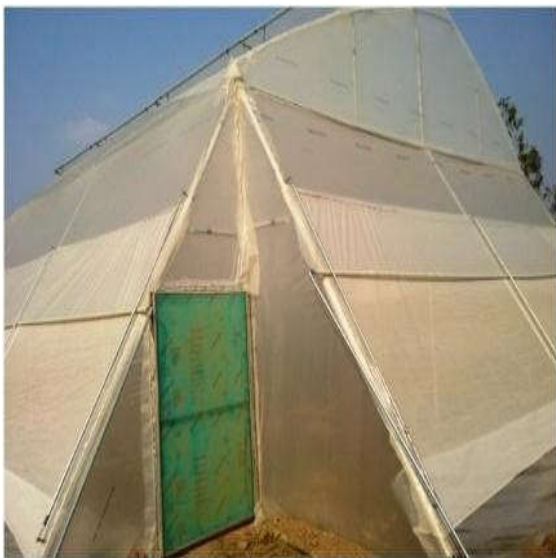


Fig. 3. Polyhouse cultivation, Horticulture Garden, PFDC, PJTSAU, Hyderabad



Fig. 4. Different colored shadenets, college farm, PFDC, PJTSAU, Hyderabad

transparent to light, anti-fogging and anti- algae. Polyhouse cultivation is very important because it can moderates temperature and humidity, increases yield, quality and reduces crop duration, conserve moisture thus needs less irrigation, cultivation of off-season crops possible, helps to grow crops in different climatic conditions as it provide favourable condition to plant and to grow high value crops for export market. Moreover, it helps in raising early nurseries for different crops and also helps in hardening of tissue cultured plants and grafts. Shed net are used in rising of nursery structure which is made up of polythene threads. To reduce light intensity different shed net are

available such as 15 %, 35 %, 40 %, 50 % and 90 %. It is also available in different colours like green, white, black, blue or red and different colour combinations like green × black, black × black, green × green or white × green. It helps to control pests and diseases, manipulation of microclimate and insect proof feature and creates self-employment opportunities for educated youth.

2.2.2 Micro irrigation

Precise and regulated application of irrigation water and plant nutrients at low pressure and frequent intervals through drippers/emitters

directly into the root zone of plant with the help of close network of pipes is known as drip irrigation system. The advantages of drip irrigation are to improve quality, ensure early maturity of the crops, water saving up to 40% - 70%, controls weed growth, saving of fertilizer (30%) and labour cost (10%), fertigation /chemigation can be made efficiently, control diseases, use of saline water is possible, soil erosion is eliminated suitable for uneven/undulating land, high water use efficiency and increase in production and productivity of fruit crops. The most important feature of plastics in drip irrigation system is the unit made by plastics is rust proof. The other quality like resistant to UV radiation, wide pressure compensation range, easy fitting of accessories, crack resistant and easy to roll back. This system is mostly made up of HDPE plastics. The sub lines and lateral lines having wide range of wall thickness from 0.5 to 2 mm.

Sprinkler irrigation is a type of pressurized irrigation that consists of applying water to the soil surface using mechanical and hydraulic devices that simulate natural rainfall (see Fig. 1). These devices replenish the water consumed by crops or provide water required for softening the soil to make it workable for agricultural activities. The goal of irrigation is to supply each plant with just the right amount of water it needs. Sprinkler irrigation is a method by which water is distributed from overhead by high-pressure

sprinklers, sprays or guns mounted on risers or moving platforms. Today a variety of sprinkler systems ranging from simple hand-move to large self-propelled systems are used worldwide.

2.2.3 Mulching

A protective covering (as of plastic film, sawdust, compost, grass, hay, dry leaves, or stones) spread or left on the ground to reduce evaporation, maintain even soil temperature, prevent erosion, control weeds, enrich the soil, or keep fruit clean. These prevent the loss of moisture and acts as a barrier between the soil and atmosphere. It helps in moderating the soil temperature and micro-climate in the plant root zone, which helps to increase yield and early maturity of crops. In addition to this plastic mulch can maintain soil moisture and prevent weed growth around plant. Generally black plastic mulch film is used in fruit production but two sided coloured plastics mulch films such as yellow/black, white/black, red/black or silver/black also used in specific crops, which determine its energy radiating behavior and also influence the micro climate around the plant [11-13]. Plastic mulch film having different thickness and choose based on type and age of plant. It available from 7 to 100 micron thickness but for medium duration crop 25 to 50 micron and for long duration crop 50 to 100 micron thickness is suitable.



Fig. 5. Drip Irrigation system under shadenet



Fig. 6. Drip irrigation system in open field with mulch and without mulch

Table 1. Comparison of the effect of different colors of plastic on light and weed control

Plastic Color	Light Reflectivity	Light Absorptivity	Weed Suppression	Comments
Black	Low	High	Excellent	Most common. Does well in temperate climates
Clear	Low	Low	Poor	Best in cool regions and for fall crops
White/Silver	High	Low	Excellent	Reflection interferes with movement of aphids. Best for tropical climates

(Angima 2009, Penn State Extension 2015, and Sanders 2001.)



Fig. 7. Mulching (Silver & Black) demonstration in red gram, PFDC, Hyderabad



Fig. 8. Different colored mulch sheets

2.3 General Plasticulture Applications

2.3.1 Soil solarisation

Soil Solarisation is normally done during summer months when the air temperature more than 35°C. This is done by covering the moist soil with a transparent polyethylene film exposed to sunlight. Soil solarisation can prevent weeds growth, occurrence of bacteria, fungi, nematodes and other soil borne pathogens and pests, helps in reducing usage of weedicides/herbicides and pesticides. The effectiveness of soil solarization enhances plant growth by improving soil colour, structure, temperature, moisture etc. Soil moisture, day length, temperature and intensity of sunlight are the factors effecting soil solarisation. Suggested polyethylene film for soil solarisation is 25 micron transparent polyethylene film.

2.3.2 Low tunnels

Plastics tunnel popularly known as low tunnels are miniature structures producing greenhouse

like effect. These tunnels facilitate the entrapment of carbon dioxide, thereby enhancing the photosynthetic activities of the plant that help to increase yield. These structures also protect the plants from high wind, rain, frost and snow. Besides being inexpensive, these structures are easy to construct and dismantle.

Low tunnels have been used for producing healthy and high value nurseries. Use of low tunnels has been effective in crops such as Tomato, Cucumber, Radish, Beans, Asparagus, Strawberries, Melon and Tobacco etc.

2.3.3 Propagation and nursery

In the propagation plastics are generally used in layering and grafting. In grafting polythene strips are used to tie stock and scion. Different colours of poly-wrappers used in layering. Red, blue and black poly-wrappers having higher success in rooting and survival by increasing physiological activities (etiolating effect) which is essential for cell division and cell enlargement. In nursery plastics are used in form of nursery bag, plug

tray, crate and hanging basket. It is easy to handle, planting, transplant and transport. This plastic nursery bags can be used in different size and thickness depend on crop.

2.3.4 Plant protection nets

Nets are used for the protection of plants from excess sunlight, birds, insects, snow, hails wind, heavy rainfall etc. The selection of nets varies as per the application with different mesh sizes or

strength required to withstand weather conditions.

2.3.5 Packaging

Packaging is one of the most critical areas in the distribution and marketing of agricultural produce. More than 30% of agricultural produce is lost between the chain of farm and consumer. The packaging must stand up to long distance transportation, climate, storage condition, multiple handling during distribution



Fig. 9. Soil solarisation under polyhouse and open field



Fig. 10. Low tunnels



Fig. 11. Plug trays



Fig. 12. Air layering



Fig. 13. Plant protection nets



Fig. 14. Fruits and Vegetables packaging using plastic sheets



Fig. 15. Banana bunch covering with plastic

and marketing of agricultural produce. Traditional packaging techniques such as wooden crates and jute bags have many disadvantages like untreated wood can easily become contaminated

with fungi and bacteria, material may be too hard or rough for produce like soft fruits, need of disposal of the crates after use so not reusable and ultimately cost of such material is more.

Generally LDPE (Low Density Polyethylene), PVC (Polyvinyl Chloride), PP (Polypropylene), LLDPE (Linear low density polyethylene), HDPE (High Density Polyethylene) and PA (Polyamide) are used as plastic material in fruit packaging. Plastic packaging is very important because plastics are flexible, light weight, cost effective, hygienic, transparent so product visible from outside, easy printable, reusable, increases shelf-life of the produce [14-16]. It provides invaluable support during processing, used in making of different packaging materials like flexible plastic films, tray with over wrap, punnets, net bag, foam sleeve, crates and also used in storing, preserving and transporting of fresh as well as processed fruits.

2.3.6 Banana bunch covering with plastic

Each banana plant produces one bunch of bananas approximately every nine months. To protect the banana bunches from sunburn, wind damage and insects, they are covered in plastic bags until they're ready to be harvested. Blue PE bags used for banana cultivation to improve bananas' quality, appearance and protect from birds and pests. Available in tie or regular bags, bundle or loose bags. Also known as banana ripening bags, banana bunch covers, banana covers and crop covers for bananas. Allowing faster & more trustworthy harvest. Allowing adequate ripening of the banana. Improving the quality & appearance of the fruit. Protecting from external natural conditions (wind, rain, sun damage, etc.). Preventing mechanical injuries (marks & scratches). Preventing birds, insects & fruit flies from damaging the fruit & causing spots. Film thickness is 20 - 45 microns.

2.3.7 Lining of water bodies/farm ponds

The use of plastic films as a lining material has offered tremendous scope as lining material which provides an impervious lining thus prevent water losses due to seepage. The performance of these films as lining material has been found very satisfactory. These linings using Poly Vinyl Chloride (PVC) and Low Density DWM Bulletin 9 Polyethylene (LDPE) film have been tried experimentally. Out of all the types tested so far, LDPE film appears to be the best whereas, PVC lining has several limitations. It cannot be manufactured in wide width and, further, the stability of this film is hampered by the migration of plasticizers, which are essential for extruding flexible PVC film. In India, where plastic materials are always sold on weight basis, PVC film becomes too expensive compared to LDPE film.

Due to its higher specific gravity, PVC film gives 40% less film for a given weight compared to LDPE film. LDPE film lining which had been tried on an experimental basis for the past several years is now extensively used in states like West Bengal, Gujarat, Rajasthan, Madhya Pradesh, Punjab, Haryana and the irrigation departments of other states. The experience indicates that lining with plastic films is a convenient and economical proposition.

3. RESULTS AND DISCUSSION

3.1 Protected Cultivation

Under PFDC Hyderabad, the research trials were carried out under polyhouse and shadenet. During the year 2018-19 the trials were carried on "Optimization of N P K fertigation levels of tomato (Heem sohna) under different irrigation levels with and without mulch in poly house condition and shadenet condition. The results were compared under different climatic conditions such as under polyhouse and shadenet with and without mulch. The obtained results were compared with open field condition with and without mulch. The trial is conducted at horticulture garden, college of agriculture, PJTSAU, Hyderabad. The highest yields are recorded in polyhouse condition without mulch, followed by shadenet and open field condition. Similarly the research trial on green capsicum were carried out in different colored shadenets (White, Black & Red). The trial were conducted at college farm, college of agriculture, PJTSAU, Hyderabad. The highest yield recorded under red colored shadenet followed by black and white colored shadenet.

3.2 Micro Irrigation

The drip irrigation system is followed under polyhouse, shadenets and open field conditions. The drip system is set for different irrigation levels (0.6 & 0.8 Epan) with respect to daily evapotranspiration. Daily irrigation scheduling were calculated using suitable formula by taking daily evaporation readings, dripper discharge, dripper spacing, row to row spacing, plant to plant spacing etc. It was found to be the best in terms of saving of water (30-70%) and increase in yield (20-60%) over conventional method.

3.3 Mulching

Effect of mulching on Bhendi, water melon, cucumber, tomato, chilli, red gram, cotton,



Fig. 16. Lining of farm pond with plastic film

marigold and maize were demonstrated under open field condition. Effect of mulching on tomato & capsicum were demonstrated under polyhouse and shadenets during the year 2017-18. The growth and yield parameters were recorded and compared with no mulch crops under respective climatic condition. The results showed that crops under mulch were recorded highest yield (10-60%) compare to no mulch. Similarly results depicted that there is no effect of mulching technology under polyhouse and shad net on yield parameters.

4. CONCLUSION

For qualitative and quantitative horticultural production, plastics can be used for various purpose i.e. mulching, cladding materials for protective structures, nets, pressurized irrigation, soil solarization, plastic traps, propagation and packaging. By using plastics in horticulture not only increase production but also minimize the pest, diseases and weed population as well as saving fertilizers and water, minimize the use of herbicides and pesticides as compared to conventional methods. Hence PFDC Hyderabad provides technical awareness and support to the farming community of the state and also to the officers of State Department of Horticulture/Agriculture, Telangana State Micro Irrigation Project (TSMIP), District Agro Advisory and Transferred of Technology Centres (DAATTC), Krishivignan Kendras (KVKs) and Non-Government Organizations (NGO's) personnel by conducting training programmes, demonstrations and survey etc. for disseminating Plasticulture applications more viable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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