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Application of plasticulture in horticulture: A review

Sarthak Bhattacharya, Sugnik Das and Tanushree Saha

Abstract
Plastic has become a popular material in our daily life due to its structural integrity, chemical property and versatile nature. Plastic has many valuable applications in high-tech horticulture includes drip irrigation, plastic mulches, packaging and storage for superior quality of produce and in post-harvest management. Plasticulture means the use of plastics in agriculture, horticulture, water-management, food grain storage and in related areas. Use of plastic in horticulture crop production has increased dramatically in the last ten years even though the number of agricultural plastic manufactures has been reduced by 40% over the same period. The use of plasticulture in the production of horticultural crops (vegetables, small fruits, flowers, plantation crops, and ornamentals) helps to mitigate the sometime extreme fluctuations in weather, especially temperature, rainfall and wind, which occurs in many part of the country.

Keywords: Plastic, plasticulure, horticulture

1. Introduction
The word plastic is derived from the Greek words “PLASSIEN” and “PLASTIKOS” meaning to mould or shape a soft substance permanent or temporary. Plastic encompasses a wide variety of resins or polymers with varied characteristics. While there are natural polymers but only synthetic polymers are referred as plastics. Plastic has become a popular material in our daily life due to its structural integrity, chemical property and versatile nature. Plastic has many valuable applications in high-tech horticulture includes drip irrigation, plastic mulches, packaging and storage for superior quality of produce and in post-harvest management. The plastic films are easily available, easy to handle, transport and lay. This lead to the use of plastic films as mulches, which is today the most preferred material. Now a days LDPE (Low-density polyethylene) and LLDPE (Linear low-density polyethylene) plastic films are commonly used for mulching. LLDPE black colour mulch film is most popular, owing to the twin properties of down gauging and better puncture resistance. The idea of using polyethylene film as mulch in plant production saw its beginnings in the mid-1950s. Dr. Emery M. Emmert of the University of Kentucky was one of the first to recognize the benefits of using LDPE (Low-density polyethylene) and HDPE (High-density polyethylene) film as mulch in vegetable production. Emmert also wrote on other topics such as the use of plastic for greenhouses instead of glass and plastic in field high tunnels. Today, Dr. Emmert is considered the "father of plastic greenhouses". He was jokingly also called the "plastic surgeon" due to his use of plastic instead of glass for greenhouses and his use of clear and black plastic as mulch in vegetable production. Approximately 2,500 square miles (6,500 km^2) of agricultural land utilize polyethylene mulch and similar row covers for crop production in the world. Plasticulture is a system of growing crops in a way so that a significant benefit is derived from using plastic polymers. The discovery and development of polyethylene polymer in the late 1930s, and its subsequent introduction in the early 1950s in the form of plastic films, mulches, and drip-irrigation tubing and tape, revolutionized the commercial production of several horticultural crops and gave rise to plasticulture. Use of plastic in horticulture crop production has increased dramatically in the last ten years even though the number of agricultural plastic manufactures has been reduced by 40% over the same period. The later discovery of other polymers such as polyvinyl chloride, polyproplene, and polyesters, and their use in pipes, fertigation equipment, filters, fittings and connectors, and row covers further extended the use of plastic components in this production system The use of plasticulture in the production of horticultural crops (vegetables, small fruits, flowers, plantation crops, and ornamentals) helps to mitigate the sometime extreme fluctuations in weather, especially temperature, rainfall and wind, which occurs in many part of the country.

Plastic Mulches

The black plastic film does not allow sunlight to pass through onto the soil. Thus, photosynthesis does not take place in soil in absence of sunlight below the black film. Hence, it arrests weed growth completely. The black plastic mulch is helpful in conserving moisture and controlling weed growth. However, it may increase the soil temperature. While the black plastic film has proved to be effective in plains to keep crop cool during summer, the transparent plastic film is effective in hilly areas for raising soil temperature in cold climatic conditions during winter. In wavelength selective or photo-selective films (also known as two-side coloured) are designed to absorb specific wavelengths of sun's radiation, which changes the spectrum of the sunlight passing through the film or being reflected back into the plant canopy which helps growers to control different plant properties such as leaf and fruit size, rot development, bloom size, inter nodal length, branching, plant height, yield, encourage fruit to grow lower down on plants and aid in disease control by keeping insects away.

Table 1: Increase in Yield of fruit crops through Plastic mulching:

Crop	Yield(t/ha)		Increase in yield (%)
	Unmulched	Mulched	
Mango	4.93	7.16	45.23
Litchi	111.00	125.00	12.61
Guava	18.36	23.12	25.93
Ber	7.02	8.92	27.06
Pineapple	10.25	11.75	14.63
Papaya	73.24	120.29	64.24
Banana	53.99	73.32	33.95

Source: NCPAH, New Delhi (National Committee on Plasticulture Application in Horticulture)

Table 2: Increase in Yield of vegetable crops through Plastic mulching:

Crop	Yield(t/ha)		Increase in yield (%)
	Unmulched	Mulched	
Cabbage	14.30	19.90	39.16
Cauliflower	18.58	25.02	34.66
Tomato	69.10	94.85	37.26
Chilli	16.79	19.71	17.39
Okra	6.91	8.56	23.88
Bitter gourd	20.12	25.63	27.39
Brinjal	36.73	47.06	28.12
Broccoli	15.64	25.14	60.74

Source: NCPAH, New Delhi (National Committee on Plasticulture Application in Horticulture)

Advantages of Plasticulture

The initial driving forces for the use of plastics in horticulture were first to increase earliness and total crop productivity of high value horticultural crops (Abdul-Baki and Spence, 1992) [1], second to take advantage of out of season production and third to use something as effective but much less expensive than glass as a protective covering. The promotion of earliness coupled with more productive and predictable total yields, holds for most all field grown horticultural crops where plastics are used. Earliness is especially important in the response to plastic covers for vegetable crops such as tomato, cucumber, pepper, brinjal, melon, sweet corn and for cut flowers. The improvement of cut flower quality is often a compelling factor for using plastic covers.

Other beneficial effects of plasticulture with row crop mulching or covers in the field are the conservation of water through reductions in surface evaporation; a reduction in the loss of soil nutrients by leaching (Wein and Minotti, 1987) [4], weed control (especially for vine crops), protection of plants against wind, rain, hail and insects, and an increase in atmospheric CO_2.

Future prospects

There will be many new developments with plastics for controlled environment horticulture. Plastics offer an option for both increased vertical and horizontal expansion in horticultural crop production and needed improvements in quality of the products grown. Use of plastic films will be extended during the next decade to many additional crops and in developing countries. Plastic films with coloured stripes and other colour pattern may be developed that will help repel insects (Brown and Brown, 1992 and Scott *et al.*, 1989) [2, 3] and biodegradable plastics ultimately will be fabricated to avoid undesirable residues, alleviate disposal problems, avoid "plastic pollution" and be more environmentally acceptable.

The expanded use of plastic film covers for greenhouses and row crops and as soil mulches will continue and will push the productivity of high value fruits, vegetables, flowers and ornamentals into new geographical frontiers, including the tropics in both agriculturally developed and less developed nations as has been witnessed recently for China, Kora, Egypt and Nigeria.

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