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Plasticulture in Agriculture

Applications, Benefits and Environmental Perspectives

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In the present era, the world is witnessing a rapid growth in population, which has significantly intensified the demand for food. Consequently, enhancing food production has become a critical necessity to address the widespread issue of global hunger. The advent of the Green Revolution emerged as a milestone in the agricultural history of our country, transforming it from a food-deficient nation to one that is largely self-reliant in food grain production. During the early years, India struggled to fulfill its food grain requirements; however, the Green Revolution brought about a decisive shift in agricultural productivity and food security. To move towards a more progressive and resilient agricultural future, it is essential to adopt advanced and sustainable farming technologies capable of revitalizing the agricultural sector in the coming years. Among various modern horticultural innovations, plasticulture has emerged as a highly effective agricultural input with immense potential to revolutionize Indian farming systems. Plasticulture is a scientifically driven technique applied in both agriculture and horticulture, aimed not only at improving crop yields but also at enhancing the efficient use of agricultural inputs. By promoting resource-use efficiency, plasticulture helps in reducing overall production costs. Furthermore, this technology offers multiple advantages such as improved soil moisture retention, reduced fertilizer dependency, and accurate delivery of water and nutrients, thereby contributing to sustainable agricultural development.

Importance of Plastic

In the pre-plastic era, agricultural production relied exclusively on indigenous knowledge systems and conventional farming techniques developed through long-term field experience. The transition toward the use of plastic materials in agriculture has markedly transformed crop management practices by offering several functional advantages, such as minimizing soil erosion losses, improving soil moisture retention, suppressing competitive weed flora, regulating the activity of pathogenic microorganisms and insect populations, extending the post-harvest longevity of agricultural produce, and increasing overall crop yield efficiency. A diverse range of synthetic polymers is widely employed in agricultural applications, including polyethylene (PE), polypropylene (PP), ethylene-vinyl acetate (EVA), polyvinyl chloride (PVC), polycarbonate (PC), polymethyl methacrylate (PMMA), and glass fiber-reinforced polyester. More recently, bio-based plastic netting materials derived from biodegradable polymeric compounds—such as polyamino acids, polysaccharide-based derivatives, polyhydroxybutyrate, polycaprolactone, polyhydroxyalkanoates, and polylactic acid—have emerged as sustainable alternatives, owing to their enhanced environmental compatibility and inherent biodegradability.

Advantages of plasticulture

- **Early crop establishment and accelerated growth:** Dark-colored and transparent plastic mulches modify the soil microclimate by intercepting solar radiation, which alters soil temperature and facilitates earlier planting as well as faster vegetative development.
- **Conservation of soil moisture:** The application of plastic mulch significantly reduces evaporative water loss from the soil surface, thereby lowering irrigation frequency and maintaining uniform moisture availability to reduce plant water stress.
- **Effective weed suppression:** Plastic mulching restricts weed emergence by preventing light penetration to the soil surface and physically obstructing weed growth.
- **Improved fertilizer-use efficiency:** When combined with drip irrigation, plastic mulch limits nutrient leaching beyond the root zone, allowing targeted delivery of nitrogen and other essential nutrients. This approach substantially decreases fertilizer input compared with conventional broadcast fertilization under flood or furrow irrigation systems.
- **Enhanced produce quality:** Plastic mulches reduce direct contact between crops and soil, thereby lowering the incidence of fruit rot and soil-borne diseases in fruits and vegetables.
- **Improved soil aeration and biological activity:** Mulching minimizes soil surface crust formation caused by rainfall and solar exposure, reduces weed pressure, improves soil aeration, and promotes beneficial microbial activity.
- **Minimization of root injury:** Suppression of weeds eliminates the need for mechanical cultivation, which in turn reduces root disturbance and supports healthier plant growth and development.

Disadvantages of plasticulture

- **Economic cost:** The use of plastic mulching involves additional expenses related to specialized equipment, plastic films, transplanting machinery for raised plastic beds, and increased labor requirements for both laying and removing the mulch. Consequently, the overall cost of crop production under plastic mulching is considerably higher than cultivation on unmulched (bare) soil.
- **Environmental implications:** Conventional plastic mulch films often persist in the soil after use, leading to environmental accumulation and creating technical as well as economic difficulties in their collection and disposal. In contrast, biodegradable plastic materials represent a sustainable alternative, as they are gradually broken down by soil microorganisms, thereby reducing long-term environmental risks.

Applications

Propagation and Nursery Management: Plastic materials play a crucial role in vegetative propagation techniques such as grafting and layering. In grafting operations, polyethylene strips are commonly used to firmly join the scion and rootstock, ensuring proper cambial contact. For layering, poly-wrappers of different colors are employed, with red, blue, and black wrappers enhancing physiological responses through etiolation effects that stimulate cell division and elongation, thereby improving rooting success and plant survival rates. Plastics are extensively used in nursery operations through nursery bags, pro-trays, plug trays, hanging baskets, plastic trays, coco-pits, and other containers for raising seedlings and germinating seeds. To maintain insect-proof nursery conditions, especially during the rainy season, nylon net structures have been commercialized to create a protected, virus-free growing environment. During peak summer conditions, when temperatures may rise to 40–45 °C, the use of 40–45% shade nets enable successful nursery production of early-season crops such as cauliflower and cabbage (Kaur and Singh, 2022). Conversely, in severe winter

conditions, nurseries of vegetables including cucumber, tomato, capsicum, brinjal, and other cucurbitaceous crops can be raised by covering insect-proof net houses with plastic sheets of approximately 200-micron thickness. With minor structural modifications, it is possible to establish year-round production of healthy, virus-free seedlings within a single nursery facility.

Drip Irrigation System: Drip irrigation systems, largely dependent on plastic components, can achieve water savings of approximately 60–70%, thereby allowing irrigation sources such as wells or canals to support nearly three times more cultivated area. In this system, water is delivered at a controlled rate through emitters that release water directly near the plant root zone via plastic pipelines and laterals. The widespread use of plastics in drip irrigation is primarily attributed to their resistance to corrosion and chemical degradation, making them highly suitable for surface, subsurface, and inline irrigation applications.

Naturally Ventilated Polyhouse Technology System: Naturally ventilated polyhouses are protected cultivation structures enclosed on all sides with 40-mesh insect-proof nylon nets, which safeguard crops against adverse climatic conditions, insect pests, and disease incidence. In such structures, insect-proof nylon nets may also be incorporated in roof ventilation areas to facilitate natural air circulation while preventing insect entry. These polyhouses operate without electrical energy, relying solely on natural ventilation. They are particularly suitable for the cultivation of high-value vegetable crops such as tomato, capsicum, and parthenocarpic cucumber, as well as ornamental crops including rose, chrysanthemum, and gerbera, especially in peri-urban agricultural systems.

Mulching: Mulching refers to the practice of covering the soil surface around plants using organic residues or synthetic plastic films to suppress weed growth, reduce moisture loss through evaporation, and moderate soil temperature during cooler night conditions. This practice protects plant root systems from extreme fluctuations in temperature and moisture, while also reducing soil erosion caused by heavy rainfall.

- **Infrared-Transmitting Film Mulch:** This advanced polymer-based mulch selectively transmits specific wavelengths of the electromagnetic spectrum and represents a recent innovation in plastic mulch technology.
- **Coloured Plastic Film Mulches:** Coloured mulches influence plant growth by reflecting photosynthetically active radiation; red mulch has been shown to enhance tomato yield, blue mulch is most effective for pepper cultivation, silver mulch aids in whitefly management, while yellow-brown plastic mulch has been reported to delay the onset of yellow leaf curl disease.
- **White Plastic Film Mulching:** White mulch reduces soil temperature by reflecting a significant portion of incoming solar radiation.
- **Black Plastic Film Mulching:** Black mulch acts as an efficient absorber and emitter of infrared radiation, effectively blocking ultraviolet, visible, and infrared light due to its opaque nature.

Conclusion

Plasticulture has the potential to markedly lower the carbon footprint associated with agricultural and allied products, depending on the nature and extent of its application. The adoption of bioplastic materials presents a viable pathway to substantially reduce dependence on fossil-based resources that pose serious environmental risks. With a projected expansion in the production and use of bioplastics in the near future, sustained research and technological innovation in biodegradable polymer systems has become increasingly essential. This need is closely linked to our obligation to protect environmental integrity, positioning advancements in biopolymer science as a critical catalyst for realizing their full potential in forthcoming years.

References

1. **Kasirajan, S. and Ngouajio, M. (2012)**. Polyethylene and biodegradable mulches for agricultural applications: a review. *Agronomy for Sustainable Development*, **32** (2): 501-529.
2. **Steinmetz, Z. *et al*. (2016).** Plastics in Agriculture: Research, Innovation, and Emerging Technologies. *Science of The Total Environment*, 550: 109-119.