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Rani B Thallapally

Assistant Professor, Fruit Science,
College of Horticulture, Mojerla,
SKLTGHU, Wanaparthy District,
Telangana, India

Dr. Purnima Mishra

Associate Professor, Agricultural
engineering, College of
Horticulture, Mojerla, SKLTGHU,
Wanaparthy District, Telangana,
India

Corresponding Author:

Rani B Thallapally

Assistant Professor, Fruit Science,
College of Horticulture, Mojerla,
SKLTGHU, Wanaparthy District,
Telangana, India

Orchard floor management practices in arid and semi-arid fruit crops for quality yield

Rani B Thallapally and Dr. Purnima Mishra

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Abstract

The orchard floor is a substantial portion of an orchard, which can be managed in different ways to support the soil health and promote productivity and quality. Recent studies put emphasis on the constructive effect of live mulch in fruit crops in terms of yield, quality and alleviating disorders. Dry weather coinciding with elevated temperatures in arid zones have detrimental effects on the important physiological processes of plants. Living mulch with legumes like mustard and *Medicago sativa* (Alfa alfa, a perennial legume), enrich the soil by nitrogen fixing. Organic matter mulch adds to the soil, aggregate it, ensure that the soil remains consistently moist, which is crucial for preventing fruit cracking in fruits such as Pomegranate, Bael. Non-organic plastic sheeting preserve soil moisture. Reflective properties of aluminum faced plastic mulch interfere with the movement of aphids in orchards. New photo-degradable or bio-degradable mulches have been developed, which will solve this problem of plastic removal or disposal. In this paper, available research on beneficial effects of mulches, live mulches, and intercrops in arid fruit orchards is presented.

Keywords: Arid, fruit, intercrop, live mulch, mulch, vertical mulch, weed

Introduction

The practice of treating the ground soil surface understory of an orchard is the floor management. Once the orchard layout and planting are completed, the fruit producer is then concerned of optimal growth, highest possible yields of main crop. To ensure that fruit trees remain productive, there are several essential considerations related to soil management practices, such as manuring, mulching, intercropping etc. These practices are essential for ensuring the highest profitable quality fruits. Floor management aims at maintaining soil in good condition, or improving the condition if necessary. This includes protection from direct sunlight and from the impact of rainfall and wind erosion. The vacant space needs to be productively utilized by annual crops like vegetables and flowers, which do not leave vacant space. The study found that live mulch with *Eragrostis cynosuroides* (Darbh or Kusha) can lower the soil surface temperature to 20.28 °C reducing convective heat thus occurrence of spongy tissue in Mango by 100%. New photo-degradable or bio-degradable mulches have been developed, which will solve this problem of plastic removal or disposal.

Objectives of floor management

1. To maintain fertility level and replenishment against losses.
2. To maintain soil moisture and enhance water holding capacity.
3. To suppress weed population.
4. To provide proper soil conditions for gaseous exchange and microbial activities through addition of organic matter.
5. To check or reduce soil erosion.
6. To ensure supply of nutrients for growth and development of plants.
7. To utilize vacant land for additional income because such a loss is inconceivable for small holders.

Floor management involves maintenance of the physical condition of the soil, moisture, nutrient content and its biome. It is the process of creating, maintaining, and renewing the soil structure to ensure good physical conditions, adequate gas exchange and maximum nutrient availability.

Mulch

Mulching is an important part of successful fruit crop production. Mulch improve soil tilth, conserve soil moisture, minimize water evaporation, as well as suppress weed growth (Shirgure *et al.*, 2003) [14]. Organic waste mulching over a period shall be helpful in restricting the upward movement of soluble salts and thus escaping their toxicity menace in salt-affected dry land soils. It support biodiversity by providing habitat for beneficial insects. In addition, mulch layer placed around tree trunks can regulate temperatures as well as protect from damage by machinery. Suitable organic materials are straw, dried leaves, saw dust, coir dust, special types of paper and polythene sheets can be used for mulching.

Mandal and Chattopadhyay (1994) [7] observed maximum fruit set per plant in custard apple with black polythene mulch

followed by straw mulch and minimum with control.

Studies on growth and biomass of ber (*Ziziphus mauritiana*) as influenced by various soil moisture conservation techniques under rainfed condition by Singh *et al.*, (2012) [16] revealed that mulching increased the canopy spread of 256.1 cm significantly over unmulched plants (198.6 cm). Ghosh and Bauri (2003) [3] reported that the fruit retention of Mango cv. Himsagar grown in rain fed soils was significantly higher with the application of black polythene mulch (68.0%) than paddy straw mulch (63.0%) and control (45.3%). Chattopadhyay and Patra (1992) [2] recorded higher yield of Pomegranate under black polythene soil cover followed by saw dust, banana trash and control. Jagtap and Wachal (1993) [4] reported maximum yield under sugarcane trash mulch compared with control in Ber. Mukherjee *et al.*, (2004) reported that fruit weight of Ber cv. Mundia was significantly higher under the black polythene mulching as compared to control. Singh *et al.*, (2010) [15] reported maximum fruit weight in Aonla cv. NA-7 under paddy straw (43.16 g) followed by grass mulch (41.15 g) and maize straw mulch (41.15 g) as compared to control (39.0 g).



Reflective properties of aluminum faced plastic interfere with the movement of aphids in orchards. Plastics transmit the warming wavelengths of the sun, result in warmer soils than black plastic, but cooler soils than clear plastics. Crops grown on The IT (Infrared transmitting) will develop 7 to 10 days earlier than crops grown on black plastic.

Live mulch

Live mulches have a greater suppressive effect on all weeds than crop residue mulch. Oyeogbe *et al.* (2017) [10] opined that live mulches are effective in suppressing the weeds and improving the soil fertility through biological Nitrogen fixation. Legume cover cropping in grape, mango, guava and other fruit crops is becoming a practice in the management of orchards. It suppresses the weeds mainly by shading, and allelopathy (Petit *et al.* 2018) [12]. Living mulches are crops grown along with the main crop which can suppress the growth of weeds through fast growing nature without causing reduction in crop yield (Bhaskar *et al.* 2021) [1]. Pest incidence will be minimized due to functional diversity i.e. species of live mulches main crop belongs to different families. Bael fruits can crack for a number of reasons, including soil moisture depletion. When the fruit is young and developing rapidly, a quick depletion of soil moisture can cause cracking. Fruit cracking in custard apple usually happens from a heavy rainfall or irrigation after a prolonged dry

spell. Evenly distributed irrigation schedule and constant and uniform moisture level in the soil will reduce this Problem. Fruit rot in custard apples occur due to infection of a fungus called *Phomopsis annonacearum* can. This disease is most likely to occur after heavy rain, when the fungus in the soil splashes onto the fruit.

One of the major constraints in arid areas is soil erosion. In soil erosion prevalent areas, certain permanent cover crops like *Calapogonium muconoides*, *Centrosema pubescens* and *Peuraria phaseoloides* are raised in the alley spaces. They are leguminous crops, establish in a short period, dry up during summer to conserve moisture. With summer showers they come up again because of their profuse seeding habit and spread themselves as a vegetative mat by the time the heavy monsoon starts pouring in. Such permanent cover cropping is a common feature in rubber plantations of Kerala and Kanyakumari district. Red clover (*Trifolium pretense*), white clover (*Trifolium repense*) species are useful for improving soil fertility. Orchard grass (*Dactylis glomerata*) is suitable for areas facing north, tall fescues (*Festuca arundinaceae*) a drought tolerant perennial grass.

The amount of soil organic carbon (SOC) may rise with the use of live mulches. SOC depletion in agricultural soils is up to 30 to 40% higher than that of natural vegetative cover (Poeplau and Don 2015) [11].

According to Lal 2004 [6], The process of carbon sequestration is evident under live mulch that is transferring atmospheric carbon dioxide (CO₂) into SOC by the production of plant biomass. The amount of soil organic carbon (SOC) may rise with the use of live mulches. SOC depletion in agricultural soils is up to 30 to 40% higher than that of natural vegetative cover (Poeplau and Don, 2015) [11]. Due to the variation in plant carbon inputs and rates of mineralization, crop management techniques can have an impact on SOC sequestration in both conventional tillage and no-till soils. The process of transferring atmospheric carbon dioxide (CO₂) into SOC and soil inorganic carbon (SIC) pools

by the production of plant biomass is known as soil carbon sequestration under live mulch (Lal, 2004) [6].

Dry weather coinciding with desiccating winds affect quality of fruits in arid areas A potential live mulch species have benefits including temperature regulation by conserves the soil moisture, slow evaporation and reduced fluctuations in microclimate. Reduce temperature by evaporative cooling. The other benefits are improvement in soil health, nutrient availability, soil microbial activity. However, taking into the consideration of risk of competition against main crop, mulch species is selected and additional nutrient supply is planned.



Intercropping

Growing any economic crop in the unoccupied space between the perennial tree rows is known as intercrop. There will be no returns from fruit trees during their formative years of juvenile stage. Intercropping is one of the best methods to tackle this problem. Growing intercrops not only fetches income to grower but also helps in soil management by reducing weed growth, checking erosion and enriching soil. Fast growing and early fruiting crops like papaya, pineapple, banana, guava, vegetables such as brinjal, tomato, chillies and spices like ginger and turmeric can be selected based on other factors. Ber: Leguminous intercrops such as mungbean, mothbean and cowpea can be grown under rainfed conditions. Gram, chilli and other vegetables can be grown between tree rows until the trees occupy full space. Interculture should be done to remove weeds which cause losses of nutrients and water and act as alternate host for the diseases. Cover cropping with *Stylosanthes* sp. and moth bean improves fertility and moisture status of the soil.

The studies on multistorey cropping system have shown that the crop combinations such as Aonla- Ber- Brinjal - Moth bean- Fenugreek, Aonla- Bael- Karonda- Moth bean- Gram, Aonla- Khejri- Suaeda- Moth bean- Mustard and Aonla- Drumstick- Senna- Moth bean- Cumin were found to be sustainable and remunerative under arid ecosystem. In aonla based multi storey cropping system, brinjal (*Solanum melongena*) was identified as potential crop giving an average net return of Rs 56,000/ha. (Saroj P. L. 2018) [3].

Crop diversification studies in ber (*Ziziphus mauritiana*) and aonla (*Embllica officinalis*) based cropping studies led to the recommendation that initial phase of ber orchard (4 years), Indian aloe (*Aloe barbadensis*) and cluster bean (*Cyamopsis tetragonoloba*) are the low input and highly remunerative crops giving net returns of Rs. 65,802 and Rs. 26,144/ ha, respectively.

Under ber based cropping system, it has been demonstrated that ber plantation brings down bulk density, increases porosity and organic carbon content of soil. (Saroj P. L.2018) [13]

In Aonla Fruits, vegetables, flowers and a few medicinal and aromatic plants are well-suited for intercropping in aonla orchards. Some Aonla based models are: aonla + ber (2-tier), aonla + guava (2-tier), aonla + ber + phalsa (3-tier), aonla + dhaincha + wheat or barely, aonla + dhaincha + onion/garlic/fenugreek or brinjal and aonla + dhaincha + German chamomile (3-tier).

Green manuring

Green manuring crops are becoming increasingly popular in fruit production due to their potential for providing essential nutrients and improving plant health. Green manures have been shown to be especially effective in reducing nutrient leaching and increasing organic matter content, as well as potentially enhancing beneficial microbial populations in the soil. In India, green manure crops like Sunhemp, Cowpea, Daincha, Lupins etc. are more commonly used. Cowpea and French beans grow well under guava and sapota tree. Crops such as legumes, brassicas, and grains are commonly used to increase nitrogen levels in soils, provide habitats for beneficial organisms, reduce energy and water inputs required for fertilizer production and transport, protect against erosion of topsoil, chemically transform pesticides and pollutants into less mobile forms before they enter natural water systems or human food chains, and create humus-rich soils which can improve soil structure for improved seedling emergence, root growth and yield potential. Additionally, many green manuring crops offer multiple benefits from a single crop including weed suppression, making them a highly desirable component of an overall sustainable fruit farming system.



Green leaf manuring

Plant	Scientific name	Nutrient content (%) on air dry basis		
		N	P2O5	K
Gliricidia	<i>Gliricidia sepium</i>	2.76	0.28	4.60
Pongamia	<i>Pongamia glabra</i>	3.31	0.44	2.39
Neem	<i>Azadirachta indica</i>	2.83	0.28	0.35
Gulmohur	<i>Delonix regia</i>	2.76	0.46	0.50
Peltophorum	<i>Peltophorum ferrugenum</i>	2.63	0.37	0.50
Weeds				
Parthenium	<i>Parthenium hysterophorus</i>	2.68	0.68	1.45
Water hyacinth	<i>Eichhornia crassipes</i>	3.01	0.90	0.15
Trianthema	<i>Trianthema portulacastrum</i>	2.64	0.43	1.30
Ipomoea	<i>Ipomoea</i>	2.01	0.33	0.40
Calotrophis	<i>Calotrophis gigantea</i>	2.06	0.54	0.31
Cassia	<i>Cassia fistula</i>	1.60	0.24	1.20

Soil nutrient management

Application of organic manures compost, farmyard manure improve soil physical properties through increased soil organic matter. The increased plant biomass produced by fertilizer, results in increased return of organic material to soil in the form of decaying roots, litter and crop residues.

Soil nutrient management in fruit crops is an essential component of any successful orchard production. In order to maximize quality yield and, growers must ensure that there is an adequate supply of the necessary nutrients to their trees. Nitrogen, phosphorus, potassium, calcium, magnesium, and micronutrients, sourced from both organic and synthetic fertilizers. Especially for coarse textured soils, organic manure application improves water retention properties of soil. Appropriate soil testing should be conducted annually to identify deficiencies and surpluses while timing of applications should be decided according to the plant's critical requirement period.

Organic and inorganic manures can be used as sources of nutrient elements for fruit crops. Continuous application of inorganic fertilizers results in soil destruction, which should be avoided as far as possible. Organic manures help in improvement of soil tilth, aeration, water holding capacity and microbial activities. Commonly available organic manures include farmyard manure, compost, vermicompost, leaf mould, oil cakes, fishmeal and meat meal. Biofertilizers help in improving soil characters and plant growth and fruit quality through enhancing hormonal activities.

Soil nutrient management biofertilizers: Commonly used growth promoting organisms of biofertilizers include Rhizobium species, Azospirillum, Pseudomonas and VAM (Vesicular-arbuscular mycorrhizae). Integrated nutrient management incorporating inorganic and organic sources of nutrients, biofertilizers and other practices, which will help to maintain soil health and environment is an ideal approach in orchard management.

Conclusion

It is concluded that there are various methods that can be employed to increase fruit growth, production and productivity. Among all the practices, orchard floor management is one way of sustainable production and additional income. However, further Research development is necessary in this perspective and ensure that these practices are implemented effectively by farmers.

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