

Strategies for successful rainfed fruit cultivation through moisture conservation in Himachal Pradesh

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Water is one of the most important component for successful orcharding. It affects the fruit quality as well as production. But due to climate change the water resources are shrinking day by day and erratic nature of rainfall makes fruit growing further more difficult. Hence, the only way to cope up with this problem is efficient utilization of rainwater by minimizing the runoff losses. For this purpose, runoff water from fields can be collected both on the field (in situ) and off the field (ex situ). This collected water can be utilized by plants during water stress conditions. It will not only enhance the fruit production along with fruit quality but also will bring sustainability in fruit production.

Keywords: Fruit, Moisture conservation, Rainfed

HIMACHAL Pradesh is a beautiful hill state known for its temperate fruit cultivation like apple, pear, peach, nectarine, plum, apricot etc. The state has an area of about 2,32,140 ha under fruit production with an annual production of 8,28,230 MT. Some areas of the state are particularly known for their quality fruit production; like Kinnaur and Lahul Spiti districts of state are known for their quality apple production, whereas Rajgarh area of Sirmour district is known as peach bowl of country. Although the state receives ample amount of rainfall but its distribution is not uniform in nature. Maximum amount of rainfall (about 80%) in the state takes place in the months of July, August and September. This leaves maximum period of the year under water scarce conditions. Apart from this, most of the orchards in state are established on undulating lands which are susceptible to soil erosion and run-off losses having rain-fed conditions. These conditions make fruit growing further more difficult.

Under such circumstances

efficient use of rainfall along with conservation of available soil is the only solution to cope up with this problem. Rain water can be efficiently utilized by minimizing the runoff losses. The runoff water from the fields can be collected by constructing small ponds either in the field or away from the field. This water can be utilized for irrigation purposes during the period of water scarcity or stress. Runoff water can also be utilized in another way by modifying the traditional system of basin making to new and advanced system of basin like cup and saucer

basin, crescent bunding, full and half-moon system of basin etc. Besides these, organic mulches such as grass mulch, polythene mulches and nylon mulch mat provides a good medium for *in situ* moisture conservation to enhance fruit productivity. All these water conservation strategies will bring sustainability in fruit production and will increase the fruit productivity in rain-fed areas of Himachal Pradesh.

Methods of moisture conservation

Contour farming (Terracing): Contour farming, refers to the



Contour farming
Source: <https://contourlines.org/research/>

practice of tilling sloped land along lines of consistent elevation in order to conserve rainwater and to reduce soil losses from surface erosion. The objective of contour farming is to catch and retain water which can be achieved by making furrows, crop rows, and wheel tracks across slopes. Thus it will increase infiltration and more uniform distribution of water.

Mulching: Mulch (Organic and Inorganic) is a natural or artificially applied layer of plant residues or other material on the soil with the objective of:

- Moisture conservation
- Temperature control
- Weed control
- Prevention of surface compaction or crust formation
- Reduction of surface runoff and soil erosion
- Increment in soil fauna
- Improvement in soil structure
- Reduction of certain insect pests
- More efficient use of soil nutrients
- It allows the absorption of more rain water and reduces irrigation frequency

Organic mulching

Organic mulches are those tend to decay after a particular interval of time and are temporary in nature. These natural mulches improve soil quality and contain high amounts of nutrients. These living mulches are considered more environmentally friendly than plastics and add nitrogen to the primary crop. Commonly available organic mulches include (Table 1):

Grass mulch: it is the most common type of mulch that is being used by the farmers of Himachal Pradesh. The grass which is grown between the rows of trees in orchard dried under sun. After that it is used as mulch in fruit tree basins. It is biodegradable in nature and neutral in pH. It has good moisture retention and weed controlling properties.

Pine needle mulch: Pine needle mulch is also an excellent source of mulch in fruit crops. It will act as excellent winter mulch for strawberries. Its decomposition rate is low so it is advisable to add organic matter to soil before mulching. Pine needle mulches are



Grass mulch in nectarine



Pine needles mulching in strawberry

slightly acidic in nature suppresses weeds; lightweight; free of weed seeds; does not pack down; reusable.

Leaves: Deciduous trees tend to drop their leaves in autumn/fall. Those fallen leaves can also be used a mulch. They tend to be dry and blow in the wind, so are often chopped or shredded before application. Leaves will work into soil to supply good organic matter.

Biodegradable mulch: These mulches are made out of plant starches and sugars or polyester fibres. These mulch films may be a bit more permeable allowing more water into the soil. At the end of the season these mulches will start to break down from heat. Microorganisms in the soil break down the mulch into two components, water and CO₂, leaving no toxic residues behind. This source of mulch requires less manual labour since it does not need to be removed at the end of the season and can actually be tilled into the soil.



Biodegradable mulch in strawberry
Source: https://smallfruits.org/files/2019/07/ProgressReport_no2007_08.pdf

Inorganic mulches

These are those mulches which do not decay over the time and are not temporary. These mulches need to remove after the completion of growing season. Plastic/polythene

Table 1. Recommended thickness for various organic mulches

Mulch material	Thickness (inches)
Compost	3–4
Green leaves	3–4
Dry leaves	6
Grass clippings	2–3
Bark	2–4
Wood chips	2–4

Source: Singh J 2002. Mulching. *Basic Horticulture*, pp. 149–52. Kalyani Publishers, New Delhi.

mulches come under these mulches. Plastic mulches have been used by commercial growers since early 1960's, with black and clear plastics being most popular.

Plastic Mulches

Black Mulch: Black plastic mulch is most popular colour used. As a black body absorber, the plastic mulches absorb all incident solar radiation including visible UV and infrared. So, mulching in hot areas especially in summer is done by leaving a gap between mulch and surface (because by doing this, there is an intermediate layer of still air which inhibits the transferring of heat by conduction). But in temperate areas mulching is done in winter in a continuous manner i.e. without leaving a gap because it will provide protection against frost and also increases the soil temperature. Thickness of mulch which is commonly used as a mulch material is of 100-micron thickness (Table 2).

Clear (Transparent) Mulch: Transparent mulch absorbs a very little solar radiation. Water droplets that condense on the underside of transparent plastic mulch allow solar light (short wave radiation) in, but blocking outgoing radiation



Black polythene mulch in nectarine



Bicolour mulch in nectarine



Nylon mat mulch in nectarine

i.e. long wave radiation (heat). This heat is normally lost to atmosphere by bare soil. Weeds become a huge problem under these mulches which affects the efficacy of these mulches.

Two side colour mulches (Bicolour mulches): These are also called wavelength selective mulches. These types of mulches absorb specific wavelengths of sun's radiation, which changes the spectrum of sunlight passing through the film or being reflected back to plant canopy. These changes have a huge effect on plant growth and development. Some common type of bicoloured mulches are silver black mulch, yellow colour mulch and blue colour mulch.

Nylon mulch mat: Nylon mulch mat (of 90 GSM thickness) is porous in nature which allows rainwater infiltration and proper soil aeration. Hence, it can utilize rain water which otherwise can not be utilized by the use of polythene mulches. This property of nylon mulch mat makes it an extremely useful orchard floor management practice under rainfed conditions of the state. Other than that it is quite economic in nature due to its high durability.

On field rain water harvesting: Water harvesting in its broadest sense



Rainwater harvesting by making small ponds in orchards

Table 2. Recommended thickness of plastic mulch for different crops

Thickness (microns)	Crops Recommended
20-25	Annual - short duration crops
40-50	Biennial - medium duration crops
50-100	Perennial - long duration crops

Source: Anonymous, 2011. Practical manual on plastic mulching. National Committee on Plasticulture Application in Horticulture, Department of Agriculture and Cooperation Ministry of Agriculture, Government of India, New Delhi.

Table 3. Response of plastic mulch on different fruit crops

Crop	Thickness of film (micron)	Increase in yield (%)
Apricot	100	30-35
Peach	100	30-35
Guava	100	25-30
Kinnow	100	45-50
Pomegranate	100	35-40
Strawberry	25	40-50

Source: Anonymous, 2011. Practical manual on plastic mulching. National Committee on Plasticulture Application in Horticulture, Department of Agriculture and Cooperation Ministry of Agriculture, Government of India, New Delhi.

will be defined as the "collection of runoff for its productive use". *Ex situ* water conservation is the process of collecting and concentrating runoff water during periods of peak rainfall into an on farm water reservoir such as small farm pond, tank etc. for future productive uses.

Crescent Bunding: Crescent shape or semicircular bunds with a diameter of 6 to 13 m are prepared and catch pits are also dug on the same time on upper side of slope.

Bunding are made individually for each tree. While the crescent bunds help to collect rain water, the catch pits conserve the same.



Crescent bunding
Source: FAO, 1999

Modified system of tree basins

Half moon system: In half moon system, semicircular bunds are created at downstream side of the plant. The shape and design of the structure is semicircular with bunds having 30 cm width and 30 cm high at a radius of 2.5 m away from the tree trunk and 5% outward slope for rain water collection.

Full moon system: In full moon water harvesting system, circular bunds are created around the periphery of the plant. The shape and design of the structure is circular bunds having 30 cm width and 30 cm high at the radius of 2.5 m away from the tree trunk and 5% inward slope for rain water collection. There are earthing up around the tree trunk in the radius of 30-40 cm to avoid water stagnation around tree trunk.

Cup and saucer method: In cup and saucer method a circular pit of about 0.50 m width and 0.50 m depth around the tree is prepared at distance of 1-1.5 m from tree trunk. The slope of the basin is kept towards outside so that rainwater is



Half moon system in almond



Full moon system in almond



Cup and saucer system in almond

Source: Vision 2050, CITH Srinagar, Jammu and Kashmir

collected in the pit.

Opening of catch pits and ditches: In rainfed areas, the rainfall is erratic in nature which makes fruit production more difficult. In that situation it is important to minimize the runoff losses whenever rainfall takes place. For this purpose catch pits and ditches are developed around the trees. The runoff water collected in the pits can be utilized by the trees during water stress conditions.

V- shape ditches: In the land area at 4–6 m intervals V-shaped ditches are made. Down the line ditches are covered with soil bunding. The trees are planted in the pits based on spacing needed.

Development of catch pits: To harvest the rain water catchments in the form of pits is made around each tree, the size of which is determined by slope of land, requirement for optimum fruit production and canopy of fruit tree. Depending upon topography of soil, catchment area can be developed all around the trees or on its two sides.

Increase in moisture storage capacity of soil: In light texture soils, water is lost through ploughing. The water holding capacity can be increased as:

- Increasing organic matter of soil
- Placement of slowly permeable layer at the bottom of profile/ or appropriate depth to check deep percolation. Bentonite clay barrier has been found to be highly suitable as it has very low hydraulic conductivity (10–15 tn Bentonite/ha is required).

Use of anti-transpirants: Anti-transpirants are the chemicals, which when sprayed on the plant forms a film which increases the diffusion resistance of water from stomata and thus reduces transpiration losses of water. Several anti transpirants have been used in fruit crops e.g.

Stomatal closing type: PMA (Phenyl mercuric acetate), Alachlor, Butachlor.

Reflectant type: Kaolinite (3–8%).

Film forming type: Ethyl alcohol.

Growth retardant type: Cycocel

or CCC (2-chloroethyl, trimethyl ammonium chloride).

SUMMARY

Moisture conservation is an important tool for successful fruit production under water scare conditions and where rainfall is the primary source of water for the fruit production. In such conditions, moisture conservation techniques like contour farming, mulching and rainwater harvesting are crucial to maintain optimal soil moisture levels throughout the growing season. These techniques are helpful in maintaining the optimum soil moisture by reducing evaporation and runoff losses and increasing infiltration which further helps in quality fruit production. By retaining moisture in the soil, fruit trees can continue to grow and develop even during dry periods, which can result in improved fruit production along with fruit quality. Additionally, moisture conservation techniques can help to reduce soil erosion, improve soil fertility and conserve water resources, which are all essential in rainfed areas where water is limited. Thus, by adopting these techniques farmers of the state can reap better returns from fruit cultivation even in water scare conditions.



V shape ditches around olive trees



Catch pits around olive trees

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Earth provides enough to satisfy every man's needs, but not every man's greed.

—Mahatma Gandhi