



## **Organic Mulching - A Water Saving Technique to Increase the Production of Fruits and Vegetables**

**PREM RANJAN<sup>1\*</sup>, G. T. PATLE<sup>1</sup>, MANJEET PREM<sup>2</sup> and K R SOLANKE<sup>3</sup>**

<sup>1</sup>Department of Soil and Water Engineering, College of Agricultural Engineering and Post-Harvest Technology, (CAU), Ranipool, Sikkim, India.

<sup>2</sup>Department of Farm Machinery and Power Engineering, College of Agricultural Engineering and Technology, Anand Agricultural University, Godhara, Gujarat.

<sup>3</sup>Department of Farm Machinery and Power Engineering, College of Agricultural Engineering and Post-Harvest Technology, Central Agricultural University, Gangtok, Sikkim, India.

### **Abstract**

In the present situation of globalization and health awareness demand of the virtuous horticultural crops has increased worldwide. The increasing demand for the fruits and vegetables and market competition has forced the farmers to produce more and high-quality fruits and vegetables for sustaining in the international market. Use of organic mulching is one of the suitable methods which could help the horticultural growers to increase the production with good quality of produce. Looking to the water scarcity and the challenges that arise due to climate change, adoption of organic mulching at large scale by the Indian farmers would help the farmers to overcome several problems considering the advantages of organic mulching. From the findings of the several studies shown that mulching with organic materials increases the soil nutrients, maintains the optimum soil temperature, restricts the rate of evaporation from the soil surface, restricts the weed growth and prevents the soil erosion. It also helps to improve the soil health. Organic mulches are cheap materials; therefore, the cost of mulching is also economical. In this paper, an attempt has been made to overview on the various types of mulching, mulching techniques, benefits and limitations of mulching.



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### **Introduction**

Agriculture is the mainstay of most of the rural population for their livelihood and major contributor to the Indian economy. Indian Agriculture is facing

several challenges. It is now depending on the heavy use of fertilizer, pesticides, irrigation and several agricultural inputs, which are constantly degrading and polluting the quality of soil, water

**CONTACT** Prem Ranjan  prem009ranjan@gmail.com  Department of Soil and Water Engineering, College of Agricultural Engineering and Post-Harvest Technology, (CAU), Ranipool, Sikkim, India.

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and our environment. The farmers use excess doses of fertilizers and pesticides to increase the yield of the crop but these over doses of fertilizers and other chemicals are hazardous for our soil health. Also, the application of excessive irrigation water is causing the problems of soil erosion and salinity etc. The availability of water for agricultural use has decreased day by day due to the increased demand of the industrial and domestic sectors particularly in developing countries. In India, the agriculture sector is the prime (81%) consumer of water in which it is used mostly for irrigation purpose. During last few years, groundwater levels have been dropped by 0.5 to 1 m below the ground surface in the many parts of the country. The large variation in the temporal-spatial variation in rainfall is observed several regions of the country are experiencing the drought. Improving the water use efficiency without increasing cost of production is an ongoing goal in crop production system. Hence, more resourceful and well-organized use of water in farm needs to be the top most priority. The population of the country is increasing day by day for which more production of food grains is required for feeding the huge population. However, due to these reasons, natural resources (like soil and water) are being constantly under pressure and requires a systematic and precise approach to increase the productivity of agricultural crops. Considering the above, several questions arise in the mind namely How to increase the productivity of agriculture without using the excess fertilizers and chemicals? How to minimize the degradation of soils? How to conserve the moisture in the soil? How to control the weeds in our fields? How to add nutrients to our soils?

In order to minimize degradation of soils, water and other natural resources and for environmental protection, we should adopt the conservation practices. These are more essential to obtain sustained and consistent yields, conservation of soil, water and other natural resources. The sustained yield of the crop is achieved by the conservation of soil, water and adopting conservation farming. Mulching is one of the conservation practices by which these goals can be achieved. The word mulch has derived from the Germanic term "mulch" means soft to decay, which apparently referred to the use of organic materials and agricultural wastes (like straw, grass clippings, compost and leaves) spread over the

ground as mulch<sup>1</sup>. A mulch is natural or artificially spread layer of plant residues or other material on the surface of the soil. The important objectives of mulching in agriculture are namely moisture conservation, temperature control, prevention of surface compaction, reduction of runoff and erosion, improvement in soil structure and weed control. The improvement of the soil means improvement in the soil structure, increase in water holding capacity, moisture conservation, improvement in soil drainage property. Use of organic mulches prevents the soil erosion and moderate's the soil temperature, provides nutrients to the plants as it slowly composts, giving plants a season-long feeding and the landscape as it directly defeats the pathogens and pests, enhances beneficial organisms, neutralizes pollutants. It also affects the humans in the case of economic, aesthetic, and ease of operation and in ease of weeding. Application of mulch is the magic to any garden or orchard, especially during a drought period. Similarly, it is very useful for garden or orchard in semi-arid and arid regions. It works as an insulator which cools and moderates the soil temperature during hot days and cold nights. It enhances the beneficial microbial activity and helps in fighting disease. It also restricts the evaporation of moisture from the field. It prevents soil moisture from the direct solar radiation and air flow across the soil surface, which results in lower losses of soil moisture. Evaporation of moisture from the surface of the soil is greatly distressed crop water use efficiency. The evaporation from soil surface was accounted 25-50 per cent of total evapotranspiration of crop land<sup>2,3</sup>. Several researchers reported that the mulching with agricultural waste such as straw, compost, grass clippings and leaves, etc. had increased the water retention and prevented the soil evaporation<sup>4,5,6,7</sup>. Higher water use efficiency would help to decrease the cost of production. In addition to this, mulching practices also help to restore the soil health with its physical, chemical and biological properties, it creates a suitable atmosphere for earthworms and other beneficial micro-organisms to grow on the soil. Weed seedlings cannot survive under the mulched condition and avoid the use of chemical weedicides. The multiple effects contribute towards the increase in the yield up to 50-60 percent under rain fed conditions<sup>8</sup>. Also, a mulched layer can reduce soil erosion by abating the influence of raindrops and water runoff on soil<sup>9,10,11,12</sup>.

### Types of Mulches and its Suitability

There are many types of mulch materials like natural, synthetic, petroleum, conventional, inorganic and organic mulches. But generally, they are classified as organic mulch and inorganic mulch. Organic mulches that are found in nature and can be broken down by soil organisms due to decomposition whereas, inorganic mulches are man-made material or anything like a rock that cannot be broken down by soil organisms. Organic mulches more beneficial than inorganic mulches. Choice of organic or inorganic mulch mainly depend on the user but the using an organic mulch means utilizing a material available in the field and it might be degraded and breaks down into organic matter. Organic mulch adds the nutrient in the soil and increases soil fertility. Inorganic mulches, like plastic sheets, are easy for handling and look a good choice due to its durability, but are non-recyclable and are not environment-friendly.

### Organic Mulch

Organic mulches are those natural origin materials which can decompose naturally, like agricultural wastes which are used as mulch, such as bark chips, grass clippings, wheat or paddy straw, plant leaves, compost, rice hulls, and sawdust, etc. It decays over time and it increase the water holding capacity of soil<sup>13</sup>. It also provides the soil with nutrients as it breaks down. It also improves water use efficiency indirectly. A mulched layer restricts the weed growth by obstructing light penetration to the soil surface<sup>14</sup>. Lower weed prevalence significantly improves water use efficiency. However, among organic materials, there is a wide range of choices each with different characteristics and suitability for different growing conditions. The total production of organic waste by human, livestock and crops are approximately 38 trillion metric tons worldwide, and about 600 to 700 million metric tons of agricultural wastes (as well as 272 million metric tons of crop residues) are existing every year in India, but most of them remains unutilized<sup>15</sup>. Some of the organic mulching materials which are commonly used are described below.

### Bark

These are good mulch materials because they contain more moisture and retains this moisture for longer periods and helps in the supply of moisture to the growing crop. It is commonly used for vegetation

and landscaping, it should be avoided to use in vegetable fields because it is acidic. However, these mulches (fig.1) are excellent for cover the paths between beds.



Fig. 1: Bark mulch<sup>16</sup>

There are two types of bark mulch namely hardwood and softwood

1. Bark (Hardwood): Hardwood bark mulches are one of the common mulches used in countryside plantings. It is a by product of the paper and wood industries which can be recycled as a mulch. Hardwood bark contains more nutrients than softwood bark, but they are not available easily. The pH of these types of barks is slightly alkaline.
2. Bark (Softwood): Softwood barks are tough to decay than hardwood barks. Its pH is acidic in its reaction. These barks are available in various sizes which fits in many countryside needs. Apply to a depth of 2-4inches.

### Grass Clipping

Grass clipping is one of the most easily and abundantly available mulching material in Indian agriculture. If fresh grass clippings are used in the field, it decomposes easily and increases the percentage of nitrogen in the soil. The different types of grass clipping are widely available such as green or fresh and dry grass. Normally, green grass clippings are not used in the rainy season because it may chance to the development of its own root systems which will be harmful to crop growth. Apply of green clippings can heat up quite a bit and possibly cause damage to plants. So, always the dried grass

always preferred to use as mulch. Apply to a depth of 2-3 inches.



**Fig. 2: Grass clipping<sup>17</sup>**

**Dry Leaves**

Leaves are beneficial for soil it contributes nutrients when used as mulch. It is widely used in natural forest areas and where trees are plentiful. Dry leaves are the easily and abundantly available and it makes a better mulch if it composted. However, dry leaves are not easily available in the spring season, they are valued as overwinter mulch. To restricts the blowing of dry leaves, small branches and wood barks are kept over the dry leaves mulch. The thickness of the dry leaves mulching is about 3-4 inches.



**Fig. 3: Dry leaves<sup>17</sup>.**

**Straw**

Straw (fig.4)is an ideal for mulching because it can be easily applied in the field, stays in place and reflects sunlight which helps to bear fruit in some vegetables. It is used as winter protection and as a summer mulch in vegetable fields. These mulches provide great insulation, water penetration and weed

control. The main advantageous property is that it does not contain weed seeds itself. Straw mulches are avoided to use in high traffic areas due to its highly inflammable properties. The thickness of the straw mulching is about 6 to 8 inches.



**Fig. 4: Straw mulch<sup>18</sup>.**

**Compost/Manure**

The compost is good mulch and soil conditioner, it can be easily prepared at home by composting of different types of waste materials like leaves, straw, grass and plant residues, etc. The availability and application of compost in Indian agriculture is old age practice. It improves the soil properties like physical, chemical and biological properties and enhances the carbon content which improves the water retention capacity of the soil. Compost is the good material for improving the soil health. It should not be used in the vegetable field because they have too much nitrogen and it may contain weed seeds. The excellent use of compost is at the time of bed preparation or as ‘top



**Fig. 5: Compost Mulching<sup>17</sup>.**

dressing' thinly in the early part of the season. It is used as a mulch in some nutrient loving plants like roses. Apply at a depth of 3-4 inches.

#### Sawdust

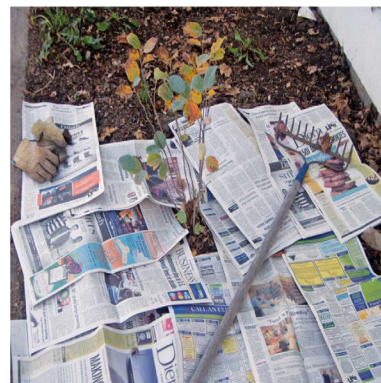
Sawdust is a very common type of mulch in areas where easily available. It is found during the finishing operations of wood, it has less nutritive values and it has only half of nutrients than straw. Due to high C: N ratio, the decomposition is very late. Its decay will cause deficiency of nitrogen in the soil, so regular fertilizer application is necessary. Its nature is acidic, so it should not be used in acidic type of soils. However, it retains moist for longer periods.



**Fig. 6: Sawdust as mulch<sup>19</sup>.**

#### Newspaper

Newspaper mulching (fig.7) helps to control weeds and is readily available. The newspaper layer biodegrades into the soil in a small time. The newspaper is better than plastic because it will eventually decompose. Newspaper mulch can save a lot of time and effort, in fields where weeds are already matured in the previous season and dropped seeds will be germinate in the coming season. However, the usage of newspaper mulches is avoided in high windy areas. The combined sheets of 2 or more sheets of newspaper should be used and its edges should be pasted with heavy materials to safety from blowing like pebbles, gravels, etc. Commonly, use of glossy paper in vegetable fields



**Fig. 7: Paper mulch<sup>20</sup>**

should be avoided because the ink could leach into the soil.

#### Some other types of Organic Mulch

**Alfalfa:** It is an excellent type mulching material because it is generally cut before it can put out seeds. As a mulch, it is very nutritive for soil because it contains high nitrogen and it has also long -lasting ability.

#### Seaweed

Seaweed makes an excellent mulch if it freshly collected and it contributes mineral into the soil. Seaweed shrinks a lot as if it dries, so, thick layer should be applied in field. Before applying in field seaweeds should be sprayed by fresh water to minimize the brings of salt in the soil.

### Cocoa Bean Hulls

It is an excellent mulching material to increase the soil fertility. It contains nitrogen, phosphate and potash. It is acidic in nature, pH 5.8. It is used in



**Fig. 8: Cocoa bean hulls<sup>17</sup>.**

the landscape due to its sweet smell and attractive appearance.

### Corncoobs (Crushed)

It is another exceptional and cheap mulch material. Corncob mulch can be coloured for increasing its appearance and used for landscape.

### Hops (Spent)

This mulching material obtained inexpensively and collect from local breweries. They have good appearance and they do not burn readily. It has strong odour but after half or over the year it should be used.

### Mushroom Compost

It is an organic plant fertilizer available in areas where it should be grown commercially. It is available in market as a spent mushroom compost/ spent mushroom substrate. It is reasonably inexpensive. It increases the fertility of soil due to its rich nutrient values. This type of compost increases the water retention capacity of soil.

### Peanut Hulls

It is a good appearance mulch that located near peanut processing areas. These are the organic mulches which are generally used in fields as a mulching material. Also, farmers using the other many crop residues available in the field as a mulch.

### Advantages of Organic Mulching

Mulch layer reflects the maximum sunlight or else sunlight heats the soil. It maintains the optimum soil temperature. The rate of evaporation from the soil surface was restricted due to the avoiding of direct entry of solar radiation. So, its application is beneficial in hot and dry climates. Mulch layer also restricts the weed growth because if soil is covered with mulch layer then light will not reached at soil surface. It also protects soil surface to erosion from the high-speed wind and surface runoff. It restricts the rainwater flow rate and hence restricts the soil and water runoff. Rainwater surface runoff does not arrive in direct contact and rainwater runoff slows down and increase the infiltration amount of water which indicates the more available soil moisture for plant use. Organic mulches are also improved the soil characteristics. It improves the soil physical, chemical and biological properties. These mulches are slowly decomposed, and they increase organic content in the soil which helps to keep the soil loose. These organic contents become food for the useful earthworms and other micro-organisms available in the soil. The organic mulches also improve the organic carbon in the soil. More the organic carbon, more the fragile of the soil. It facilitates the better root penetration and root development and extraction of nutrients from a deeper layer of the soil. It improves root growth of the crop, increases the infiltration of water, and water retention capacity of the soil. The organic mulches attract most of the soil beneficial micro-flora which in turn act on the degradable wastes and aids in the release of plant nutrients.

### Limitation of Organic Mulching

After many advantages it has also some limitation, they can keep the soil too moist on poorly drained soils and restricting oxygen in the root zone. If it is applying near to or in contact with the stalk, the trapped moisture creates an environment conducive to the growth of diseases and pests. Many of organic mulches cause the breeding spots for many insects and pests. Mulches such as hay and straw contain seeds which may become weeds. These organic mulches are easily biodegradable, and they can serve for the only short period.

### Criteria for the selection of Mulching Material

#### Cost of the Material

If the suitable mulching material is available at little or no cost then don't buy mulching material. Use locally available material.

**The Crop selected to Mulch**

Do not mulch with material from the crop which increases the risk of conveying viruses or pest to the cultivated crops. Also, don't use that mulch material which contains weed seeds.

**The Period when the Mulch is to be used**

During summer season light, colored materials are beneficial as a mulch they reflect the heat. During early spring season use of dark colored materials are beneficial as a mulch it helps to warm the soil which permit crop planting earlier and accelerate the growth of crop.

**Best time or way for applying Mulch**

Organic much should be applied in the late fall, after the saturating of soil after initial heavy rainfall; or it may be applied in the late spring, though soil has even retained moisture, but the soil has warmed. At the beginning of the rainy season, the soil has moist and often heats up, causing the soil to release steam. If we apply thick mulch now the soil cannot breathe properly, and steam can't release. Which can increase the chances of many types of pest, insects and disease to be appear. For balancing the soil and mulch to minimizing the risk of occurring of any type of disease, after applying of mulch it can well-watered for 2-3 months before the beginning of rainy season. Also, the best time to applying of mulch is nearby the end of the rainy season. Now the steam in the soil has released but still moisture is available in the soil, which helps the mulch to decomposes into the soil. The moisture will be retained by the mulching material, and it will be used for the plant for many weeks or even months. Also, the best time to applying the mulch are after the bed preparation. Before applying of organic mulch, remove weeds from the field. Ensure that the selected mulching material has free of any weed seeds. Generally, avoid the mulch material which is contaminated with pesticides or disease. If we apply these materials, they can increase the chances of attack of insects or pest on the cultivated crop. Apply a layer of plain cardboard or a 4-6 pages thick layer of newspaper before using the mulch in field. These applied cardboard or newspaper layer will control annual weed sand, they also help to reduce perennial weeds. If the mulch material is coarser, then it should be applied more thickly. Mostly, a3-6-inchmulch layer controls most of

the annual weeds. The fine mulches less water and air penetration than coarser material.

**Effect of Organic Mulching on Vegetative Growth**

The application of organic mulch increases the crop growth such as earliness flowering, fruit set and harvesting period also it increased the no. flowers and fruits in tomato crop over control<sup>21</sup>. Maximum plant height and a maximum number of leaves are observed in plots mulched with 4-inch wheat straw<sup>22</sup>. A maximum number of fruits per plant is observed in mulching with grass. The growth and yield of plant were more in drip irrigated crop with mulch than comparing with drip alone. Between the different operation tried, the drip irrigated with straw mulch applied crop was recorded the highest growth in plant height in all the years<sup>23</sup>. The production of ground nut pod (17-24 percentage) and haulm yields (16 percentage) more in straw mulch than the black or transparent polythene mulch and no mulch condition because favorable soil moisture and temperature, earlier seedling growth, more and earlier flowering, matured pod numbers, lower bulk density and minimum weed growth<sup>24</sup>. The number of leaves of okra plant formed under sawdust, trash and no mulch treatment were 43, 36, and 27 respectively, and maximum girth diameter under both treatment trash and sawdust was 37 mm, but on control plot it reached only 26 mm dia. The yield of fruits was almost comparable in both mulched treatment in trash mulch 7.5 tonnes/ha. and in sawdust mulch 7.6 tonnes/ha. while in control plot recorded 5.2 tonnes/ha. The dry matter of sawdust, trash and no treatments ash content were 0.25, 0.20 and 0.17 kg, respectively<sup>25</sup>.

**Effect of Organic Mulching on Production**

The yield and starch content of potato were higher by 27.9 percentage and 18.18 percentage respectively under paddy straw mulch compared to un-mulched plot<sup>26</sup>. The yield of tomato and okra increased by 100 and 200 % in straw mulch (6 t/ha) applied condition than over control treatment<sup>27</sup>. The production of Okra was much higher in straw mulch applied condition than dust mulch applied condition<sup>28</sup>. Increase in grain yield in sugarcane trash mulch, wheat straw mulch, soybean straw mulch and interculturing operation over control (no mulch) was 12.64 percentage, 9.06

percentage, 7.46 percentage and 3.74 percentage, respectively<sup>29</sup>. The drip plus sugarcane trash mulch treatment has recorded 53 percentage higher fruit yield<sup>30</sup>.

#### Effect of Mulching on Soil

The starting of evaporation from mulched soil period is slightly higher than the bare soil in the late stage. The total and available soil moisture storage capacities are depending on porosity, texture and structure of soil<sup>31</sup>, it can develop with the help of organic mulching. The wetting depth of soil is increases with increase of machining rates Soil wetting depth increased with increases in mulch rates. Based on these study, straw mulching has the ability of storing more soil water from small amounts precipitation<sup>32</sup>. The soil moisture conserved is higher in straw mulch treatment which is about 55 % more compared to control<sup>33</sup>. Similar beneficial effects of mulching are observed through enhancement of soil environment resulting in healthier plant growth and yield of potato were observed<sup>34</sup>. The soil moisture available up to the depth 1.5 m of soil increased due to the applying of wheat residue mulch at rate of 6730 kg/ha compared to bare soil<sup>35,36</sup>. The total soil moisture depletion from sowing to harvest at 15 cm, 30 cm and 45 cm soil depths was 9.14 percentage, 11.33 percentage and 11.92 percentage, respectively in Rabi sorghum. Percentage increase in soil moisture in sugarcane trash mulch, wheat straw mulch, soybean straw mulch and intercultural operation over control (no mulch) was 28.19 percentage, 17.81 percentage, 12.26 percentage and 7.54 percentage, respectively. Average soil temperature observed in sugarcane trash mulch, wheat straw mulch, soybean straw mulch, intercultural operation and Control (no mulch) was 19.58 °C, 20.04 °C, 20.37 °C, 20.73 °C and 21.33 °C, respectively<sup>29</sup>. Instead, soil temperature is recorded lowest in grass mulched field. The temperature recorded in white plastic mulch treatment is 1.17 °C, 2.48 °C and 3.78 °C compared to black plastic mulch treatment, no mulch and grass mulch treatment, respectively. The both plastic mulch treatment are suggested for the farmers or users to produce most warm-season vegetable crops in winter season by increasing soil temperature and during hot season use grass mulch treatment to reduce soil temperature<sup>37</sup>.

#### Role of Mulching in Weed Management

The germination and nourishment of many weeds can be controlled by mulch treatment. The mulches can cover the soil surface or work like a physical

barrier and prevent the germination of weeds or physically control seedling appearance. The less weed intensity is recorded in polythene and straw mulch plots compared to the chemical and unmulched<sup>38</sup>. Daisley *et al.*<sup>39</sup> and Ossom *et al.*<sup>14</sup> has observed that in the mulch and unmulched treatment control of weed has recorded large differences in plots of eggplant, cow pea and sweet potato. The combination of drip and sugarcane trash mulched is best treatment that save water about 44 percent and produce the highest fruit yield (approx. 51 metric tonne/ha). In the areas of where weed intensity is more, the adoption of drip along with plastic mulch is better. This treatment reduced the weed intensity about 95%, increase the fruit yield about 53 % and save the irrigation water about 44% compared to flood irrigation without mulching<sup>30</sup>.

#### Conclusion

Mulching with organic materials increases the soil nutrients, maintains the optimum soil temperature, restrict the rate evaporation from the soil surface, restrict weed growth and prevent soil erosion. It improves the all properties of soil like physical, chemical and biological. The organic mulches are decomposing easily and increase the organic content like carbon etc., in the soil which helps to maintain the soil loose. These organic matters are beneficial for the growth of earthworms and soil microorganisms it is also food of these beneficial microorganisms. Organic mulches have also some advantageous properties like it has environment-friendly and add beneficial nutrients in the soil. It could maintain the soil moisture, and increase water use efficiency. It increases the production but also produces quality fruits. With the conservation of soil and water, the increase in yield also achieved to the extent of more than 50 percent. Organic mulches are easily available in farm these are the crop residue of the cultivated crop, plants leave compost and other organic materials. These are the cheap materials, so the cost of mulching is economical. The organic mulch offers a more beneficial opportunity for farmers. Hence, there is wide scope for the practice and usage of organic mulching materials in crop production with the conservation of natural resources factors including soil and water. However, disease buildup and other disadvantages should be considered before applying organic mulches for better results.



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