Effects of Mulching Practices on the Management of Weeds

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Abstract Application of mulches is effective in reducing soil erosion through air and water, in retaining the soil moisture content, and also in suppressing the weed growth, which ultimately altogether improve the soil health. In the tropical production systems, the crop yields are drastically declined by the weed competition which has severely affected the small land holding farmers who cannot afford to purchase herbicides and other yield improving chemicals. Thus, the mulching practice of leaving the crop residues in the field after crop harvest can be a solid tool to suppress weeds, especially in the conservation agriculture systems. As a result, the weed emergence and biomass are reduced by the increased amount of the post-harvest crop residue. More than 10,000 tons ha^{-1} residue is required to effectively manage reduce the weed emergence and biomass together, as compared with the treatment of the bare soil having no crop residues. There are several physical methods used for suppression of weeds in cultivation. However, here the main focus is on the application of numerous mulches for the purpose of weed management and soil fertility. Mulches are a strong too for weed management in organic farming. Either the biodegradable mulching materials are used or various mulch films are utilized in the process of mulching. Ideally the organic mulches can be conveniently collected from the surrounding nature, which becomes a cheaper source of crop production. Also, the use of biodegradable mulches has a positive effect on environment unlike the chemical weed control measures. Generally, the physical weed control methods may result both in the positive or negative effect on the growth and yield of herbs and vegetables; however the target of weed suppression can be easily achieved which indirectly ends with a desirable production i.e. when weeds are suppressed the available soil resources will be utilized by the crop plants. Yes, if these mulches are used as 'living mulches' in crop production, then the living mulches do compete with the main crop for essential resources available in the soil. Apart from the weeds, the living cover crop (used as mulch) also affects the main crop at the same time. Consequently, a significant heed must be given during the selection of the most suitable 'living mulch' with the aim to achieve effective weed suppression in a crop production

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strategy. Various scientists have well described their experiences with a variety of biodegradable mulches including chopped newspapers, straw, photodegradable and biodegradable films, compost and gravel etc., but this special attention is given only to the to the use of mulches in medicinal plants cultivation. Therefore, the use of physical methods (mulches in our case) for weed control in the agronomic crops should also be made effective as in the medicinal plants cultivation. Nowadays, there is a steady increase in the human and livestock populations, while reciprocally the per capita arable land is declining with the passage of time. The farmers since long have been utilizing numerous methods to meet the requirements of the demand for enhancement in the production of the food crops. Worldwide, the infesting weeds are the key challenge in getting the desirable production of a crop. Among the major weeds in the crop production, about 10 weeds are there which grow in almost every crop and severely influence the target yields of these crops. The list of these problematic weeds comprises of *Cannabis sativa*, *Chenopodium* spp., *Medicago lupulina*, *Taraxacum officinale*, *Cirsium arvense, Stellaria meidia, Cynodon dactylon,* thistles, grasses, etc. The mulch material physically suppresses the growth of emerging weeds because the soil surface is covered and the growing weeds are shadowed due to which they fail to get suitable conducive environment to compete with the target crop. Mulching is eco-friendly, safe, feasible, less expensive and has shown fruitful results, when compared with other weed management techniques. Mulching also helps in early maturity of the main crop plants which ultimately enhances the crop yields. However, it is a pre-requisite for using the mulching process to have the prior knowledge of the site of cultivation of the crop.

Keywords Crop residues · Herbicides · Mulching · Crop production · Farmers income

1 Introduction

Mulching is actually the process of covering the soil surface with the help of organic materials like straw, husks, stocks, or any biological biomass which could be the biomass of a weed that is uprooted and spread on the soil surface. Or mulch could be any inorganic material like black or white plastic etc. which should bio-degradable.

Mulches generally limit the weeds growth using the resource limitation principle, thus the available light is hampered and the growing weeds are smothered. Rice straw used as mulch controlled the weeds growth effectively. Also the living mulches substantially decreased the biomass of the weeds growing with the main crop. Also, the biomass of weeds was effectively decreased in vetch plots that were treated with oat plants as mulch and grazing was also conducted, in comparison with the bare plots with no mulch applied. Further, the different mulching materials have a variety of effects on the growth of weeds. For instance, the straw mulch and use of polythene significantly suppressed the weeds growth, however the other mulch types resulted in no effect.

In sericulture, mulching gives a greatly favorable environment to the mulberry trees to effectively utilize the organic manures as well as the bio fertilizers so that the quantity and quality of the mulberry leaves are improved. The bio and organic amendments in the mulched treatments in addition to the reduced doses of inorganic fertilizers resulted in the improvement of the chemical, physical and biological features of the concerned soils.

Many of the cover crops growing in winter such as peas, hairy vetch, crimson clover, and rye can effectively manage the plant diseases like the fruit rots in tomato. Further, the hairy vetch and rye as cover crops substantially improved the fruit yield of tomato, as compared with the fallow plots (control). The polyethylene as mulch and the spent mushroom compost both effectively enhanced the fruit yield of tomato and significantly suppressed the growing weeds in organic production of tomato crop.

2 Pros and Cons of Mulches for the Management Weeds

Pros

The benefits of mulching are numerous. Many of the possible benefits are listed below in detail.

- **Soil moisture conservation**
  Mulches prevent rapid evaporation and make water and nutrients available to the crop roots and thereby create conditions favorable for the new root growth.
- **Improved rain infiltration**
  The rain water is sufficiently absorbed into the soil by capturing and slowing down the movement of water through mulches.
- **Inhibition of weed seed germination**
  Mulches reduce seed germination of weeds by preventing light from hitting the soil surface.
- **Reduction in weed biomass**
  This can also be termed as smothering of weeds or weeds suppression. Field trials in commercial vineyards showed an annual loss of 50–65% of the covered weed biomass. Some follow-up with hand crews or spot herbicide applications is often necessary to achieve complete weed control with mulches. To be effective, mulches must be applied in a uniform layer to soil before weed germination and replenished on a regular basis.

Mulches are capable of suppressing the weeds growth in several ways. These include, (1) there is physical influence of the mulch and its depth. In this way, there are several factors involved which make a combined effect. These factors include decrease in soil temperature, moisture, and also lack of light availability. (2) the mulch inhibits the seed germination due to the phyto-toxic constituents produced by

the micro-flora living within the composted material. This is probably because the immature composts are greatly effective in suppression of weeds.

The phyto-toxic components mentioned above include a variety of the volatile organic constituents, which include phenolic acids, ammonia, and organic acids (i.e. acetic and propionic acids, isobutyric and isovaleric acids together). The compost maturity and its C:N ratio determine the levels of these chemicals. A very higher C-N ratio always results in the excessive accumulation of the organic acids. On the other hand, a very lower C-N ratio ends in the amassing of ammonia compound. These chemical compounds effectively inhibit the seeds germination; can cause injury to these plants, especially when the composts are very immature. Thus, a rationale is lying there for using these composts in the distances between the plants, but should be put very adjacent to them.

- **Crop seed protection**
  Mulches are spread over the surface of the soil to protect seed from the erosive effects of water and fluctuations in soil temperature and moisture. Mulches can sometimes be applied together with seed or fertilizers. However, too much mulch mixed with seed can result in poor stands. Netting, disking, and asphalt spray are among the methods used to anchor loose mulch in order to prevent loss via erosion.
- **Improving soil chemical environment**
  Organic mulches add organic matter and plant nutrients to soil upon decomposition. Thus, they improve carbon sequestration.
- **Improvement in soil structure**
  Mulches improve the soil structure through addition of organic matter to the soil.
- **Reduction in nitrogen loss**
  The volatilization and leaching loss of nitrogen is reduced under mulched condition. During decomposition of organic mulches soil mineral nitrogen is immobilized by microbes and thus its loss is minimized.
- **Increase in soil fertility**
  Cation exchange capacity is substantially influenced by organic matter content in soils containing predominantly low activity clays. Improvement in the cation exchange capacity of soil improves the fertility status of these soils. Mulches also influence the availability of nutrients through their effect on physical conditions, hydrothermal regime and biological activity of the soil.
  The weed growth is indirectly promoted by the N fertilizer application, and as a result the weed competition with rice crop has decline the rice yield to much extent. However, the effect of the placement of nitrogen fertilizer on the weeds population has not been studied yet.
- **Reduction in soil pH**
  Furthermore, decomposition of organic mulches add organic acids to the soil resulting in low soil pH which influences the bioavailability of many plant nutrients viz., Fe, Mn, Zn, Cu, etc.

- **Soil protection from rain splash**
  Mulches protect the soil from rain splash which reduces the soil erosion and splashing of pathogen inoculum on to the plants.

Cons

- Cultivation or irrigation practices that disturb the mulch barrier limit the effective life of the mulch.
- Mulches made up of organic materials will decompose in response to normal microflora and microfauna activity.
- Mulches have little or no impact on re-growth of perennial weeds such as field bindweed.
- Vertebrate pest activity may increase or be hidden by mulches.

3 Types of Mulches Used for the Management Weeds and Diseases

Generally, there are two types of mulches including organic and inorganic mulches.

3.1 Organic Mulch

There are various positive attributes of the organic mulch, which effectively conserves the soil moisture through reduction in the water loss via evaporation, diminishes the soil erosion through wind and water, keeps the soil temperatures quite normal for the crop plants, hampers the growth and number of weeds, helps in development of beneficial soil microbes, and last but not the least decreases the spread of soil borne pathogens due to protection of the soil from splashing upon the crop plants during watering or rainstorms. Further, the mulching process can help in avoiding the mowing practices around trees and shrubs, which is also helpful in preventing mechanical injury to the tree trunks. Mulch also stops the process of heaving (i.e. upward protrusion of the plant roots out of soil) when it is used as a winter protection tool, during freeze and/or thaw periods. The eroded areas can also be stabilized, which helps prevent the soil erosion through wind and water both. Organic mulches get decomposed with the passage of time, which improve the soil quality and structure, and the nutrients are returned to the soil. The inorganic mulches are mostly utilized for creation of barriers to the growing weeds; and are sometimes used for the purpose of decoration. Inorganic mulches include rocks or gravels which do not decompose readily. The rocks absorb and then reflect heat that can be fatal to the plants in hot and dry weather conditions. Due to extremely slow decomposition, the inorganic mulches are not capable of improving the quality of the soil.

4 Different Types of the Organic Mulches

1. **Tree barks (softwood)**
   The softwood bark is also one of the by-products of the lumber and paper industries. The pine bark is one of the common examples of softwood and is mostly utilized under the larger trees and also the shrubs. The pine bark is somewhat acidic in nature i.e. having lower pH. It takes sufficient time to get decomposed, and does not required replacement quite often, unlike the other types of organic mulches do.
2. **Tree barks (hardwood mulch)**
   The shredded and torn hardwood is considered a by-product of the lumber and paper industries. The size of this hardwood ranges from shredded smaller chips to somewhat larger nuggets. This kind of mulching is mostly applied around the trees and/or shrubs and in the perennial beds too. The natural or dyed varieties contain this shredded bark. The dyed varieties are mostly a mixture of the hardwood or the recycled wood waste that contain the artificial dyes.
3. **Cocoa bean hulls/cocoa bean mulch**
   The cocoa hulls are one of the by-products of the chocolate industry. The weight of the hulls is light due to which they are easy to handle and can be used for any planting area. These hulls smell pleasantly as well. These should be applied up to one inch deep and must be watered lightly to hold them firmly. These hulls get decomposed rapidly and thus should be applied annually. These chocolate by-products are detrimental to the grazing animals if it is consumed; therefore it is better to choose another mulch type if there are pets frequent moving in the area. We can develop the leaf mulch at home with composting of the shredded and aged leaves that can be used in all types of garden beds. The leaves infected with scab, anthracnose, or leaf spot should be eliminated and must not be used in the compost for mulch purpose. The grass clippings should be spread in layers across the perennial beds and should be turned over when growing season is getting close to end. Dry up each layer before adding any additional layer. In addition, the application should not be made in thick layers because clippings get mat. Also, the clippings from lawns should not be used if the lawn is already treated with a herbicide or an insecticide. Further, the grass clippings that started seeding should not be applied in order to stop the growth of undesirable turf grass in the garden beds.
4. **Municipal tree waste**
   The utility companies and the city or village arborists mostly prepare mulches and make them available free of cost for the home owners. This type of mulch is normally composed of somewhat larger and not-aged wooden chunks. Thus, the fresh material use higher amounts of the soil nitrogen as it gets decomposed, and this mulch type is particularly useful in making pathways.
5. **Composted animal manure**
   Well-composted animal manure can also be utilized as mulch or as a soil amendment. This animal manure is a best option for any new planting beds because

it adds nutrients to the soil and boosts the soil quality. Fresh animal manures must not be applied in garden beds as the plant roots might be burnt with it. Extreme care must be taken when the animal manure is being used in the vegetable gardens. The manure must be well-composted before using it as mulch in temperatures between the ranges of 130–140°F for a period not more than a week, and be composted for about 4–6 months in order to eradicate the potential disease causing organisms. The layers of white and black newspapers may be applied for weeds suppression. Two to three layers can be applied at a time and must be covered with an organic material i.e. leaf mulch or grass clippings for the purpose of holding it in place. The newspapers will finally get decomposed which may then be incorporated into the soil.

5 Types of Inorganic Mulches

1. **Landscape fabric**
   The landscape fabric is the best choice for a long-term effect on the weeds suppression because the landscape fabric allows the water and air to pass through it. It is also used along with other organic mulches and gets decomposed more rapidly than any other inorganic mulch. Examples of stones include crushed gravel, marble chips, and volcanic rock. Stones cannot sustain moisture and thus cause heat stress on the nearby plants. The light reflection and ground heating causes the roots to burn.
2. **Plastic film (polyethylene)**
   The plastic film is an impermeable film i.e. in which the water and nutrients cannot penetrate. To warm the soil in spring vegetables the plastic film is used along the rows; however for long-term use, it is not the best choice. Plastic film gets deteriorated upon exposure to the sunlight and can be used for one season only.
3. **Rubber as mulch**
   The rubber mulch comprises of recycled or ground tires of the vehicles. This type of product is still under research; however, the initial studies showed some possibility of toxicity levels and also there is a risk of flammability as well. Also, the rubber mulch can be functional in the soil for an indefinite time. It is therefore not recommended for application in the home landscape practices.

6 Instances Where Mulches Worsened the Practice of Weeds Management

The organic mulch can enhance the soil acidity (i.e. lowering the soil pH) which negatively affects the crop productivity (Tables 1, 2, 3 and 4).

Table 1 Different types of mulches and their effect on weeds and crops (Chopra & Koul, 2020)

S. No	Mulch type	Crops	Weeds targeted	Impact	References
Organic mulch					
1	Alfalfa	Corn cropping system	*D. aegyptium*, *D. arvensis*	Rich in nitrogen; durable for long time	Lal (1974)
2	Ash	Garlic	*A. vineale*, *A. candanse*	Controls weed growth	Tiedjens (1940)
3	Bark	Used in vegetation and landscaping	*T. officinale*, *E. prostrate*	Moisture content remains high for long duration	
4	Dry leaves	Natural forest area	*D. bipinnata*,	Enrich soil with nutrients	David (2007)
5	Grass clipping	Gardens, groundnut, legumes	*L. aphaca*	Enhances the %age of the soil nitrogen because of its quick decomposition	Ashrif and Thornton (1963)
6	Newspaper	Vegetable garden Potting cups	*M. indica*	Controls weed; time saving; biodegradable	Ashrif and Thornton (1963) and Lal (1974)
7	Saw dust	Conifers, blueberries, strawberries	*C. album*, *S. media*	C-N ratio is higher, thus decomposes slowly; somewhat less nutritive, having longer moisture retention period	Kumar and Dey (2011)
8	Seaweed	Gardens	*C. arvensis*, *C. rotundus*	Provide minerals; reduce water requirement	Robinson (1988)
9	Stubble	Stevia, vegetables, wheat	*E. helioscopia*, *C. album*	Decrease water demand; reduces weed	Bilalis et al. (2002)
Synthetic mulch					
10	Plastic mulch	Cauliflower, stevia	*E. colonum* *A. viridis*	Controls weed; increases warmth	Isenberg and Odland (1950)
A	Black plastic mulch	Muskmelon	*A. retroflexus* *C. esculentus*	Large scale use; warmth is provided to the crop in winters; crop production is improved	Tiffany and Drost (2016)

(continued)

Table 1 (continued)

S. No	Mulch type	Crops	Weeds targeted	Impact	References
B	Clear plastic mulch	Muskmelon	*E. crusgalli*	Less solar radiations is absorbed; the soil borne diseases are reduced	Chakraborty and Sadhu (1994)
C	Red plastic mulch	Tomato, zucchini honeydews	*P. oleracea*	Reduce effect of early blight in many crops	Angima (2009)
D	Other colors plastic mulch (yellow, blue, grey mulch)	Black pepper	*C. esculentus, A. spinosus*	Used in winter crops; insect repellent; resulted in 2nd green revolution in India	
11	Gravels, pebbles, crushed stones	Gardens	*C. arvensus C. rotundud*	An inch layer can effectively control the emerging weeds	Sanders (2001)
12	Rubber	Home gardens	*P. lanceolata D. sanguinalis*	Can be applied easily in gardens, and easily available as well	Gupta and Yadav (1979)

Table 2 Mulching treatment for weed management in different crops (Chopra & Koul, 2020)

Crop	Types of mulches	Region of Experimentation	Outcomes	References
Blueberry	Black polythene mulch	Pennsylvania	Black plastic mulch effectively increases the yield and controlled the weeds	Gupta and Yadav (1979)
	Corn cob, sawdust, and wood chips	Pennsylvania	The wood chips and saw dust from the beech and red maple can effectively control the weeds growth	
Brinjal	Straw mulch, 30μ silver bicoloured, black plastic as mulch	The tropical and subtropical regions of Iindia (Bhagalpur, Bihar)	Highest yield-480.24 quintal ha^{-1} was achieved from a 30 μ bi-colored silver mulch Weeds were effectively controlled	Kumar et al. (2019)

(continued)

Table 2 (continued)

Crop	Types of mulches	Region of Experimentation	Outcomes	References
Carrot	leaf mulch, black polythene mulch, sugarcane straw mulch, paddy straw mulch, grass mulch, blue polythene mulch, white polythene mulch	Gwalior, M.P., India	54.69 tons ha^{-1} of yield was achieved with the help of black polythene mulch, as it is the maximum yield obtained from the various mulch plots Weeds were managed	Jaysawal et al. (2018)
Cauliflower	RD of N and K Polythene mulch with different conc. of OPE i.e. open pan evaporation	Assam, India	About 282.53 quintal ha^{-1} yield was achieved by using a bi-layer polythene mulch with 24.96 lit of OPE supplemented through drip irrigation $plant^{-1}$; 125% fertigation of N & K was done. Weeds were controlled too	Bhoutekar et al. (2017)
Garlic	Grass mulch and black polyethylene mulch	Addis Ababa, Africa	Reduced weed growth, increased soil moisture content and crop yield	Mahdiesh et al. (2012)
Lemon	Maize straw, Bajra straw, brankad, grasses, black polythene and FYM	At rainfed research sub-station, India	Maximum yield (1848 kg ha^{-1}) and soil content was obtained under black polythene mulch, followed by FYM mulch (1780 kg) and brankad mulch yield (1744 kg ha^{-1})	Kumar et al. (2015)
Maize	Plastic and straw mulch	Arid and semi-arid regions	Weeds were managed and increase in yield was 60%; plastic-mulch better than organic mulch in efficacy	Qin et al. (2015)
	Legume mulch: Leucaena twig mulch, Sunhemp, Sunhemp + Leucaena	Selakui, Dehradun India	Control soil erosion; reduce number of weeds; 59.3 kg ha^{-1} increase in N uptake recorded for Leucaena + sunhemp mulch, and 2.36 tons ha^{-1} yield increase	Sharma et al. (2009)

(continued)

Table 2 (continued)

Crop	Types of mulches	Region of Experimentation	Outcomes	References
Onion	Water hyacinth, Rice straw mulch	Dhaka, Bangladesh	Yield was increased with water hyacinth mulch and weeds infestation was decreased 10.46 tons ha^{-1} yield was obtained	Larentzaki et al. (2008)
Musk melon	Grass mulch, black polythene mulch, polythene (transparent) mulch	MPKV, Rahuri, India	Black polythene mulch and grass mulch were more effective than transparent mulch causing 80.02% weed control; increase in yield ha^{-1} was achieved	Johnson et al. (2004)
Potato	Straw as mulch	Northern Hessen, Germany	Aphids and weeds infestation was much reduced	Saucke and Doring (2004)
	Plastic mulch	North China Plain, China	Decreased weeds and increased yield	Wang et al. (2008)
Stevia	Poplar leaf, pine needles, tree leaf mulch, silver oak	Western Himalaya, India	poplar mulch and silver oak mulch both enhance the nutrition matter of the soil, also decrease the weed growth	Kumar and Dey (2011)
Strawberry	Blackpolythene,transparent polythene, plastic mulch	Punjab, India	Black polythene proved to be most useful in attaining 41% higher fruit yield and effective weed control	Rajbir et al. (2006)
	Wheat straw, paddy straw, saw dust, cut grass, black polythene, and transparent polythene	Chatha, Jammu, India	The black plastic as mulch highly effective causing 7% increase in total sugar content, 11.83 g increase in fruit weight, 3.93% increase in fruit length, and 143.38 g increase in total yield/plant	Bakshi et al. (2014)

(continued)

Table 2 (continued)

Crop	Types of mulches	Region of Experimentation	Outcomes	References
Sugarcane	Straw, no straw, straw burnt on soil	Bandeirantes Paraná, Brazil	Highest suppression of weeds was recorded under 75 and 100% straw mulch treatments	Hoshino et al. (2017)
Tomato	Black polythene mulch, Straw mulch Strawmulch + different combinations of drip system	Bangladesh	Black mulch increased the yield, also increased C-content upto 27.07%. Weeds were decreased	Cong et al. (2005)
Wheat	Plastic and straw mulch	Arid and semi-arid regions	Weed control and increase in yield Plastic mulch was more effective than straw mulch	Qin et al. (2015)
	Legume mulching: Leucaena twig as mulch, Sunhemp as mulch, Sunhemp + Leucaena as mulch	Selakui, Dehradun, India	Weeds were controlled 69.5 kg ha^{-1} increase in N uptake through sunhemp + Leucaena mulch; 2.38 t ha^{-1} increase in yield	Sharma et al. (2009)
Winter Pigeon pea	Paddy straw mulching, sugarcane trash@ 8 t ha^{-1}	B.C.K.V, Jaguli, Naida, West Bengal, India	the yield was increased upto 2.07 t ha^{-1} with sugarcane trash mulch. Weed management was also effective	Basu et al. (2009)

Table 3 Type of mulch and soil used in accordance with the existing conditions

S. no	Type of mulch used	Soil type/area/crop stage	References
1	Thinner film	Early germination	Ngouajio (2011)
2	Clear plastic mulch	Field prone to Soil born diseases	Chakraborty and Sadhu (1994)
3	Silver color film	Insect repellent	Penn State Extension (2015)
4	Stubble	Nutrient deficient	Orzolek and Lamont (2015)
5	Thicker mulch	Orchard mulch	Orzolek and Lamont (2015)

(continued)

Table 3 (continued)

S. no	Type of mulch used	Soil type/area/crop stage	References
6	Black film plastic mulch	Saline water area	Sanders (2001)
7	Black film	Sandy soil	Orzolek and Lamont (2015)
8	Thin and transparent film	Soil solarization	Ngouajio (2011)
9	White film	Summer cropped land	Orzolek and Lamont (2015)
10	Sea weeds	Water deficient area	Robinson (1988)
11	Black film plastic mulch	Weed control in cropped land	Penn State Extension (2015)
12	Transparent film	Weed control through solarization	Sanders (2001)

Table 4 Enhancement in soil moisture content under different mulches

Crops	Types of mulches used	Mulched plots	Non-mulched plots	Percent increase	References
Allium cepa	Grass mulched	18.20	17.1	0.30	Larentzaki et al. (2008)
Sugar beet	Peat	19.70	17.5	2.6–7.3	Lal (1974)
Gardens	Dry leaves	12.42	10.13	6–8	Ashrif and Thornton (1963)
Mustard	Sawdust	22.70	17.2	3.8–6.1	Kumar and Dey (2011)
Maize	Sunhemp + Leucaena	14.62	12.54	19.90	Sharma et al. (2009)
Tomato	Straw	100	86.1	16–27	Cong et al. (2005)
Potted shrubs	Bark chips	12.17	9.34	20–23	Stelli et al. (2000)

7 Conclusion and Recommendations

Mulching provides a favourable environment for effective utilization of plant biomasses, food wastes, organic manures and other biological materials for the purpose of improving the growth and yield of crops. Bio and organic amendments in mulched plots along with reduced dose of inorganic fertilizers play a vital role in improving the physical, chemical and biological characteristics of soil, thereby optimizing the yield potential of crops. The use of organic mulches under water stress condition along with the systematic inputs of organic fertilizers including bio fertilizers may be recommended for sustainable farming (Fig. 1).

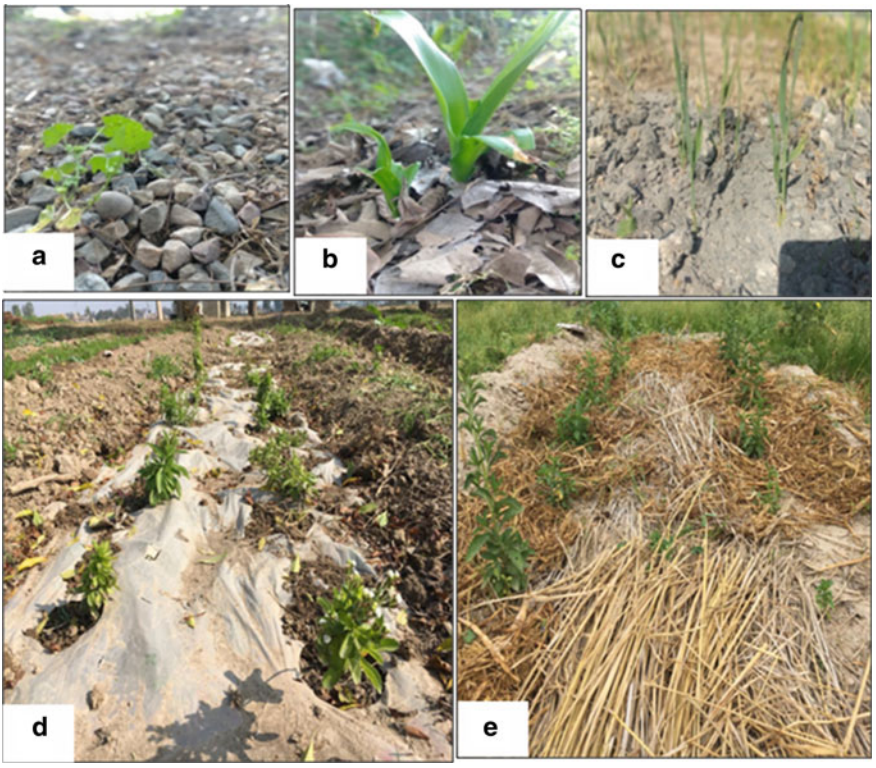

Fig. 1 Various fields where different mulches are used: **a** Pebbles as mulch, **b** Dry leaves as mulch, **c** Ash used as mulch, **d** Plastic used as mulch, **e** Stubbles as mulch

The role of mulch is not ignorable in agricultural practices. Like a coin having two sides, mulches also have some positive as well as negative impacts on the associated crops, weeds and soils. In addition, mulching helps in soil moisture retention, in controlling weeds growth, and in enhancing the crop yields. It also affects the soil pH, making the soil acidic that indirectly diminishes the fertility of soil and then decline the crop yield ultimately. Therefore, the selection of proper mulches by farmers is an important aspect with the purpose to increase the crop productivity. Thus, mulch type must be chosen by considering the soil type, the crop that is to be cultivated, the climatic conditions of the area, and the target weeds to be managed.

The physical methods also play major role in the organic and integrated plant protection strategies. Like the vegetable crop, mulches must also be regularly applied in the medicinal plants under row cultivation. There are numerous similarities in growing the vegetables and the medicinal plants including the fact that both are grown in smaller areas, pesticides are limitedly used in both and the weeds are the major trouble in their cultivation. Therefore, out of the various physical weed control methods, mulches seem to be the best option.

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