Plastic film mulching: economical, efficient water saving and yield enhancing technology for sugarcane

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Abstract

Mulching is a process of soil surface management in such a way to reduce water losses though evaporation from the soil surface. There are different types of mulching techniques starting from shallow plowing or harrowing to organic like trash mulching and polyethylene sheet application that is widely used in vegetables production. Polyethylene sheet mulching also reduces weed infestation while black. In sugarcane transparent polyethylene sheet is practiced in China. It improves sugarcane germination by increasing soil temperature in cold season for at least five days. It also improves germination up to 15-20%. It saves water for first 80-90 days (4 irrigations). Fine plastic film imported from GSIRI, China was tested on farmers' fields/sugar mills' farms on seven locations in different areas of sindh. It proved that cane yield can be increased by 152 maunds with a net profit of rupees 21000/- per acre. Moreover due to raising soil temperature, in lower Sindh where sugarcane is planted late during November onward after harvesting paddy, this technology is quite better to improve germination.

Mulch & Mulching

A mulch is a layer or cover of material applied to the surface of an area of soil. Its purpose is any or all of the following:

- to conserve moisture
- to improve the fertility and health of the soil
- to reduce weed growth
- Moderate soil temperature during hot weather.

Mulching: The practice of covering the soil/ground to make more favorable conditions for plant growth, development & efficient crop production. The practice of mulching may yield many other benefits to growing crop.

Types of mulch:

1) Soil hoeing (Shallow hoeing)

- It acts like a mulch
- Fine hoed soil decrease moisture evaporation from soil surface by breaking capillary

action.

- **Enhance water availability for 20 days**

- **Deep plowing is not good because**
  - It increase air circulation and hence decrease soil moisture.
  - It may break roots.

2) Organic mulches

- *Grain straw/ hay* 0.55% N, 0.07 % P, 0.83% K
- *Wood shavings/saw dust*
- *Tree leaves/litter* 1.3% N, 0.2% P, 0.7%K
- *Cotton gin waste*: 2.8% N, 0.2% P, 0.6% K
- *Peat moss:*
  - These are valuable, wildlife habitats & one of the largest store of carbon.
  - Its long lasting & packaged behavior make it convenient as a mulch.
  - When wetted & dried, it forms a dense crust that not allow water to soak in.
  - Lower the pH of soil, making it useful to acid loving plants.
  - It is costly and less available.

	
Straw mulch	Peat moss

3) Cover crops (living mulch)

Groundcovers are plants which grow close to the ground, under the main crop and provide benefits of mulch.

They are usually fast-growing, e.g. **Clovers** & food legume **Masoor.**

Cover crops

- Suppress weeds
- Protect soil from rain or runoff
- Improve soil aggregate stability
- Reduce surface crusting
- Add active organic matter to soil
- Fix nitrogen
- Scavenge soil nitrogen
- Suppress soil diseases and pests

4) Trash mulch

Trash of cane can be used as mulch by:

- **A) Soil surface incorporation**

- **B) Soil cover application/trash blanket**

Trash mulching can

- Normalize (Increase/decrease) soil temperature.
- Conserve soil moisture.
- Suppress weeds growth.
- Improve nutritional status of soil:
  - On decomposition cane trash adds: 5.3 kg N, 1.1 kg P & 5.8 kg K per ton of trash to soil
  - K requirements reduce by 25-30 Kg/ha
  - N requirement reduce by 50-60 Kg/ha
- Soil microbial activities increased
- Trash conserve parasites and predators
  - Survival rate of pest larvae is low
  - More incidence of spread of natural enemies
  - Pests infestation is markedly reduced
- Used in ratoon crop.

Table-1. Impact of trash mulching

Treatment	Cane yield t/ha	Increase t/ha
Trash burning	83.9	--
Trash blanket	95.1	11.2
Trash lined in each inter-row	90.1	6.2

Source : McIntyre et al 1996

5) Plastic sheet mulches: Latest mulch about 60 years old

- **Plastic mulch** is either made up of polypropylene polymers or it is made up of polyethylene polymers. These are technically biodegradable but break down is very

slow. Hence these need manual removal at the end of the season. Initially break down into ketones & aldehydes that pollute soil.

- **Quality biodegradable mulches**
  Quality biodegradable mulches are made from plant starches and sugars or polyester fibres such as of wheat and corn. These mulches start break down from heat & Microorganisms in soil decompose it to water & CO_2, with no toxins.It is of less manual labour since it does not need removal at the end of season and can be tilled into the soil. However, these are more delicate & be placed on a less hot day with less tension.

Advantages of plastic mulching

- It capture sunlight and warm the soil even in night that increase germination and growth rate.
- Herbicides coated mulch suppresses weeds.
- These also can be placed by machine or hand.
- It is completely impermeable to water. It prevents direct evaporation of moisture form soil thus conserves moisture and prevents salts accumulation.
- By conserving moisture it also reduces loss of plant nutrient through leaching.
- It provides a barrier to pathogens hence reduce insect attack
- When compared to organic mulches, it serves for a longer period to conserve moisture.

Table 2. Plastic mulch effect on maize (TNAU)

Treatment	Seasonal total water (mm)	Yield (kg/ha)	WUE (kg/ha/mm)
Control	463	5562	11.90
Plastic mulch with 20 µm	373	5650	15.10
Cumbu straw	401	5594	13.90
Coir pith	403	5466	13.86

Table 3. Effect of plastic mulch on yield & quality sugarcane (Millard, 1974)

Treatment	Cane yield t/ha	Est. recoverable sugar %	Cane population 000/ha
Control	133	9.9	139
Plastic on row	158	10.1	147
Plastic on inter-row	129	10.2	131

Sugarcane plastic mulching in Pakistan

- It is mainly practiced in vegetables
- It is also practiced in some orchards.
- In other countries it is also being practiced in crops like maize and sugarcane.
- It is now being introduced by PARC in collaboration GSIRI China and as well sugar mills of Pakistan.
- 1st time it was practiced in 2010-11 in Sindh.
- In china its use is on about 7 million ha/annum

Plastic mulching on Sugarcane in Pakistan

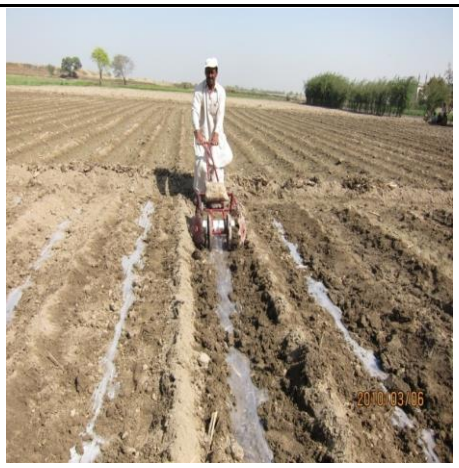
Manual plastic mulching	**Mechanized mulching**	**Emerging of sugarcane plants**
		

Table 4. Impact of plastic mulching in sugarcane at different locations in Sindh

Site/Location	Brix (%)		Yield (t ha^{-1})	
	PFM	No PFM	PFM	No PFM
Sarfraz Nizamani Farm Jhirk site, Thatta	22.5	22.6	107.5	89.2
Ramesh Farm, Chohar Jamali, Thatta	21.7	21.4	116.6	100.0
Habib Sugar Mill Farm, S. Banzirabad	21.9	21.3	148.3	125.0
Faran Sugar Mills Farm, Sh. Bhirkio,TMK	22.7	22.6	105.0	98.3
Average	22.2	21.9	119.4	103.1

PFP: Plastic film mulching

Table 5. Impact of herbicidal plastic mulch on sugarcane at Makli Farm, Thatta

Treatment	Weed Control	Germination (%)	Yield (t ha^{-1})	Yield Increase (%)
Chinese Film	Broad/Narrow	65	126.6	11.7
Local film	Broad leaves	60	121.6	7.3
Control	None	45	113.3	--

Table 6. Plastic film mulching Cost of production/income

Item	**Description**	**Amount**
A) Cost of application of plastic film per hectare	Rs. 12500+5000 (labour) +3750 (weedicide)	Rs. 21,250/ha
B) Yield of Control (4 trials, 2011-14)	89.2-125 t/ha	105.3 t/ha
C) Yield of mulched plots (4 trials, 2011-12)	105-148.3 t/ha	120.9 t/ha
D) Yield increase	6.7-23.3 t/ha	15.2 t/ha
E) Additional income @ Rs 4500/ton	15.2 x 4500	Rs. 68,400
F) Water saving (4 irrigations)	Rs. 1250/irrigation/ha	Rs. 5,000
Net income	**E + F - A**	**Rs. 52,150/ha or 21000/acre**

Impacts of Plastic mulching noted in the field are:

- Plastic film increased soil temperature by 4 °C and humidity by 5-10%.
- It increased germination by 20%.
- Early germination by 5-7 days
- Increased yield by 6.7-23.3 t/ha
- Can be used on plant and ratoon crops
- Conserve/saved water up to 90 days.
- In lower Sindh after harvesting paddy, sugarcane is planted late during November onward, then this technology is quite better to improve germination

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