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Effect of Mulch on Soil Moisture, Temperature, Weed Infestation and Winter Season Lac Yield of Ber *(Ziziphus mauritiana)* under Rainfed Condition

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Abstract Lac cultivation on ber *(Ziziphus mauritiana)* is a profitable option of agriculture for the farmers of Jgharkhand, Chhattisgarh, Odisha, Madhya Pradesh, West Bengal. Water management has been established to be an important facto for quality broodlac production. An experiment was conducted during 2010-2013 to study the impact of mulching with two polyethylene mulches, viz. black and clear transparent and three in form of grass mulch, soil mulch and lac mud for conservation of soil moisture, soil temperature, weed suppression and lac yield of ber *(Ziziphus mauritiana),*in comparison to control (no mulch application), comprising four replications. The soil moisture conservation was higher in black polyethylene followed by clear transparent polyethlenr and grass mulch. Transparent and black polyethylene greatly increased soil temperature, with thee transparent variety giveng the highest temperatures and grass mulch, the lowest. Mean soil temperature under grass mulch was lower by 1.3, 1.4 and 1.2^0 C compared to clear polyethylenr mulch in 2011, 2012 and 2013, respectively. The maximum reduction in weed population was observed in black polythylene and the lac production was more under mulch treatments in general, though not significantly, barring the year 2011-12 under rainfed condition.

Keywords Lac, Mulches, Soil moisture, Soil temperature, Weed reduction

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Introduction

Mulching is known to positive affect the soil plant system : soil temperature, reducing evaporative humidity, good weed control and increased yield with better qualititative traits [1]. Mulches reduce water evaporation from soil and help maintain stable soil temperature [2]. Conservation of soil moisture is one of the major advantages of mulch farming system [3]. Anikwe et al. [4] and Kumar and Lal [5] had also reported that the use of polyethylene mulch has conserved soil moisture.

Mulching benefits yield by improving soil physical conditions, including improved stability in the topsoil [6]. Mulches are also important for weed comntrol [7, 8]. Besides, mulching improves plant growth, yield and yield quality [9, 10].

Lac is a natural resin, secreted by a tiny insect known as lac insect. The Indian lac isect *Kerria lacca* (Kert) (Homoptera : Tachardiidae) is cultured for commercial production on traditional host plants *palas (Butea monosperma) ber (Ziziphus mauritiana)* and *kusum (Schleichera oleosa).* Two strains of *Kerria lacca* i.e., *rangeeni* and *kusmi* contribute significantly in lac production. *Rangeeni* strain produces two crops in a year known as *katki* (rainy season) and *baisakhi* (summer season) crop while *kusmi* strain also produces two crops in a year known as *aghani* (winter season) and jethwi (summer season) crop. Ber is a hardy host plant on which both the strains of lac insect can be grown and good quality lac *(kusmi)* can be produced on it with higher productivity.

It was reported that grass/straw mulch had a significant impact on plant growth and development of ber during establishment stage in studies carried out at Indian Institute of Natural Resins and Gums [11, 12]. Hence, an attempt was made to assess the effect of different kinds of mulches with respect to changes in soil moisture, temperature, weed infestation and lac yield of ber

Materials and Methods

Study area and mulching details

The experiment was carried out at Indian Institute of natural Resins and Gums Farm. Ranchi ($23^0 23´$ N longitude, $85^0 23´$ E latitude, and 650 m above MSL) from July 2010 to June 2013. The average annual rainfall is 1326 mm of which on an average 1127 mm (85%) is received from June to September minths. Soil of the experimental plot was of sandy loam texture, soil reaction 4.38, organic carbon 0.29%,bulk density 1.41 g cm^{-3}, available N 144.16, P_2O_5 10.62 and K_2O 157.75 kg ha^{-1} with 20.8% field capacity, 10.9% permanent wilting point and 41.7% porosity.

The experiment was laid out in randomized block design with plot sizes measuring 12 m × 4 m area replicated four times in an area measuring 11.52 m^2 (–0.1152 ha) with six treatments. Each treatment consisted of 12 ber plants of uniform size with 4 m × 4 m plant to plant and row to row spacing. Five mulch treatments and an unmulched treatment were applied. The treatments were unmulehed control (T_1), black plastic polyethylene film mulch (T_2), transparent/clear polyethylene film mulch (T_3), grass mulch (T_4), soil mulch (T_3), grass mulch (T_4), soil mulch (T_5) and lac mud mulch (T_6). For polythene mulch treatment, black and transparent polyehylene film of 2.0 m diameter with 0.001 mm (100 μ) thickness was spread uniformly in the basin area of individual plant. Grass mulch was applied in the same area at the rate of 9.3 t/ha. For soil mulch, upper crust of the soil, up to 10 cm depth, was tilled once during the crop cycle. Lac mud, a waste product of lac, was applied in the rate of 8.3 t/ha.

Soil moisture and temperature

The soil moisture was measured at fortnightly interval (13—15 days interval) throughout the year barring monsoon period (June-September) by gravimetric method from 0-30 and 30-60 cm depth of soil profile. Delayed imposition of mulches allowed the data recording from November, every year. The soil different depths was sampled by manual coring and gravimetric moisture content (g/g) of the soil samples was calculated on even dry weight basis and converted into volumetric moisture content (cm/m). Soil temperature from each treatment at 30 and 60 cm depth was recorded at the time of collecting the soil sample for moisture analysis by digital thermometer with an accuracy of ± 1.0% range. For the year 2010-11, the soil temperature could be tecorded fro February 2011 onwards.

Weed infestation

The occurrence and extent of weeds were studied at the time of mulch imposition (October-Novemver) and at the removal of mulch material (1st week of June) every year in a 0.5 m2 quadrant from each treatment across all the replications; thus making a total pf 24 observations. The above-ground parts were clipped with a secateur at soil surface, oven dried at 65^0C for 48 hours and weighed with a digital balance to determine the dry matter (DM). The weed suppression percent by weight was calculated by

$$\text{Weed suppression (\%)} = \frac{\text{(Wt.of DM at the time of mulch imposition – Wt pf DN at the time of removal of mulch material)}}{\text{Wt. of DM at the time of mulch imposition}} \times 100$$

Table 1. Mean soil moisture (%) under various treatments during different years. *BPS- Black polyethylene sheet, TS-Transparent sheet, GM- Grass mulch, SM-Soil mulch, LM-Loc mud.

Treatment	2011 (Jan-Dec)	2012 (Jan-Dec)	2013 (Jan-May)
T_1- Control	11.97	12.03	10.93
T_2 - BPS*	17.33	15.73	14.44
T_3 - TS*	15.95	13.52	12.90
T_4 - GM*	14.16	13.54	12.00
T_5 - LM	12.68	12.70	11.22
SEm (±)	0.42	0.34	0.23
CD at 5%	0.88	0.73	0.49

Table 2. Mean soil temperature (^{0}C) under various treatments during different years.

Treatments	2011 (Feb-Dec)	2012 (Jan-Dec)	2013 (Jan-May)
T_1	23.2	22.6	23.6
T_2	23.8	23.4	24.2
T_3	24.2	23.6	24.3
T_4	22.9	22.2	23.1
T_5	23.6	22.6	23.7
T_6	23.2	22.6	23.2
SEm (±)	0.16	0.11	0.11
CDat 5%	0.25	0.23	0.23

Lac yield attributes

Inoculation of broodlac on ber plants for winter season (aghani) crop was done as per ahoot length available and the mean rate was 250, 400 and 500 g/tree during July-August in 2010, 2011 and 2012, respectively and the crop was harvested during February-March every year. Data on broodlac yield ratio and broodlace thickness was recorded.

Results and Discussion

Soil moisture

Table 1 shows that these was improvement in moisture conserved under different mulching treatments. For all the three years, moisture conservation under black polyethylene (T_2), transparent polyethylene (T_3), and grass mulch (T_4) were found significantly superior over control (T_1). Remaining three treatments T_1, T_5 and T_6 were at par between them. T_2 was also found significantly superior over T_3 and T_4 terms of soil moisture conserved. This means that black plastic mulch reduced more soil water evaporation than the other used mulch materials and, thus helped retain soil water.

Soil temperature

Results indicated that for all types of mulches, maximum soil temperature was recorded under transparent polyethylene sheet. Mean soil temperature under grass mulch was lower by 1.3, 1.4 and 1.2^{0}C compared to transparent polyethylene sheet in 2011, 2012 and 2013, respectively (Table 2). The reason may be attributed to the fact that the under surface of clear plastic mulch is usually covered with condensed water droplets. This water is transparent to incoming shortwave radiation but is opaque to outgoing long wave infrared radiation; so, much of the heat lost to the atmosphere from bafre soil by infrared radiation is retained by clear plastic mulch. The prevention of direct contact of solar radiation alongside increased moisture content with the soil by the organic mulches explains the low soil temperature under grass mulch. The effect of mulching materials on soil temperature obtained in this study in agrement with those reported by El- Shaikh and Fouda [13] and various other researchers, who have done experiment on this aspect.

Weed infestation

Black polythene, grass mulch and soil mulch showed least weed infestation compared to the control (unmulched) and transparent polythene (Fig.1). At the time of mulch removal from the plots, the

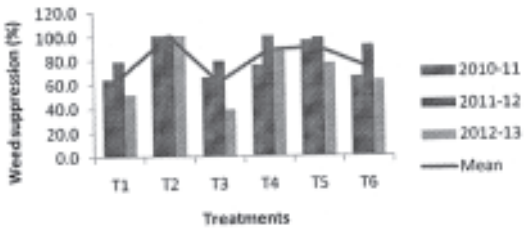

Fig. 1. Weed suppression (%) under different mulches in different years.

Table 3. Lac crop yield parametrs for ber under different kind of mulches (2011-13).

Treatments	201-11 Yield ratio	201-11 Brood thickness (mm)	2011-12 Yield ratio	2011-12 Brood thickness (mm)	2012-13 Yield ratio	2012-13 Brood thickness (mm)
T_1-Control	9.8	4.3	2.8	3.0	0.9	2.8
T_2-BPS	11.2	4.7	4.3	2.9	1.3	3.4
T_3-TS	11.0	5.5	4.8	5.7	1.6	3.6
T_4-SM	10.7	5.1	2.5	3.2	0.8	2.5
T_5-LM	7.3	4.2	2.8	2.5	1.1	2.8
SEm (±)	2.45	1.25	0.67	1.41	0.67	0.93
CD at 5%	NS	NS	1.4	NS	NS	NS

unmulched plots and transparent polythene showed greater weed coverage. Black polythene mulch gave the highest (100%) mean weed suppression whereas the transparent polythene treatment gave the least (61.4%) suppression. Thus, black polythene mulch proved to be the most effectivefor weed suppression than any other treatments. The result obtained was in conformity with Mamkagh [14]. Hatami et al. [15] and Singh and Kamal [16] who have reported that in addition to the positive role of black polyethylene mulch in soil moisture conservation, it inhibits weeds growth as an extra benefits.

Lac yield

Analysis of data for ber for the winter crop season 2010-11 showed the maximum yield ratio (11.2:1) with black polyethylene, while maxmum thickness of encrustation (5.5 mm) was observed with transparent polyethylene mulch. Lac mud showed (Table 3) the least yield ratio (7.3:1) and thickness (4.2 mm).

For 2011-12, transparent polyethylene mulch showed the maximum yield ratio (4.8: 1) and broodlac encrustation thickness (5.7 mm). The lowest broodlac yield ratio was found under soil mulch (2.5:1), which broodlac thickness was found to be lowest in lac mud (2.5 mm). The data analysis showed the significant difference in broodlac ratio under white transparent polyethylene over control. Similarly, clear polyethylene mulch showed the maximum yield ratio (1.6:1) and broodlac thickness (3.6 mm) in 2012-13 crop season. The lowest broodlac yield ratio (0.8:1) with broodlac thickness (2.5 mm) was found to be under soil mulch. Table 3 shows that barring the crop year 2011-12, where transparent polyethylene, black polyethylene and grass mulch showed the significant difference over soilmulch. lac mud and control treatments; they were statistically at par in all other years i.e., treatments. Both black polythene mulch and transparent polythene mulch have registered significantly higher lac yield ratio over soil mulch, lac mud mulch and control. Increased soil moisture under these mulches might have caused improved lac yield ratio over other mulch types.

Conclusion

It is concluded that mulch treatments, in general, were found superior over control in terms of increased soil moisture, soil temperature, weed suppression and lac yield. For all the three years, black polyethylene conserved the maximum soil moisture and weed suppression was also the maximum under this treatment. Maximum soil temperature was recorded under transparent polyethylene. However, soil mulch and application of lac mud do not have significant bearing on improving soil moisture and controlling soil temperature in ber plant periphery. Black and transparent polyethylene film alongside grass mulch is clearly the better option to go with. Grass mulch seems to be the best option with resource-constrained farmers as it also improves soil organic matter in the long run and is environment friendly.

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