EFFECT OF DIFFERENT ORGANIC MULCHES ON THE CANE YIELD AND RECOVERY IN SUGARCANE

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ABSTRACT: *Mulching is an effective practice to conserve soil moisture, particularly for sugarcane which is heavy feeder and remains in the field more than a year's time. A field trial during 2011-12 was conducted at National Sugar and Tropical Horticulture Research Institute (NSTHRI), Thatta to examine the impact of organic mulches on cane yield and recovery in sugarcane. Sugarcane trash, banana leaves and rice straw were used as mulching materials and mulching effects were compared with control. The results showed that sugarcane field mulched with banana leaves was most effective to produce 259.33 cm cane length, 3.45 cm cane girth, 7.24 tillers stool^{-1}, 18.15 internodes cane^{-1}, 15.61 kg weight of 10 canes, 99.91 tons cane yield ha^{-1}, 23.11 brix and 11.56% recovery. The sugarcane trash mulching ranked second with 92.66 tons cane yield ha^{-1}, 22.75 brix and 11.38% recovery; mulching with rice straw ranked third with 90.50 tons cane yield ha^{-1}, 23.07 brix and 11.53% recovery; while sugarcane fields without mulching (control) showed lowest overall crop performance and recovery. It was concluded that sugarcane fields mulched by banana leaves caused effective suppression of weeds, conserve moisture most effectively and when processed in soil after irrigation banana leaves mulching also acted as the compost to improve crop performance. Whereas, the crop mulched with sugarcane trash and rice straw showed similar performance for all the traits studied. However, there was no linear trend of effectiveness for mulch materials on brix content and recovery.*

Key words: Sugarcane, mulching, banana leaves, rice straw, sugarcane trash, cane yield, brix, recovery

INTRODUCTION

Sugarcane, *Sachharum officinarum* L. is an economically important plant in the Gramineae family as it is the best source of producing white sugar in the world [1]. Sugarcane is also viable source of livelihood for millions of people in Pakistan [2]. On the basis of area Pakistan ranked 5th position and is the 15th largest sugar producer in the world. Sugarcane is cultivated on about one million hectares and is the main source of the raw material for 84 sugar mills and provides employment and returns for the agricultural community of the Country, which is the Pakistan's second biggest and important agro-industry after textiles. The area under sugarcane in Pakistan during 2014-15 was 1.141 million hectares showing 2.7% decrease over preceding year; and production this year was 62.652 million tons indicates 7.1% decrease over the last year production; while the yield ha^{-1} remained 54.91 tons showing a 4.5 percent decrease over the preceding year [3]. This indicates a significant decreased in the overall sugarcane production in the country which might be linked with a variety of factors including shortage of water and other management lacks. However, there are several cultural practices that are viable to conserve soil moisture and water shortage can be dealt with including use of organic mulches. The organic mulch materials not only conserve soil moisture, but also effective to suppress weeds; and the materials after continuous initial irrigations become compost and to some extent can improve the soil organic matter as well.

There are several techniques for water consideration and mulching is one of the most important and effective techniques in agriculture, it is the method in which organic or synthetic materials are placed above the soil and near the plants as to provide a better environment for growth and development of crop plants [4, 5, 6 & 7]. Mulching has good impact on crop return, standard and time of harvesting. Some of mulches are also good repellent of insects [8]. Mulching works as a tool which increases the soil moisture by controlling evaporation from the soil surface [9], improves infiltration [10]. To protect the soil from water erosion and wind erosion, covering the soil is necessary. This can only be achieved by using mulch in agriculture [11]. Mulches have been widely used in agriculture to minimize evaporation from the soil, to speed up plant growth in low temperatures by rising soil temperature, to lessen erosion and to help in controlling weeds [12].

Due to environmental concerns, increasing casts and negative impacts of chemicals including herbicides/weedicides on soil and plant health as well as great usage of hybrids, short physique and high yielding varieties in various crops the amount of organic matter in the soil is reduced, usage of farmyard and green manure is also very limited and most of the plant residues are consumed as fuel inclusion of organic mulching materials is very necessary [13].

Mulching minimizes the worsening of soil by avoiding the runoff, decreases the weed invasion and reduces the evaporation rate. In this way it helps in soil moisture preservation, control of temperature instability, improving soil physico-chemical and biological properties, as put in essential elements to the soil and to enhance crop growth and yield [7]. For the living soil microbial population must be 108 per cubic centimetre and for this population adequate amount of organic matter is needed for their survival, development and reproduction [14]. Residues of commonly growing crops are not only major source of considerable amount of nutrients but also influencing quality, physico-chemical and biological functions and properties of soil and water [15]. According to [16] the efficiency of water was highest in sugarcane when applied at 0.9 IW:CPE ratio with mulching as compared to 0.6 and 1.2 IW:CPE ratio when the soil was not mulched. While, the maximum efficiency of water was examined with 0.6 IW:CPE ratio under the trash mulching than 0.9 and 1.2 IW:CPE ratios. The current study was mainly aimed at

examining the effect of organic mulches including banana leaves, rice straw and sugarcane trash on cane yield and recovery in sugarcane.

MATERIALS AND METHODS

The present study was conducted during 2011-2012 to investigate the effect of organic mulches on the yield and sugar recovery of variety Thatta-10. The experimental trial was designed at the research area of National Sugar and Tropical Horticulture Research Institute, Thatta in RCBD with three replications having net plot size of 14m x 3m ($42m^2$). Seedbed preparation was adopting following the recommended land preparation practices. Initially deep ploughing with disc plough was operated and after deep ploughing the ploughed field was left for a fortnight time; followed by precision land levelling by laser leveller. After soaking dose, the experimental fields were given gobal plough, followed by rotavator; and then the ridges were developed at intra row distance of 90 cm. The planting of sugarcane variety Thatta-10 was done by placing the seed sets by end-to-end method. After completion of germination, the banana leaves, rice straw and sugarcane trash were spread systematically to cover the ground completely and kept the seedling apparent, so that mulch may not constrain the seedling growth. The control plots in all three replications were kept un-mulched.

The recommended dose of fertilizers as N=220 kg ha^{-1}, P=120 kg ha^{-1} and K=100 kg ha^{-1} was applied. Total amount of Phosphorus, Potash and $1/3^{rd}$ of Nitrogen was applied during plantation and remaining Nitrogen was applied in two equal parts, first at 1^{st} earthing up (3-1/2 months after planting) and second after 1-1/2 month of 1^{st} earthing up respectively. The growth and cane yield parameters were measured at the field; while brix and recovery were determined in the laboratory. The procedures adopted for recording observations as under:

Cane length: It was calculated at the field from the selected sugarcane plants with the help of measuring tape in centimetres from base of the plant up to the last internode and averaged.

Cane girth: It was recorded in centimetres from each plot from selected plants with Vernier Calliper and averaged.

Tillers $stool^{-1}$: Tillers were calculated by totalling the stalks germinated in each plant from the selected plants in each plot and averaged.

Internodes $cane^{-1}$: The Internodes were calculated from the base of the plant till the last internode from selected plants in each plot and averaged.

Weight of 10 canes (kg): 10 canes were selected from each plot and weighed in Kilograms.

Cane yield ha^{-1}(mt): Yield per hectare was recorded from the following formula:

$$\text{Cane yield (m.t ha}^{-1}) = \frac{\text{Yield plot}^{-1} \text{ of given treatment}}{\text{Plot area (m}^2)} \times 10000$$

Brix (%): It was calculated by putting a drop of juice, placed on the prism of the Refractometer and noted the reading.

Sugar recovery (%): It was calculated according to the procedure and method described in laboratory manual for Queensland sugar mills [17].

The statistical analysis and mean separation tests were applied following Steel and Torrie [18].

RESULTS

Cane length (cm)

The effect of different mulching materials on the cane length was statistically significant ($P<0.05$) and cane length was markedly highest (259.33 cm) in plots mulched by banana leaves, while cane length reduced considerably in plots mulched by sugarcane trash and rice straw with average cane length of 243.33 cm and 241.67 cm, respectively (Table-1). Where the minimum of 232.33 cm cane length was examined in check plots, whereas the soil surface was left uncovered. This indicates that weeds banana leaves resulted in weed suppression more effectively than the sugarcane trash and rice straw, and banana leaves worked as compost that contains sufficient amounts of potassium and other nutrient elements. The variations in LSD test indicated that the cane length mulched by sugarcane trash and rice straw was statistically non-significant ($P>0.05$) but significant ($P<0.05$) for the rest of the mulching treatments and control. These findings are well supported by results of [19] who found that trash mulching improved cane length over no mulching.

Cane girth (cm)

The statistically significant ($P<0.05$) differences in sugarcane variety Thatta-10 for cane girth were observed in between different mulching materials. The maximum cane girth of 3.45 cm was recorded in plots mulched by banana leaves, followed by average cane girth of 3.16 cm recorded in plots mulched by sugarcane trash; while cane girth decreased considerably to 3.14 cm in plots mulched by rice straw (Table-1). Whereas, the minimum cane girth of 3.02 cm was calculated in control plots, where the soil surface was kept without mulching. This higher cane girth in plots mulched by banana leaves was mainly associated with effective suppression of weeds and banana leaves when processed in soil after irrigation also act as the compost. The differences in cane girth shown by LSD test indicated that plots mulched by sugarcane trash and rice straw were show non-significance ($P>0.05$) but significance ($P<0.05$) when plots mulched by banana leaves as well as when compared with control. Similar findings were also reported by [19] who concluded that cane girth increases significantly by trash mulching.

Number of tillers $stool^{-1}$

The effect of different mulching materials on the number of tillers $stool^{-1}$ of sugarcane was statistically non-significant ($P>0.05$). The number of tillers $stool^{-1}$ was relatively higher (7.24) in plots mulched by banana leaves, followed by 6.64 average tillers $stool^{-1}$ observed in plots mulched by sugarcane trash; while the number of tillers $stool^{-1}$ declined to 6.60 in plots mulched by rice straw. However, the minimum number of tillers (6.01) $stool^{-1}$ was observed in control plots, whereas the mulching was not applied (Table-1). The higher number of tillers $stool^{-1}$ in plots mulched by banana leaves was chiefly linked with effective moisture conservation, weed suppression, coupled with nourishing nature of banana leaves as compost when processed in soil after irrigation. Hence, it is assumed that use of banana leaves as mulch in sugarcane could be most appropriate disposal of waste material of

banana crop. However, the sugarcane trash and rice straw were equal in the effectiveness for weed suppression.

Number of internodes cane^{-1}

The effect of different mulching materials explained by analysis of variance on the number of internodes cane^{-1} of sugarcane was statistically significant (P<0.05). The internodes cane^{-1} was significantly higher (18.15) in plots mulched by banana leaves, while sugarcane trash as mulch material ranked second with 17.03 average number of internodes cane^{-1}, whereas the number of internodes cane^{-1} diminished to 16.86 in plots mulched by rice straw. However, the lowest number of internodes (16.26) cane^{-1} was noted in control plots, where the soil surface kept uncovered (Table-1). This higher number of internodes cane^{-1} in plots mulched by banana leaves was mainly associated with the increasing cane length; likewise the number of internodes cane^{-1} was simultaneously improved. The LSD test suggested that the differences in the number of internodes cane^{-1} in plots mulched with sugarcane trash and rice straw were statistically non-significant (P>0.05) and significant (P<0.05) when compared with the plots mulched with banana leaves and control. In ecological farming soil must be mixed with composts, sliced straw, and other organic materials as to supply nutrients, especially nitrogen to crop plants [20].

Weight of 10 canes (kg)

Statistically significant (P<0.05) differences was observed among different mulching materials on the weight of 10 canes of sugarcane. The weight of 10 canes was obviously greater (15.61 kg) in plots mulched by banana leaves, followed by average 10 canes weight of 14.48 kg and 14.14 kg achieved from the plots mulched by sugarcane trash and rice straw, respectively. However, the minimum weight of 10 canes (13.54 kg) was obtained from the plots kept without mulching (Table-2). This higher weight of 10 canes in plots mulched by banana leaves was mainly associated with increased cane length and cane girth and the weight of 10 canes was increased with their improvement concurrently. The LSD test demonstrated that the differences in the weight of 10 canes in plots mulched with sugarcane trash and rice straw were non-significant (P>0.05) whereas significant (P<0.05) with the plots mulched with banana leaves as well as control. Similarly, [21] showed that both the mulch materials (plastic and bagasse mulches) were effective to suppress weed infestation and for obtaining better results in sugarcane.

Cane yield (tons ha^{-1})

The cane yield ha^{-1} of sugarcane was significantly (P<0.05) affected by various mulching materials (Table-2). Cane yield was highest (99.91 tons ha^{-1}) in plots mulched by banana leaves, followed by cane yield of 92.66 tons ha^{-1} was obtained from the plots mulched by sugarcane trash, while the plots mulched with rice straw resulted in average cane yield of 90.50 tons ha^{-1}. However, the minimum cane yield (86.63 tons ha^{-1}) was observed in control plots where the soil surface was kept untreated (no mulching). This higher cane yield ha^{-1} in plots mulched by banana leaves was mainly associated with increased cane length, higher cane girth, increased number of tillers stool^{-1}, higher number of internodes cane^{-1} and greater weight of 10 canes. There was a simultaneous increase in the cane yield ha^{-1} with improvement in these traits of economic importance. The LSD test suggested that the variations in the cane yield ha^{-1} in plots mulched with sugarcane trash and rice straw were non-significant (P>0.05) whereas significant (P<0.05) when evaluated with other treatments including control. According to [15] and [22] improved cane yield when fields were mulched by organic mulches including sugarcane trash.

Brix content (%)

The effect of different mulching materials on the brix content of sugarcane juice was statistically non-significant (P>0.05). The brix content was relatively higher (23.11%) in juice collected from the plots mulched by banana leaves, followed by brix content of 23.07 % determined in juice collected from the plots mulched by rice straw, while the sugarcane juice collected from the control plots (without mulching) contained brix of 22.75 %. However, the lowest brix content (22.75 %) was determined in juice collected from the plots mulched by sugarcane trash. Although, the brix content was relatively higher in juice collected from the plots mulched by banana leaves, but the variation in brix content between treatments was natural and no linear trend for this character was determined. This indicated that brix content in sugarcane juice was not influenced by the mulching material. According to [23] Soil Organic Content (SOC) increased by 33% when mulching with straw up to 10 years and eventually crop yield were increased.

Sugar recovery (%)

The analysis of variance indicated that the effect of different mulching materials on the sugar recovery in sugarcane juice was non-significant (P>0.05). The data in Table-2 showed that the sugar recovery was relatively higher (11.56%) in cane juice collected from the plots mulched by banana leaves, followed by sugar recovery of 11.53 % determined in juice collected from the plots mulched by rice straw, while the recovery % in cane juice obtained from the control plots (without mulching) was 11.42 %. However, the least recovery % (11.38 %) was observed in juice obtained from the plots mulched by sugarcane trash. It was noted that there was no linear trend of recovery as it was noted in cane yield contributing traits. [24,25,26] argued that trash-mulched plots are remarkably easy to irrigate and bagasse, paddy husk, hay, straw, etc. can also be used as mulching material and show positive effect on crop plants.

Table 1: Cane length, cane girth, tillers stool^{-1} and internodes cane^{-1}of sugarcane as influenced by different mulching materials

Mulch materials	Cane length (cm)	Cane girth (cm)	Tillers stool^{-1}	Internodes cane^{-1}
Sugarcane trash	243.33b	3.16b	6.64	17.03b
Banana leaves	259.33a	3.45a	7.24	18.15a
Rice straw	241.67b	3.14b	6.60	16.86b
Control	232.33c	3.02c	6.01	16.26b
S.E..±	2.1731	0.0417	0.3571	0.3646
LSD 0.05	5.3173	0.1021	--	0.8921
LSD 0.01	8.0565	0.1547	--	1.3516

Table 2: Weight of 10 canes, cane yield, brix and recovery in sugarcane as influenced by different mulching materials

Mulch materials	Weight of 10 canes (kg)	Cane yield (t ha^{-1})	Brix content (%)	Sugar Recovery (%)
Sugarcane trash	14.48b	92.66b	22.75	11.38
Banana leaves	15.61a	99.91a	23.11	11.56
Rice straw	14.14b	90.50b	23.07	11.53
Control	13.54c	86.63c	22.84	11.42
S.E..±	0.3790	2.4290	0.4681	0.2336
LSD 0.05	0.9274	5.9435	--	--
LSD 0.01	1.4051	9.0052	--	--

Table 3: Mean squares corresponding to cane length, cane girth, tillers stool^{-1}, internodes cane^{-1}, weight of 10 canes, cane yield, brix and recovery of sugarcane as influenced by different mulching materials

Source	d.f.	Cane length	Cane girth	Tillers stool^{-1}	Inter-nodes cane^{-1}	Wt of 10 canes	Cane yield	Brix content	Recovery
Replications	2	14.1	0.004	0.233	0.219	0.152	6.321	0.903	0.223
Mulches	3	377.0**	0.099**	0.761^{NS}	1.868**	2.276**	93.29**	0.093^{NS}	0.022^{NS}
Error	6	7.083	0.003	0.191	0.199	0.215	8.84	0.328	0.081

CONCLUSIONS

After analysis of the results of the present study in depth, it was concluded that sugarcane fields mulched by banana leaves caused effective suppression of weeds, conserve moisture most effectively and when processed in soil after irrigation banana leaves mulching also acted as the compost to improve crop performance. Whereas, the crop mulched with sugarcane trash and rice straw showed similar performance for all the traits studied. However, there was no linear trend of effectiveness for mulch materials on brix content of juice and recovery percentage.

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