IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Effect of Mulching on Growth and Yield of Sugarcane at Subtropical Region of Nepal

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Abstract: A two-year field study (2021-2022) was conducted at the National Sugarcane Research Program, Jeetpur, Bara, Nepal to evaluate the effect of mulching on sugarcane production. The randomized complete block design (RCBD) with three replications and six treatments viz., Black plastic mulch (T1), White plastic mulch (T2), Sugarcane trash mulch (T3), Rice straw mulch (T4), Intercropping with pea (T5), and Control. Results revealed significantly higher average cane yield in Black plastic mulch (102.09 t/ha) used plots and Pea intercropped plot (99.52 t/ha). Black plastic mulched plots showed superior plant height (213.42 cm), higher millable canes (103,324/ha), and thicker canes (23.18 mm.). Similarly, Intercropping with Pea improved soil fertility, yielding comparable plant height (206.83 cm), millable canes (97,088/ha), and the highest single cane weight (1.043 kg). Yield improvements correlated positively with parameters like cane diameter, plant height, and millable cane count. The study concludes that Black plastic mulch is ideal for maximizing sugarcane yield in subtropical region of Nepal, while intercropping with pea offers dual benefits of soil enrichment and productivity. It is recommended to adopt Black plastic mulch for higher yields and consider intercropping for resource-efficient sustainable practices.

***Index terms*- Mulching, Sugarcane trash, Rice Straw, Plastic, Intercropping**

I. INTRODUCTION

Sugarcane *Saccharum officinarum L.* is an important commercial crop and primary source of sugar in tropical countries. Sugarcane in Nepal covers 62,567 hectares, with a production of 3,159,434 metric tons and productivity of 50.5 metric tons per hectare. In Nepal, sugarcane cultivation plays a significant role in the agricultural economy. It contributes 2.1% to the GDP and generates Rs. 17 billion annually (MoALD, 2023). However, this yield remains below the potential productivity seen in neighboring countries like India and Bangladesh, where average yields range from 70 to 80 metric tons per hectare (FAO, 2022).

Water stress due to limited rainfall during Feb-March caused reduced germination, root establishment, tillering, poor juice quality. The average yield of sugarcane in Nepal is constrained by various factors, including water unavailability during growth period, heavy weed infestation, poor nutrient uptake during cold season (Tripathi 2019). Mulching is an essential agronomic practice in modern agriculture that significantly enhances crop growth and productivity by improving soil moisture retention, regulating temperature, and suppressing weed growth. For sugarcane, a high-demand crop known for its extensive growth cycle and resource requirements, mulching has proven to be an effective strategy for optimizing yield and quality.

Mulching helps to increase absorption of nutrients such as phosphorus and nitrogen which can improve yield by 30% (Ball-Coelho et al., 1993). Beside this, it helps to regulate soil temperature and water use efficiency. it reduces weed occurrence, conserves moisture and enhances soil health. (Hasino et al, 2017). Mulching with a combination of Gliricidia leaves and sugarcane trash can increase cane and sugar yields by 34% and improve the number of millable stalks by 8% (De Silva et.al., 2013). Furthermore, mulching helps to protect the soil surface from the negative impacts of direct raindrops and sunlight, contributing to better soil structure and fertility. Research has demonstrated that these mulching techniques significantly increase cane yield, number of millable canes, and economic returns. Studies suggest that black plastic mulch can increase yield by up to 15% compared to non-mulched treatments, while organic mulches like straw and sugarcane trash mulch improve long-term soil health and productivity (Das et al., 2021). It is indicated that coloured plastic films affect the plant root zone temperature, microbial life, soil properties, and moisture levels. By improving the plant microclimate, coloured plastic mulches increase plant growth, development, quality, and yield of most crops. Black and silver-coloured plastic mulches are reported to enhance growth, yield, and quality in most crops than other coloured mulches. The application of sugarcane trash found beneficial for sustaining productivity of sugarcane in calcareous soil (Jha et al., 2019).
Hence, the current study was carried out to investigate the effect of mulching on growth and yield of sugarcane at subtropical region of Nepal.

II. MATERIALS AND METHODS

2.1 Experimental site

The field experiment was conducted at the research block of the National Sugarcane Research Program in Jeetpur, Bara, Nepal, during the 2021-2022 growing season. The research site is situated at 27°06'48" N latitude and 84°57'07" E longitude, with an elevation of 98 meters above sea level. The area experiences a hot and humid climate during the summer and cooler conditions in winter. The average maximum temperature at the site ranges from 22.7°C to 34.5°C, while the average minimum temperature varies between 8.5°C and 25.9°C. The site receives an average annual rainfall of 1550 mm.

The soil exhibited a grayish-brown color and a sub-angular blocky structure. The texture was identified as sandy loam. The soil pH was measured as moderately acidic, with a value of 5.96. The organic matter content was low, recorded at 1.0%. Similarly, the total nitrogen content was low, with a value of 0.06%. In contrast, the available phosphorus level was high, measuring 33.76 ppm, and the extractable potassium content was also high, at 145.29 ppm (Khadka et.al. 2016).

2.2 Experimental design and treatment details

The experiment was carried out at NSRP during 2021 and 2022 for efficient resource use and enhancing the sugarcane productivity. Trial was planted in October which is main season for sugarcane in Nepal. The design was RCB with three replications and six mulching treatments namely, Black plastic mulch (T1), White Plastic mulch (T2), Sugarcane trashes mulch (T3), Rice straw mulch (T4), Intercropping with Peas (T5) and Control. The variety was Co-05011. Two budded sets of cane were planted in furrow with 90 cm row spacing. The area of the plot was 27 square meter (6 rows of 5 meter long). Cane setts were treated by Carbendazim 0.01% solution before planting. The chemical fertilizers were applied @ 150:60:40 N P_2O_5 K_2O kg/ha. Half dose of nitrogen and full dose of phosphorus and potash were applied at the time of planting as basal and remaining 75kg N was top-dressed in two equal splits at 60 and 90 days after planting. Growth and yield parameters were recorded for each treatment. Key observations included were plant height, number of millable canes, cane diameter, single cane weight and yield. The collected data were subjected to analysis of variance (ANOVA) using GenStat statistical software.

Table 1: Performance sugarcane genotype under various sources of mulching at NSRP, Jeetpur, Nepal in 2021

Treatments	PHT (cm)	CD (mm)	MC (no.)	SCW (kg)	Yield (t/ha)
Black plastic Mulch	200.83	22.80	98500	1.05	94.70
White plastic Mulch	183.53	20.23	85309	0.81	65.80
Sugarcane trash Mulch	177.67	20.83	91300	0.87	75.63
Rice straw Mulch	188.33	22.23	86633	0.99	82.33
Intercropping with Pea	194.67	23.37	103067	1.08	96.37
Control	175.90	19.73	83967	0.75	67.60
Grand Mean	**186.82**	**21.53**	**91463**	**0.93**	**80.41**
Max	210.70	26.40	113400	1.22	107.30
Min	164.00	17.30	76700	0.62	61.50
F-value	<.001	0.015	0.005	0.002	<.001
LSD	8.22	2.08	9360	0.13	8.57
CV%	2.4	5.3	5.6	8.2	5.9

Note: MC-Mill-able Cane; PHT-Plant Height; CD-Cane Diameter; SCW-Single Cane Weight

Table 2: Performance sugarcane genotype under various sources of mulching at NSRP, Jeetpur, Nepal in 2022

Treatments	PHT (cm)	CD (mm)	MC (no.)	SCW (kg)	Yield (t/ha)
Black plastic Mulch	226.0	23.56	108148.1	1.026	109.48
White plastic Mulch	214.4	22.41	84814.8	0.984	89.63
Sugarcane trash Mulch	210.2	22.56	88888.9	0.944	91.48
Rice straw Mulch	216.8	22.22	98888.9	0.947	95.91
Intercropping with Pea	219.0	23.22	91111.1	1.003	102.67
Control	188.3	22.00	85925.9	0.904	70.83
Grand Mean	**212.5**	**22.66**	**92963.0**	**0.968**	**93.33**
Max.	233.0	23.89	114444.44	1.132	118.22
Min.	182.0	21.00	76666.67	0.838	64.22
F-value	0.031	0.25	0.14	0.24	0.003
LSD	20.58	1.52	12520.8	0.11	14.79
CV%	5.3	3.7	7.4	6.3	8.7

Note: MC-Mill-able Cane; PHT-Plant Height; CD-Cane Diameter; SCW-Single Cane Weight

Table:3 Combined analysis of performance of sugarcane genotype under various sources of mulching at NSRP, Jeetpur, Nepal in 2021 and 2022

Treatments	PHT (cm)	CD (mm)	MC (no.)	SCW (kg)	Yield (t/ha)
Black plastic mulch	213.42	23.18	103324.07	1.036	102.09
White plastic mulch	198.97	21.32	85061.91	0.899	77.71
Sugarcane trash mulch	193.93	21.69	90094.44	0.909	83.56
Rice straw mulch	202.57	22.23	92761.11	0.970	89.12
Intercropping with Pea	206.83	23.29	97088.89	1.043	99.52
Control	182.12	20.87	84946.30	0.829	69.21
Grand Mean	**199.64**	**22.10**	**92212.79**	**0.948**	**86.87**
Year					
F-value	<.001	0.026	0.54	0.20	<.001
LSD	5.9	0.98	4943.3	0.06	4.94
Treatment					
F-value	.<001	0.036	0.001	0.003	<.001
LSD	10.23	1.70	8562	0.11	8.56
Year* Treatment					
F-value	0.406	0.52	0.086	0.12	0.207
LSD	14.46	2.40	12108.5	0.156	12.11
CV %	4.3	6.4	7.8	9.8	8.2

Note: PHT-Plant Height; MC-Mill-able Cane; CD-Cane Diameter; SCW-Single Cane Weight; No.- Number, LSD-Least Significant Difference

III. RESULTS AND DISCUSSION

3.1 Plant height

The average plant height of sugarcane in black plastic mulch was significantly higher 213.42cm compared to other mulching treatments and control but at par with intercropping with pea in which the mean plant height was 206.83 cm in both the years 2021 and 2022 which demonstrated its effectiveness in enhancing sugarcane the productivity of 102.09 and 99.52 t/ha respectively. The plant height in control plot was significantly lower (182.12 cm) as compared to all mulching materials whose effects were also reflected on yield. The positive correlation between plant height and yield were also reported by Millard 1974, who found that the higher stalk length of sugarcane was due to better developed root system in plastic mulched treatment.

3.2 Cane Diameter

The variation in cane diameter across the year and treatments, indicates the influence of management practices on sugarcane growth. The cane diameter in 1st year was significantly higher (23.37 mm) in the sugarcane which was intercropped with pea but black plastic mulched resulted significantly higher cane diameter (23.56 mm) over the other treatments. Higher cane diameter in intercropping may be due to enhanced soil fertility through nitrogen fixation by pea plants and higher cane diameter in black plastic mulched treatment attributed to improve soil moisture conservation and temperature regulation. Similar finding was also reported by Ahmed et. al., 2013 who reported that Black plastic significantly increased the size of stalk girth of sugarcane for plant crops (4.97 cm) and ratoon crops (5.15 cm) over other colored plastic mulched treatment and control. In the combined analysis, cane diameter i.e., 23.29 mm and 23.18 mm in sugarcane intercropping with pea and black plastic mulched treatment respectively were significantly higher as compared to rest of the treatments. Comparatively higher cane diameter of 27 and 26 mm in Cane + gram and Cane +lentil respectively over sole cane and Cane + wheat was reported by Rasool et. al., 2011. Rice straw mulch (22.23 mm) and Sugarcane trash mulch (21.69 mm) also enhanced cane diameter compared to the control. The treatments with larger cane diameters, such as sugarcane trash mulch and black plastic mulch, corresponded to higher yields, highlighting a positive correlation between cane diameter and productivity.

3.3 Millable cane

Black plastic mulch recorded the higher numbers of millable cane (103,324.07 canes/ha), followed by intercropping with pea (97,088.89 canes/ha) and rice straw mulch (92,761.11 canes/ha). Sugarcane trash mulch also had significant number of milliable canes (90,094.44 canes/ha) compared to white plastic mulch (85,061.91 canes/ha) and control (84,946.30 canes/ha). Treatments with a higher number of millable canes in black plastic mulch and intercropping with pea, corresponded to higher yields (102.09 t/ha and 99.52 t/ha, respectively), demonstrating a positive relationship between millable cane count and yield. The significant increase in millable cane count under black plastic mulch can be attributed to its ability to retain soil moisture, regulate temperature, and suppress weeds, creating optimal conditions for sugarcane growth. Similarly, intercropping with pea likely enhanced soil fertility through nitrogen fixation, promoting better cane establishment. Treatments like rice straw and sugarcane trash mulch also showed improved results due to their organic nature, which supports soil health and provides moderate temperature regulation. Plastic film mulching significantly increased soil temperature and moisture, enhancing sugarcane emergence, tillering, and effective stalk numbers (Shu-ning, 2014)

3.4 Single cane weight

The single cane weight (SCW) varied significantly across treatments. In combined analysis, statistically higher SCW was observed in intercropping with pea (1.043 kg) which was at par with black plastic mulch (1.036 kg) and rice straw mulch (0.970 kg). Higher plant height and Cane diameter in these treatments may be the factor of increasing cane weight. Higher SCW was also positively correlated with increased yield, with intercropping with pea (99.52 t/ha) and black plastic mulch (102.09 t/ha) producing the higher yields.

3.5 Cane yield

Result in 2021 revealed that among the mulching treatments, sugarcane intercropping with peas achieved significantly higher yield (96.37t/ha) but at par with black plastic mulch (94.70 t/ha). Similarly, in 2022, significantly higher cane yield (109.48 t/ha) obtained from black plastic mulch followed by sugarcane intercropping with pea where 102.67 t/ha cane yield was achieved. The average yield over the two years was significantly higher (102.09 t/ha) in black plastic mulch compared to all the treatments except with sugarcane intercropping with pea with the cane yield of 99.52 t/ha. The yield of sugarcane mulched with sugarcane trash and rice straw showed similar result of 83.56 and 89.12 t/ha respectively. Similar finding was also reported in a study of organic mulching viz., sugarcane trashes and rice straw in sugarcane yield (Soomro et. al., 2016). Higher yield in black plastic mulch may be due to enhancement of soil moisture retention, suppression of weeds and creation of favorable condition for sugarcane growth. Ahmed, 2013 said that sugarcane setts planted on plots mulched with black polyethylene sheet established faster and had improved growth parameters compared to those without mulch. Likewise, Transparent and blue plastic mulches encouraged weed population which were suppressed under black plastic (Ashrafuzzaman, 2011) that may be the reason of higher cane production in black plastic mulch. At the same time, higher yield in intercropping may be due improvement of soil fertility through nitrogen fixation, suppression of weeds, and enhanced resource efficiency. Sugarcane-legume intercropping enriched the soil microbiome and plant growth (Malviya, 2021). Varghese et. al. (2006) revealed that intercropping of vegetable pea with sugarcane gave significantly higher cane yield. Sugarcane intercropped with soybean has recorded significantly higher cane yield of 122.82 t/ha as compared to sole sugarcane cropping (74.3 t/ha) (Geetha et. al., 2019). Similarly, Veerabhadraiah et. al. (1986) observed 17% more cane yield in sugarcane intercropped with soybean.

IV. CONCLUSION

In conclusion, mulching significantly enhances sugarcane growth and yield in subtropical regions of Nepal. Black plastic mulch achieved the highest yield closely followed by intercropping with pea. Both treatments possess higher plant height, cane diameter, millable cane count, and single cane weight. The findings highlight the importance of adopting mulching techniques to boost productivity and resource efficiency. Black plastic mulch and sugarcane-pea intercropping are recommended for achieving sustainable sugarcane cultivation and higher yields.

V. ACKNOWLEDGEMENTS

I would like to acknowledge National Sugarcane Research Program, Jeetpur Bara and Nepal Agricultural Research Council (NARC) for allocating budget for conducting the research trial. I'm grateful to Executive Director and Program Directors of NARC for facilitating the research activities.

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