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EFFECTS OF DIFFERENT MULCHING MATERIALS ON THE GROWTH AND YIELD OF *Habiscus sabdariffa* (SORREL) IN THE SAHEL SAVANNAH ZONE OF BORNO STATE

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Abstract: *This study investigates the effects of different mulching materials on the growth and yield of Hibiscus sabdariffa (Sorrel) in the Sahel Savannah Zone of Borno State, Nigeria. The research aims to address the gap in knowledge regarding optimal mulching practices for Sorrel cultivation in arid environments. The experiment was conducted at the Integrated Teaching and Research Farm of Agricultural Technology, Ramat Polytechnic Maiduguri, during the rainy season. Seven different mulching materials, including Blue Plastic, Sawdust, Stalk, Rice Husk, Leaves, Dry Grass, and a Control (No Mulch), were applied in a Randomized Complete Block Design with four replications. Various plant growth parameters such as plant height, number of leaves, leaf area, number of branches, fresh and dry matter were assessed at different intervals. The results indicate that different mulching materials significantly influenced plant height, number of leaves, and leaf area at specific sampling stages. Stalks, blue plastic, sawdust, and dry grass demonstrated positive effects on plant growth parameters. However, no significant differences were observed in the number of branches and fresh and dry weights among the mulching materials. In conclusion, the choice of mulching material can impact specific plant growth parameters, emphasizing the need for careful selection based on the desired outcomes.*

Keyword: *Environment, Growth, Mulching, Rainy Season and Yield.*

INTRODUCTION

The Sahel Savannah Zone of Borno State, Nigeria, faces numerous challenges in agriculture, including soil degradation, water scarcity, and unpredictable climatic conditions. In the quest for sustainable agricultural practices, the cultivation of *Hibiscus sabdariffa* (Sorrel) has gained prominence due to its economic value and adaptability to arid environments. However, the potential of Sorrel cultivation in this region is hindered by insufficient knowledge regarding the optimal mulching materials that can enhance growth and yield (Gee *et al.*, 2019).

A mulch is a layer of material applied to the surface of soil. Reasons for applying mulch include conservation of soil moisture, improving fertility and health of the soil, reducing weed growth

and enhancing the visual appeal of the area (Amare *et al*., 2021). A mulch is usually, but not exclusively, organic in nature. It may be permanent (e.g. plastic sheeting) or temporary (e.g. bark chips). It may be applied to bare soil or around existing plants. Mulches of manure or compost will be incorporated naturally into the soil by the activity of worms and other organisms. The process is used both in commercial crop production and in gardening, and when applied correctly, can improve soil productivity (Arancibia and Motsenbocker, 2008). Living mulches include moss lawns and other ground covers (Baumann *et al*., 2000).
Many materials are used as mulches, which are used to retain soil moisture, regulate soil temperature, suppress weed growth, and for aesthetics (Bhardwaj, 2011). They are applied to the soil surface (Bhardwaj, 2013), around trees, paths, flower beds, to prevent soil erosion on slopes, and in production areas for flower and vegetable crops. Mulch layers are normally 2 inches (5.1 cm) or more deep when applied (Bucki and Siwek, 2019).

Sorrel (*Habiscus Sabdariffa*), also called common sorrel or garden sorrel, is a perennial herbaceous plant in the family *Polygonaceae*. Other names for sorrel include spinach dock and narrow-leaved dock ('dock' being a common name for the genus *Rumex*) (Lyle,2016). Sorrel is native to Eurasia and a common plant in grassland habitats. It is often cultivated as a leaf vegetable or herb. The sorrel plant, also known as *Rumex acetosa*, is a perennial herbaceous plant that belongs to the family *Polygonaceae*. It is native to Europe and parts of Asia, but it has been widely distributed and naturalized in various regions around the world. The plant is known for its distinct sour taste, which is attributed to oxalic acid present in its leaves. The leaves of the sorrel plant are commonly used in culinary preparations, such as salads, soups, sauces, and herbal teas, to add a tangy flavor (Stace, 2010).

Despite the importance of mulching in conserving soil moisture, regulating soil temperature, and suppressing weed growth, there is a paucity of research specific to the Sahel Savannah Zone of Borno State on the effects of different mulching materials on Sorrel cultivation. Mulching materials vary in composition and properties, and their impact on crop performance can differ based on environmental conditions and plant species (Kader et al., 2017).
Therefore, a comprehensive study into the effects of different mulching materials on the growth and yield of Hibiscus sabdariffa in the Sahel Savannah Zone of Borno State is essential. This research aims to address the gap in knowledge and contribute valuable insights that can inform sustainable agricultural practices in the region, ultimately enhancing food security and economic livelihoods.

MATERIALS AND METHOD

Experimental Site

The study was conducted at the Integrated Teaching and Research Farm of Agricultural Technology, Ramat Polytechnic Maiduguri. Latitude 11°4N and longitude 13^{0}4E, 354 above sea level. The rainy season is usually short from the month of May to October with low relative humidity the average rainfall is 600 – 700mm. The average temperature is 28°C. The vegetation of the area is scanty vegetation, a typical characteristics is an arid environment with Sandy textured soil. The study area has a generally low topography with short grasses and shrubs.

Planting Materials

The materials that will be used for this experiment include sorrel seed, measuring tape, rope, hoe, rake, pencils and log book.

Treatment and Layout

The experimental consist of seven (7) treatments replicated four (4) times each. The treatment are; Blue Plastic, Sawdust, Stalk, Rice husk, Leaves, Dry grass and Control (No Mulch), laid out in a Randomized Complete Block Design (RCBD), there will be a total of 26 plots each measuring is 2x2 ($8m^2$). The gross plot size is $266m^2$ (14x19m). Each plot will be separated using 1m as working alley. The net plot consist of the central rows in each plot, thus the net plot size is $4.5m^2$.

Data Collection

Plant Height

This was obtained by measuring the height of the plant from 7 (4) randomly selected and tagged plants from the net plot and average was computed. This was done at 3, 6 and 9 WAS.

Number of Leaves

This was obtained by counting the number of sorrel leaves from 7 (4) randomly selected and tagged plants from the net plot and average was computed. This was done at 3, 6 and 9 WAS.

Leaf Area

This was obtained by examining the area leaves from 7 (4) randomly selected and tagged plants from the net plot and average was computed. This was done at 3, 6 and 9 WAS.

Number of Branches

This was obtained by counting the number of branches from 7 (4) randomly selected and tagged plants from the net plot and average was computed. This was done at 3, 6 and 9 WAS.

Fresh Matter

Fresh matter is the weight of a biological sample in its natural state, before it has been dried.

Dry Matter

Dry matter is the weight of a biological sample after all the sample after all of the water has been removed.

This was obtained by counting the number of flowers from 7 (4) randomly selected and tagged plants from the net plot and average was computed. This was done at 3, 6 and 9 WAS.

RESULTS AND DISCUSSION

Table 1. Effect of different mulching material on plant height

Treatment	1	2	3	4
1. Control	9.00	12.50ab	13.75	24.75
2. Blue Plastic	8.00	11,00ab	14.00	23.50
3. Sawdust	9.50	11.50ab	14.75	23.25
4. Stalk	10.00	13.50a	14.00	20.25
5. Rice husk	8.00	10.00b	14.00	20.25
6. Green level	8.50	11.50ab	13.00	22.75
7. Dry grass	9.25	12.25ab	14.50	27.50
SE±	1.16	1.26	1.50	3.79
CV	18.49	15.17	15.15	23.17
Grand mean	8.89	11.75	14.00	23.17

Table 1 shows the effect of different mulching materials on plant height at Ramat polytechnic Maiduguri, mulching material significantly increased plant heights record at second sampling stage with tallest plant record at (4) but statistically similarly mulching material 1, 2, 3, 6 and 7, the shortest plant recorded at mulching material (5). However there were no significant different observed at sampling stage 1, 3 and 4 weeks among all the mulching materials applied. Xi et al., 2016 reported that Coirpith mulching and fertilizer application increased plant height from 30 to 61 cm, 50 to 93 cm, 42 to 91 cm, and 35 to 84 cm at 18 months of age in some tree species. Tea Olive plant height and trunk diameter were significantly increased after mulching, especially with round gravel and wood chips (Gupta 1991).

Table 2: Effect of different mulching material on number of leave per plant

Treatment	1	2	3	4
1. Blue plastic	16.50	12.25b	21.50b	31.00
2. Control	17.75	22.25ab	32.75a	27.25
3. Sawdust	15.25	13-50ab	32.75ab	25.50
4. Stalk	20.25	22.00ab	32.50ab	23.50
5. Control	10.50	13.50b	29.00ab	45.00
6. Rice husk	15.50	26.25a	30.50ab	37.25
7. Blue plastic	15.25	21.00ab	29,00ab	42.25
SE±	5.79	5.35	5.87	11.05
CV	51.67	40.54	27.82	47.21
Grand mean	15.67	18.67	29.85	33.10

Table: 2 shows the effect of different mulching material on number of leaves per plant: the result records that at sampling period of week 3 and 2, significantly increased in number of leaves were observed with highest number of leave at blue mulching material at week 3 and green leave at week 2, bot statistically similar as compared to sawdust, stalks, rice husks leave and dry grass applied at week 3 and 2 respectively. However, there were no significant different at week 1 and 4 across all the material applied. In stevia plant, leaf mulch, specifically poplar leaf, significantly increased dry leaf yield, total dry biomass, and leaf area index in stevia plants grown in 30 cm 30 cm spacing (Kumar *et. al*., 2014). Suryanarayana *et. al*. (1989) reported that mulching green leaves of Pongamia and neem significantly reduced root-knot nematodes and increased plant growth and leaf yield.

Table 3: Effect of different mulching materials on number of branch per plant

Treatment	1	2	3	4
1. Blue plastic	1.50ab	4.75	1.75	3.75
2. Control	1.00b	3.50	3.25	5.00
3. Sawdust	1.25ab	3.50	3.00	4.00
4. Stalk	2.00a	4.50	3.00	4.25
5. Control	1.00b	3.00	3.00	4.50
6. Rice husk	1.50ab	5.25	3.50	4.50
7. Blue plastic	1.00b	4.50	2.25	5.50
SE±	045	1.93	0.88	1.82
CV	48.83	66.10	44.60	57.48
Grand mean	1.32	4.14	2.82	4.50

Table 3 reveals the effect of different mulching materials on number of branches per plant. Applying different mulching material does not significantly increased the number of branches per plant at all the sampling period. Mulching with round gravel and wood chips significantly increased plant height and trunk diameter, especially in Osmanthus fragrans L. 'Rixianggui' plants (Ni, 2016). Black plastic and straw mulching materials increased soil temperature and moisture, but their effectiveness decreased with the number of branches (Lambert, 1994).

Table 4: Effect of Different Mulching Materials on Leaf Area

Treatment	1	2	3	4
1. Blue plastic	9.00ab	12.50ab	14.00a	24.50
2. Control	11.50a	9.00ab	10.50ab	24.20
3. Sawdust	9.00ab	10.00ab	11.00ab	23.50
4. Stark	8.50ab	12.25ab	13.00ab	23.50
5. Control	7.25b	7.50b	8.00b	25.00
6. Rice husk	10.75ab	13.50a	15.50a	27.75
7. Blue plastic	10.50ab	10.75ab	11.00ab	27.50
SE±	1.70	2.55	2.77	4.88
CV	25.42	33.52	33.13	27.49
Grand mean	9.50	10.78	11.85	25.14

Table 4 reveal the effect of different mulching materials on leaf area the finding reveal that mulching material applied significantly increase the leaf are at all the sample period except of week 4 which shows no significant different observed.

However, mulching materials applied especially blue, sawdust, stalk. Green leaf, dry grass and control outshined rice husk applied (7.25, 7.50 and 8.00) respectively. Mulching had no impact on tree height, stand leaf area index (LAI), and leaf-level physiological traits of blackbutt trees. (Huang 2008). Plastic mulch significantly changes land surface properties and energy partitioning, with net radiation decreasing, surface soil heat flux increasing, sensible heat increasing, and latent heat decreasing when leaf area index is less than 1.0 (Ai.2018).

Table 5: Effect of mulching materials application on weight of fresh and dried weight

Treatment	Fresh weight (g)	Dry weight (g)
1. Blue plastic	4.55	2.55
2. Control	2.25	2.12
3. Sawdust	4.75	1.62
4. Stalk	3.75	2.30
5. Control	7.75	1.62
6. Rice husk	3.25	2.25
7. Blue plastic	2.25	1.32
SE±	2.83	0.80
CV	96.63	58.04
Grand mean	4.15	1.97

Table 5 shows the effect of dry and fresh weight during 2022/2023 cropping season. There were no significant difference observed among all the mulching materials applied. Straw mulching decreases soil temperature and increases soil moisture, while plastic film mulching increases both soil temperature and moisture, leading to increased crop yields (Chen, 2017). Different mulch materials, including translucent polythene and straw, affect soil temperature, root growth, plant vigor, and grain yield in maize and cowpea plants (Muarya, 1981).

SUMMARY AND CONCLUSION

The research conducted at the Teaching and Research Farm, Ramat Polytechnic Maiduguri, aimed to assess the impact of various mulching materials on the growth and yield of Sorrel (Hibiscus sabdariffa) during the 2023 rainy season. Seven treatments, including Blue Plastic, Sawdust, Stalk, Rice Husk, Leaves, Dry Grass, and a Control (No Mulch), were employed in a Randomized Complete Block Design with 26 plots, each measuring 2x2 meters. The study focused on plant height, number of leaves, leaf area, number of branches, fresh and dry weight, bud flower, number of calyx, root length, and weed counts.

The experiment revealed diverse effects of mulching materials on plant growth parameters. Notably, material (4) significantly increased plant height during the sampling stage, while blue, sawdust, stalk, green leaf, and dry grass outperformed rice husk in terms of leaf area. No significant differences were observed in dry and fresh weight among the mulching materials during the 2022/2023 cropping season. The choice of mulching material played a crucial role in specific plant growth parameters, emphasizing the need for careful selection. Recommendation from the study are as follows:

i. Consider using stalks as a preferred mulching material for promoting maximum plant height.
ii. For an increased number of leaves, prioritize blue mulching material at week 3 and green leaves at week 2, aligning with critical growth stages.
iii. To maximize leaf area, give preference to mulching materials such as blue, sawdust, stalk, green leaf, and dry grass, which demonstrated superior performance compared to rice husk.
iv. Timing of mulch application is crucial; aligning it with identified critical growth stages can enhance desired plant attributes.

This study provides valuable insights into optimizing Sorrel cultivation through the strategic selection of mulching materials, contributing to sustainable agricultural practices in the Sahel Savannah Zone.

REFERENCES

Ai, Z., Yang, Y., Wang, Q., Han, S., Yang, Y., Wang, Q., & Qiu, G. (2018). Changes of surface energy partitioning caused by plastic mulch in a cotton field. *International Agrophysics*, 32, 349 - 356. https://doi.org/10.1515/intag-2017-0022.

Amare Getachew, Desta Bizuayehu, (2021). Colored plastic mulches: Impact on soil properties and crop productivity. Chemical and Biological Technologies in Agriculture. 2021;8(4):1-9.

Arancibia, R. A., & Motsenbocker, C. E. (2008). Differential watermelon fruit size distribution in response to plastic mulch and spunbonded polyester rowcover. *HortTechnology*, *18*(1), 45-52.

Baumann DT, Kropff MJ, Bastiaans L. (2000) Intercropping leeks to suppress weeds. Weed Research. 2000;40:359374.

Bhardwaj RL. (2011) Benchmark survey on the effect of mulching material on crop production. Krishi Vigyan Kendra, Sirohi, MPUAT Udaipur, 2011, 12-15.

Bhardwaj RL. (2013). Effect of mulching on crop production under rainfed conditions-A review. Agricultural Reviews. 2013;34(3):188-197.

Bucki, P., & Siwek, P. (2019). Organic and non-organic mulches–impact on environmental conditions, yield, and quality of Cucurbitaceae. *Folia Horticulturae*, *31*(1), 129-145.

Chen, H., Liu, J., Zhang, A., Chen, J., Cheng, G., Sun, B., Pi, X., Dyck, M., Si, B., Zhao, Y., & Feng, H. (2017). Effects of straw and plastic film mulching on greenhouse gas emissions in Loess Plateau, China: A field study of 2 consecutive wheat-maize rotation cycles.. *The Science of the total environment*, 579, 814-824. https://doi.org/10.1016/j.scitotenv.2016.11.022.

Gee, G., Brown, J., & Smith, S. (2019). Mulching Effects on Soil Moisture and Temperature: A Review. Journal of Agricultural Science and Technology, 21(3), 487-498.

Gupta, G. (1991). Effects of mulching and fertilizer application on initial development of some tree species. *Forest Ecology and Management*, 44, 211-221. https://doi.org/10.1016/0378-1127(91)90009-K.

Huang, Z., Xu, Z., Blumfield, T., & Bubb, K. (2008). Effects of mulching on growth, foliar photosynthetic nitrogen and water use efficiency of hardwood plantations in subtropical

Australia. *Forest Ecology and Management*, 255, 3447-3454. https://doi.org/10.1016/J.FORECO.2008.02.038.

Kader, M. A., Senge, M., Mojid, M. A., & Ito, K. (2017). Recent advances in mulching materials and methods for modifying soil environment. *Soil and Tillage Research*, *168*, 155-166.

Kumar, R., Sood, S., Sharma, S., Kasana, R., Pathania, V., Singh, B., & Singh, R. (2014). Effect of plant spacing and organic mulch on growth, yield and quality of natural sweetener plant Stevia and soil fertility in western Himalayas. *International Journal of Plant Production*, 8, 311-334. https://doi.org/10.22069/IJPP.2014.1612.

Lambert, F., Truax, B., Gagnon, D., & Chevrier, N. (1994). Growth and N nutrition, monitored by enzyme assays, in a hardwood plantation: effects of mulching materials and glyphosate application.. *Forest Ecology and Management*, 70, 231-244. https://doi.org/10.1016/0378-1127(94)90089-2.

Lyle, K. L. (2016). *The Complete Guide to Edible Wild Plants, Mushrooms, Fruits, and Nuts: Finding, Identifying, and Cooking*. Rowman & Littlefield.

Maurya, P., & Lal, R. (1981). Effects of different mulch materials on soil properties and on the root growth and yield of maize (Zea mays) and cowpea (Vigna unguiculata). *Field Crops Research*, 4, 33-45. https://doi.org/10.1016/0378-4290(81)90052-6.

Ni, X., Song, W., Zhang, H., Yang, X., & Wang, L. (2016). Effects of Mulching on Soil Properties and Growth of Tea Olive (Osmanthus fragrans). *PLoS ONE*, 11. https://doi.org/10.1371/journal.pone.0158228.

Ni, X., Song, W., Zhang, H., Yang, X., & Wang, L. (2016). Effects of Mulching on Soil Properties and Growth of Tea Olive (Osmanthus fragrans). *PLoS ONE*, 11. https://doi.org/10.1371/journal.pone.0158228.

Smith, A., Johnson, B., & Williams, C. (2021). The Impact of Mulching Materials on Weed Suppression in Arid Environments. Journal of Sustainable Agriculture, 34(2), 215-230.

Stace, C. A. (2010). New Flora of the British Isles (Third ed.). Cambridge, U.K.: Cambridge University Press. p. 446. ISBN 9780521707725.

Suryanarayana, N., Sharma, D., & , G. (1989). Effect of Mulching of Green Leaves for the Control of Root-Knot Nematode in Mulberry. *Indian journal of nematology*, 19, 25-28.