INVESTIGATING THE IMPACT OF MULCHING ON SOILS

CASE STUDY ON KALES IN THE SCHOOL FARM

SCHOOL:
Shree Swaminarayan Academy, Mombasa, Kenya

GLOBE STUDENTS:

1. KHUSHI AGGARWAL
2. DARREN AMORE
3. KHAIROON RIDHWAN
4. CELESTINE CLAUDE

GLOBE TEACHERS: HENRY MOSETI
DORCUS NEEMA
BERNARD MABELE

SHREE SWAMINARAYAN ACADEMY
Teach through expounding of themes

COUNTRY

KENYA

TABLE OF CONTENTS

ABSTRACT

Started in China as early as 500 BC, mulching can be seen as an early agricultural technique, used widely in many different societies/communities as means of regulating the soil's temperature, retaining soil moisture and providing the soil with minerals/nutrients as a result of neutral alkaline pH. The investigation of mulch on soils is deeply rooted in scientific and agricultural aims that underscore the agriculture bundle and its protocols. Ethically, mulching has become an agricultural technique used by many arid area farmers, because of its ability to protect the soil of the plantation, in result decreasing the rate of soil erosion and the overall rate of evaporation from the soil (which can be most advantageous for a farmer who cannot rely on heavy rainfall to occur during their period of harvesting and growing their crops).

Moreover, mulching can be seen as a more 'natural' substitute to using expensive, artificial chemical fertilisers or pesticides on a plantation that a farmer might want to sell as 'organic' and 'healthy'. The reason for this occurrence is that mulch has properties that can provide for a plantation and give it a healthier environment to grow in, than using chemical fertilisers that can leave a plant looking diminished or deficient.

Our studies imply that using mulch on plantations increases their efficiency and creates a conducive space for them to be able to flourish healthily. Samples of pH, moisture level, light intensity and temperature were obtained from our study site, the school farm, over a period of a month. We used half of the kale patch for the measurements and the other half was our control experiment. Through this study, we aimed to completely prove that mulching is a safer, cost-effective and cleaner alternative when it comes to increasing plant productivity.

INTRODUCTION

Today's improper use of agricultural land and the increase in chemical-based fertilisers have reduced soil quality to a high amount. As global temperatures are rising, more harm is being inflicted upon the soil. Some of these problems may include high rates of soil erosion and changes in plant nutrients and pH.

Many traditional methods are pure and quite effective, some of which are still being used today and may be known as 'organic' farming. Some of these methods may include the use of animal manures, cover cropping, crop matures etc. Weed has always been a concern when it comes to agriculture. They are considered a problem because weed affects the health and nutrients of the plant. Weeds compete with crops for sunlight, water, nutrients, and space. In addition, they harbour insects and pathogens, which attack crop plants. This could affect the overall crop health and may cause conditions that are not suitable for the particular plant/crop.

Our group's research is based on weed management. We are using a method called mulching. This is a method of weed management that consists of the use of plant-based materials, which in some cases may also be known as organic mulch. Some examples of this type of materials may include grain straw, fresh or old hay, fresh-cut forage or cover crops, chipped brush, wood shavings, tree shavings, cotton gin waste, rice or buckwheat hulls, dried grass, and other crop residues. The most widely used organic mulches are hay and straw, as recent studies show.

We are looking at how mulching affects the various plant components and their necessities and how mulching is a better agriculture practice than the other methods that include the use of chemical-based agricultural improvement methods. Not only does mulch prevent weed growth, but it also improves and stabilises the right soil conditions that are required for crops. We used dried grass as our mulch.

Nowadays there is a lot of waste. We can utilise this waste in various ways. The dried grass we used was mowed grass from our school's field which is indeed a waste. We utilised this mulch to find out how the soil's moisture, temperatures and pH are affected at different times of the day and light intensities. We conducted an experiment and research on our school farm on how mulch changes soil quality, and protects the soil from different conditions. We will conclude with how it is an effective and affordable agriculture technique.

RESEARCH QUESTIONS

1. How does Mulching affect the soil pH?
2. Is mulching a good substitute for chemical fertilisers and herbicides?
3. Is mulching an effective agricultural practice?

HYPOTHESIS

1. Mulching increases the soil pH.
2. Mulching is a good substitute for chemical fertilisers and herbicides.
3. Mulching is a very effective agricultural practice.

RESEARCH METHODS

Materials and Methodology

1. Digital soil metre
2. Camera/Smartphone
3. Salinity test Kit
4. Digging shovel/garden shovel/hoe
5. Water Hose/Pipe
6. Mulch (dry grass)
7. Notepad and pen
8. Watch (or an instrument that can tell time)
9. Universal indicator
10. Test tubes
11. Small beakers
12. Glass rods
13. Distilled water
14. Filter paper and funnels
15. pH scale chart
16. Pipette

Planning investigations

We first acquired a soil measurement metre to measure the soil, finding out its pH, moisture, light intensity and temperature, which we then used to obtain the above-mentioned variables. We carried out our experiment on an area of a kale plantation where half of it was covered in mulch and the other half was not (control experiment). The region we took measurements from was our school farm. We then took 'shifts' in our group to test for the qualifications that we needed from the kale farm, while also looking over the mulch and providing more when needed.

Carrying out investigations

We began by taking measurements for three consecutive weeks, during 3 different times of the day; morning, afternoon and evening hours. We took our apparatus and measured both sides of the farm, one side with mulch and one side without, checking if mulch affects soil quality or not. Our team took samples of soil from both sides to get accurate values for pH because we reached a point where it did not change. Our results are discussed herein, can be quantified to direct averages of tests done during the three weeks we had measured for.

Figure 1(a) conduction of our measurements/investigations

Procedure for Universal Indicator Test

We collected two samples of soil from both the mulched and non-mulched plots and brought them for a universal indicator test. We then placed them into 2 small beakers and labelled them as sample A (the mulch sample) and sample B (the non-mulch sample). We then took our samples to the lab to test for their pH. We began our test by first taking each sample of soil (approx.40g) and completely dissolving them in distilled water by adding about 50 ml of water in each beaker. After filtering, we collected the filtrate and added 4-6 drops of universal indicator to each beaker. The mulched sample yielded a pH of 7.0 and the non-mulch sample yielded a pH of 8.0 on the pH scale chart. This test was done as a test for the accuracy of the results from the digital soil metre (see page 9-11).

Figure 1(b) conduction of the universal indicator test.

MAP OF STUDY SITE(S)

Figure 2(a) Kale Farm at Satellite view

Figure 2(b) Kale Farm after the 3 weeks of measurements

Figure 2(c) Kale Farm on 7 March 2023

Our site of investigation is watered and taken care of daily. Our school's young farmers club also plays a major role in taking care of the farm. As shown in the images above it is located at the exits and entrances of the school where it can be noticed by everyone who passes by. The soil of the farm is well maintained and saturated with the required nutrients and the crops also receive the right amount of sunlight. Our farm's weather conditions would differ from 32°C to 35°C with an average temperature of 33°C. Furthermore, at some times of the day, the sun would only cast sunlight on only a portion of the farm, leaving the shaded side bare and out of reach from the sun. This caused a difference in light intensity between the mulched side and the non-mulched side.

RESULTS

Once we got our quantifications for the soil quality factors, we recorded them and plotted the results, which are shown below.

18, January 2023

TIME TAKEN		MULCH SIDE	NON−MULCH SIDE
7:50 AM	**pH Levels**	6.5	7.0
	Moisture	Normal	Wet
	Light Intensity	Low	Low
	Temperature	28°C	27°C
11:27 AM	**pH Levels**	6.5	6.0
	Moisture	Wet	Wet
	Light Intensity	High	High
	Temperature	29°C	30°C
14:45 AM	**pH Levels**	6.5	5.5
	Moisture	Wet	Wet
	Light Intensity	High+	Normal
	Temperature	31°C	31°C

Figure 3(a) Table of results for 18, January 2023

24, January 2023

TIME TAKEN		MULCH SIDE	NON−MULCH SIDE
8:43 AM	**pH Levels**	7.0	6.0
	Moisture	Wet	Wet+
	Light Intensity	Normal	High
	Temperature	28°C	27°C

11:41 AM	**pH Levels**	7.0	6.0
	Moisture	Dry	Wet+
	Light Intensity	High+	High
	Temperature	30°C	31°C
15:08 AM	**pH Levels**	6.5	6.0
	Moisture	Dry	Normal
	Light Intensity	High	Normal
	Temperature	31°C	30°C

Figure 3(b) Table of results for 24, January 2023

30, January 2023

TIME TAKEN		MULCH SIDE	NON−MULCH SIDE
8:43 AM	**pH Levels**	6.5	6.0
	Moisture	Wet+	Wet+
	Light Intensity	Low	Low+
	Temperature	26°C	27°C
11:26 AM	**pH Levels**	5.5	5.0
	Moisture	Wet+	Wet+
	Light Intensity	High+	Normal
	Temperature	31°C	31°C
13:25 AM	**pH Levels**	5.0	6.0
	Moisture	Wet	Wet+
	Light Intensity	High+	Normal

	Temperature	32°C	29°C

Figure 3(c) Table of results for 30, January 2023

DATE		MULCH SIDE	NON-MULCH SIDE
18 January 2023	**ph**	6.5	6.0
24 January 2023	**pH**	7.0	6.0
30, January 2023	**pH**	6.0	6.0

Figure 3(d) Average pH table for mulched and non-mulched side

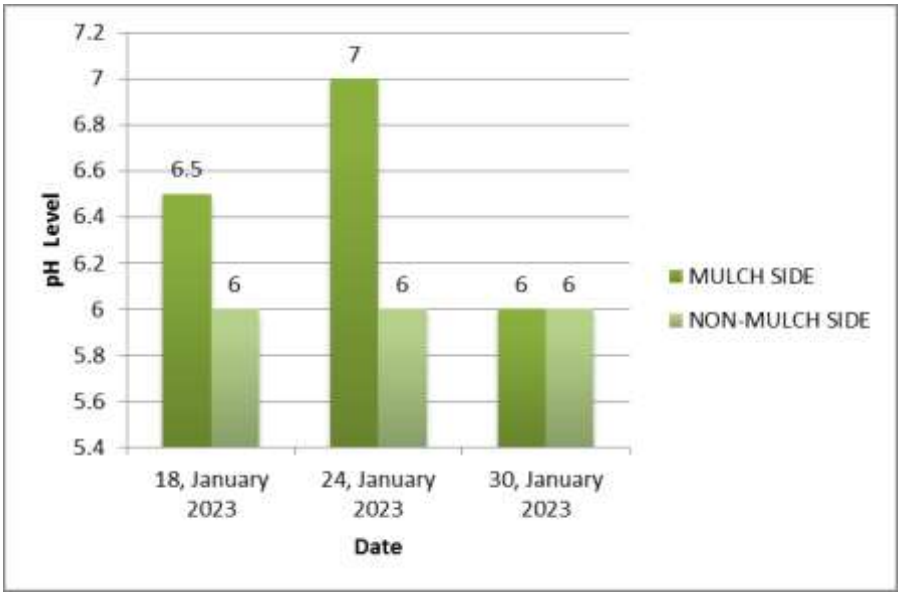

Figure 4(a) Graph on Average pH Table

DATE		MULCH SIDE	NON-MULCH SIDE
18 January 2023	**Temperature**	29°C	29°C
24 January 2023	**Temperature**	30°C	29°C
30, January 2023	**Temperature**	30°C	29°C

Figure 3(e) Average temperature table for mulched and non-mulched side

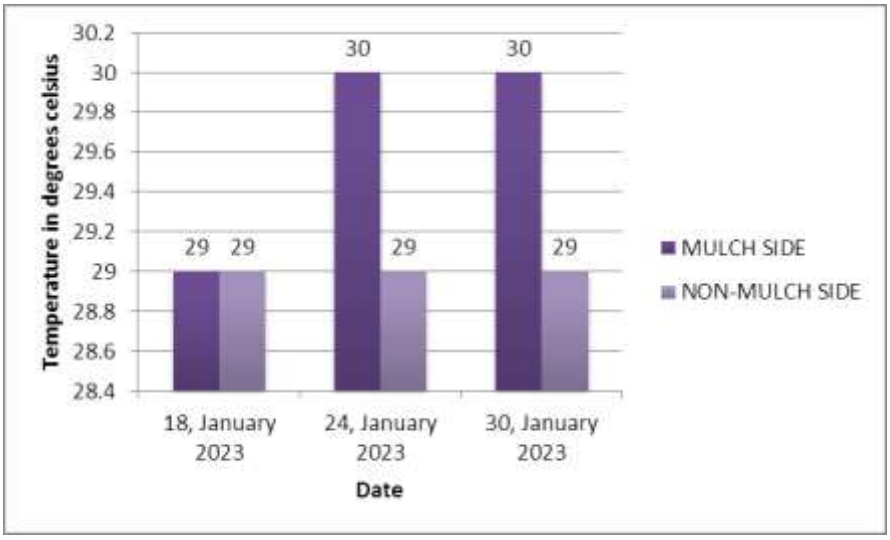

Figure 4(b) Graph on Average temperature Table

DISCUSSIONS

In the first results, we applied the dry mulch and watered it the previous day. The first variables we measured showed that the mulched side of the kale patch was slightly acidic with a constant pH of 6.5, and the other side varied from 7.0, 6.5 and 5.5. The moisture measured on the non-mulch side read wet for all the three times we measured, (morning, midday, and afternoon before school ended) because the patch was freshly watered. We instantly observed that the mulched side retained more heat than the non-mulched side, which can actively be supported by the results prominent in the following weeks of measurements.

We still used the same mulch previously applied for the second week of measurements and watered it again. However, we found slight observations in the growth of the kale in the differentiation from the mulched side to the non-mulch side. We saw that the mulch side had less growth than the non-mulch side, provided that mulch provided the soil with suitable nutrients that increased root growth. We observed that the kales on the non-mulched side appeared a little “droopy’’ or “withered” than the mulched side. Thereafter, we noticed that the mulched soil retained a more neutral to slightly acidic pH, which is best suitable since it provides the best minerals and nutrients for plants, for example; phosphorus, magnesium, calcium and sodium. To confirm our pH results we also conducted a test to determine if the pH results from the apparatus were accurate using a pH metre.

For the last measurements we took, we observed that the mulched side retains moisture and heat slightly longer than the side without mulch, which creates a conducive environment for the kale to grow healthier. Furthermore, we concluded that using mulch would help the soil retain more moisture than compared to the non-mulch side, as illustrated in our third table, most predominantly in the evening of the 30th, we found that there was a slight increase in temperature on the mulched side in variation to the non-mulch side, the difference was quite new as it was a contrast of 3° in comparison to the 1° or no difference seen before. We

deduced that the mulch allowed for slower moisture evaporation in the soil which could be observed in the overall texture of the soil as we looked at and compared samples.

The results we obtained over the measurement period additionally with the averages prove that our hypothesis is supported and that mulching retains heat and moisture which benefits the plant output and leads to better-yielding crops. In the end, the kales on the mulched side looked better than those on the non-mulched side regardless of the dry weather. The main reason we embarked on this particular study on mulching was to eliminate the need to use harmful, expensive and chemical-rich fertilisers on plants which would eventually poison the surrounding lands. We showed that plant efficiency can be increased through more sustainable and economic ways that are safe for the soil's productivity on surrounding land. Secondly, we sought to address the issue of excess soil erosion directly in the plant area. This usually rids the area of important minerals the plants need to be healthy and the use of organic mulch especially greatly reduces erosion, eventually reducing the plant's productivity.

We summarised all the results we collected over the measurement period and compiled the averages for pH and temperature with the date as a variable into the bar charts shown above (Fig.4*a* and *b*),which clearly illustrates the changes of temperature and pH in both mulched and non-mulched plots. As shown in figure 4.*a*, the average pH of the non-mulched side actually stays stabilised whereas the average pH of the mulched side fluctuates slightly. On the other hand, the average temperature variations, as shown in figure 4.*b* shows how the temperatures on the non-mulched side are stable (do not change) where the temperatures on the mulched side increase by 1°C. Some factors that may cause these fluctuations in pH and changes in temperatures could be due to moisture being trapped in the mulch for a longer time.

Some other limitations we faced, for example, were the type of mulch method we used. Since we used dry grass, it proved to be quite light and we had to add on some mulch a few times. Secondly, the type of mulch we used might not have supplied the desired results. Another major limitation of our data collection was our class schedule. Because of this, we sometimes were not able to do our measurements precisely on time, as illustrated in the slight differences in time in our results. While carrying out the universal indicator test, one impediment we came across was that since the soil we used had a dark brown pigment, the colour of the filtrate after adding the indicator was not easily interpreted and we had to add more drops of indicator to show the colour clearly

CONCLUSION

Fundamentally, mulching would be a good method for farmers because of its sustainable properties, which would be able to provide a plantation with a simple material (such as dry grass) that would be able to aid a farms soil to retain its moisture during dry seasons, regulate the soil temperature, and subdue weed growth.

We firmly believe that mulching could be an effective method for plantation farmers to take advantage of, especially since it is easily accessible for farmers who live in dry areas. Farmers who want to grow their crops in arid areas, where there is little to no rainfall, may see mulching as a means of decreasing the rate of evaporation from the soil cover. It is also great for long-term periods. Not only that, but it is also affordable and requires less processed materials and/or cheaper materials as they are easily accessible. Furthermore, as said in our earlier discussion because of its pH regulating properties it is able to provide the crops with a good source of nutrients and minerals, this inference is supported by the observation we saw after five weeks (the period it takes to fully grow a kale patch) of taking care of our farm, we noticed that the mulched side had grown more in comparison to the non-mulched side, and appeared "healthier" and nourished.

We suggest, as per our research, farmers use this method. We encourage the use of mulch as it is quite effective according to today's changing climate conditions, and also for long-term farming. Our research and experiments were done multiple times, with a control experiment, which shows the difference in the quality between the side covered in mulch and the side not.

We have concluded that mulching is an affordable, cheap, easily accessible, quite effective and wonderful method of agricultural farming for long-term periods. This is an advantage to very rural/rural areas or LICs that work in the primary sector, and have these as the only source of food/income. They are unable to afford chemical or processed fertilisers and pesticides that are used in today's modern farming techniques. These farmers can use the wastes such as wood chips, dry grass, etc, that are available to them sustainably and cheaply to improve their agricultural farming.

BIBLIOGRAPHY

Paine, L. K., & Harrison, H. (1993). The historical roots of living mulch and related practices. *HortTechnology*, *3*(2), 137-143.

Iqbal, R., Raza, M. A. S., Valipour, M., Saleem, M. F., Zaheer, M. S., Ahmad, S., ... & Nazar, M. A. (2020). Potential agricultural and environmental benefits of mulches—a review. *Bulletin of the National Research Centre*, *44*(1), 1-16.

Nzeyimana, I., Hartemink, A. E., Ritsema, C., Stroosnijder, L., Lwanga, E. H., & Geissen, V. (2017). Mulching as a strategy to improve soil properties and reduce soil erodibility in coffee farming systems of Rwanda. *Catena*, *149*, 43-51.

Bristow, K. L. (1988). The role of mulch and its architecture in modifying soil temperature. *Soil Research*, *26*(2), 269-280.

Thakur, M., & Kumar, R. (2021). Mulching: Boosting crop productivity and improving soil environment in herbal plants. *Journal of Applied Research on Medicinal and Aromatic Plants*, *20*, 100287.

Kumar, S., & Dey, P. (2011). Effects of different mulches and irrigation methods on root growth, nutrient uptake, water-use efficiency and yield of strawberry. *Scientia Horticulturae*, *127*(3), 318-324.

GLOBE IVSS 2023 BADGES

I AM A COLLABORATOR

We collaborated with our school's Biology laboratory, to conduct the Universal Indicator test, additionally we also maintained our farm, with help from our school's Young Farmers Club Members.

I MAKE AN IMPACT

We created awareness on mulching as an agricultural method used by farmers as a means of regulating soil pH, retaining soil moisture, reducing soil erosion and the overall rate of evaporation from the soil.

I AM A DATA SCIENTIST

We executed thorough research concerning the issues we set out to resolve. Such as conducting the Universal Indicator test, and finding results, that we then incorporated into our results in our report, furthermore, we used the data from the Digital Soil metre to represent data in tables, which we analysed and discussed in the report.