APPLICATION OF WALKI®BIOMASS COVER AS A BETTER ALTERNATIVE TO PLASTIC MULCHING

by

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ABSTRACT

Key words: Mulch, Biodegradable, plastic mulching, WALKI® BIOMASS COVER, moisture properties, water potential.

Mulch is a material that works as a protective layer over the soil so as to retain water and prevent excess evaporation. They are either in the form of continuous sheets like plastic mulch or they come in a shredded form, like wood chips etc. Plastic mulching, though it's not good for the soil is one of the most widely used mulch materials. The main problem with plastic mulching is its disposal after use, since it being non-biodegradable it cannot be decomposed. So, all that plastic accumulates in the soil, and can cause environmental hazards. In recent years research has been conducted to find a better alternative to plastic mulching, including invention of the biodegradable plastic. It was found that biodegradable plastic had remarkably similar temperature and water retention properties but was coming at a higher price than regular plastic. This thesis is focused on achieving the purpose of mulching using Walki Biomass cover, a paper-based laminate that also has a mesh of biodegradable plastic which is partly water resistant and is a 100% biodegradable.

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INTRODUCTION

Mulching is the agronomic technique of leaving mulch on the soil surface to conserve soil and water while also promoting plant development (Jordán et al. 2011). Any substance other than soil or live plants that serves as a permanent or semi-permanent protective cover over the soil surface is referred to as 'mulch' (Jordán et al. 2011). There are many types of materials used for mulching. Plastic Film mulching is a widely used approach in agriculture across the world (Gao et al. 2019, Berger et al. 2013). It is mostly used in areas with minimal water input because of its ability to increase product quality and output by moderating drastic weather fluctuations, improving growth conditions, and prolonging the growing season.

But recently, due to its heavy use in the past 30 years, the amounts of plastic residues in soil have reached unwanted numbers in some parts of the world (Gao et al. 2019). This has led to some serious problems in the soil (Liu et al. 2014).

Plastic is said to cause detrimental effects when accumulated in the soil (Liu et al. 2014). The main problem with plastic mulching is its disposal after use, since it being non-biodegradable it cannot be decomposed (Moore and Wszelaki 2016). A number of studies exploring plastic film alternatives have been conducted in recent years, including one using biodegradable plastic film and a straw cover, but no substantial impacts have been found (Ren et al. 2017). For instance, there was no significant difference between biodegradable plastic mulching and plastic film mulching when comparing their temperature and moisture properties (Li et al. 2016, Moreno et al. 2016). In fact, the biodegradable mulch was much more expensive than the film (Moreno et al. 2016). This

paper is focused on achieving the purpose of mulching using Walki Biomass cover. Walki®Biomass Cover is a material which is made up of paper that is water resistant and 100% biodegradable at an inexpensive price (Walki 2010). This can be a better substitute to plastic mulching since this material has been proven to be an effective tool in covering and preserving biomass through tarping (Wetzel et al. 2017).

2.3 Objective

The objective of this thesis is to test the properties of Walki®Biomass Cover as a mulching material and compare it to plastic mulching through various experiments to see if Walki®Biomass Cover is a better alternative. Experiments will be done using both plastic and Walki®Biomass Cover (separately) to test water retention properties, and overall health of the plant.

1.2 Hypothesis

Walki®Biomass Cover will have properties that make the product suitable for application as an alternative to plastic mulching.

2. LITERATURE REVIEW

2.1 MULCHING

Mulch is a layer that is often used in agricultural fields on top of the soil to conserve water and create favorable conditions for the plants/trees (Prosdocimi et al. 2016). Mulch is any material that serves as a permanent or semi-permanent protective cover over the soil surface.

2.1.1 Advantages of mulching

Mulching has been proven to have many advantages. First and foremost, the advantage of mulching is that it helps prevent water and soil loss thereby facilitating retention of water and improving the chemical and biological properties of the soil (Prosdocimi et al. 2016, Patil et al. 2013). Secondly, it helps the soil improve its infiltration capacity. Furthermore, mulching has been proven to regulate topsoil temperature allowing healthier root development and germination. Also, mulching helps to avoid soil deterioration by preventing runoff and soil loss, as well as weed infestation and water evaporation (Patil et al. 2013). According to the reports, mulching increases crop yield by 50-60% compared to no mulching under rainfed settings ((Patil et al. 2013).

2.1.2 Types of Mulching

There are two main types of mulching materials; 1) Organic mulch and 2) inorganic mulch.

1) Organic Mulch: - This includes natural materials such as, dry leaves, straw, bark, pine needles, chipped wood etc. (Patil et al. 2013). Organic mulches help to improve the soil's condition as they degrade. This organic matter in the soil provides food for helpful earthworms and other soil microorganisms, resulting in an extremely permeable soil. As the mulch decomposes, it also serves as a source of nutrition for the plants.
2) Inorganic Mulch: - This includes man made synthetic materials that are often non-biodegradable such as plastic, stones, rocks, rubber etc. (Patil et al. 2013; Jared 2001). Inorganic mulch is better at preventing disease causing pests and weeds.

2.2 PLASTIC MULCHING

Low-density and linear low-density polyethylene are the most common types of plastic mulch films (Sintim and Flury 2017). Plastic mulching has been widely used for its ability to reduce evaporation and soil erosion, regulating soil and air temperatures and most important of all suppressing and controlling weed and pests. China and the Middle East are likely to drive future demand, with the global market for agricultural plastic films expected to increase at a compound annual growth rate of 7.6% from 2013 to 2019, reaching a market size of $9.66 billion USD (Sintim and Flury 2017). In 2012 plastic mulch films accounted for more than 40% of the total plastic films used in agriculture (Sintim and Flury 2017).

2.2.1 Disadvantages of Plastic mulching

In open weather situations, plastic films can peel and deteriorate over time, requiring replacement (Zribi et al. 2015). The biggest problem with plastic mulching is that it needs to be disposed of safely to avoid soil contamination at the end of the crop growth cycle. Some disadvantages include excessive costs of collecting and discarding films, as well as the recycling process (Divya and Sarkar 2019). Plastic films are frequently abandoned in a landfill or burned, releasing harmful compounds into the atmosphere and soil. The majority of agricultural plastics photodegrade when exposed to UV radiation, making them unsuitable for recycling. Also, Plastic films with a contamination level of more than 5% by weight are usually not accepted for recycling (Divya and Sarkar 2019).

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2.3 APPLICATION OF WALKI®BIOMASS COVER

2.3.1 About Walki®

Walki® is a Finland based company that started in the early 1930's in the city of Valkeakoski and is rapidly expanding worldwide with operations in twelve countries across Europe and Asia (Laitinen 2014). The company focusses on three business segments: consumer packaging, industrial packaging, and engineered materials. In this paper we will be focusing on one of their many products called the Walki®Biomass Cover.

The Walki®Biomass Cover is a paper-based laminate made mostly from renewable, fibre-based materials (Laitinen 2014). It is made up of two papers joined by a mesh and biodegradable plastic.

2.3.2 Current Applications

Logs, wood chips, thinning residuals, and other wood waste left on the forest floors after logging operations can be used as fuel and are hence left on the site to dry before being collected (Laitinen 2014). The quality of this fuel can be compromised by a variety of circumstances such as rain, snow, and other elements. The calorific value of forest residue increases as the moisture content drops, allowing the residue to become significantly more valuable. Walki®Biomass Cover, therefore, is applied here to cover the wood, protecting it from any kind of moisture thereby helping the wood to retain its energy (Laitinen 2014).

According to research, Walki®Biomass Cover can reduce moisture by up to 18%. Other advantages of the cover include the fact that dry wood makes it easy to manage when collecting and chipping and also allows for longer logging wood storage (Laitinen 2014). Furthermore, since the cover is made of paper, it may be chipped and burnt with the rest of the wood which eliminates the problem of disposal.

MATERIALS AND METHODS

3.1 MATERIALS

The experiments were conducted in the Lakehead University Greenhouse. For this experiment materials required include Walki®Biomass Cover and Plastic film cut into 10” x 20” pieces (10 cutouts of each), Grass seeds, planting soil, spade, knife, 30 Gardening trays (10” x 20”), 2 liter Measuring jug, Moisture meter, Paper weights (in this case wooden blocks).

3.2 METHODS

1- Gardening trays were taken and divided into 3 groups of 10 and were labeled Plastic, Control and Paper.

2- A wet soil mixture was prepared in such a way that the moisture meter reading was 9.9, and then this soil was added to each of the trays using a spade as shown in figure 1.

Figure 1. Initial setup

3- In the trays labeled ‘Plastic’, black plastic sheets were used to cover the top. Similarly trays that were labeled ‘Paper,’ were covered on the top by

Walki®Biomass Cover and the control experiments were not covered with anything on the top.

4- 8 equidistant holes were made with a knife as shown in Figure 2

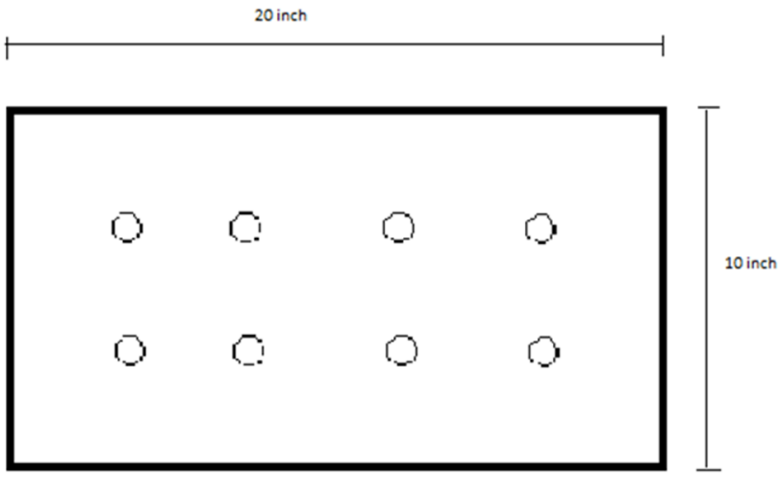

Figure 2. Representation of the Film/Paper layout.

5- In each hole about 10 grass seeds were planted.

6- Wooden blocks were kept on sides so as to prevent movement of the mulch.

7- The entire setup is displayed in figure 3.

Figure 3. Trays set up with plastic, paper and no cover.

8- These trays were left in the green house for 3 weeks/until dry.

9- Average moisture readings of the soil were taken every 2nd day and were recorded till the end of the 3-week period.

10- All trays were observed and checked regularly for any type of weed that could grow in the soil causing competition, if present they were removed.

RESULTS

At the end of the 23-day period the average moisture content of each of the experiments is shown in Table 1.

Table 1. Average moisture content of each experiment

Day	Plastic	Paper	Control
1	9.9	9.9	9.9
3	9.2	9.4	4.4
5	8.4	8.2	0
7	8.5	7.4	0
9	7.6	6.4	0
11	7.2	3.4	0
13	6.3	1.5	0
15	5.8	1.6	0
17	4.8	1.2	0
19	3.2	0	0
21	1.2	0	0
23	0	0	0

As seen in Table 1. The control experiment dried up the earliest. i.e on day 5th therefore there was no apparent germination. Grass seeds began to emerge on day 4 under the plastic, whereas germination began a day later in the paper mulch experiments. For better understanding of the experiment Table 1 has been transformed into a chart as seen below in figure 4

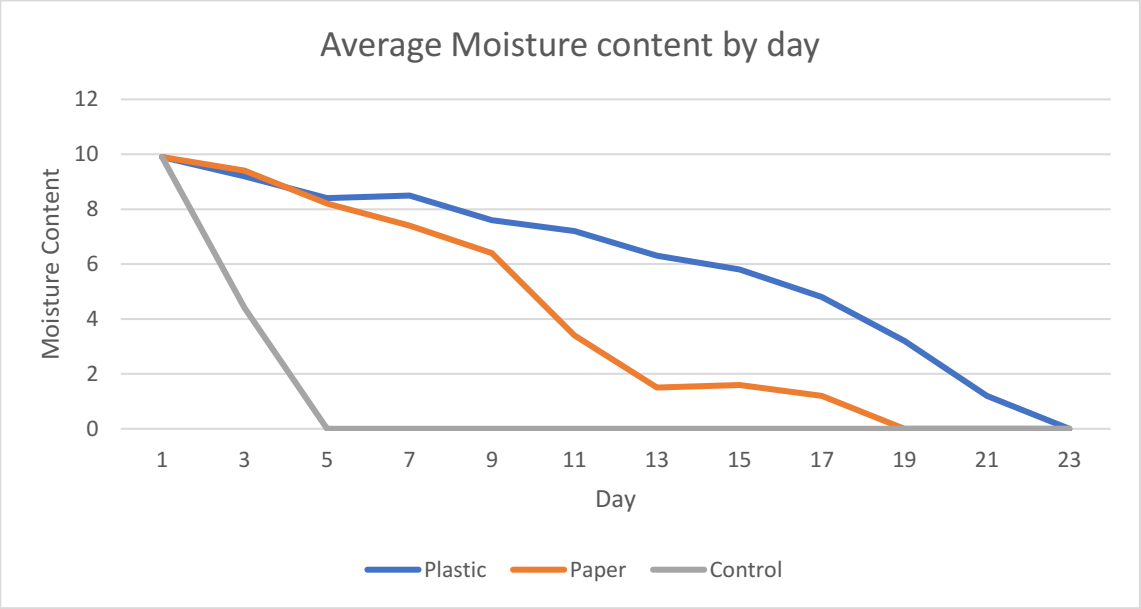

Figure 4. Average moisture content by day.

The Walki®Biomass Cover performed well in holding the moisture until the first week of the experiment, when moisture measurements began to fall sharply, and by the end of the second week, it had totally dried out. So about 250 ml water was added just enough to keep the grass fresh and alive so that root and shoot development could be compared between the experiments. As for Black plastic the soil lasted 21 days without the need for additional water.

At the end of 21 days the root and shoot development of each experiment was observed and it was seen that plastic mulch performed better and yielded better quality grass (Figure 5).

Figure 5. Shoot and root length of paper and plastic mulch. (top and bottom left - Paper, top and bottom right – Plastic)

Figure 6 below shows part of the experiment that was extended for another week after the 3-week period. Paper mulch grass had completely dried up

Figure 6. Plastic vs paper mulch at the end of 30-day period

DISCUSSION

The experiment in this study was done assuming factors such as light and aeration are provided adequately. Within experimental limits, the results clearly suggested that there was a huge variation within the 3 experiments and that plastic mulch performed much better than Walki®Biomass Cover. Therefore, our hypothesis is rejected. The best possible explanation for this could be the fact that, since the Walki®Biomass Cover is made up of wood fibers (paper) it tends to absorb water due to the difference in water potential (Alava and Niskanen 2006; Jacobs 1935). The paper being dry absorbs water that is present in the soil through simple diffusion, this water then gets evaporated thereby leaving no/little water for plant development. Plastic on the other hand yielded superior results due its non-permeability to water and the color of the mulch (Lalitha et.al 2010). According to (Younis et.al 2012), The dark color of the mulch not only absorbs more heat, but it also holds part of it, resulting in warm and humid circumstances around the roots, thereby improving germination rate. Another possible explanation for this phenomenon is the activation of the glycolysis process, which results in a decrease in inhibitory and dormancy-inducing substances as well as the mobilization of auxins (Younis et.al 2012).

But the negative side of the plastic could be far more dangerous to the environment. By altering the edaphic biocoenosis, speeding carbon and nitrogen metabolism, and potentially destroying SOM, they have the ability to affect soil quality. Inducing soil water repellency, raising the danger of mycotoxin development in soil, and increasing the emission of climate-relevant gases are all part of this. Many attempts have

been made to reduce or reuse them by extending the life of plastic, but the cost appears to exceed the benefits of increased yield and water savings.

Currently no other use of Walki®Biomass Cover known except that it is used as shield to cover logs and wood chips to prevent any moisture in the wood, preserving its calorific value. Potential application of Walki®Biomass Cover could be in slightly moisture areas as a dehydrating agent since this experiment showed us that it could absorb moisture from the soil. Comprehensive research with the aim of gaining an extensive understanding of the potential uses of Walki®Biomass Cover is needed. As this material is new to the market its use is not yet sufficiently understood, a final judgement on the use of Walki®Biomass Cover as a mulching material for wetter sites will require long-term field experiments.

CONCLUSION

This experiment proves to be beneficial in understanding the response of 2 different mulching materials, but the test does not give any information on the growth conditions of the grass. It helps provide better knowledge for large-scale field management of agricultural crops. The experiment has its limitations and was performed assuming that factors such as light, temperature and water are stable and uniform. More samples can always improve the results, as well randomizing the arrangement of the trays would be beneficial to ensure the greenhouse environment did not affect the results. Variations in the seedling growth could happen due to genetics as well, although with grass this would not be expected to be significant. One last design aspect would be to add the process of watering every two weeks to all samples as adding water to the Walki paper sample's part way through did affect the results and further displayed how efficient the plastic cover is versus alternatives. The experiment gave an insight into how different materials behave differently for the same objective.

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